B 3.6 CONTAINMENT SYSTEMS

B 3.6.13 Ice Condenser Doors

BASES

BACKGROUND

The ice condenser doors consist of the lower inlet doors, the intermediate deck doors, and the top deck doors. The functions of the doors are to:

a. Seal the ice condenser from air leakage and provide thermal/humidity barriers during the lifetime of the unit; and

b. Open in the event of a Design Basis Accident (DBA) to direct the hot steam-air mixture from the DBA into the ice bed, where the ice would absorb energy and limit containment peak pressure and temperature during the accident transient.

Limiting the pressure and temperature following a DBA reduces the release of fission product radioactivity from containment to the environment.

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 inlet doors separate the atmosphere of the lower compartment from the ice bed inside the ice condenser. The top deck doors are above the ice bed and exposed to the atmosphere of the upper compartment. The intermediate deck doors, located below the top deck doors, form the floor of a plenum at the upper part of the ice condenser. This upper plenum area is used to facilitate surveillance and maintenance of the ice bed and contains the air handling units that remove heat from the ice bed. Equalization vents located at the periphery of the intermediate and top decks are provided to balance small pressure differentials occurring across the decks during normal operation.

The ice baskets held in the ice bed within the ice condenser are arranged 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 lower 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

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BACKGROUND (continued)

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.

The ice, together with the containment spray, serves as a containment heat removal system and is adequate to absorb the initial blowdown of steam and water from a DBA as well as the additional heat loads that would enter containment during the 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.

The water from the melted ice drains into the lower compartment where it serves as a source of borated water (via the containment sump) for the Emergency Core Cooling System (ECCS) and the Containment Spray System heat removal functions in the recirculation mode. The ice and the recirculated ice melt (via the Containment Spray System) also serve to clean up the containment atmosphere.

The ice condenser doors ensure that the ice stored in the ice bed is preserved during normal operation (doors closed) and that the ice condenser functions as designed if called upon to act as a passive heat sink following a DBA.

APPLICABLE SAFETY ANALYSES

The limiting DBAs considered relative to containment pressure and temperature 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 assumed not to occur simultaneously or consecutively.

Although the ice condenser is a passive system that requires no electrical power to perform its function, the Containment Spray System and ARS also function to assist the ice bed in limiting pressures and temperatures. Therefore, the postulated DBAs are analyzed with respect to Engineered Safety Feature (ESF) systems, assuming the loss of one ESF bus, which

APPLICABLE SAFETY ANALYSES (continued)

is the worst case single active failure and results in one train each of the Containment Spray System and the ARS being rendered 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 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."

For very small break events occurring in the lower compartment that do not by themselves produce sufficient breakaway pressure to open the lower inlet doors, slowly released steam will migrate through the Divider Barrier into the upper compartment. In this situation, the Containment ARS will actuate at its defined pressure setpoint (including a defined time delay) and open the lower inlet doors, returning the steam/air mixture to the lower compartment and displacing it into the ice condenser where the steam portion of the flow will be condensed (Ref. 1). The Containment ARS can also be actuated manually.

In addition to calculating the overall peak containment pressures, the DBA analyses include the calculation of the transient differential pressures that would occur across subcompartment walls during the initial blowdown phase of the accident transient. The internal containment walls and structures are designed to withstand the local transient pressure differentials for the limiting DBAs.

The ice condenser doors satisfy Criterion 3 of 10 CFR 50.36(c)(2)(ii) (Ref. 3).

LCO

This LCO establishes the minimum equipment requirements to assure that the ice condenser doors perform their safety function. The ice condenser lower inlet doors, intermediate deck doors, and top deck doors must be closed to minimize air leakage into and out of the ice condenser, with its attendant leakage of heat into the ice condenser and loss of ice

LCO (continued)

through melting and sublimation. All lower inlet doors, intermediate deck doors, and top deck doors must be OPERABLE to ensure the proper functioning of the ice condenser in the event of a DBA. Ice condenser door OPERABILITY includes the absence of any obstructions that would physically restrain the doors from opening (i.e., prevent initial breakaway under any circumstances), and for the lower inlet doors, being adjusted such that the initial opening torques are within prescribed limits. The ice condenser doors function with the ice condenser to limit the pressure and temperature that could be expected following a DBA.

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 condenser doors. Therefore, the LCO is applicable in MODES 1, 2, 3, and 4.

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

ACTIONS

Note 1 provides clarification that, for this LCO, separate Condition entry is allowed for each ice condenser door.

Note 2 provides clarification that entry into the Conditions and Required Actions is not required for short duration (< 4 hours) routine activities during Modes of Applicability for the Intermediate Deck and Top Deck Doors.

A.1

If one or more ice condenser lower inlet doors are inoperable due to being physically restrained from opening, the lower inlet door(s) must be restored to OPERABLE status within 1 hour. The Required Action is necessary to return operation to within the bounds of the containment analysis. The 1 hour Completion Time is consistent with the ACTIONS of LCO 3.6.1, "Containment," which requires containment to be restored to OPERABLE status within 1 hour.

B.1 and B.2

If one or more ice condenser doors are determined to be partially open or otherwise inoperable for reasons other than Condition A or if a door is found that is not closed, it is acceptable to continue unit operation for up to 14 days, provided the ice bed temperature instrumentation is monitored once per 4 hours to ensure that the open or inoperable door is not

BASES

ACTIONS (continued)

allowing enough air leakage to cause the maximum ice bed temperature to approach the melting point. The Frequency of 4 hours is based on the fact that temperature changes cannot occur rapidly in the ice bed because of the large mass of ice involved. The 14 day Completion Time is based on long term ice storage tests that indicate that if the temperature is maintained below 27°F, there would not be a significant loss of ice from sublimation. If the maximum ice bed temperature is > 27°F at any time or if the doors are not closed and restored to OPERABLE status within 14 days, the situation reverts to Condition C and a Completion Time of 48 hours is allowed to restore the inoperable door to OPERABLE status or enter into Required Actions D.1 and D.2. Ice bed temperature must be verified within the specified Frequency as augmented by the provisions of SR 3.0.2. Entry into Condition B is not required due to personnel standing on or opening an intermediate deck or top deck door for short durations (< 4 hours) to perform required surveillances, minor maintenance such as ice removal, or routine tasks such a system walkdowns

C.1

If Required Actions B.1 or B.2 are not met, the doors must be restored to OPERABLE status and closed positions within 48 hours. The 48 hour Completion Time is based on the fact that, with the very large mass of ice involved, it would not be possible for the temperature to increase to the melting point and a significant amount of ice to melt in a 48 hour period.

D.1 and D.2

If the ice condenser doors 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 3.6.13.1

Verifying, by means of the Inlet Door Position Monitoring System, that the lower inlet doors are in their closed positions makes the operator aware of an inadvertent opening of one or more lower inlet doors. The Surveillance Frequency is based on operating experience, equipment

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SURVEILLANCE REQUIREMENTS (continued)

reliability, and plant risk and is controlled under the Surveillance Frequency Control Program.

SR 3.6.13.2

Verifying, by visual inspection, that each intermediate deck door is closed and not impaired by ice, frost, or debris provides assurance that the intermediate deck doors (which form the floor of the upper plenum where frequent maintenance on the ice bed is performed) have not been left open or obstructed. In determining if a door is impaired by ice, the frost accumulation on the doors, joints, and hinges are to be considered in conjunction with the lifting force limits of SR 3.6.13.7. The Surveillance Frequency is based on operating experience, equipment reliability, and plant risk and is controlled under the Surveillance Frequency Control Program.

SR 3.6.13.3

Verifying, by visual inspection, that the top deck doors are in place and not obstructed provides assurance that the doors are performing their function of keeping warm air out of the ice condenser during normal operation, and would not be obstructed if called upon to open in response to a DBA. The Surveillance Frequency is based on operating experience, equipment reliability, and plant risk and is controlled under the Surveillance Frequency Control Program.

SR 3.6.13.4

Verifying, by visual inspection, that the ice condenser lower inlet doors are not impaired by ice, frost, or debris provides assurance that the doors are free to open in the event of a DBA. The Surveillance Frequency is based on operating experience, equipment reliability, and plant risk and is controlled under the Surveillance Frequency Control Program.

SURVEILLANCE REQUIREMENTS (continued)

SR 3.6.13.5

Verifying the initial opening torque of the lower inlet doors provides assurance that no doors have become stuck in the closed position and maintains consistency with the safety analysis initial conditions. Verifying the doors are free to move provides assurance that the hinges and spring closure mechanisms are functioning properly and not degrading.

The verifications consists of:

a) Ascertaining the opening torque (torque required to just begin to move the door off of its seal) of each door when pulled (or pushed) open and ensuring this torque is $\leq$ 675 in-lb, as resolved to the vertical hinge pin centerline, and
b) Opening each door manually to the full extent of its available swing arc (i.e., up to slight contact with the shock absorber) and releasing the door, verifying that the spring closure mechanisms are capable of returning the door toward the closed position.

The opening torque test a) should be performed first to minimize the loss of cold head in the ice condenser and prevent any preconditioning of the seal area. During the freedom of movement test b) the cold head is not required, and once the effect of cold head is reduced through outflow, the door may not completely return to its seal from the open position.

The opening torque test limiting value of 675 in-lb is based on the design cold head pressure on the closed lower inlet doors of approximately 1 pound per square foot. The Surveillance Frequency is based on operating experience, equipment reliability, and plant risk and is controlled under the Surveillance Frequency Control Program.

SR 3.6.13.6 (deleted)

SR 3.6.13.7

Verifying the OPERABILITY of the intermediate deck doors provides assurance that the intermediate deck doors are free to open in the event of a DBA. The verification consists of visually inspecting the intermediate doors for structural deterioration, verifying free movement of the vent assemblies, and ascertaining free movement of each door when lifted with the applicable force shown below:

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SURVEILLANCE REQUIREMENTS (continued)

	Door	Lifting Force
a.	Adjacent to crane wall	< 37.4 lb
b.	Paired with door adjacent to crane wall	≤ 33.8 lb
c.	Adjacent to containment wall	≤ 31.8 lb
d.	Paired with door adjacent to containment wall	≤ 31.0 lb

The Surveillance Frequency is based on operating experience, equipment reliability, and plant risk and is controlled under the Surveillance Frequency Control Program.

REFERENCES

1. UFSAR, Chapter 6.

2. 10 CFR 50, Appendix K.

3. 10 CFR 50.36, Technical Specifications, (c)(2)(ii).

4. MCS-1558.NF-00-0001 "Design Basis Specification for the NF System".