

May 4, 1981SECY-81-286

## POLICY ISSUE

(Information)

For: The Commissioners

From: William J. Dircks  
Executive Director for Operations

Subject: PRESSURIZED THERMAL SHOCK

Purpose: This paper presents background information on the issue of pressurized thermal shock of reactor pressure vessels and describes actions underway and planned by the staff for dealing with the issue.

Discussion: The issue of pressure vessel thermal shock has been considered by NRC for many years. The early concerns were centered around the integrity of the vessel when subjected to cold emergency core cooling (ECC) water during a large break, loss-of-coolant accident (LOCA). A number of analyses have been made by industry experts, NRC staff and NRC contractors. Based on these analyses, as well as thermal shock experiments (unpressurized) at ORNL, the staff has concluded that a crack cannot propagate through the vessel wall during a large break LOCA.

For normal operation and anticipated operational occurrences, NRC regulations (10 CFR 50, Appendix G) place requirements on vessel fracture toughness aimed at providing an adequate margin of protection against fracture, taking into account the potential for such factors as thermal shock. There may be some PWR transient sequences, however, in which the vessel could be subjected to thermal shock at the same time that primary system pressure remained high. In these pressurized thermal shock transients, the vessel would be subjected to tensile stresses superimposed upon the thermal stresses resulting from the thermal gradient across the vessel wall.

Contact:  
Thomas E. Murley, NRR  
49-27517

8105260144

The probability of pressure vessel failure due to pressurized thermal shock depends on the following factors:

- (a) the frequency and severity of overcooling transients;
- (b) the probability that the primary system remains pressurized or is repressurized through operator actions;
- (c) the existence of a flaw of sufficient size to propagate at the location of high thermal stresses; and
- (d) the fracture toughness, or resistance to crack propagation, of the vessel, which depends on the copper content of weld material and on the irradiation history of the vessel.

Several overcooling transients have occurred in operating PWRs, the most serious of which was a transient at the Rancho Seco plant on March 20, 1978. The NRR staff requested B&W to perform a fracture mechanics analysis of the vessel for the transient conditions experienced, and the staff performed an independent analysis. The staff concluded that, although the Appendix G limits were exceeded, the Rancho Seco vessel was not damaged to the extent that it reduced its expected service life. The staff stressed, however, that the safety implications were minimal only because the transient occurred very early in plant life when the fracture toughness of the vessel remained high.

The TMI Action Plan included a task (II.K.2.13) that requires a detailed analysis for all PWRs of the potential for thermal shock of reactor vessels resulting from cold safety injection flow during small break LOCAs. This work is proceeding on schedule. In addition, the Office of Research has a pressurized thermal shock test facility under construction at ORNL (discussed in SECY-79-459), and the first tests are scheduled for 1982.

During the past year, RES has studied overcooling transients more severe than the Rancho Seco transient and has investigated a range of vessel material properties. One of the results of a recent fracture mechanics analysis carried out by ORNL indicated that, if the Rancho Seco transient had occurred after 10 effective full-power years (more than twice its current level), the probability of failure of the Rancho Seco vessel would have been very high.

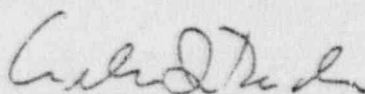
After reviewing these analyses, NRR called a meeting with the PWR industry Regulatory Response Groups (RRGs) and the PWR reactor manufacturers on March 31, 1981. The RRG representatives agreed

to send NRR a report by May 15, 1981, describing their on-going work and addressing the issue of pressurized thermal shock. They were, subsequently, requested to provide a generic basis for continued safe operation of the plants.

On April 10, 1981, Demetrios Basdekas wrote a letter to Congressman Udall in which he reiterated his concern about pressurized thermal shock transients. He further suggested that those PWRs with high copper content weld material that have operated for 4 effective full-power years be shut down until the issue is resolved in the technical arena.

The staff received a progress briefing from the PWR Owners Group on April 29, 1981. At this briefing, the Owners Group representatives asserted that there was no need for immediate corrective actions. These assertions were based on the low probability of severe overcooling transients, as well as the high fracture toughness of the vessels at this time. They agreed to provide more technical backup in their May 15 report.

The NRR staff has made an independent review of this issue and has concluded that no immediate licensing actions are required for operating reactors (Enclosure 1). The staff will review the RRG report when it is submitted, and in addition, the NRR and RES staffs will prepare a state-of-the-art report on pressurized thermal shock within the next few months. We will keep the Commission informed of the progress of these reviews.



William J. Dircks  
Executive Director for Operations

Enclosure:

Memo, Eisenhower to Denton  
dtd April 28, 1981, "Thermal  
Shock to PWR Reactor"