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

SAFETY EVALUTION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

ROCHESTER GAS AND ELECTRIC CORPORATION

R. E. GINNA NUCLEAR POWER PLANT

DOCKET NO. 50-244

1.0 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. This resulted in the generation of an NRC Generic Letter 81-21 dated May 5, 1981 (reference 1) to all PWR licensees. The licensees were to provide an assessment of the ability of their facility's procedures and training program to properly manage similar events. This assessment was to 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.

Rochester Gas and Electric Corporation's (RG&E's)(licensee's) response of November 13, 1981 (reference 2) reference a study by the Westinghouse Owners Group (reference 3) and the study's applicability to Ginna. Additional information was provided by the licensee by letter dated October 26,1983 (reference 4).

2.0 Discussion

In their submittal the licensee referred to a Westinghouse study that 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 applicable to all 2, 3 and 4 loop 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 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 temperature. This SER will deal with the T hot analysis because the Ginna plant is considered to be a T hot plant.

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

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

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 are conditions which would permit the Residual Heat Removal System (RHRS) to be used. The analysis showed that neither cooldown rate could meet this condition without upper head voiding unless the depressurization was halted when the primary temperature reached 350°F and the upper head given time to cool off. A hand calculation showed 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 included the effect of the CRDM cooling fans and resulted in a significant increase in the rate of cooldown of the upper head. The CRDM cooling fans provide cooling of the CRDM magnetic jack coil winding. The system consists of axial fans that pull containment air past the coil housings and across the Reactor Vessel Head. The analysis was based on a hand calculation which assumed that the CRDM fan cooling system removes 780KW at full power. This energy removal was equal to an upper head cooldown rate of 32°F/hr when the upper head temperature was 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 was 350°F.

Based on these analyses the Westinghouse report made the following conclusions and recommendations for operator guidelines:

1. If the CRDM cooling effect is included the operator can reach shutdown cooling entry conditions without void formation if a 25°F/hr cooldown rate is used. The operator should maintain 50°F subcooling in the system.

2. If the CRDM fans are not available the operator should commence a 25°F/hr cooldown and should depressurize at a rate which maintains 50°F subcooling until the sytem reaches 1900 psi. At this point the depressurization rate should be changed so that a 200°F subcooling margin is maintained until the system reaches 1200 psi. At this time the depressurization should be stopped. When the primary temperature reaches 350°F, a 20-hour cool-off period should be allowed before depressurization.

3.0 Evaluation

The Ginna submittal concludes that the results of the Westinghouse study were incorporated into the Westinghouse generic guidelines. The Ginna procedures were modified to include the guideline instructions on natural circulation cooldown. The generic guideline that is applicable to Ginna calls for a 25°F/hr cooldown and a 9 hour soak time when the CRDM fans are not available. This differs from the 20 hour soak time recommended in the Westinghouse study. This study was based on a plant with an inverted top hat upper support plate (USP). Plants in this configuration have 12 inch thick USPs and upper head volumes of 846 ft^3. The Ginna plant is characterized as a flat USP plant. It has a upper head volume of 580 ft and a 5 inch thick USP. Consequently Westinghouse and the licensee have concluded that a 9 hour cooloff.period is necessary when the CRDM fans are not available.

The Ginna submittal concludes that a 25°F/hr cooldown plus a 9 hour hold period will take 17 hours. The amount of auxiliary feedwater necessary for a cooldown of this length is 72,000 gallons. The Ginna Technical Specifications require that 22,500 gallons be available in the two condensate storage tanks. Normally each tank will contain this amount. 50,000 gallons are available in the hotwells and normally between 30,000 and 75,000 gallons are available in the AVT condensate storage tank. The amount of total condensate grade feedwater is, thus, between 102,500 gallons and 170,000 gallons. The AVT condensate storage tank and hotwell water would be made available by the condensate transfer pumps. Operator action would be required to energize these pumps following a loss of offsite power. The operator must manually transfer these pumps from a non-safeguards emergency bus to a safeguards electric bus however, sufficient time would be available to make this transfer. Additionally, the demineralized water treatment system and an unlimited amount of city water can be made available for use as feedwater.

The analysis which included the effect of the CRDM fan cooling was performed on a generic rather than a plant specific basis. The capacity of the CRDM cooling system at Ginna may differ from that used in the analysis. (This analysis assumed that the system was operating at full capacity removing 12KW/drive mechanism). The system is not safety grade and during a loss of offsite power event the system may or may not be capable of being powered by the diesel generator. The licensee has demonstrated however, that they have sufficient condensate supplies to support an extended cooldown without the CRDM cooling fans.

The Ginna procedures include an instruction to limit cooldown to 25°F/hr and to maintain the required subcooling margins. The indications of void formation and instruction on void mitigation are given. The licensee concludes that the operators have received training on this procedure.

The staff emphasizes the importance of training and procedures in resolving this issue. The review of generic guidelines was part of TMI Action Item I.C.1, Generic Review of Vendor Guidelines. The Westinghouse Owners Group Emergency Response Guidelines include ES-0.2, Natural Circulation Cooldown. This guideline incorporates the results of the analyses previously discussed. These guidelines were reviewed and approved by issuance of the Generic Letter 82-22 (reference 5). The staff concludes that if the licensees appropriately implement the generic emergency guidelines into their plant-specific procedures, adequate procedures will be available for the operator to safely conduct a controlled natural circulation cooldown even if limited upper head voiding should occur. The staff concludes that the licensee's training program should include discussions of the St. Lucie event, how voiding occurs, the safety significance of the consequences of voiding and a discussion of the applicable procedures. The licensee confirmed by letter dated October 26, 1983 that the procedures are covered in training and all these items are addressed.

4.0 Conclusions

Upper head voiding, in itself, is not a safety concern provided that the operator is equipped with 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 analysis concludes that a 20 hour cooloff period before depressurization is necessary to prevent voiding when the CRDM fans are not operating. Natural circulation tests are planned at Diablo Canyon and will provide experimental verification of the upper head heat loss calculations. The staff concludes that the licensee has demonstrated the ability to cooldown without voiding and have sufficient condensate supplies.

This SER did not attempt a review of guidelines or procedures. This effort is being conducted under TMI Action Item I.C.1, Generic Review of Vendor Guidelines. The staff finds that upon acceptable implementation of the NRC-approved Westinghouse Owners Group Emergency Response Guidelines, the licensees' procedures will be adequate to perform a safe natural cooldown.

5.0 Acknowledgement

This evaluation was prepared by M. Keane

Date: November 22, 1983

References

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

2. Maier, J.E. to D. M. Crutchfield, "Generic Letter 81-21, Natural Circulation Cooldown," November 13,1981.

3. Letter w/enclosure, Jurgensen to Check, "St. Lucie Cooldown Event Report," W-OG-57, April 20, 1981.

4. Maier, J. E. to D. M. Crutchfield, "Natural Circulation Cooldown, Generic Letter 81-21," October 26, 1983

5. Generic Letter 82-22, "Safety Evaluation of "Emergency Response Guidelines," June 1, 1983.

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