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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

CONCERNING

NATURAL CIRCULATION COOLDOWN - GENERIC LETTER 81-21

FOR

ARKANSAS NUCLEAR ONE, UNIT 1

ARKANSAS POWER AND LIGHT COMPANY

DOCKET 50-313

Background

On June 11, 1980, S[illegible] Unit 1 experienced a natural circulation cooldown event which resulte[illegible] formation of a steam bubble in the upper head region of the reactor v[illegible]sel. Subsequently, an NRC Generic Letter dated May 5, 1981 (Reference 1) was sent to all PWR licensees. The licensees were asked to provide an assessment of the ability of their facility's procedure and training program to properly manage similar events. The 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 revision to their procedures.

The licensee, Arkansas Power & Light Company, responded to this request in Reference 2. Additional information, in response to staff requests, was provided in References 3 and 4. The following is our evaluation of the licensee's responses to Generic Letter 81-21.

Evaluation

In its initial submittals, References 2 and 3, the licensee stated that a natural circulation cooldown was unlikely. The licensee's operating philosophy is to maintain the unit in hot standby unless an extended loss of offsite power occurred. The licensee stated that operating experience has shown that an extended loss of offsite power was unlikely. The licensee did, however, develop and implement operating procedures for performing a natural circulation cooldown.

The natural circulation procedure which was developed was not based upon analysis. In Reference 3, the licensee stated that the procedure did not specifically preclude void formation in the RCS. Rather, the procedure provided instructions to the operator for recognizing void formation and methods for collapsing voids if they formed.

In Reference 5, we reiterated that it was the staff's position that the natural circulation cooldown procedure should be developed to prevent upper head voiding to the extent possible. In addition, we requested that the licensee provide the demonstration (analysis and/or test) we believed was necessary to develop a natural circulation procedure.

The licensee responded, in Reference 4, with a revised natural circulation cooldown method. The licensee now intends to continuously vent the reactor vessel upper head to the containment during the cooldown. The flow of primary coolant through the reactor vessel upper head and out the upper head high point vent will keep the upper head cool enough to prevent flashing of the upper head as the reactor coolant system is depressurized. This method allows the operators to perform a 40°F/hr cooldown to the Decay Heat Removal System (DHRS) conditions.

Reference 4 also contained a supporting calculation to demonstrate that the proposed natural circulation cooldown guidelines will prevent reactor vessel upper head void formation. The RETRAN02 computer code, Reference 6, was used to analyze the thermal response of the Arkansas Nuclear One - Unit 1 reactor vessel upper head during the cooldown. An eight-volume model was utilized for the upper head. A time dependent volume was utilized to simulate the reactor vessel upper plenum fluid temperatures and pressures based upon the operator guidelines. The upper head metal was simulated in the model. No credit was taken for flow of the reactor coolant loop fluid through the top portion of the upper head with the exception of the flow through the high point vent.

The model was initialized assuming a system pressure of 2155 psig and upper head metal and fluid temperatures of 600°F. The reactor vessel high point vent was then opened and a 40°F/hr primary system cooldown was initiated. System pressure was maintained at 2155 psig until the hot leg temperature reached 450°F.

System pressure was then decreased, within the allowed Technical Specification Pressure-Temperature envelope, throughout the remainder of the cooldown. DHRS actuation conditions were achieved in a little more than eight hours. The reactor vessel upper head remained subcooled throughout the cooldown.

We have reviewed the licensee's analyses. The RETRAN02 code has previously been reviewed by the staff and found acceptable (Reference 7). We have reviewed the code application and noding utilized and find it appropriate for this simulation. Based on this review, we have concluded that the natural circulation cooldown analysis of Reference 4 provides reasonable assurance that the cooldown can be performed without formation of a reactor vessel head void.

The licensee has stated that he intends to revise the natural circulation cooldown procedure to reflect the cooldown method modeled in the analysis. We recommend that the revised procedure also include guidance for recognizing and mitigating a reactor vessel head bubble should one form during the cooldown.

The licensee has verified that there is sufficient supply of condensate grade auxiliary feedwater to support a natural circulation cooldown. Initially, water is supplied to the emergency feedwater pumps from the condensate storage tank which normally contains 200,000 gallons. This is sufficient inventory to support an eight-hour cooldown. In addition, if the condensate storage tank inventory was depleted, the operators are instructed to align the emergency feedwater suction to the service water system. The service water system can take suction from either Lake Dardenelle or the emergency cooling pond. These sources provide a virtually unlimited condensate supply.

The licensee has stated that it has implemented training following the St. Lucie 1 event relative to void formation, void recognition and corrective actions. RSB did not review this training.

Conclusion

The staff concludes that upper head voiding is not a safety concern provided the operator is equipped with proper training and procedures. However, upper head voiding makes reactor coolant system pressure control more difficult and, therefore, if the situation warrants, natural circulation cooldown should be done without voiding.

The licensee proposed a continuous venting of the reactor vessel head during a natural circulation cooldown. Based upon the calculations which have been performed, we have concluded that a natural circulation cooldown to the DHRS conditions can be performed in approximately eight hours without formation of a reactor vessel head void.

We recommend that the licensee's revised natural circulation cooldown procedure include guidance for coping with a reactor vessel head void should one form.

The staff concludes the licensee has sufficient condensate supplies to perform a natural circulation cooldown.

Contributor: R. Jones.

Dated: July 11, 1985

References

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

2. Letter, D. C. Trimble (AP&L) to D. G. Eisenhut (NRC), "Natural Circulation Cooldown - Generic Letter 81-21," November 13, 1981.

3. Letter, J. R. Marshall (AP&L) to J. F. Stolz (NRC) "Natural Circulation Cooldown," July 13, 1983.

4. Letter, J. T. Enos (AP&L) to J. F. Stolz (NRC) "Natural Circulation Cooldown Analysis - Generic Letter 81-21," February 28, 1984.

5. Letter, J. F. Stolz (NRC) to J. M. Griffin (AP&L), "Response to Generic Letter 81-21, Natural Circulation Cooldown," April 23, 1984.

6. EPRI NP-1850-CCM, RETRAN-02 Computer Code Manual, May 1981.

7. Letter, C. O. Thomas (NRC) to T. W. Schnatz (Utility Group for Regulatory Licensing), "Acceptance for Referencing Licensing Topical Reports EPRI CCM-5 and EPRI NP-1850-CCM, September 4, 1984.