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Office of Nuclear Reactor Regulations
Attn: John F. Stolz, Chief
Operating Reactors Branch No. 4
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Sir:

Three Mile Island Nuclear Station, Unit 1 (TMI-1)
Operating License No. DPR-50
Docket No. 50-289
EFW-LOFW Analysis

In supplement to our responses of February 4, 1983 (83-040), March 22, 1983 (83-055) and December 9, 1983 (83-0349) and to our discussions with members of your staff on April 23, 1984, enclosed please find the revised results of our analysis for the determination of the minimum EFW flow for a seismic event with loss of feedwater (LOFW) transient. This revised analysis indicates that 350 gpm EFW will safely shutdown the unit with RC pump heat subject to a 20 minute delay in delivery of EFW to the steam generators.

Tests performed in cold shutdown extrapolated to hot conditions demonstrate that 400 gpm is available under worst case seismic events. A summary of the calculations of the extrapolation to hot conditions is also enclosed.

Detailed calculations, which were reviewed by M. Caruso (NRC) at TMI-1, have been revised to include the friction characteristic of the as-built (as-installed) EFW cavitating venturi. The revised calculations continue to indicate that one (1) EFW pump can deliver 400 gpm to two (2) OTSG's under hot conditions with the pump recirculation line open.

Sincerely,

H. D. Hukill
VP-TMI-1

cc: R. Conte
J. Van Vliet
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Seismic Event with Loss of Feedwater

Assumption

a. Only one (1) EFW pump (motor driven available)

b. 350 gpm EFW delivered to the OTSGs due to EFW pump recirculation back to condensate storage tank (EFV-8 A/B/C locked open) following a 20 minute delay.

c. Reactor at 102% of 2535 MWt at start of event.

d. HPI automatic initiation at 1600 psig.

e. Reactor coolant pumps heat included (16 MWt).

f. 1.2 ANS 1972 decay heat assumed.

Results

- PORV lifts about 7 minutes after the start of the event and operates cyclically for about 40 min.

- The RC becomes saturated and the safety valves lift about 15 minutes after the start of the event and operate cyclically for about 10 min.

- Pressurizer goes solid in 12 minutes.

  (Safety valve operation and capacities for LOFW (Tave = 650°F, Prcs = 2500 psig) are enveloped by EPRI test program for steam/water).

- No core uncovery (minimum inventory of 7340 ft^3).

- HPI is automatically initiated at about 140 minutes into the event.

- No Departure from Nucleate Boiling (DNB) during any phase of the transient.

- RCS Pressure does not exceed 110% of design pressure.

It should be noted that this analysis for LOFW is conservative in that no credit is taken for the following TMI-1 system features and procedural requirements:

o Operator starting the EFW pumps on LOFW

o Manual action on loss of heat sink

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An additional case assuming trip of the reactor coolant pumps at loss of subcooling was conducted. The results show a much earlier HPI initiation (about 60 minutes into the event) and greater water inventory (8000 ft^3 min)

- o Operator actions to treat loss of heat transfer
  - HPI initiation
  - tripping of two RCPs
  - Opening of the PORV at 2300 psi pressure
- o HPI initiation upon loss of subcooling margin

Emergency Feeedwater (EFW) System

Determination of EFW Motor Driven Pump capacity by cold test and calculated extrapolation to "Hot" Conditions (i.e., OTSG at 1050 psig).

- Reason for running "Cold" in lieu of "Hot" test
  - Heat source during HFT is limited to energy input from 4 RC pumps (16 MW)
  - This heat is removed by supplying approximately 100 gpm EFW
  - Severe transients in RCS due to addition of 400 to 500 gpm EFW is main concern
- Cold Test Methodology
  - Test procedure selected was TP 233/3
  - TP 233/3 Purposes:
    a. Check EFW Annubar instrumentation and EFW flow indications
    b. Check performance of EFW cavitating venturis
    c. Get data for EFW pump performance
  - Test Procedure:
    a. Feed one (1) OTSG with one (1) motor driven EFW pump
       - Pump recirculation line closed (allows suction flow indicating switch to be used as flow data point)
       - EFV-30 valve throttled
       - Record flows (annubar & suction flow indication), OTSG level change and system pressures
    b. Feed one (1) OTSG with two (2) motor driven EFW pumps
       - Pump recirculation line closed
       - EFV-30 valve wide open (in order to measure maximum cavitation flow through cavitating venturis)
       - Record flows (annubar & suction flow indication), OTSG level change and system pressures
    c. Repeat a & b, above for other OTSG
       - Calculated extrapolation

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a. Determine EFW pump flow from test data

1. As measured by EFW pump suction flow indication
2. As measured by annubar
3. As calculated by OTSG level change (wide & operating range)
4. As inferred from cavitating venturi expected performance formula.

b. Calculate average of flows in a.

c. Plot average flow and pump discharge pressure, i.e., pump system head-flow graph. Discharge pressure used includes a correction for the difference between the indicated pump discharge pressure, PX-67/PX-68, and the discharge header pressure, PI-476/PI-477 which is higher. PX-67/PX-68 read low because of friction drop due to bearing cooling flow.

d. Plot additional pump performance points from TP 273/3 test program (run in 1973-74)

e. Superimpose resulting system pump head curve (actual pump performance) on calculated system resistance curves for condition of one (1) EFW pump feeding two (2) OTSGs under "hot" conditions with pump recirculation line open

f. Intersection of actual system pump head curve with calcuated "hot" system resistance is extrapolated flow.

NOTE: Comparison of actual test data with calculated system resistance for the portion of the system from the EFW pump discharge to the cavitating venturi shows good correlation of data with calculation. Friction drop through the cavitating venturi and downstream pipe to OTSG is accounted for by calculation. Pipe loss is calculated using Crane Tech. Paper No. 410; venturi unrecovered loss is calculated using vendor data for the as-built, as-installed venturi.

Extrapolated performance shows that one (1) EFW pump can deliver 400 gpm to two (2) OTSGs under hot conditions with pump recirculation line open.