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May 5, 1982

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Subject: Byron Station Units 1 and 2
Braidwood Station Units 1 & 2
Boration of Reactor Coolant
System
NRC Docket Nos. 50-454, 50-455,
50-456, 50-457



Dear Mr. Denton:

This is to provide information regarding boration of the Byron/Braidwood reactor coolant systems during an extended loss of off-site power. NRC review of this information should close Confirmatory Issue 13 of the Byron SER.

Attachment A to this letter explains the manner in which a typical Byron/Braidwood reactor can be brought to the cold shutdown condition without the use of reactor coolant pumps, the normal charging and letdown paths and the excess letdown path. Two methods are identified which will maintain the required shutdown margin during the reactor coolant system cooldown and depressurization.

A summary of the attached explanation will be provided in response to FSAR question 212.154 in the next amendment. Please direct questions regarding this matter to this office.

One signed original and fifteen copies of this letter are provided for your use.

Very truly yours,

T. R. Tramm

T. R. Tramm
Nuclear Licensing Administrator

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ATTACHMENT A

BORATION FOR COLD SHUTDOWN WITHOUT LETDOWN

A calculation was performed examining the feasibility of reaching cold shutdown (defined to be 200°F and atmospheric pressure) without letdown for a typical Byron/Braidwood unit. The results show that the boron concentration as a function of time and temperature is sufficient to maintain the core subcritical with the required shutdown margin.

Initial Conditions

The plant is presumed to be operating at power with boron concentration C_i and xenon concentration X_i . The reactor is tripped and brought to zero load hot standby condition (defined as T_{avg} of 557°F, 2250 psia, and pressurizer liquid level at 25% of span). The most reactive control rod is presumed to stick during the trip. After reaching zero load hot standby conditions, the normal and excess letdown lines are lost. The operator must then proceed to cold shutdown via either of two methods. In the first method, all RCS depressurizations are accomplished by opening the pressurizer power operated relief valves. Normal pressurizer spray is presumed to be unavailable because the reactor coolant pumps may not be operating. Table 1 lists the equipment required.

Shutdown Procedure

Initially, independent of the method used to reach cold shutdown, 4 wt.% boric acid from the boric storage tanks will be used to fill the pressurizer liquid level from 25% of span to 95% of span while the plant is held at zero load hot standby conditions. This will provide sufficient boron to compensate for xenon decay at hot standby. The 95% pressurizer level indication will ensure that the pressurizer is not water solid. The pressurizer pressure will be held constant at 2250 psia using manual control of pressurizer heaters and the reactor coolant temperature will be reduced from 557°F to 350°F by relying on natural circulation through steam generators. At 350°F, the pressure will be reduced, using either of the two depressurization methods, from 2250 psia to 415 psia. The RHR system will then be used to reduce the temperature from 350°F to 200°F while maintaining a constant pressure of 415 psia. At 200°F and 415 psia, the pressure will be reduced to atmospheric using the same method as used during the previous depressurization.

Depressurization with Spray

The operator must select one of two methods for depressurization - either via CVCS auxiliary spray or the PORV's. If the CVCS auxiliary spray is to be used (Table 2 and Figure 1), the pressurizer liquid level at the beginning of the depressurization cycle (i.e., at 350°F and again at 200°F) should be as low as possible while still keeping the heaters covered. This will minimize the mass of

saturated liquid in the pressurizer which will flash to steam as the pressurizer pressure is reduced. It will also provide space in the pressurizer for accepting the spray water without "pegging" the pressurizer level indicator. When cooling from 557°F to 350°F to 200°F, the operator first allows the coolant to contract to 25% of pressurizer level indication span, and thereafter adds 4 wt.% boric acid to maintain 25% of span indication and increase boron concentration. In this way, the pressurizer heaters will be kept covered and the operator will avoid a situation where there is too much liquid in the pressurizer without the ability to letdown. Depressurization from 2250 psia to 415 psia at 350°F, and from 415 psia to atmospheric pressure at 200°F, will be accomplished by spraying until pressurizer level indication increases to 95% of span.

Depressurization with PORV's

If the PORV's are to be used for depressurization (Table 3 and Figure 2), the pressurizer liquid level at the beginning of each depressurization cycle (i.e., at 350°F and again at 200°F) should be as high as possible to maximize the mass of steam which can be discharged without covering the pressurizer heaters. When cooling from 557°F to 350°F, the operator will maintain the pressurizer level at 95% of level indication span by adding 4 wt.% boric acid, via some other method than spraying, to makeup for coolant contractions in the pressurizer. Depressurization from 2250 psia to 415 psia at 350°F, and from 415 psia to atmospheric pressure at 200°F, will be accomplished by opening one PORV, discharging steam and allowing the pressurizer liquid level to decrease.

TABLE 1

SUMMARY OF SYSTEMS AND EQUIPMENT REQUIRED FOR
COLD SHUTDOWN BORATION WITHOUT LETDOWN

Boric Acid Tank
Boric Acid Transfer Pump
Centrifugal Charging Pump
/ Charging Line
Pressurizer Level Indication
Pressurizer Heater
CVCS Auxiliary Spray or Pressurizer Relief Valve
Residual Heat Removal Loop

TABLE 2

COLD SHUTDOWN VIA CVCS AUXILIARY SPRAY

<u>TIME HOURS</u>	<u>RCS T_{AVERAGE} °F</u>	<u>BORON CONCENTRATION PPM</u>
0	557	Ci
3	557	536 + .923 Ci
4	500	543 + .935 Ci
-	450	842 + .89 Ci
-	400	1072 + .857 Ci
9	350	1266 + .83 Ci
12	350	1581 + .77 Ci
18 ¹ /37 ²	200	1583 + .77 Ci
24 ¹ /43 ²	200	2125 + .693 Ci

¹ 2-Train RHR Cooldown.

² Single Train Cooldown.

TABLE 3COLD SHUTDOWN VIA PORV'S

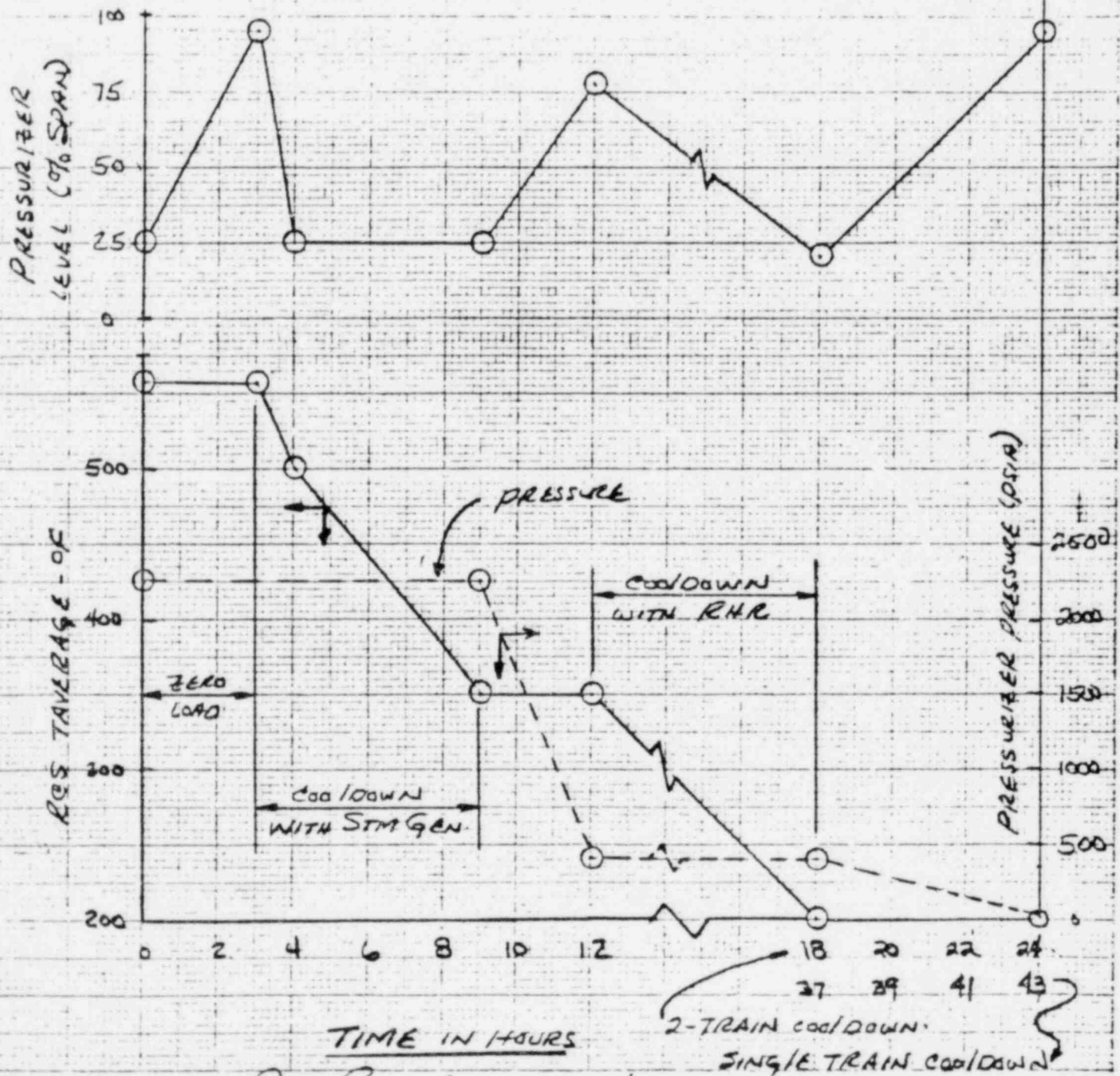
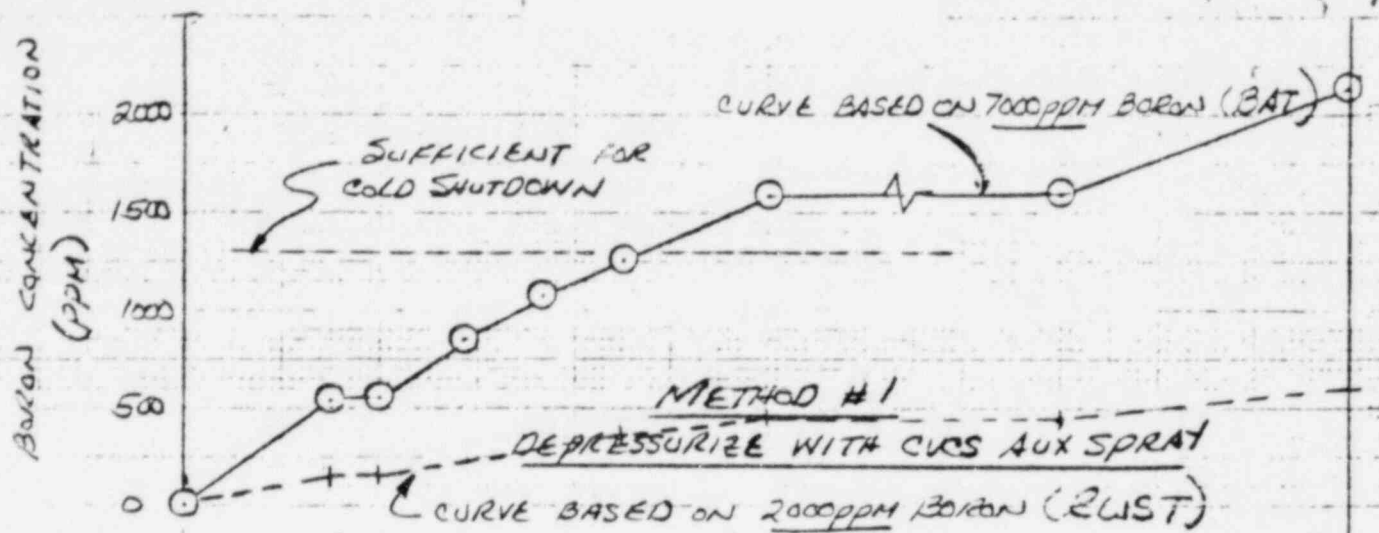
<u>TIME HOURS</u>	<u>RCS T AVERAGE °F</u>	<u>BORON CONCENTRATION PPM</u>
0	557	Ci
1 3.0	557	536 + Ci
5.5	500	927 + Ci
7.5	450	1185 + .9 Ci
9.0	400	1389 + .87 Ci
10.5	350	1159 + .84 Ci
11.0	350	1617 + .87 Ci
15.0 ¹ /36.0 ²	200	1996 + 81 Ci
16.0 ¹ /37.0 ²	200	2029 + .824 Ci

¹ 2-Train RHR Cooldown.

² Single Train RHR Cooldown.

FIGURE 1

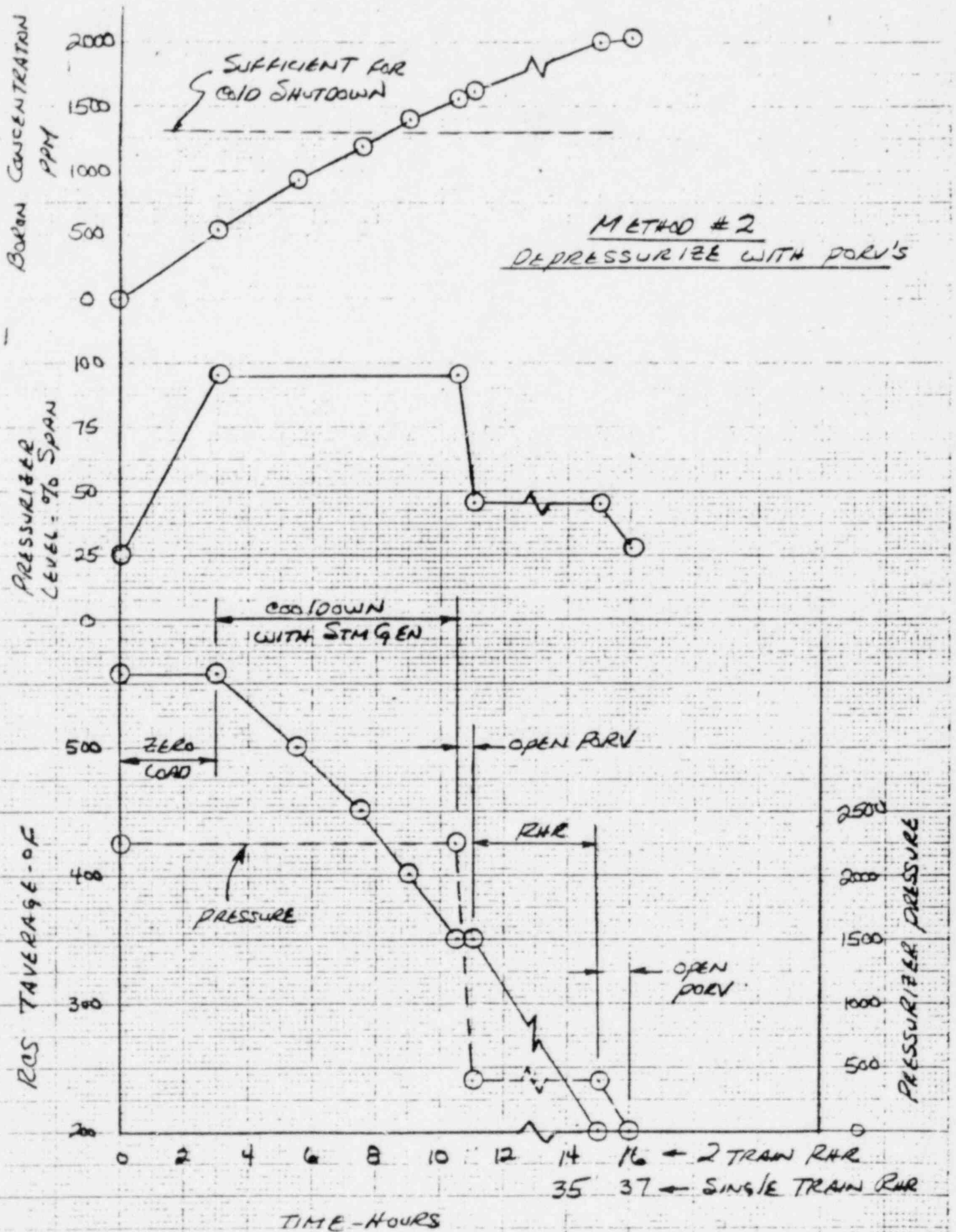
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FIGURE 2

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Dr. Baillie

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