# U.S. NUCLEAR REGULATORY COMMISSION
# STANDARD REVIEW PLAN
## OFFICE OF NUCLEAR REACTOR REGULATION

SECTION 6.5.4 ICE CONDENSER AS A FISSION PRODUCT CLEANUP SYSTEM

REVIEW RESPONSIBILITIES

Primary - Accident Analysis Branch (AAB)

Secondary - Containment Systems Branch (CSB)

I. AREAS OF REVIEW

The following areas of the applicant's safety analysis report (SAR) are reviewed:

1. Fission Product Removal Requirement for the Ice Condenser System

Sections of the SAR related to accident analysis, dose calculations, and fission product removal and control are reviewed to establish whether fission product scrubbing of the containment atmosphere is required for mitigation of offsite doses following a postulated accident. This review usually covers SAR Sections 6.2, 6.5.4 and 15.2.X.X.

2. Design Bases

The design bases for the fission product removal function of the ice condenser system are reviewed to determine whether they are consistent with the requirements placed upon this system by the assumptions made in the accident evaluations of SAR Chapter 15.

3. System Design

The descriptive information concerning the portions of the ice condenser system design important to its fission product removal function is reviewed to familiarize the reviewer with the design and post-accident functioning of the ice condenser. This includes:

a. The basic design concept, the systems, subsystems, and support systems required to carry out the fission product cleanup function of the ice condenser.

b. Descriptive information and figures from SAR Section 6.2, as related to:

(1) The time required to establish a steady flow of predictable magnitude of an air-steam-iodine mixture through the ice beds.

(2) The time of melt-out of the ice beds.

4. Testing and Inspections

The details of the applicant's proposed preoperational test to be performed for system verification and operational tests and inspections to verify the continued status of readiness of the iodine removal capacity of the ice condenser systems are reviewed.

5. Technical Specifications

At the operating license stage, Sections 3 and 4 of SAR Chapter 16 are reviewed to establish surveillance requirements for the sodium hydroxide concentrations in the ice.

II. Acceptance Criteria

The acceptance criteria for the fission product cleanup function of the ice condenser system are:

1. Ice Alkalinity

The ice condenser system is acceptable for elemental iodine removal if the ice contains a quantity of sodium hydroxide sufficient to assure that the water solution from ice melting has a pH of at least 9.0.

2. Duration of Iodine Scrubbing Function

The ice condenser is assumed to be effective for iodine removal only during that period following an assumed accident when a steady flow of predictable magnitude of the air-steam-iodine mixture has been established. At present, steady flow is assumed to commence with the operation of the post-accident mixing fans.

3. Tests and Inspections

Preoperational and inservice tests should assure that the proper ice alkalinity is maintained. Other inspections associated with the pressure suppression function will assure the adequacy of ice quantity and geometry.

III. REVIEW PROCEDURES

The reviewer selects and emphasizes aspects of the areas covered by this review plan as may be appropriate for a particular case. The judgment on areas to be given attention and emphasis in the review is based on an inspection of the material presented to see whether it is similar to that recently reviewed on other plants and whether items of special safety significance are involved.

The first step in the review of ice condenser fission product removal is to determine whether the ice condenser system is used for accident dose mitigation purposes. Chapter 15 of the SAR is reviewed to determine whether a dose reduction credit was assumed for the ice condenser. If no fission product removal credit is assumed in the accident analysis, no further review is required. (The heat removal aspects of the system are reviewed by the CSB.)

If the ice condenser system is used for iodine removal, the iodine removal effectiveness of the ice condenser system is reviewed. The review includes the following:

1. System Design and Evaluation

a. Ice Chemistry

The chemistry of the ice is usually modified to include sodium hydroxide in order to improve the iodine scrubbing effectiveness of the ice condenser system. If the concentration of the sodium hydroxide is such that the ice, after melting but prior to any dilution meets the pH requirements stated in the acceptance criteria of this review plan, the system is considered effective for elemental iodine removal. For ice condenser systems similar to those of the D. C. Cook and Sequoyah plants (with a steady-state flow rate of approximately 40,000 cfm) an efficiency of 30% per pass for elemental iodine is assigned. The system is considered ineffective for organic and particulate iodine removal.

b. Duration of Iodine Scrubbing Function

It is not feasible to specify the exact time of the fission product release following a postulated loss-of-coolant accident. In addition, the flow rates and air/steam fractions of the flow through the ice condenser vary significantly during and immediately following the accident. For dose calculation purposes, therefore, the following conservative assumptions are made:

(1) The iodine removal effectiveness of the ice condenser commences with the establishment of a steady-state air-steam flow by the air-steam return fans. (A single failure of one of the fans is assumed.)

(2) The initial concentration of iodine is assumed uniform throughout the entire containment. (This assumption may be modified in the future.)

(3) The effectiveness of the ice condenser as an iodine removal system is assumed to cease with the melt-out of the first ice bed.

c. Evaluation

The air-steam fan flow rate is used with the above assumptions in modeling fission product behavior for the loss-of-coolant accident (see Appendix A to Standard Review Plan 15.6.5).

2. Technical Specifications

The technical specifications are reviewed to assure that they require periodic inspection and sampling of the ice in order to confirm the continued state of readiness of the system, i.e., the system meets the chemistry requirements specified in the acceptance criteria of this review plan.

IV. EVALUATION FINDINGS

The reviewer verifies that sufficient information has been provided and that the review and calculations support conclusions of the following type, to be included in the staff's safety evaluation report:

"We have reviewed the fission product scrubbing function of the ice condenser and conclude that the addition of sodium hydroxide to the ice, as proposed by the applicant, will reduce the elemental iodine concentration of the steam-air mixture flowing through the ice beds following a loss-of-coolant accident. We estimate an elemental iodine removal efficiency of _____% per pass during the time period starting at_____minutes after the accident and ending at_____minutes. The applicant's proposed program for preoperational and periodic surveillance tests will assure a continued state of readiness for the ice condenser iodine removal function."

V. REFERENCES

References for this standard review plan are listed in the following sections of the bibliography for filters, sprays, and iodine maintained in the AAB office:

Section V, General Fission Product Behavior.

Section VIII, Iodine Removal by the Ice Condenser.

SRP 6.7