REV. 1

DATE 5/5/79

EMERGENCY PROCEDURE EP- 6

TITLE: REACTOR COOLANT PUMP SEAL FAILURE

APPROVALS: PORC(Vice-Chairman) N.H. Williams DATE 5/9/79

UNIT SUPT.: G.A. Kuehn DATE 5/9/79

B&W Bill Robinson DATE 5/11/79 NRC Frank Orr DATE 5/11/79

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REACTOR COOLANT PUMP SEAL FAILURE

1.0 Symotoms

The pump performance parameters which indicate a pump/seal is approaching a failure condition are as follows:

1.1 Frame vihration exceeds 5 mils - or

1.2 Shaft vibration exceeds 30 mils - and

1.3 The sum of unner seal leakage and seal return flow increases to greater than 1.9 GPM - or

1.4 The sum of unper seal leakage and seal return flow exceeds seal injection flow.

Additional parameters which may indicate a seal is approaching a failure condition are as follows:

1.5 RCS pressure decreasing.

1.6 Makeuo tank level or PZR level decreasing.

1.7 Seal return line temperature increasing to near system temperature.

Seal cavity instrumentation readings will indicate seal failures as discussed below:

1.3 Seal failure indications

1.3.1 Assuming seal cavity instrumentation is working properly, the following conditions will indicate that two seals have failed and the one remaining is functional. Under these conditions, total leakage should be no greater than 1.8 GPM.

Case No. 1:
Pump is idle or running with the seal return line valve open.

A. Uoner and middle seals failed.
Upper and lower seal cavity pressure will be less than one-tenth of system pressure.

B. Lower and middle seals failed.
The upper and lower seal cavity pressure will be greater than nine-tenths of system pressure.

C. Upper and lower seals failed.
The upper seal cavity pressure will be less than one-tenth of system pressure and the lower seal cavity pressure will be greater than nine-tenths of system pressure.

Case No. 2:
The seal return line valve is closed. The pump should be idle as the pump should not be running with the return line valve closed.

A. Upper and middle seals failed.
The upper and lower seal cavity pressure will be less than one-tenth of system pressure.

B. Lower and middle seals failed.
This condition cannot be determined by reading seal cavity pressure. The upper and lower seal cavity pressure will be greater than nine-tenths of system pressure. This is the same as would be indicated for all seals intact.

C. Upper and lower seals failed.
The upper seal cavity pressure will be less than one-tenth of system pressure and the lower seal cavity pressure will be greater than nine-tenths system pressure.

1.8.2 The following conditions will indicate a single seal failure. Under these conditions, total leakage should not be greater than 1.35 GPM. A seal is considered failed when the ΔP of that seal is less than one-tenth of system pressure.

Case No. 1:
The seal return line valve is open.

A. Upper seal failed.
The upper cavity pressure will be less than one-tenth system pressure.

B. Middle seal failed.
The lower cavity pressure minus the upper cavity pressure is less than one-tenth system pressure.

C. Lower seal failed.
The system pressure minus the lower seal cavity pressure is less than one-tenth system pressure.

Case No. 2:
The seal return line is closed.

A. Upper seal failed.
The upper cavity pressure will be less than one-tenth system pressure and the lower seal cavity pressure will be approximately one-half system pressure.

B. Middle seal failed.
Cannot be determined by reading seal cavity pressure because the pressure indication will be the same as for no failed seals or the lower seal failed.

C. Lower seal failed.
Cannot be determined by reading seal cavity pressure because the pressure indication will be the same as for no failed seals or the middle seal failed.

1.8.3 The following conditions will indicate that all three seals are leaking. Heavy reliance must be placed upon the upper seal leak meter.

Case No. 1:
The seal return line is open.

A. The sum of the seal return flow and the upper seal leakage is greater than 1.9 GPM. Under this condition, seal cavity pressure readings may be meaningless.

B. Pump shaft vibration exceeds 30 mils.

C. Seal return line temperature increases to near system temperature.

Case No. 2:
The seal return line is closed.
Same as Case No. 1 above.

2.0 Immediate Actions

2.1 Automatic Actions

2.1.1 None.

2.2 Manual Actions

2.2.1 If the operating RCP exhibits the following failure modes and backup RCP's are available, trip the affected RCP and refer to EP-32, Rev. 2 steps 5.1, 5.2 (except 5.2.1), and 5.3, and 5.4.

A. When frame vibration exceeds 5 mils - or

B. Shaft vibration exceeds 30 mils - and

C. Upper seal leakage and seal return flow increases to greater than 1.9 GPM. - or

D. Upper seal leakage and seal return flow exceeds seal injection flow.

2.2.2 If an operating RCP exhibits the following failure modes and backup RCP's are not available, trip the affected RCP and refer to EP-32, Rev. 2 steps 5.1, 5.3, and 5.4.

A. Shaft vibration exceeds 70 mils - or

B. Upper seal leakage exceeds MU system capability to maintain RC system water level.

2.2.3 If no RCP's are operating and the plant is in natural circulation, no immediate action is required upon detection of RCP seal failure(s).

3.0 Supplementary Actions

NOTE: The objectives of the Supplementary Actions are to maintain an adequate reactor coolant inventory and pressure. With no reliable pressurizer level indication, however, reactor coolant inventory cannot be directly measured or determined during a loss of RCP seal event. The operator should utilize makeup as necessary to maintain RC pressure constant or slightly increasing. This should maintain inventory and slowly fill the pressurizer. As the pressurizer becomes almost full, the operator may have to throttle down on makeup flow to keep pressure from increasing. The final objective is to arrive at a full pressurizer (solid) condition at a controlled pressure with makeup flow exactly equal to seal leakage plus letdown.

If, by maintaining a constant or slightly increasing RC pressure, pressurizer level is still decreasing, this will be indicated as follows when the pressurizer heaters are uncovered:

(1) Rapid superheating of the pressurizer steam volume as indicated by a sudden increase in the pressurizer temperature RTD readout; or

(2) A deviation from the null value being trended on the low level brush recorder in the control room.

If this occurs, secure all pressurizer heaters and increase makeup flow to keep the heaters covered. When there is again indication that the heaters are covered, re-energize the heaters as necessary per 3.1.1 below.

As an aid to determining and trending pressurizer level, calculate pressurizer level using the DVM method of EP-21 Section 4.8 as conditions permit.

3.1 If the RCP seal failure causes leakage that is less than the capacity of 1 MU pump, proceed as follows:

3.1.1 If the loss of a RCP seal results in a decreasing pressurizer level or reactor coolant system pressure, verify MU-V18 is open. Maintain pressure constant or slightly increasing with MU-V17 (Note: MU-V17 may be in manual). Adjust pressurizer heaters to maintain a pressurizer water temperature corresponding to the saturation pressure being controlled to.

3.1.2 If pressurizer level continues to decrease, open DH-V-5A. Jog open MU-V16A and/or MU-V16B to compensate for the leak. (Note: Borated water is now being drawn from the BWST).

3.1.3 Monitor makeup tank level and pressure. If makeup tank level approaches 30" after DH-V5A is opened, cycle MU-V12 closed as necessary to maintain makeup tank level above 30". The makeup pump minimum recirculation line will increase makeup tank level with MU-V12 closed. If makeup tank level becomes too high, adjust by cycling MU-V12 and DH-V5A as necessary. At no time should makeup tank pressure vs. level be allowed to exceed that shown on Enclosure 1.

CAUTION: When the low level alarm is reached on MUT level (55") MU-V12 should be shut. As level increases, MU-V12 should be reopened at the high level alarm (86").

3.2 If RCP seal leakage is greater than the capacity of one (1) makeup pump, proceed as follows:

3.2.1 If required, start the second HPI pump (MU-P-1A) and continue to throttle MU-V16A and B.

CAUTION: When operating a MU/HPI pump, a minimum total flow of 100 GPM and maximum flow of 500 GPM per pump must be observed. Adjust the flow by using valves MU-V16A and B for MU-P-1A and 1B.

3.2.2 If the BWST level becomes low (10 feet) and the MUT level remains low (30 inches), water supply to the makeup pumps must be shifted to the RB sump as follows: (lineup given for "A" DH train which must be used to supply water to the suctions of MU-P-1A & MU-P-1B).

NOTE: Concurrence should be received from R. C. Arnold or J. G. Herbein prior to opening DH-V6A. Opening this valve and providing makeup water from the RB sump should be considered only if all other methods to provide RC makeup have been exhausted.

NOTE: Notify H.P. prior to commencing operation of the DH system off the RB sump. This operation will substantially change the radiation dose rates and contamination potential in the Auxiliary Building.

3.2.2.1 Open DH-V6A.

3.2.2.2 Open DH-V102A.

3.2.2.3 Start DH-P-1A.

3.2.2.4 Open or check open DH-V128A.

3.2.2.5 Open DH-V7A.

3.2.2.6 Shut DH-V5A.

3.2.2.7 Close MU-V36 and MU-V37 to stop MU pump recirculation.

CAUTION: When the low level alarm is reached on MUT level, MU-V12 should be shut. As level increases, MU-V12 should be reopened at the high level alarm.

NOTE: In this lineup, the DH pump is supplying RB sump water to the makeup pump suctions for high pressure injection into the RCS.

3.2.3 After RCS pressure decreases to 300 psig, throttle HPI discharge flow by throttling MU-V16A/B and change the lineup to normal LPI as follows:

3.2.3.1 Open DH-V4A.

3.2.3.2 Verify flow in the DH system and adjust flow with DH-V128A.

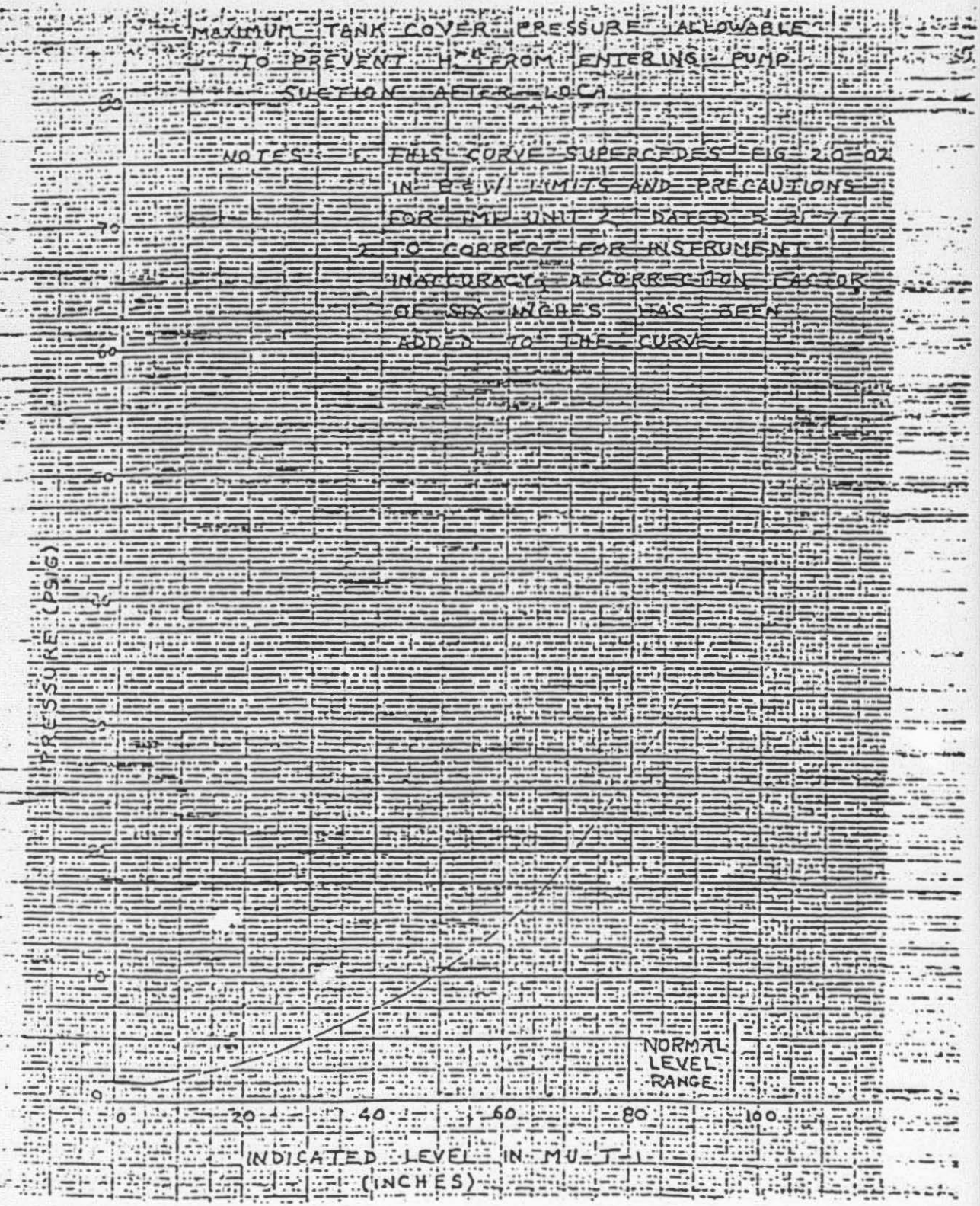
3.2.3.3 Stop the High Pressure Injection Pumps.

3.2.3.4 Close MU-V16A/B and MU-V17 (HPI flow valves).

3.2.3.5 Close DH-V7A from the LPI pump discharge.

NOTE: Injection flow path is now as follows: Spill coolant to RB sump, RB sump to LPI pump, LPI pump to RCS via DH-V4A.

3.2.3.6 Remain in this cooling configuration until BWST can be refilled, then evaluate whether or not to reinitiate HPI.


MAXIMUM TANK COVER PRESSURE ALLOWABLE
TO PREVENT H2 FROM ENTERING PUMP
SUCTION AFTER LOCA
NOTES 1. THIS CURVE SUPERCEDES FIG 2.0-02
IN P&W LIMITS AND PRECAUTIONS
FOR MP UNIT 2 DATED 5-21-77
2. TO CORRECT FOR INSTRUMENT
INACCURACY, A CORRECTION FACTOR
OF SIX INCHES HAS BEEN
ADDED TO THE CURVE
PRESSURE (PSIG)
70
60
50
40
30
20
10
0
NORMAL
LEVEL
RANGE
0
20
40
60
80
100
INDICATED LEVEL IN MU-T
(INCHES)