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C Parrish
D Wigginton
K Heitner
Gray Files
J Taylor
E Jordan

Docket Nos. 50-315
and 50-316

Mr. John Dolan, Vice President
Indiana and Michigan Electric Company
c/o American Elctric Power Service Corporation
1 Riverside Plaza
Columbus, Ohio 43216

Dear Mr. Dolan:

By letter dated July 2, 1982, the Indiana and Michigan Electric Company responded to NRC Generic Letter 82-21, "Natural Circluation Cooldown", dated May 5, 1981 for the Donald C. Cook Nuclear Plant, Unit Nos. 1 and 2.

We have reviewed your submittals and conclude that there is reasonable assurance that steam formation at the upper head of the reactor vessel during natural circulation cooldown will not occur. This conclusion is based on our review of the Westinghouse study applicable to the Donald C. Cook Nuclear Plant, the training program as was described by IMEC for natural circulation cooldown and the existence of sufficient condensate supply consistent with our recommendations. We did not review the guidelines or procedures. This effort is conducted as part of TMI Action Plan Item I.C.1 generic review of the vendor guidelines and is addressed in our Generic Letter 83-22 dated June 3, 1983. A copy of our Safety Evaluation on natural circulation cooldown is enclosed. This action completes our review.

Sincerely,

Steven A. Varga, Chief
Operating Reactors Branch No. 1
Division of Licensing

Enclosure:
As stated

cc w/enclosure:
See next page

OFFICE	ORB#1	ORB#3 KH	ORB#1				
SURNAME	DWigginton:ef	KHeitner	SVarga				
DATE	11/16/83	11/16/83	11/17/83				

Indiana and Michigan Electric Company

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The Honorable Tom Corcoran
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James G. Keppler
Regional Administrator - Region III
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Safety Evaluation Report for D. C. Cook Units 1 and 2
Regarding Generic Letter 81-21, Natural Circulation Cooldown

Background

On June 11, 1980, St. Lucie Unit 1 experienced a natural circulation cooldown event which resulted in the formation of a steam bubble in the upper head region of the reactor vessel. Consequently the NRC Generic Letter dated May 5, 1981 was sent to all PWR licensees. Per that letter the licensees were asked to provide an assessment of the ability of their facility's procedures and training program to properly manage similar events. This assessment should include:

(1) A demonstration (e.g., analysis and/or test) that controlled natural circulation cooldown from operating conditions to cold shutdown conditions, conducted in accordance with their procedures, should not result in reactor vessel voiding

(2) Verification that supplies of condensate grade auxiliary feedwater are sufficient to support their cooldown method, and

(3) A description of their training program and the revisions to their procedures.

The licensee responded to this request in the reference 2 letter. The following is our evaluation of the licensee's response.

Evaluation

In its submittal, the licensee refers to a study performed by

Westinghouse for the Westinghouse Owners Group. This study evaluates the potential for steam formation in Westinghouse NSSS's and recommends modifications to the operator guidelines.

The results of the Westinghouse report, W-OG-57 (Reference 3), are bounding in that they are applicable to all 2, 3, and 4 loop Westinghouse plants. The report concludes that in previous analyses for operating guidelines and safety analyses, void formation in the upper head is explicitly accounted for if it is calculated to occur. These previous analyses indicate that voiding is not a safety concern because the voids will collapse when they come in contact with the subcooled region of the vessel.

The present analysis differentiates between T_{hot} and T_{cold} plants. T_{cold} plants are those which during normal reactor coolant pump operation, have sufficient flow between the downcomer and the upper head such that the temperature of the upper head is approximately the same as the cold leg temperature. T_{hot} plants have an upper head temperature between the hot leg and cold leg temperatures. This SER will deal with the T_{hot} analysis because the D. C. Cook units 1 and 2 are considered to be T_{hot} plants.

The analysis is done using the WFLASH code with a best estimate model. The WFLASH code has 2-phase capability and can track void propagation. The analysis assumes an inverted top hat upper support plate design since it results in a large upper head volume and hence conservatively large total heat in the upper head region. The initial upper head temperature is conservatively set equal to the hot leg temperature. Metal heat addition to the upper head area from the vessel and internals is taken into account. It is assumed that the reactor coolant pumps are stopped at the beginning of the transient.

The analysis is done for two cooldown rates 25°F/hr and 50°F/hr. An analysis is also done which accounts for the effect of the Control Rod Drive Mechanism (CRDM) cooling fans. These fans blow containment air across the vessel head and provide cooling of the upper head and the CRDMs.

One of the conditions that must be met during a cooldown is that the primary system pressure be 400 psia when the primary system temperature is 350°F. These conditions will permit the Residual Heat Removal System (RHRS) to be used to continue plant cooldown. However, RHR entry conditions vary somewhat from plant to plant. The analysis without the CRDM fans shows that upper head voiding will occur unless the depressurization is halted at 1200 psia and cooldown continued to a hot leg temperature of 350°F and the upper head is allowed time to cool off before depressurization to the RHRS point. The reference report calculates this cool-off period to be approximately 20 hours for a 25°F/hr cooldown rate and approximately 27 hours for a 50°F/hr cooldown rate.

An additional analysis includes the effect of the CRDM cooling fans and results in a significant increase in the rate of cooldown of the upper head. Per the reference report the CRDM fan cooling system removes

780KW (12 Kw/drive train times 65 drive trains for the analyzed plant) at full power. This energy removal is equal to an upper head cooldown rate of 32°F/hr when the upper head temperature is 600°F. Assuming that the cooldown rate is proportional to the temperature difference between the upper head metal and the containment atmosphere, the CRDM fans would cool the upper head at a rate of 17°F/hr when the upper head fluid is 350°F.

Based on these analyses the Westinghouse report makes the following recommendations for operator guidelines:

1. If the CRDM cooling effect is available the operator can reach shutdown cooling entry conditions without void formation if a 25°F/hr cooldown rate is used and a 50°F subcooling at the hot leg is maintained..

2. If the CRDM fans are not available the operator should commence a 25°F/hr cooldown and depressurize at a rate which maintains 50°F subcooling until the system reaches 1900 psia. At this point the depressurization rate should be changed so that a 200°F subcooling margin is maintained until the system reaches 1200 psia. At this time the depressurization should be stopped, but the cooldown continued. When the hot leg temperature reaches 350°F, a 20-hour holding period should be allowed before depressurization to RHRS entry conditions.

Although the above recommendations were based on best estimate analyses, these analyses were conducted for a worst case plant i.e., a 12" thick inverted top hat upper support plate with upper head region volume of 847 ft^3. Recognizing that not all plants fit that description Westinghouse conducted another set of analyses that account for the variations in the upper head internal design, i.e., whether the upper support plate is of the top hat, flat, or the inverted top hat design. The upper support plate design determines the rate of heat conduction and the upper head water volume which must be adequately cooled before depressurization to the RHRS conditions is attempted. This additional set of analyses was presented by Westinghouse in the background information for the Westinghouse emergency response guidelines ERGs (ES-0.2).

The D. C. Cook plants have a 5" thick top hat upper support plate design with upper head region volume of 580 ft^3. The Westinghouse ERGs recommend a 200°F subcooling margin and an 8 hour cooloff period at 1200 psig for this type of plant.

The licensee has revised it's natural circulation cooldown procedures to prevent void formation in the reactor vessel head. The revision was based on a 25°F/hr cooldown rate and a 650°F upper head region temperature. This temperature approximately corresponds to the saturation condition for 2250 psig system pressure. The licensee committed to review the generic guidance developed by Westinghouse Owners Group and update, if necessary, their procedures as part of the efforts for item I.C.1 of NUREG-0737.

The licensee states that each unit has a condensate storage tank (CST) with a capacity of 500,000 gallons and a technical specification minimum of 175,000 gallons. The service water system provides an unlimited source of water (Lake Michigan) as a backup to the CSTs.

The staff emphasizes the importance of procedures and operator training in resolving this issue. The review of generic guidelines is part of TMI Action Item I.C.1, Generic Review of Vendor Guidelines (Reference 4).

The staff concludes that if the licensee appropriately implements the generic NRC-approved emergency guidelines into their plant-specific procedures, adequate procedures will be available for the operator to safely conduct a controlled natural circulation cooldown.

Our review of the licensee's training program included discussions with the IMEC staff to determine if the training included the following:

- How voiding occurs and its consequences,
- Signs that voiding is occuring
- Discussion of procedures to prevent and mitigate voiding
- Discussion of the St. Lucie 1 event of June 11, 1980, and
- Proper simulator modeling of upper head voiding.

We are informed that the licensee's training program covers all of the above points which are considered acceptable for this issue.

Conclusion

Upper head voiding, in itself, does not present any safety concerns provided that the operator has adequate training and procedures to recognize and react to the situation. Voiding in the upper head makes RCS pressure control more difficult and therefore, if the situation warrants, natural circulation cooldown should be done without voiding.

The Westinghouse analyses provide the length of the holding period necessary to cooldown the upper head region on natural circulation without void formation when the CRDM fans are not available. Natural Circulation tests are planned for Diablo Canyon. These tests will provide experimental verification of the upper head cooling rate calculations.

The staff concludes that the licensee has verified it has sufficient condensate supplies and adequate training. This SER did not attempt a review of operating procedures. The staff finds that upon acceptable implementation of the NRC-approved Westinghouse Owners Group Emergency Response Guidelines with appropriate plant specific modifications, the licensee's procedures will be adequate to perform a safe natural circulation cooldown.

References

(1) Generic Letter 81-21, "Natural Circulation Cooldown", May 5, 1981.

(2) R. S. Hunter, Indiana and Michigan Electric Companys to H.R. Denton, NRC, July 2, 1982.

(3) Jurgensen, R.W. to P.S. Check, "St. Lucie Cooldown Event Report," W-OG-57, April 20, 1981.

(4) Generic Letter 83-22, "SER of Emergency Response Guidelines,"June 31, 1983.