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APAE

2 Memo No. 68

APAE-MEMO-68

EMERGENCY SHUTDOWN
OF THE APPR-1
BY POISONING WITH BORON

Contract AT(11-1)-318

Issued November 26, 1956

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DATE FEB 22 1957 *pet*

For The Atomic Energy Commission

H. F. Canale

Chief, Declassification Branch

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EMERGENCY SHUTDOWN OF THE APPR-1 BY POISONING WITH BORON

In this description it is assumed that the reader is familiar with the results and analysis of the APPR-1 Zero Power Experiments, AP Memo No. 61. As described in that report, the APPR-1 will be operated with Rods A and B full out and with the other five rods ganged. It has been demonstrated that any two rods can stick in their operating position and that the other five rods will shut the reactor down and maintain it subcritical after cooling down to room temperature at any time during the core life. However, if for some reason, the reactor is operated with completely arbitrary positioning of the rods, the reactor may not be subcritical upon cooldown if two rods are stuck.

The worst case is if Rods A and 1 (or any equivalent combination) stick in the fully withdrawn position. In that case the reactor will be subcritical from scram at the mean operating temperature of 440°F . If this occurs at 5 MW years (the worst case), as the reactor cools down it will become critical when the temperature reaches 350°F . It is assumed that the heat losses from the system are about 50 BTU/sec. The reactor will cool down in about 6 or 7 hours and will level out at a power level equal to this heat leakage, and will continue to run at this level indefinitely. While this is not a hazardous situation, it is obvious that some means must be provided to shut down the reactor. This is accomplished by injecting boron in soluble form into the primary system.

In making this provision it was decided to size the equipment for the worst case with three rods stuck out. 20 grams of B-10 in a core volume of 111 liters of water will make the reactor subcritical on cool down to room temperature at any time

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during the reactor lifetime. The following procedure can be repeated as many times as desired if it is desired to add additional poison to the system.

The volume of the primary system, including the primary coolant make-up tank, is 6300 gallons. Reducing this volume to 2300 gallons by draining a large portion of the make-up tank volume will require 8380 grams of natural boron or 106 pounds of boric acid to attain the desired poison concentration in the primary system. Boric acid has been selected as the best poison from the standpoint of clean-up of the system.

The boric acid is dissolved in 100°F water and pumped into the primary system through the primary make-up pumps. Since the solubility of boric acid in 100°F water is .56 pounds per gallon, 189 gallons of water will be required to dissolve the 106 pounds of acid.

A 250-gallon tank is installed adjacent to the primary make-up tank and connected with proper valving to the suction pipe of the make-up pumps. When the condition arises requiring poisoning of the core, 200 gallons of 100°F water from the make-up tank will be admitted to the mixing tank. The remaining water will be dumped. The required boric acid crystals will be added to the mixing tank. The solution will be injected into the primary system by opening the valve in the line from the tank to the make-up pump suction. By running both make-up pumps, completely opening the primary blowdown valve and by-passing the demineralizers and filter, the solution will be pumped into the primary system at a rate of 5 gpm.

Although the poison will be felt by the reactor immediately, the complete poisoning will require approximately one hour to complete.

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