



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

APR 13 1984


Mr. P. Rahe  
Westinghouse Electric Corporation  
P. O. Box 355  
Pittsburg, PA 15230

SUBJECT: PWR BORGW DILUTION EVENT ANALYSES CONDUCTED BY LANL

Dear Mr. Rahe:

Enclosed for your information are the analyses and background information relating to the safety significance of an unmitigated Boron Dilution Event. These calculations were conducted by Los Alamos National Laboratory at the request of the Reactor Systems Branch to determine the safety significance of an unmitigated Boron Dilution Event during various shutdown modes as part of resolution of Generic Issue 22. The staff intends to complete its review of these reports by May 15, 1984.

Sincerely,

  
R. Wayne Houston, Assistant Director  
for Reactor Safety  
Division of Systems Integration  
Office of Nuclear Reactor Regulation

8404270133 XA

on 3/3/92

## ENCLOSURE

### Background Information

While PWRs are shutdown, the reactor is maintained in a subcritical condition by a combination of the insertion of control rods and boration of the reactor coolant to a level that results in the required shutdown margin. In this mode of operation, the Chemical and Volume Control System (CVCS) is normally in operation providing a small amount of makeup to the RCS and, for most PWRs a small amount of injection flow to the Reactor Coolant Pump (RCP) seals for their proper operation. The letdown portion of the CVCS provides a flow path out of the RCS into the cleanup portion of the CVCS. Suction for the charging pumps, while in this mode, is normally from the Volume Control Tank (VCT) which is fed by RCS letdown flow and from the makeup system. This system automatically provides the proper ratio of boric acid and pure water to maintain the VCT at a predetermined level and the RCS at the desired boron concentration by utilizing boric acid and pure water pumps, tanks and blenders. Should the makeup system or its associated control system malfunction, the RCS may be supplied with relatively pure makeup water resulting in a reduction in boron concentration, therefore a reduction in shutdown margin. Unchecked, criticality can result and if all control rods are already inserted into the core, the only way to shutdown the reactor would be to initiate boration which, like the dilution process, is slow.

The Standard Review Plan (NUREG-0800), Chapter 15.4.6, requires the analysis of inadvertent boron dilution events (BDE) and requires the assumption of a spectrum of initial plant operational modes. The SRP 15.4.6 requires that there be sufficient time for the operator, or the system, to sense the BDE in progress, diagnose it, and terminate the transient before total loss of shutdown margin; that is, before the reactor becomes critical.

For all operational modes except refueling, the SRP requires that there be at least 15 minutes between the time the operator becomes aware of the BDE in progress (by alarms) and the time criticality occurs. For the refueling mode, the SRP requires at least 30 minutes of operator action time.

Prior to the issuance of SRP 15.4.6, PWRs were licensed, in general, without a clear definition of the required operator alarms for BDE events. While we cannot conclude that operating plants have specific alarms to detect BDEs in conformance with the SRP 15.4.6 requirements, neither can we conclude that the indirect alarm systems in place are inadequate. The only occasion the alarm systems and associated analyses are systematically reviewed is during reload applications. In many cases, we have found either inadequate or totally absent dedicated alarm systems for the mitigation of potential BDEs.

At the request of the NRC staff LANL performed an evaluation of BDE consequences. This analysis led to an initial conclusion that no backfit of the SRP 15.4.6 position was warranted. However, this analysis was based on an unmitigated boron dilution event in a Westinghouse 4-loop plant (Zion) with the reactor vessel head on and a steam bubble in the pressurizer, or with the vessel head removed. In order to substantiate the conclusion that no action need to be taken on operating reactors without installed alarms, additional analyses were performed for both different reactor types and operational modes. We were specifically concerned with the degree of overpressure which could occur.

The analyses were also conducted by LANL, using TRAC PF-1. These analyses, which are still in draft form, are attached for your information. Based on our review to date, our preliminary conclusion is that an unmitigated BDE does not present a challenge to reactor vessel or RHR system integrity, and is not a safety problem. There appears to be adequate time for operator action.