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INDIANA MICHIGAN POWER

February 10, 2002
AEP:NRC: 2591-01

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Mail Stop O-P1-17
Washington, DC 20555-0001

SUBJECT: Donald C. Cook Nuclear Plant Unit 1
Docket No. 50-315
Emergency License Amendment Request for One-time Limited Duration Exemption from Ice Condenser Inlet Door Surveillance Testing

REFERENCES: (1) Letter from A. C. Bakken III, Indiana Michigan Power Company, to U. S. Nuclear Regulatory Commission (NRC) Document Control Desk, "Emergency License Amendment Request for One-Time Limited Duration Exemption from Ice Condenser Inlet Door Surveillance Testing," AEP:NRC:2591 dated February 8, 2002.

Dear Sir or Madam:

In the referenced letter, Indiana Michigan Power Company (I&M), the licensee for Donald C. Cook Nuclear Plant Unit 1, proposed to amend Facility Operating License DPR-58. I&M proposed to add a license condition allowing a one-time limited duration exemption from the surveillance requirement to verify that the opening, closing and frictional torque of the ice condenser inlet doors are within specified limits as required by Technical Specifications 4.6.5.3.1.b.3, 4.6.5.3.1.b.4, and 4.6.5.3.1.b.5, respectively.

In a February 8, 2002, telephone conversation between I&M and the Nuclear Regulatory Commission (NRC), the NRC requested additional information regarding postulated failures of the ice condenser lower inlet doors and the impact on the design and licensing basis. The requested information is provided in the Attachment.

There are no new regulatory commitments made in this letter.

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Should you have any questions or require additional information, please contact Mr. Gordon P. Arent, Manager of Regulatory Affairs, at (616) 697-5553.

Sincerely,

A. C. Bakken, III
Senior Vice President, Nuclear Operations

/dmb

Attachment

c: K. D. Curry
J. E. Dyer
MDEQ - DW & RPD
NRC Resident Inspector
R. Whale

AFFIRMATION

I, A. Christopher Bakken III, being duly sworn, state that I am Senior Vice President, Nuclear Operations of American Electric Power Service Corporation and Vice President of Indiana Michigan Power Company (I&M), that I am authorized to sign and file this request with the Nuclear Regulatory Commission on behalf of I&M, and that the statements made and the matters set forth herein pertaining to I&M are true and correct to the best of my knowledge, information, and belief.

American Electric Power Service Corporation

A. C. Bakken III
Senior Vice President, Nuclear Operations

SWORN TO AND SUBSCRIBED BEFORE ME

THIS 10 DAY OF February, 2002

Notary Public

My Commission Expires Apr 4, 2004

DANIELLE M. SCHRADER
Notary Public, Berrien County, MI
My Commission Expires Apr 4, 2004

Additional Information Regarding Postulated Failures of the Ice Condenser Lower Inlet Doors and the Impact on Design and Licensing Basis

As discussed in Reference 1 of the cover letter, surveillance testing deficiencies for the Donald C. Cook Nuclear Plant (CNP) Unit 1 lower inlet doors raised questions with regard to the force needed to hold a door open or move it from an intermediate position (Technical Specifications (TS) 4.6.5.3.1.b.3, 4, and 5). It should be noted that the surveillances for initial door opening torque and freedom from ice and debris (TS 4.6.5.3.1.b.1 and 2) remain valid. The two surveillances, combined with monitoring of ice bed temperature and inlet door position indication throughout the cycle (TS 4.6.5.1.a and 4.6.5.3.1.a, respectively) ensure that gross door failure has not occurred. CNP report NTS-2002-005-REP, Rev. 0 (Reference 1), shows that lower inlet door performance is relatively insensitive to the torque parameters measured in TS 4.6.3.1.b.3, 4, and 5 and that there is reasonable assurance that the lower inlet doors would open and function properly during an accident.

Following receipt of I&M's February 8, 2002, submittal, additional questions were raised regarding the effect of doors sticking closed, opening prematurely, and the potential for maldistribution of flow through the ice condenser on the Large Break (LBLOCA) and Small Break Loss of Coolant Accident (SBLOCA). The steamline break accident is bounded by the Loss of Coolant Accident (LOCA) analysis and, as such, is not addressed separately. The following sections provide the background and the impact on the accident analysis for these effects.

BACKGROUND ON ICE CONDENSER FLOW MALDISTRIBUTION

Maldistribution of flow through the ice condenser could have two potential impacts on containment response during accident mitigation. First, containment pressure response could be affected. Second, the contribution of melted ice to the containment sump inventory could be affected by changes in ice melt rate.

The ice condenser concept originated in the mid-1960s and was validated by a series of tests conducted at the Westinghouse Waltz Mill test site. Testing included sensitivity studies for various ice bed configurations, energy release, and blowdown rates. A computer code, referred to as the Transient Mass Distribution (TMD) code, was developed based on the Waltz Mill test results (Reference 2). During CNP licensing, the Advisory Committee on Reactor Safeguards (ACRS) reviewed the ice condenser design, including the impact of failure of the lower inlet doors to open as designed. The Waltz Mill testing and TMD results were generally used to address ACRS concerns. Although there have been refinements to the code over time, the current TMD code that supports CNP operation still relies on the experimental data obtained during the initial testing. The general answers to ACRS questions with regard to ice condenser performance are still considered valid with respect to CNPs ice condensers.

With regard to lower inlet door performance, the thrust of the ACRS questions were that failure of one or more doors to open might result in "burn-through" or channeling in the ice bed. The responses emphasized that there was no identified failure mechanism to keep the lower inlet doors from opening, but the possibility was evaluated. Failure of one full door port (two doors) to open would have about one percent change in operating deck differential and essentially no change (actually a slight reduction) on the containment shell pressure. A significant percentage of the total door ports could fail and still be within design limits. All of the doors in a local section next to a break could fail and still be well within design limits. Crossflow was conservatively not credited in the analyses. However, in the event one or more lower inlet doors did fail to open, crossflow would occur in both the lower containment compartments and inside the ice condenser and would result in the steam/air mixture being effectively directed to the ice bed. Crossflow outside the ice condenser occurs because the flow restriction offered by the lower inlet doors is high in relation to the flow restriction in the containment lower compartments. Flow through any functional doors would tend to equalize because they represent parallel flow paths. Within the ice condenser, steam condensing at the ice surface creates a low-pressure region that draws steam flow to the ice. Even in the event of a non-mechanistic channel through the ice bed, steam would preferentially migrate to the remaining ice sections. (Reference 2)

Previous tests and analysis of door failures focused on containment pressure considerations rather than sump inventory. However, the fact that pressure does not vary significantly indicates that the amount of energy absorbed by the ice does not vary significantly. Consequently, the amount of ice converted to melt water would not vary significantly and the corresponding effect on containment inventory would be minimal.

LBLOCA

The design basis performance requirement for the lower inlet doors for a LBLOCA is that they open rapidly and fully to ensure proper venting of the energy released into the ice condenser. This opening rate is important to ensure the pressure buildup in the lower compartment due to the rapid release of energy into that compartment is maintained within analyzed limits.

ONE OR MORE LOWER INLET DOORS FAIL TO OPEN

As discussed in References 3 and 4, the design of the lower inlet door assembly is such that the door assembly would fail at a pressure below the design pressure of the loop subcompartment boundaries, essentially acting like a rupture disk. Pressure exerted against the face of the door panel would tend to pull the seal from its mounting channel at a very low differential pressure, assuming the seal was fixed by some mechanism to the face of the door panel. Assuming the seal is fixed to both the door panel and the seal channel, the seal material itself would tend to tear allowing the inlet door to open.

Evaluations (Reference 3) were also performed for door flutter or cases in which the door might initially open then close causing maldistribution. The results of the evaluation concluded that no oscillatory motion could develop which will prevent the doors from staying open.

ONE OR MORE LOWER INLET DOORS OPEN PREMATURELY

Within the CNP containment analyses, the lower inlet doors are postulated to open within milliseconds of the event. Any reduction in the number of milliseconds between the event and the opening of the door would have no impact on the performance of the ice condenser system. (References 3 and 4)

EFFECTS OF MALDISTRIBUTION FROM LOWER INLET DOOR FAILURES

The failure of one or more lower inlet doors to open would result in reduction of the vent area for the lower containment loop subcompartments. A large portion of the vent area for these subcompartments is the ice condenser lower inlet door ports. The reduction of the vent area would tend to delay the dissipation of the energy from the subcompartments resulting in potentially increased peak subcompartment pressures. The reduction of the vent area also has the potential to cause maldistribution into the ice bed. Several sensitivity studies were performed during the initial licensing to bound the potential impact of door failure for both ice bed capability and the structural capability of the subcompartments. (References 3 and 4)

Failure of a door to open, regardless of the cause, would result in less maldistribution if located close to the break location, and in greater maldistribution if occurring at any other location. The loss of the flow area for one door panel would result in an additional portion of the mass flow into each door. The limiting case for the maximum maldistribution for the worst case break location was a release in a lower loop subcompartment with doors providing venting from three other loop subcompartments remaining closed. To maximize the maldistribution a release rate produced by a 6-inch diameter line break was used. The increase in maldistribution is small and a substantial number of lower inlet door panels could remain closed and not exceed the minimum heat removal capacity of the ice bed section that would receive maximum input. (References 3 and 4)

To evaluate the maximum increase in the peak pressure of an individual loop subcompartment, a worst case example would be an assumed Design Basis Accident release within an individual loop subcompartment for which no inlet doors were providing venting relief. The doors are assumed not to provide venting even though the design configuration of the door is to "fail open" at differential pressures less than the peak within the loop subcompartment. This evaluation concluded the resultant pressure increase in that loop subcompartment and adjacent loop subcompartments would be approximately 10 percent (%). The structural elements have at least a 25 % excess capacity and would continue to perform their function. (References 3 and 4)

From the standpoint of both entrance flow area reduction and condensing capacity, the ice condenser has sufficient margin to withstand the maximum LOCA with a significant number of inlet doors closed. Additionally, for long-term containment pressure response, sensitivity studies determined that with a maldistribution of 136%, with resultant early burnout of ice condenser sections reduced the peak containment pressure. This pressure reduction occurred as a result of delaying ice bed depletion. (References 3 and 4)

SBLOCA

The significant design-basis issue for a SBLOCA is to assure that there is sufficient recirculation sump water level to preclude vortexing of the emergency core cooling system pumps during the recirculation phase. CNP's current analysis-of-record for containment recirculation sump water inventory is described in Reference 6. This analysis supplements Reference 5, the prior analysis of record, to address a change in plant operations. Based on the discussion of the water volume needed for minimum recirculation sump water level in the latter report, approximately one-fifth of the TS 3.6.5.1 value for minimum allowable ice mass must be melted to assure the minimum required sump water level is achieved following any LOCA. For each of the three cases evaluated below, a worst case situation will be postulated and considered for potential impact on the minimum recirculation sump water level during the limiting SBLOCA. Since the parameter of interest is sump water level, the worst-case for each type of lower inlet door failure is defined in a way to minimize the potential for ice melt.

ONE OR MORE LOWER INLET DOORS FAIL TO OPEN

Postulating that a single lower inlet door fails to open, the worst-case for sump inventory would be no steam flow to the ice column immediately behind the affected door. This assumption implies that the steam flow for the affected lower inlet door would be diverted through other lower inlet doors (precise flow splits depend on the assumed break location relative to the failed door), and that there is no cross flow to the ice column behind the affected lower inlet door. Thus, this situation effectively reduces the available ice mass by 1/48 or about 2.1%. Given that only about 20% of TS 3.6.5.1 ice mass is required for satisfactory sump water level in the limiting SBLOCA, the number of lower inlet doors corresponding to 80% of the TS ice mass would have to be postulated to be blocked before the available ice mass would approach its minimum allowable value for sump analysis. (Reference 7)

ONE OR MORE LOWER INLET DOORS OPEN PREMATURELY

Postulating that a single lower inlet doors opens prematurely, either to a fixed position or in an oscillatory manner, the worst-case for sump inventory would be all steam flow to the ice column immediately behind the affected door or to the upper compartment via the bypass flow area. This assumption implies that the reactor coolant system (RCS) steam release rate is sufficiently low that the area of a single lower inlet door plus the bypass could accommodate the RCS release without the lower inlet door pressure difference increasing sufficiently to open other doors. For this type of situation, containment pressure would increase due to the flow through the bypass flow area to the upper region of containment. This situation in containment would continue until the containment high pressure input to the Safety Injection (SI) signal is reached. Whether the increase in containment pressure is the result of the continuing flow through the bypass area or because the ice column behind the open door melts out is not important to the sequence of events. When the containment high pressure input to the SI signal is reached, the containment equalization (CEQ) fans will initiate. CEQ fan actuation will occur well before the containment high-high pressure setpoint is reached. The containment high-high pressure setpoint initiates containment spray (CTS). The CEQ fans provide sufficient head to open the remaining lower inlet door. The amount of ice melted behind the open door is unimportant for the postulated case, since CEQ fan operation would preclude CTS actuation while ice mass remained in the ice bed. Postulating more than a single door opening increases the amount of ice available to melt prior to CEQ fan actuation and could affect the timing of events, but does not change the sequence of events. On this basis, there is reasonable assurance that premature lower inlet door opening would not adversely affect the containment recirculation sump minimum water level. (Reference 7)

EFFECTS OF MALDISTRIBUTION FROM LOWER INLET DOOR FAILURES

Analyses performed during the design and licensing of the ice condenser showed that the maximum deviation from the theoretical lower inlet door flow split would occur for the lower inlet door nearest the refueling canal when a six-inch diameter RCS break occurs in its vicinity. The results of these analyses verified the ice condenser design criterion to limit such flow maldistribution to 150% was satisfied for the range of SBLOCA diameters anaylzed (Reference 3). Further, this analysis estimated that the effect of a single lower inlet door failing to open would increase the maldistribution at the worst-case lower inlet door by several percent. The minimum recirculation sump inventory analyses show that only about 20% of the TS minimum ice mass is required to melt to assure sufficient sump level. For lower inlet door flow maldistribution to lead to channeling through the worst maldistribution location prior to reaching the minimum sump water level, roughly five times (or 500%) as much flow must be directed through the worst-case lower inlet door to approach a condition of melt-out for that portion of the ice bed. Comparing these analytical results provides reasonable assurance that lower inlet door flow maldistribution due to either inherent flow path resistance differences or inherent flow path resistance differences augmented by failure of multiple lower inlet doors is unlikely to adversely affect the containment recirculation sump minimum water level. (Reference 7)

CONCLUSION

This addresses the questions discussed with the Nuclear Regulatory Commission regarding the February 8, 2002 emergency license amendment request. The following can be drawn on the postulated failures of the ice condenser lower inlet doors and the impact on the design and licensing basis.

The three postulated malfunctions of the lower inlet doors that have been considered do not adversely affect minimum recirculation sump water level.

Based on the design of the lower inlet doors, including the features of that design, and the differential pressures developed across the door during a LBLOCA, a failure to open condition is not expected. Assuming a condition of stuck doors could develop, there is sufficient excess condensing capacity in the ice condenser, and excess structural capacity of loop subcompartment boundaries. The bounding evaluations summarized above were based upon specific locations of doors that failed to provide venting that are not identical to the eight doors identified within Reference 1, as potentially having an excessive opening torque. These eight doors are distributed around the ice condenser and are not in any one concentrated location. Since the bounding evaluations described above are based upon groups of doors that fail to vent being located in concentrated groups that are larger than the grouping of the eight doors, the bounding evaluations remain bounding. Considering the current condition is completely bounded by the evaluations described above, there is reasonable assurance that there would be no increase in consequences as a result of this accident.

REFERENCES

1. CNP report "Review of Ice Condenser Lower Inlet Door 40 Degree Opening and Closing Force/Torque Data," NTS-2000-005-REP, Rev. 0, dated February 2002.
2. Advisory Committee on Reactor Safeguards transcripts of meetings held on 9/12/1973, 10/5/1973 and 10/11/1973 to discuss I&M's application for an operating license.
3. WCAP-7611-L, "Design and Performance Evaluation of Ice Condenser Inlet Doors," dated March 1971. (Proprietary)
4. FSAR Questions & Answers 5.31, 14.35, and Amendment 45 Question 11.
5. Fauske and Associates, Inc. (FAI) report, FAI/99-77, Rev. 2, "Containment Sump Level Evaluation for the D. C. Cook Plant," dated September 1999.
6. FAI report, FAI/01-67, "Evaluation of Proposed Change to Containment Spray Heat Exchanger Configuration in D. C. Cook," dated September, 2001.
7. AEP Design Information Transmittal (DIT), "Small Break LOCA Technical Input for Emergency License Amendment Request for One-time Limited Duration Exemption from Ice Condenser Inlet Door Surveillance Testing," dated February 10, 2002.