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REACTORS — POWER

OAK RIDGE NATIONAL LABORATORY
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SUBJECT: Procedure for Dump Tests
HRT Test I B 2 a, b, c

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DISCLAIMER

PROCEDURE FOR DUMP TESTS
HRT Test I B 2a,b,c

Introduction

Dumping the reactor is a measure designed to protect against ultimate failure of the reactor due to excessively high pressure and to minimize the amount of radioactivity released in the event of a leak in the reactor high-pressure system. However, the dumping operation itself involves some danger to the reactor, the thin core vessel being particularly vulnerable during a dump. Because of the hazards which would result from a malfunction of the dump controls, it is necessary to check the operation of the dump system before the reactor is operated for any lengthy period at elevated temperature and pressure. Therefore a series of dump tests will be carried out when the system is first started up with oxygenated water.

Summary

The initial operation of the integrated reactor system will be with oxygenated water in the reactor. During this test, essentially all components will be operated with the reactor at design temperature and pressure. However, before the system is brought to the maximum temperature and pressure, a number of tests will be carried out to make sure that a possible inadvertent dump would not cause damage to the reactor.

An outline of the planned dump experiment is given in Table I. The series begins with testswhich will show up any gross inadequacies or malfunctions in the dump system without involving any danger to the reactor. Following this the reactor will be dumped from conditions at which the system may eventually operate for long periods of time. The program may be revised if test results show this to be necessary.

Instrumentation will be provided so that the action of the dump valves and the valves in the pressurizer vent lines, and the resultant pressures in the fuel and blanket high-pressure systems and dump tanks can be studied. In addition, the operation of all pumps, valves, etc., affected by a dump will be observed.

Instrumentation

During each dump a continuous chart record will be obtained of each of the following:

1. Core pressure (2 different instruments)
2. Blanket pressure
3. Core-Blanket differential pressure (2 different instruments)
4. Fuel dump tank pressure
5. Blanket dump tank pressure

TABLE 1

Dump Test Program

Test	Initial Conditions	Action	Purpose of Test
1	300 psia, 214°C (saturated)	Dump	Check test procedure, instrumentation, operation of dump valves, cooling water circuits, etc.
2	600 psia, 214°C (p_s = 300 psia)	Bleed	Check action of pressurizer vent valves, determine time required to bleed off overpressure.
3	600 psia, 214°C (p_s = 300 psia)	Dump	Test dump system.
4	1400 psia, 250°C (p_s = 577 psia)	Bleed	Determine time required to bleed off overpressure.
5.	1400 psia, 250°C (p_s = 577 psia)	Dump	Test dump system.
6	2000 psia, 280°C (p_s = 930 psia)	Bleed	Same as Test 3.
7.	2000 psia, 280°C (p_s = 930 psia)	Dump	Test dump system.
8	600 psia, 214°C (p_s = 300 psia) rupture discs removed	Dump	Determine rate of transfer between core and blanket during steady operation and total transferred during a dump.
9	2000 psia, 280°C (p_s = 930 psia) rupture discs removed	Dump	Same as Test 8.

6. Fuel dump valve (PCV-152) position

7. Blanket dump valve (PCV-252) position

8. Fuel pressurizer vent throttling valve (PdCV-250A) position

9. Blanket pressurizer vent throttling valve (PdCV-250B) position

The fuel and blanket pressurizer vent block valves (HCV-139 and HCV-239) will be equipped with position indicators which will permit checking their simultaneous opening on the dump signal. Positions of these valves will not be recorded on all dumps, however.

Core Pressure. Core pressure will be measured by a 2000 psi Baldwin cell attached to a pressure tap at the source tube flange in the core outlet. A Sanborn high-speed recorder will be used to record core pressure. This measurement is in addition to the permanent core pressure instrument.

Blanket Pressure. Blanket pressure also will be measured by a 2000-psi Baldwin cell and recorded on the Sanborn recorder. The pressure tap will be in a blind flange on the blanket thimble opening.

The pressure cells will be installed as shown in Fig. 1. The cooling coils and insulation are to keep the cells cool (below 120°F). The interconnection and valves permit the same pressure to be put on both cells to check their readings. Reading the fuel and blanket pressures separately like this will not give an extremely accurate inidcation of differential pressure, but pressure differentials beyond the range of available d/p cells can be handled.

Core-Blanket Differential Pressure. To check the differential pressure, the output of the permanent Δp transmitter (PdE-250) is recorded on a Bristol recorder. This will record the same thing as the permanent Δp recorder (PdR-250), but at a much faster chart speed.

Dump Tank Pressures. The pressures in the fuel and blanket dump tanks will be measured by 0-500-psig transmitters installed in place of the regular pressure transmitters. (The permanent instruments have a range of only 30 psig.) Pressures will be recorded on a 2-channel Taylor recorder.

Dump Valve Positions. The stems on the dump valves will be equipped with 1-in. slide potentiometers connected to a two-channel Brush recorder to record valve position.

Pressurizer Bleed Valves. The four valves in the vent lines (HCV-139, HCV-239, PdCV-250A and PdCV-250B) will be equipped with half-inch slide potentiometers to indicate positions. Positions of the throttling valves will be recorded on a two-channel Brush recorder. For some tests, the block valve positions will be put on a Brush recorder to determine if both valves open simultaneously.

In addition to the instruments specially installed for the dump test, thermocouples will be connected to the temperature scanner (TR-6500) to give a convenient record of temperatures at important points in the reactor. Table II is a list of the thermocouples involved.

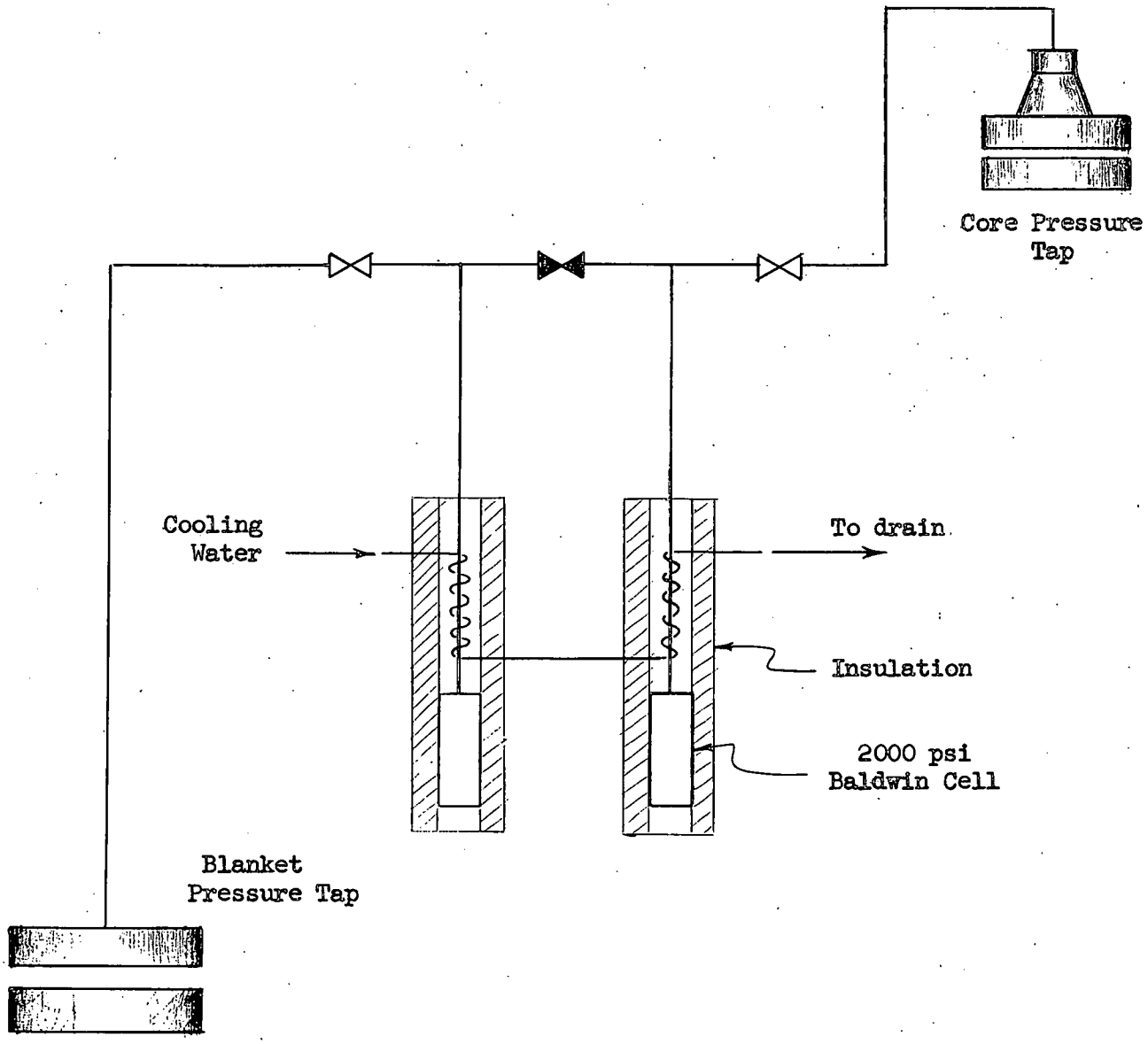

Fig. 1

Installation of
Core and Blanket Pressure Cells

TABLE II

Temperatures to be Recorded During Dumps

Thermocouple TE-	Location	TR-6500 Point No.
182	Fuel pressurizer	10
171	Fuel Heat Exchanger Inlet	12
196	Core Inlet	13
173	Fuel Dump Valve Inlet	14
365	Fuel Dump Valve Exit	15
376	Fuel Dump Tank Evaporator, Lower End	16
391	Fuel Dump Tank Evaporator, Upper End	17
384	Fuel Recombiner	18
873	Fuel Recombiner Condenser Cooling Water out	19
873.1	Fuel Recombiner Condenser Cooling Water in	20
874	Blanket Recombiner condenser Cooling Water out	21
484	Blanket Recombiner	23
476	Blanket Dump Tank Evaporator, Lower End	24
465	Blanket Dump Valve Exit	25
273	Blanket Dump Valve Inlet	26
296	Blanket Inlet	27
271	Blanket Heat Exchanger Inlet	28
296	Blanket Pressurizer	29
183	Fuel Pressurizer	30
167	Fuel Pressurizer Vent Line Inlet	31
174	Fuel Pressurizer Vent Block Valve Inlet	32
387	Fuel Pressurizer Vent Throttle Valve Inlet	34

Table II (Continued)

Thermocouple TE-	Location	TR-6500 Point No.
375-S	Fuel Recombiner	35
475-S	Blanket Recombiner	36
487	Blanket Pressurizer Vent Throttle Valve Inlet	37
274	Blanket Pressurizer Vent Block Valve Inlet	38
267	Blanket Pressurizer Vent Line Inlet	39

Procedure

Test 1. (Dump from 300 psia saturated.) This test is for the purpose of checking out the test procedure and instrumentation and showing up any gross defects in the dump controls. The pressure is chosen low enough so that even if the dump were out of control no damage to the core vessel could result. The detailed procedure to be followed is described below.

1. Load 1300 lb. of distilled water into the fuel dump tanks and 4050 lb of distilled water into the blanket dump tanks.

2. All special instrumentation should be connected and ready to go. The valves whose positions will be recorded during this test are the dump valves, PCV-152 and PCV-252, and the vent throttling valves, PdCV-250A and PdCV-250B.

3. Bring fuel and blanket high-pressure systems up to 214°C and 500 psig by the startup procedure described in the HRT Operator's Manual (Section IV A, steps 1 - 6) with the following modifications:

a. Do not start shield vacuum pump.

b. Jump out shield pressure interlock in circuit 12.

c. Omit steps 2 a./4/ and 2 b./4/ (oxygen addition).

d. Omit step 5 c. (collection of condensate in heat exchangers).

As this will be the first time the system is started up, particular attention should be given to check the operation of all components involved.

4. Several times during pressurization check Baldwin cell pressure readings against each other with the core pressure on both cells. Record results. When system reaches full pressure, set valves so core pressure is on one cell, blanket pressure on the other.

5. When system is at 214°C, turn off pressurizer heaters and reduce pressure by manual operation of vent valves HCV-139 and HCV-239. Use caution in venting to keep core-blanket differential pressure low. Reduce pressure to saturation pressure for main body of liquid in high-pressure system. (This will be about 285 psig.) As the pressure is reduced, undercurrent should cut off the circulating pumps. Fuel circulating pump undercurrent contact in circuit 12 should open, closing HCV-337 and opening HCV-335 and HCV-336. Check this action.

6. Set TR-6500 to repeat banks 1 and 2. Start dump recorders.

7. Open manual dump switch. (Dump timer should be set at minimum possible.)

8. Observe the action of dump interlocks. The following should occur immediately upon opening the dump switch:

a. HCV-139 and HCV-239 open (if not already open).

b. Fuel and blanket feed pumps stop.

c. FCV-929 and FCV-930 open, increasing cooling water flow to fuel and blanket recombiner condensers.

d. FCV-934 closes, blocking high-pressure system cooling water discharge.

e. Steam valves close.

At the end of the delay period (about 10 seconds), the following should occur:

a. Dump valves PCV-252 and PCV-152 open.

b. All purge pumps stop.

c. HCV-335 and HCV-336 close.

d. Recombiner condenser vent valves HCV-344 and HCV-444 close.

e. Cold trap valves close.

9. When the dump is complete, stop all dump recorders.

10. Set valves to put core pressure on both Baldwin cells and record their readings.

11. Remove charts from all dump recorders. Mark each removed chart with "Dump Test No. 1," the date, and the information recorded, e.g., "fuel and blanket dump tank pressures." Also mark which channel on the dual channel charts is the fuel side and which is the blanket side.

Test 2. (Bleed off overpressure, beginning at 600 psia, 214°C.) This test is to follow test 1. The purpose is to check the following:

(a). Simultaneous opening of HCV-139 and HCV-239.

(b). Throttling action of PdCV-250A and PdCV-250B.

(c). Time required to bleed off overpressure.

The detailed procedure for this test is as follows:

1. Disconnect recorder from dump valve position indicators and connect to position indicators on vent block valves, HCV-139 and HCV-239. Position of vent throttling valves will be recorded as in test 1.

2. Repeat steps 3 and 4 of test 1 except this time bring system to 600 psia and 214°C. (Caution: Do not pump relatively cool liquid into high-pressure system while it is still very hot.) Hold pressure vessel wall ΔT to 100°F when pumping up high-pressure system.

3. Jump dump timer contacts in circuit 3a. (This prevents the second stage of the dump from occurring.)

4. Set the temperature scanner to repeat bank 3. Start dump recorders. Mark time index on each chart.

5. Open dump switch.

6. Observe action of dump interlocks. The following should occur upon opening the dump switch:

a. HCV-139 and HCV-239 open.

b. Pressurizer heaters cut off.

c. Fuel and blanket feed pumps stop.

d. FCV-929 and FCV-930 open.

e. FCV-934 closes.

f. Steam valves close.

7. Watch core and blanket pressures. When they level off (at about 285 psig) restore dump switch to closed position.

8. Stop dump recorders.

9. Start feed pumps.

10. Restore pressure. (pressurizer heaters will come on automatically when dump switch is closed.)

11. While raising pressure, compare Baldwin cell readings with same pressure on both. Record both readings at several pressures.

12. When pressure reaches 500 psig, start circulating pumps.

13. Raise pressure and temperature to 600 psia and 214°C in preparation for Test 3.

14. Remove chart records. Mark each chart with "Dump Test No. 2," the date and what quantity is recorded, e.g., "core pressure."

Test 3. (Dump beginning at 600 psia, 214°C). This test is a combination of Test 1 and 2. The dump timers will be set using the information obtained in Test 2 and the system will be permitted to go through a full dump. Procedure is as follows:

1. Set dump timers on basis of results of Test 2.

2. Connect recorder to dump valve position indicators. Vent throttle valve positions will also be recorded.

3. System should be at 600 psig, 214°C. Set valves on Baldwin cells so core pressure is on one, blanket pressure on the other.

4. Remove jumpers from dump timer contacts in circuit 3a.

5. Set the temperature scanner to repeat banks 1, 2 and 3. Start dump recorders. Mark time index on each chart.

6. Open manual dump switch.

7. Observe action of dump interlocks. The following should occur immediately upon opening the dump switch:

a. Vent block valves cut off.

b. Pressurizer heaters cut off.

c. Feed pumps stop.

d. Condenser cooling water increases.

e. FCV-934 closes.

f. Steam valves close.

At the end of thetimer delay, the following should occur:

a. Dump valves open.

b. Purge pumps stop.

c. HCV-335 and HCV-336 close.

d. HCV-344 and HCV-444 close.

e. Cold trap valves close.

8. When the dump is complete, stop all dump recorders. Remove charts and mark properly. (See step 11, Test 1).

Test 4. The principal purpose of this test is to determine the time required to bleed off the overpressure when the system is operating with 100 ppm of oxygen, a temperature of 250°C and a total pressure of 1400 psia. Procedure is much the same as Test 2.

1. Bring the system to desired temperature, pressure and oxygen concentration. Follow same procedure as in step 3, Test 1 except add oxygen to fuel and blanket systems.

2. Carry out step 4, Test 1.

3. Check that both dump timer contacts in circuit 3a are jumped.

4. Set temperature scanner to repeat bank 3. Start dump recorders. Mark time index on each chart. Mark oxygen flow charts also.

5. Open dump switch.

6. Watch core and blanket pressures. When they level off (at about 605 psig) restore dump switch to closed position.

7. Stop dump recorders.

8. Start feed pumps.

9. Bring pressure back up to 1400 psia. (Pressurizer heaters will come on automatically, but set point in pressure controller may need to be retarded to prevent excessive temperatures in heaters.)

10. Put core pressure on both Baldwin cells and record readings at several points while pressure is going up.

11. Remove chart records. Mark each chart removed with necessary information.

Test 5. This is a complete dump from 1400. Procedure is as follows:

1. Set dump timers on basis of results of test 4.

2. Remove jumpers from dump timer contacts in circuit 3a.

3. Check tare settings on dump tank weigh cells, then connect fuel dump tank live weight on one manometer, blanket dump tank live weight on the other.

4. Operate concentrate-dilute switch to bring live weight in fuel dump tanks to 140 lb.

5. Store 400 lb of condensate in blanket condensate tank.

6. Connect recorders to position indicators on dump valves and vent throttling valves.

7. Check Baldwin cells.

8. Set temperature scanner to repeat banks 1, 2 and 3. Start dump recorders. Mark time index on each chart.

9. Open dump switch.

10. Observe and record dump tank live weight manometer readings at 15-sec. intervals from the time the dump switch is opened until there is no more significant change.

11. When the dump is complete, stop all dump recorders. Remove charts and mark properly. (See step 11, Test 1.)

Test 6. This is a repeat of Test 4 with different initial conditions. Initial conditions for this test are to be 100 ppm of oxygen, 280°C and 2000 psia. Venting should continue until the pressure levels off in the neighborhood of 960 psia. Between Test 5 and Test 6, the recorder should be changed from dump valve position to vent block valve position.

Test 7. This is a repeat of Test 5 with different conditions. Reconnect recorder to dump valve position indicator after Test 6. Set dump timer on

basis of results of Test 6. Bring system to 100 ppm oxygen, 280°C and 2000 psia, then go through steps 2 - 11 of Test 5.

Test 8. After the completion of Test 7, let the reactor cool off, then remove the rupture disc assembly. Test 8 will consist of dumping with the core and blanket interconnected. Record dump tank weights before startup when all the water is in the dump tanks. Start up and bring the reactor up to 600 psia and 214°C. In order to duplicate the initial conditions of Test 3, oxygen should not be added. Go through a dump as in Test 3. After the dump is completed, determine and record dump tank weights.

Test 9. This test consists of operating for some time and dumping with the rupture discs removed. Start up and bring the reactor up to 100 ppm oxygen, 200 psia and 280°C. Record dump tank weights before startup and after the operating conditions are reached. Operate for several hours, recording dump tank and condensate tank weights at intervals to determine if there is a significant transfer rate. Note in the Log any difficulties encountered in operating in this fashion. When sufficient information has been obtained at steady operation, go through a dump as in Test 7. After the dump is completed record dump tank and condensate tank weights.

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