50-327/328

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

December 13, 1999

MEMORANDUM TO: Loren R. Plisco, Director
Division of Reactor Projects
Region II

FROM: Suzanne C. Black, Deputy Director
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

SUBJECT: NRR RESPONSE TO TASK INTERFACE AGREEMENT (TIA) 99-02, SEQUOYAH NUCLEAR PLANT, UNITS 1 AND 2 - ADEQUACY OF SEQUOYAH ICE CONDENSER ICE BED AND BASKETS (TAC NO. MA4999)

By memorandum dated February 25, 1999, Region II requested technical assistance regarding the adequacy of the Sequoyah ice condenser (IC) ice beds and baskets via TIA 99-02. The subject TIA describes the results of a Fall 1998 special inspection conducted by Region II regarding the Sequoyah Unit 1 IC system. Attached to the TIA were NRC Inspection Report No. 50-327,328/98-13, which documented Region II's inspection findings, and various documents supplied by the Tennessee Valley Authority (TVA), the licensee for Sequoyah. The inspection findings led to identification of three specific concerns with respect to the Sequoyah IC condition:

1. Does the densification of the ice bed by thermal drilling and the formation of cones and voids meet the IC design basis, so that the IC is still able to perform its safety function of lowering steam pressure from a loss-of-coolant accident?

2. Can the licensee assure sufficient ice weight at a 95 percent confidence level with approximately 45 percent of the baskets unable to be weighed? Have Technical Specification requirements been met? If so, what is the upper bound of unweighable baskets where this confidence level would not be met?

3. What is the upper bound of damaged ice baskets that can be sustained so that the ice bed can perform its intended safety function?

We have reviewed the documents supplied with TIA 99-02, as well as various other applicable documents relating to Sequoyah's licensing basis. We also made this issue a topic of discussion at a public meeting with the Ice Condenser Minigroup at NRC Headquarters on August 11, 1999. As a result of this meeting, we sent a request for information to TVA on September 10, 1999. TVA provided a response to our questions by letter dated October 1, 1999. We have now completed the review requested by the TIA. The attached assessment is the result of the subject review by the Office of Nuclear Reactor Regulation (NRR).

We understand that ICs are the subject of ongoing regulatory discussions and inspections, and may require additional input from NRR. However, we consider that this memorandum and its attachment complete our review and evaluation efforts associated with TIA 99-02 (TAC Number MA4999). We believe the attached information to be responsive to your request.

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Please contact Ronald Hernan, the NRR Project Manager for Sequoyah, at 301-415-2010, if you have any questions on the attached evaluation.

Docket Nos. 50-327 and 50-328

Attachment: NRR Assessment

cc w/attachment: M. Oprendek, Region I
G. E. Grant, Region III
K. E. Brockman, Region IV

Please contact Ronald Hernan, the NRR Project Manager for Sequoyah, at 301-415-2010, if you have any questions on the attached evaluation.

Docket Nos. 50-327 and 50-328

Attachment: As stated

cc w/attachment: M. Oprendek, Region I
G. E. Grant, Region III
K. E. Brockman, Region IV

Original signed by S.Black

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Region II
by phone
12/9/99

RESPONSE TO TIA 99-02 ON ADEQUACY OF SEQUOYAH

ICE CONDENSER ICE BED AND BASKETS

TENNESSEE VALLEY AUTHORITY

SEQUOYAH NUCLEAR PLANT UNITS 1 AND 2

DOCKET NOS. 50-327 AND 50-328

Introduction

The subject Task Interface Agreement (TIA) describes the results of a Fall 1998 special inspection conducted by Region II of the U. S. Nuclear Regulatory Commission (NRC) regarding the Sequoyah Unit 1 Ice Condenser (IC) system. The inspection findings led to the identification of three specific questions with respect to the Sequoyah IC condition:

1. Does the densification of the ice bed by thermal drilling and the formation of cones and voids meet the IC design basis, so that the IC is still able to perform its safety function of lowering steam pressure from a loss-of-coolant accident?

2. Can the licensee assure sufficient ice weight at a 95 percent confidence level with approximately 45 percent of the baskets unable to be weighed? Have Technical Specification (TS) requirements been met? If so, what is the upper bound of unweighable baskets where this confidence level will not be met?

3. What is the upper bound of damaged ice baskets that can be sustained so that the ice bed can perform its intended safety function?

The following discussion describes the review findings by the Office of Nuclear Reactor Regulation (NRR) with respect to the above questions.

Formation of Ice Voids and Thermal Drilling Effects on IC Safety Function (Question # 1)

It is the nature of the ice in ICs to change from solid state to gaseous state (sublimate) during the course of normal operation of the reactor plant. The sublimation rate is highly dependent upon the location of the ice (axially and radially) within the IC. As part of the special inspection in Fall 1998, the NRC inspectors noted that sublimation had caused many ice baskets to lose ice mass in the course of a fuel cycle and a significant number of baskets were not full, as evidenced by voids and "coning." In one case, ice appeared to be completely missing in a lower 6- to 8-foot section. In addition to localized missing ice, it has been observed that sublimation rates across the ice bed may be uneven. As noted in documentation provided by the NRC inspectors and by the Tennessee Valley Authority (TVA, the licensee), thermal drilling is part of a process utilized at Sequoyah to replace the ice that has sublimated and the thermal drilling does lead to some localized ice melting, followed by re-freezing. This practice can result in (a) ice baskets freezing in place and in (b) non-uniformity in ice mass distribution.

ATTACHMENT

Non-uniformity in ice mass distribution across the ice bed, in turn, may create a potential for uneven melt progression in the event of a steam release from a design basis accident. This in turn may lead to a premature melt-through of a portion of the IC, thus creating a steam bypass path and compromising the thermal performance of the IC. Problems associated with frozen ice baskets are discussed in more detail below.

In response to the NRC inspector observations, TVA conducted a review of the "voiding and coning" issue and documented their conclusions in an internal TVA report dated December 18, 1998, which was included with the Region II TIA request. In the report, the licensee notes that, upon replenishment with flake ice, normal fusion and compaction takes place such that there is no apparent difference between the old and new ice. The effect of this ice densification on the thermal performance of the ice condenser has been addressed by previous analyses that have been reviewed and approved by the NRC staff. Specifically, tests were conducted at the Westinghouse Electric Company Waltz Mill Test Facility that included the addition of water to simulate all expected ice densification levels. These tests and test results are described in Westinghouse Topical Report WCAP-8282. The tests also included flake ice experiments where a portion of the baskets were loaded with block ice. The results showed only minor differences in the thermal performance of the IC.

The December 18, 1998, TVA report noted that ice baskets are routinely inspected visually for ice voids and other characteristics of low-weight baskets. Inspections of the ice bed are performed to identify baskets with significant loss of ice, including direct visual inspections of lower portions of ice baskets from inside the lower ice condenser. Video cameras are also used to view the entire length of selected baskets. Baskets with significant loss of ice are designated for ice addition in the ice bed servicing plan. NRR has reviewed the TVA analysis and concludes that, although no bounding analysis of ice mass nonuniformity acceptance criteria was performed, the visual inspections and servicing plan actions should be adequate to assure IC operability.

On the basis of the above discussions, the NRR staff believes that the observed effect of ice densification due to thermal drilling to correct the effects of voiding and coning will not have a significant effect on the thermal performance of the IC.

Statistical Adequacy of Ice Mass Inventory Verification (Question #2)

TS 4.6.5.1.d.2 prescribes that a representative sample of at least 144 ice baskets (of a total of 1944 baskets) is to be selected for determining the total weight of ice in the IC. Each basket selected is weighed to verify that it contains at least 1071 pounds of ice. In selecting the 144 sample baskets, the TS requires selecting six rows per bay, one each from radial rows 1, 2, 4, 6, 8, and 9 in each of the 24 bays.

Statistical sampling of ice baskets for weighing was established as a means of determining the status of the total ice inventory. The sample size of 144 baskets was determined to be sufficient to give 95% confidence level that the estimated inventory is representative of the actual amount of ice present. Since as-found baskets may be frozen in place, and thus may not be weighable, alternate ice basket sampling is permitted by the TS. However, the same specifications do not place any limit on the number of alternate baskets that may be sampled. Hence, a substantial amount of frozen ice baskets may accumulate (approximately 45% in the recent inspection findings for Sequoyah), thus eliminating a significant portion of the total ice inventory from the sampling process.

In the October 1, 1999, response to an NRC request for additional information dated September 10, 1999, the licensee stated that any number of baskets can be stuck without affecting the validity of the statistical method. The licensee's bases for the above statement are that stuck baskets are rejected solely because they cannot be lifted and that the TS requires that the alternate be obtained from the same row and adjacent bay as the original sample basket. The staff has reviewed the licensee's response, and finds it not acceptable. When an unlimited number of original sample baskets are not weighable and are excluded from the statistical sampling process, the staff believes that the new sample is no longer a representative one and that it does not provide 95% confidence level for the total of 1944 baskets. The lack of a limit in using alternatives reflects a weakness in the current form of the TS requirements, rather than a TS compliance issue.

To address this weakness, the nuclear industry is working on a proposed set of revised TSs. The staff expects that the industry group will pursue development of improved TS to address this weakness on an expedited basis.

Regarding the safety aspects of this issue, the NRR staff believes that the current approach that the licensee has taken to supplement their statistical sampling is adequate to demonstrate that they have sufficient total ice inventory. Specifically, the licensee's supplementary measures included weighing a large number of unfrozen baskets (1200 and 1306 for Unit 1 Cycle 9 and Unit 2 Cycle 9 respectively), replenishing ice, visually inspecting those that are stuck, and weighing those frozen baskets that were freed. Based on these supplementary measures and engineering judgment, as reported in Inspection Report 98-13, the staff believes that these measures should provide sufficient assurance that the ice condenser contains adequate ice inventory for the current cycle of operation. Further cycles would require similar supplementary measures, in the absence of revised TS.

In summary, the NRR staff believes that allowing an unlimited number of alternate ice baskets is a weakness in the current TS and that the current practice of supplementing the TS-required sampling, as discussed above, constitutes an adequate interim approach to ice inventory determination until acceptable, revised, TS are developed.

<u>Ice Basket Damage Implications (Question # 3)</u>

This review did not examine any analyses that may exist with respect to establishing an upper bound on the number of baskets that may be physically damaged without loss of IC operability. However, the following discussion may provide some insight relative to the importance of observed basket damage.

One effect of damaged baskets on IC operability is the potential for steam flow blockage. Another effect is basket ejection into upper containment. In this case, the consequences are ice mass loss through basket ejection, as well as the potential for missile damage to safety-related systems in the upper containment (e.g., hydrogen igniters). The latter, however, is not an IC operability concern.

Ice-basket damage of the type typically found in recent ice-condenser inspections includes dents, torn ligaments and failed or missing basket hold-down assemblies. If the damage is sufficient to cause major basket deformation or relocation, the most direct consequence could be flow blockage. However, the potential for affecting IC operability is believed to be low. In the early phase of a blowdown (i.e., the first few seconds) there would be a substantial inventory of ice within the baskets, which would provide significant resistance to basket reconfiguration. Later into the blowdown, when an appreciable mass of ice is melted, if there were any basket deformation, it would be self-compensating in the sense that localized basket displacement would produce flow restrictions as well as increased flow areas.

Damaged baskets may also be considered to lead to ejection due to seismic and hydrodynamic forces associated with a DBA. The resulting loss of ice mass could lead to degradation of IC operability. Westinghouse has indicated (DAP-90-633, November 11, 1999, letter to Duke Power in reference to McGuire and Catawba Nuclear Stations) that the potential for ice-basket ejection is limited to about 0.3% of the total ice basket population. This conclusion was made on the basis of a statistical determination of failed basket hold-down assemblies and the number of baskets (about 30%) having the appropriate location such that their missile trajectory would permit entry into upper containment without hitting existing structural barriers. Hence, the number of baskets that could be postulated to be ejected is limited to something less than six. To determine the effect of this on ice-condenser operability, it is necessary to compare the ice mass in the six baskets with the margin built into the total ice mass inventory. The staff has reviewed the above reference and finds the qualitative argument regarding hold-down assembly failure statistics and potential basket ejection trajectories to be reasonable.

In summary, basket physical damage is expected to be limited to a small percentage of the total basket population. Furthermore, basket damage would affect IC operability mainly through the mechanism of loss of ice mass. Hence, an available ice mass margin is an important figure of merit when considering basket damage. The program established by the licensee, as described in Attachment 3 to the subject TIA, should assure sufficient ice mass margin to offset any degradation of IC performance resulting from damaged ice baskets.