ENCLOSURE 1

SAFETY EVALUATION OF NATURAL CIRCULATION COOLDOWN FOR PALO VERDE, UNITS 1, 2 AND 3

Branch Technical Position RSB 5-1 (BTP RSB 5-1), "Design Requirements of the Residual Heat Removal (RHR) System", requires that test programs for PWRs shall include tests with supporting analysis to (a) confirm that adequate mixing of borated water added prior to or during cooldown can be achieved under natural circulation cnditions and permit estimation of the times required to achieve such mixing, and (b) confirm that the cooldown under natural circulation conditions can be achieved within the limits specified in the emergency operating procedures. In addition, the plant design is to be such that the reactor can be taken from normal operating conditions to cold shutdown using only safety-grade systems. Comparison with performance of previously tested plants of similar design may be substituted for these tests.

In Supplement No. 9 to NUREG-0857, "Safety Evaluation Report related to the opeation of Palo Verde Nuclear Generation Station, Units 1, 2 and 3", the staff stated that the licensee committed to perform boron mixing and natural circulation cooldown tests at Unit 1 before exceeding 5% power at Unit 2.

By letters dated January 31 and August 29, 1985, the licensee submitted procedures to be used for the tests. By letter dated October 31, 1985, the NRC advised the licensee that the staff had reviewed the procedures and found them acceptable for the conduct of the test.

In Supplement No. 10 it is stated that, on January 24 and 25, 1986, the licensee performed the boron mixing and natural circulation cooldown tests and cooled the plant using the shutdown cooling system (SCS) to approach the cold shutdown condition. The purpose of these tests was to demonstrate the design capability of Palo Verde units relative to BTP RSB 5-1. The NRC staff observed portions of these tests, which lasted about 20 hours, from the plant control room. A void in the reactor vessel upper head (RVUH) was observed during reactor coolant system (RCS) depressurization using the auxiliary pressurizer spray system. The void in the RVUH was eliminated by use of the safety-grade gas vent system in the RVUH and the charging system. Shortly after eliminating the void, the RCS reached SCS initiation conditions. Cold shutdown was obtained using the SCS. This portion of the test was conducted to verify that the plant could perform cold shutdown using only safety-grade equipment assuming a single failure. The staff observers noted, however, that the licensee made the following substantive changes to the test:

(1) The procedures were modified to demonstrate that the plant could be depressurized using auxiliary pressurizer spray with the internals of a check valve removed. This check valve is located in the main pressurizer spray line and prevents back flow from the pressurizer and/or the auxiliary pressurizer spray line through the main pressurizer spray line.

(2) A turbine trip test, which was required as part of the power ascension test, was combined with the boron mixing natural circulation test. This resulted in modifying the initiation of the natural circulation test such that the reactor coolant pumps remained in operation for about 5 to 10 minutes following the turbine trip and reactor trip.

(3) Three charging pumps would be used during parts of the test, rather than two. The additional pump was needed to compensate for letdown during the test, and to reduce the time to borate the reactor coolant system.

The first change was due to a change in the design of the main pressurizer spray line. This change was reviewed and approved by the staff prior to the test. The licensee's reason for the second change was to reduce the number of challenges to the plant protection system and reactor trips. The third change was intended to provide more plant operational flexibility during the boron mixing test.

By letter dated February 9, 1987, the licensee submitted a report entitled "An Evaluation of the Natural Circulation Cooldown Test Performed At the Palo Verde Nuclear Generating Station". The stated purpose of the report is to show that Palo Verde Nuclear Generating Station (PVNGS) Units 1, 2, and 3 comply with the requirements of BTP RSB 5-1. The testing alone was not sufficient to demonstrate compliance with RSB BTP 5-1. In addition to the effects of the procedural changes as noted above, some non-safety grade equipment and systems were used because the plant operators did not want to risk damage to any of the equipment. These included the pressurizer heaters, letdown system, reactor coolant pumps, and control element drive mechanism (CEDM) fans.

The staff was assisted by its contractor, Brookhaven National Laboratory (BNL) in the evaluation and review of the report for the natural circulation cooldown tests performed at PVNGS. The results of the BNL review are given in the Technical Evaluation Report (TER), which is provided as Enclosure 2. Based on the test results and analysis, BNL concluded:

(a) That adequate natural circulation was established and the plant was capable of removing the decay heat by natural circulation using only safety-grade equipment.

(b) That adequate boron mixing could be achieved in less than one hour by natural circulation within the main flow path of the RCS using only safety-grade equipment.

(c) That boron injection may be conducted prior to cooldown without filling up the pressurizer even when letdown is not available. However, it may able desirable to allow the pressurizer level to decrease to provide space to accommodate the additional water from boron injection.

(d) That the test demonstrated that natural circulation heat removal could cool the main flow path of the RCS to the SCS initiation temperature while maintaining adequate subcooling using only safety-grade equipment.

(e) That the test demonstrated that the RCS could be depressurized to the SCS initiation pressure under natural circulation using the auxiliary spray if the letdown system is available. However, if the let down system is not available, the pressurizer could become full and it may be necessary to use the reactor vessel head vent valve to depressurize. In this case the emergency operating procedures should allow for rapid increases in the pressurizer level during the boron injection and depressurization period to avoid overfilling of the pressurizer.

(f) That a sufficient supply of safety-grade cooling water is available in the condensate storage tank (CST) to support the plant cooldown.

(g) That sufficient atmospheric dump valve (ADV) capacity is available to support the cooldown. In addition an adequate supply of safety-grade nitrogen storage is available to control the ADVs for the duration of the cooldown.

(h) That the PVNGS natural circulation cooldown test, combined with the supporting analysis, demonstrated that the plant meets the BTP RSB 5-1 requirements for a Class 2 plant with respect to natural circulation, boron mixing, safety-grade condensate water supply and capability to operate the ADVs.

The staff has reviewed the TER and we are in agreement with its conclusions. With respect to item (e), we suggest that the licensee review the TER and consider the need to include procedures to account for rapid increases in pressurizer level if the use of the reactor head vents is a necessary method of cooldown.

We conclude that PVNGS has demonstrated compliance with the requirements of BTP RSB 5-1.