



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

Safety Evaluation Report for Palisades

Regarding Generic Letter 81-21, Natural Circulation Cooldown

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 vessel. Subsequently, an NRC Generic Letter dated May 5, 1981 was sent to all PWR licensees. 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 revision to their procedures

The licensee responded to this request in the Reference 2 letter as supplemented by Reference 5. The following is our evaluation of the licensee's response.

2.0 Evaluation

In its submittal, the licensee refers to an analysis performed by Combustion Engineering (Reference 3). The objectives of this analysis were to determine a cooldown procedure that would minimize the possibility of void formation and the time requirements to reach shutdown cooling without void formation.

The above reference shows that heat is transferred from the upper head by two processes. The first is heat transfer from the head to the containment and the second is heat transfer down through the coolant and metal to the cooler portions of the system. The analysis concludes that by conducting a cooldown at the maximum cooldown rate, the temperature difference between the upper head and the RCS will be large and heat transfer by conduction will be maximized.

A simulation of upper head cooling during natural circulation was done generically for a 3410 Mwt class Combustion Engineering plant. Heat conduction, local natural circulation in the upper head, and cooling-

induced flow were modeled. A 75°F/hr cooldown following two hours at hot standby was simulated. The maximum shutdown cooling system entry conditions of 330°F and 361 psig were assumed.

The results of the generic analysis show that when the hot leg is cooled to a temperature of 330°F, an overall combined cooling and holding period of 17.5 hours following reactor trip is necessary before depressurizing to prevent upper head void formation. Using the generic analysis assumptions the licensee concludes that for the Palisades shutdown cooling system (SDCS) entry conditions of 325°F and 250 psig an overall period of 23 hours is necessary before the plant can be placed on the SDCS.

It is further concluded in the licensee's submittal that this calculation is very conservative for the Palisades Plant. Palisades has a much more open upper head mechanical configuration because cruciform control rods are used. Therefore, actual time for the upper head to cooloff is expected to be shorter than that required in the generic report (Ref. 3).

The licensee performed an analysis which showed that 172,000 gallons of water are necessary to perform a 23 hour cooldown assuming that the steam generators are allowed to boil-off to one-third of the tube height. The technical specification minimum of condensate water for Palisades is only 100,000 gallons. Nevertheless, the licensee states that it's onsite water supplies include a 125,000 gallons seismic Category I condensate storage tank and a 75,000 gallon primary make-up storage tank. Additionally, the fire pumps can be aligned to provide an unlimited supply of water from Lake Michigan. In light of the fact that a cooldown at Palisades will take less than 23 hours, the staff concludes that the condensate supply is sufficient.

The licensee states that its procedures have been revised to include the results of the analysis discussed above. All operators will be trained on this revised procedure. The licensee states (Ref. 5) that the training for the Palisades operators includes the essential elements for this event, i.e.:

- (1) How voiding in the reactor vessel upper head occurs, and the consequences;
- (2) Identification of observable signs that voiding is occurring;
- (3) A discussion of the procedures for preventing and mitigating voiding;
- (4) A discussion of the St. Lucie event dated June 1980; and
- (5) A proper modelling of upper head voiding in the training simulator.

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 Combustion Engineering Emergency Procedures Guidelines include natural circulation cooldown as part of the Loss of Forced Circulation guidelines. The guidelines were reviewed

and approved by the NRC (Reference 4). The staff concludes that if the licensee appropriately implements 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 should limited upper head voiding occur.

3.0 Conclusions

The staff concludes that upper head voiding is not a safety concern provided that the operator is equipped with adequate training and procedures. The essential elements of training for response to this event have been included in the training program. However, upper head voiding makes RCS pressure control more difficult and therefore, if the situation warrants, natural circulation cooldown should be done without voiding.

Natural circulation cooldown tests have been conducted at San Onofre Unit 2, and the test results are currently under review. These tests will provide experimental verification of the upper head heat loss calculations.

The staff concludes that the licensee has sufficient condensate water supplies. The staff also concludes that upon acceptable implementation of the NRC-approved Combustion Engineering Emergency Procedures Guidelines and NRC-approved operating training program, the licensee will be able to perform a safe natural circulation cooldown.

4.0 Acknowledgement

S. Diab and T. Wambach prepared this evaluation.

Dated: December 15, 1983

References

1. Generic Letter 81-21, "Natural Circulation Cooldown," May 5, 1981.
2. Letter, Johnson to Director, Nuclear Reactor Regulation, "Palisades Plant-Response to Generic Letter 81-21," November 16, 1981.
3. CE-NPSD-154, "Natural Circulation Cooldown Task 430 Final Report," Combustion Engineering Nuclear Power System Division, October 1981.
4. Generic Letter 83-23 dated July 29, 1983 transmitting Safety Evaluation of "Emergency Procedure Guidelines".
5. Letter, Johnson to Crutchfield, Chief, Operating Reactors Branch No. 5, "Palisades Plant - Generic Letter 81-21 "Natural Circulation Cooldown", Additional Information November 17, 1983.