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TITLE

PRODUCTION TEST IP-289-I
H REACTOR PROCESS PUMP TRIP-OUT-TEST

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PRODUCTION TEST IP-289-I
H REACTOR PROCESS PUMP TRIP-OUT-TEST

OBJECTIVES

The objectives of this test are to obtain a current knowledge of the H Reactor flow system characteristics under various transient conditions which have a reasonable probability of occurrence. The test data will be used to reevaluate: (1) the H Reactor bulk effluent temperature limits, (2) the margin between the Ball 3X riser pressure trip settings, and (3) the quantitative adequacy of emergency flow available from the combined high tanks export system.

BASIS AND JUSTIFICATION

Changes in reactor flow characteristics and operating levels have out-dated H Reactor flow decay data. These data are used for determining (1) bulk effluent temperature limits (2) Ball 3X riser pressure trip settings, (3) whether emergency water supply from the combined high tanks export system is adequate, and (4) amount of emergency flow required to be supplied by 190 building steam driven pumps.

Power level advancements which result in closer approach to tube boiling during transient flow conditions after BPA electrical failure require more accurate knowledge of this reactor flow transient.

No experimental high tank or export flow data are available for B, D, DR, F and H Reactors. The adequacy of this last-ditch system depends upon the flow capacity of the high tank strainers and the temperature of this high tank water. This test will determine the flow adequacy of the high tank and export system at H Reactor. It is expected that this data will also be applicable to B, D, DR, and F Reactors because of their similarity of last-ditch system equipment and reactor flow characteristics with H Reactor.

TEST SUMMARY

This test will consist of two parts:

- a) Measurement of the flow characteristics during transition from the primary coolant system to the secondary coolant system (190 steam driven pumps.)
- b) Measurement of the adequacy of the last-ditch emergency water system (combined high tanks-export system) during a simulated primary and secondary coolant system failure.

TEST DETAILS AND PROCEDURES

Instrumentation

The following instrumentation will be installed and checked prior to the actual test performance:

DECLASSIFIEDTEST DETAILS AND PROCEDURES (Continued)

1. 190 Building - Visicorder or equivalent high speed recorder will monitor actuation of the reactor safety circuit power loss relays and pump speeds of one near side and one far side process pump. A 60 cycle timing signal and a signal that power has been tripped at the 151 Building will be included with the recorded data.
2. 151 Building - Oscillograph or equivalent recorder at the 151 Building will provide sufficient monitoring of bus conditions that energy loss by the pump - fly wheel - motor complex to loads other than process water pumping can be ascertained.
3. 105 Building
 - A. A calibrated Heise gauge in the control room will be set to read average of A and B riser pressures (Direct reading - not corrected to read TORP.) Motion pictures of this gauge will be obtained during the tests.
 - B. An electric timer supplied by a stable 60 cycle source and three signal lights will be mounted in the control room in such a position that they can be included in the photographs of the Heise gauge used to measure riser pressure. One signal light will be set to go on the instant the power is tripped at the 151 Building; one will be set to go on the instant the LXX relay contacts open in the No. 1 Safety Circuit; the third light will be set to go on the instant PF relay contacts open.

Equipment Change

105 Building - Far Pipe Tunnel - Raw water screens will be replaced (for test only) with eight mesh screens to reduce potential for crossheader screen plugging.

182 Building - Prior to Test II, export surge suppressors will be transferred from normal to emergency power, supplied continuously by the 184 emergency generator during the performance of Test II. Emergency bus will be separated from BPA power during Test II.

Performance of Tests - It is requested that these tests be performed during day shift.

A summarized description of the desired tests is given here. Detailed procedures for conducting the tests will be furnished by the Process Engineer and the Power Engineer at H Reactor.

TEST I: Routine trip-out test required to fulfill Process Standards - Water Plant requirement.

1. H Reactor will have been down at least 24 hours prior to beginning this test. The electric process pumps should be started at least one hour prior to the initiation of Test I to avoid unnecessary time delay between Test I and Test II, and also to allow the process pumps to be restarted immediately if needed. The maximum number of pumps available for service (preferably eight) will be used to supply maximum process flow to the reactor.

DECLASSIFIEDTEST I (Continued)

2. Emergency water supply equipment (high tanks, steam driven turbines, and export system) will be set for automatic operation (normal.) The H Reactor high tanks and export system components may be flushed and tested prior to the beginning of this test.
3. After initial riser pressure, reactor flow, pump speed data etc., is obtained; a coordinator at 151 Building will start a count-down. Recording instrumentation, timers, and cameras will be started; and when the count is completed, BPA power will be separated from the Reactor and Water Plant at the 151 Sub-Station.

Power for test instrumentation and necessary lights will be supplied by special circuit from 151 station service. The emergency bus will not be separated from BPA power during Test I.

4. Reactor flow and pressure will be allowed to decay according to pump fly-wheel characteristics until all flow is provided automatically by steam driven pumps (non-condensing.) At this point, final riser pressures and total flow data will be obtained. This will conclude Test I.

Preparation for Test II

After steady state data is obtained at the conclusion of Test I, additional data concerning a boiler reliability study will be obtained. Briefly, this will consist of returning the steam turbine condensers to service and obtaining steady state flow data in steps with selected steam turbine combinations.* It is estimated that all required supplemental data can be collected in 20 minutes. Six electric pumps will be restarted as power is made available from BPA supply. Riser pressure and reactor flow will be raised in steps, with brief pauses to obtain data correlating riser pressure to reactor flow, to the maximum process flow attainable from six pumps.

Test II: Determination of adequacy of emergency water supply system.

1. When flow is restored to maximum from six pumps, the steam driven pumps will be placed on manual control. They will be de-activated in such a manner that they can be quickly returned to service, if needed.
2. Disconnect power to the Reactor and Water Plant at the 151 Sub-Station as in step 3 of Test I.
3. Reactor process flow will be allowed to decay according to flywheel characteristics until the high-tanks trip in.
4. When the electric process pumps are no longer supplying flow to the reactor, the pump discharge valves will be closed. As BPA power is made available, one or two electric pumps will be restarted and maintained as backup for the duration of the test.

*Steam turbine pumps will be progressively dropped off until a limiting 75 psig TORP is reached.

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Test II (Continued)

4. (Continued)

Steam turbine pumps will be held on ready stand-by service with open discharge valves (control of steam pumps will be such that they can be returned to service within 20 to 30 seconds.) Pressure in steam pump discharge lines will be only that supplied by 190 storage tank head so that check valves in those lines will not open while raw water flow data is being obtained.

5. The high-tank flow will be allowed to decay until export water trips in and steady state flow available from the export system alone is obtained.

High-tank flow decay will be relatively slow; therefore, photographic recordings of riser pressure may be terminated when rate of flow decay permits accurate logging of visual pressure and flow readings.

6. The export system will be supplied by normal pumping compliments (B and/or D) and one additional steam driven supply pump at H. The effect of additional pumping capacity on the raw water system will be evaluated after initial raw water flow data is obtained by reducing the number of pumps supplying system pressure. The H steam driven raw water pump will be the one removed from the export system.
7. Test will be terminated by increasing reactor flow with steam or electrically driven pumps.

Hazards

Flow Continuity - Since the reactor will have been down a specified length of time before the BPA outage tests are performed, there is no danger of a gross reactor incident. At H Reactor, flow from any one of three sources (each high tank or the export system) will be adequate to prevent boiling in process tubes, and it is exceedingly unlikely that all three sources would experience severe screen plugging. If so, the 190 operators will have 17 minutes to provide steam turbine pump flow (three pumps) to the reactor.

In the unlikely event of unexpected total flow loss during the tests, prompt, corrective action can prevent slugs from reaching temperatures which affect subsequent proneness to rupture. In the worst case, slug jacket melting temperatures will not be reached if flow and pressure are restored within the following schedule:

10,000 gpm or 24 psi TORP within 17 minutes.

As a precaution, the outlet temperatures of 25 high power, high exposure tubes will be monitored (fast scanning) during transient and low flow stages of the tests. A tube outlet temperature in excess of 60°C will be cause for terminating that portion of the test and increasing reactor flow to at least 24 psig TORP.

DECLASSIFIEDHazards (Continued)

Direct communications between the 105 and associated 190 building control rooms will be maintained continuously during transient and low flow conditions. Should such communications fail, Power personnel will raise flow to 10,000 gpm.

Export system surge suppressors will cycle upon loss of electrical power; to avoid damage to the export system, the surge suppressors should be valved off during the brief time when BPA and 184 generator power is unavailable on Test I. (During Test II the suppressors will remain in service powered by 184 generator.)

Equipment and Safety Circuit - Filtered and raw water contains some suspended particles; therefore, a thorough check of the Panellit system for tube inlet plugging will be made before reactor startup.

Performance of this Production Test involves (1) connecting temporary leads from data recorders to critical components of H Reactor's safety circuits, and (2) running potentially dirty water through high tank and export system screens. Specific checks of the reactor emergency equipment will be made after the test is over and test leads have been removed, to ensure that emergency equipment functions as required for reactor safety. The following checks will be made:

1. Safety Circuit

- A. Check that test leads have been removed from LXX relay, 105 PF relay, and 190 power failure safety circuit.
- B. Make up the #1 Safety Circuit and check that tripping any relay which was wired into at 105 and 190 and monitored during the trip-out test actuates the #1 Safety Circuit.
- C. Check that actuation of a 151 bus under-voltage relay trips the #1 Safety Circuit.
- D. Check that a Panellit gauge will trip the #1 Safety Circuit.
- E. Check that the flux monitors will trip the #1 Safety Circuit.

2. Screens

- A. High Tank - After trip-out-test is completed and high tanks refilled, flush the high-tank discharge lines. Check that screens in service (not standby) have less than 4 psi pressure drop as specified in Process Standard A-080, HW-46000 H. Switching screens is appropriate to obtain clean screens in service. If standby screens are dirty, as determined by pressure drop greater than 4 psi, clean standby screens before startup if shutdown time permits, otherwise clean them on the next minimum outage.
- B. Raw Water - After trip-out-test is completed, replace raw water test screens with those required by Process Standard 190-B-010, HW-27155 Rev1. When raw water service is returnable within 45 minutes, startup may be made, other conditions permitting.

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Personnel - All employees and visitors in the area should be informed of the tests to avoid mishaps and injuries during the partial blackout periods.

PROCESS STANDARDS

Standard A-080, Process Standards - Reactor, HW-46000 H

The requirement that one full or two half-full high tanks be maintained during shutdown is waived during Test II.

The requirement that high tank strainers must be switched if pressure drop exceeds 4 psi is waived for Test II.

The requirement that raw water be used to cool the reactor only under emergency conditions is waived for Test II.

Standard 190-B-010, Process Standards - Water Plant, HW-27155 Rev1.

Raw water screen specifications are waived for Test II.

Standard 190-B-070, Process Standards - Water Plant, HW-27155 Rev1.

The requirement that Power must immediately restore riser pressure after loss of power to electric pumps during shutdown is waived for performance of these tests. The requirement that riser pressure be maintained above boiling suppression values except when lower pressures are requested by 105 supervisor is also waived.

SCHEDULE

The tests will be performed as scheduled by H Reactor Operation. It is requested that the tests be completed during the next scheduled outage (about November 5, 1959.) If this schedule cannot be met, a special outage, no more than two weeks after this date, should be taken to accomplish the purpose of this test.

It is estimated the the tests will not require more than five hours of additional shutdown time.

COSTS

- A. Production - Approximately five hours lost production will be associated with this test.
- B. Equipment and Maintenance - Approximate total cost is estimated to be \$2,000. These costs will be divided as follows:
 - 1. Approximately one-third will be provided by H Reactor Operation.
 - 2. Approximately two-thirds will be provided by Research and Engineering Section and will be sub-divided between Process and Reactor Development Sub-Section and Process Technology Sub-Section.

RESPONSIBILITY

Project Engineering: Will be responsible for directing test preparations, and for over-all coordination of the test.

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RESPONSIBILITY (Continued)

- H Reactor Operation: Will be responsible for the detailed scheduling of this test and for operational safety and production continuity of the reactor.
- H Power Operation : Will be responsible for supplying the required pumping conditions during this test, maintaining reliable steam supply and steam pump backup, and for detailed test procedures that concern test operations by Power personnel.
- H Processing Operation : Will be responsible for monitoring tube and bulk outlet temperatures during the testing program, maintaining communications, and for returning the system to full backup flow whenever this appears necessary during the test.
- Process Engineering: Will be responsible for observing test preparation, preparing Unit detailed 105-H Building test procedures and the selection of the 25 tubes for continuous (fast scan) temperature monitoring during the tests.
- Utilities Operation: Will be responsible for performing the actual trip of BPA power from the process pumps and for restoring power to the busses as promptly as possible consistent with obtaining good test results and following normal procedures for adding loads to the HAP0 loop.
- Plant and Industrial Engineering Sub-Section Will be jointly responsible with Reactor Engineering Unit (PAROSS) for interpretation of test results and for publishing a test report.
- Reactor Engineering: Will be jointly responsible with Plant and Utilities Engineering Sub-Section for interpretation of test results and for publishing a test report. Unit
- Process Technology : Will be responsible for the test procedures being within the Sub-Section broad intent of applicable Process Standards and that deviations from specific requirements (necessary for this test) are listed in this Production Test.
- Plant and Industrial Engineering Sub-Section : Will be responsible for furnishing instrumentation for obtaining test data, preparing test procedures for that portion related to boiler performance, and supporting the costs associated with the boiler reliability study being conducted at 184 during the course of this trip-out test.

S. S. Jones, Engineer
Reactor Engineering

J. T. Long, Engineer
Process Standards

M. A. Clinton, Engineer
Process Engineering

SSJ:JTL:MAC:gf

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