GPU NUCLEAR

GPU Nuclear, Inc.
Route 441 South
Post Office Box 480
Middletown, PA 17057-0480
Tel 717-944-7621

November 12, 1999

1920-99-20573

U.S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555

Ladies and Gentlemen:

Subject: Three Mile Island Nuclear Station, Unit 1 (TMI-1)
Operating License No. DPR-50
Docket No. 50-289
Generic Letter 81-14 Supplemental Response – Emergency Feedwater System Evaluation for Loss of Feedwater or Small Break Loss-of-Coolant Accident Following a Seismic Event

This letter provides the results of a reevaluation of the TMI-1 Emergency Feedwater System (EFWS) flow requirements for mitigation of a postulated Loss of Feedwater (LOFW) or Small Break Loss-of-Coolant Accident (SBLOCA) following a seismic event. The TMI-1 EFWS pump flow requirements for these NRC Generic Letter (GL) 81-14 events were updated to incorporate 20% average steam generator tube plugging (SGTP), the current licensed power level of 2568 MWt, the existing automatic safety grade initiation and control of the EFWS by the Heat Sink Protection System (HSPS), and proceduralized operator actions (LOFW event only).

The results of the analyses show that acceptable EFW pump performance for GL 81-14 events is less challenging than the pump performance required for the TMI-1 UFSAR Chapter 14 LOFW and SBLOCA events. The TMI-1 UFSAR Chapter 14 LOFW and SBOCA analyses were reviewed and approved by the NRC as part of TMI-1 Technical Specification Amendment No. 214. The minimum pump hydraulic performance criteria, reviewed as part of Amendment No. 214, remains bounding. Actual pump performance demonstrated during testing, exceeds the test criteria. The TMI-1 13R outage Technical Specification surveillance test results for the EFW pumps, as documented in GPU Nuclear letter to the NRC, dated October 21, 1999 (1920-99-20561), confirmed that these bounding EFW hydraulic acceptance criteria were met.

A001

NRC GL 81-14, dated February 10, 1981 required an assessment of the seismic capability of plant auxiliary feedwater systems. GPU Nuclear did not credit the turbine-driven EFW pump, and committed to mitigate the GL 81-14 LOFW or SBLOCA event following a seismic event with a single active failure. This resulted in one (1) motor-driven EFW pump (NRC SER dated August 12, 1983). GPU Nuclear responses to GL 81-14 dated December 9, 1983 and June 6, 1984 provided the results of the TMI-1 LOFW and SBLOCA analyses, based on these assumptions. These previous analyses indicated that 350 gpm total EFW flow to the steam generators would mitigate the event. The previous analysis of GL 81-14 remained conservatively bounding following installation of the safety grade HSPS in Cycle 6R.

GPU Nuclear has reevaluated the TMI-1 response to the GL 81-14 LOFW and SBLOCA events following a seismic event and a single active failure of one (1) motor-driven EFW pump to accurately reflect the current plant configuration, power levels, regulatory limits and operator response to such an event. This reevaluation demonstrates that a total EFW flow of 314 gpm to both steam generators is adequate to mitigate either event. A tabulation of the assumptions used and the results of this reevaluation are provided in Attachment I to this letter.

The motor-driven pump hydraulic performance for the GL 81-14 events was compared to the TMI-1 UFSAR Chapter 14 LOFW limiting hydraulic requirements (i.e. 275 gpm at 2662 feet, or 1149.3 psid, total dynamic head). This limiting requirement was based on two EFW pumps providing EFW flow to both steam generators at 1050 psig. Given this minimum pump performance requirement, RELAP-5 predicted that the hydraulic performance of one (1) MDP providing EFW flow to both steam generators at 1050 psig would result in a total flow of 315 gpm (for steam generators at 1075 psig, a total flow of 298 gpm is predicted). For the GL 81-14 reanalysis, the motor-driven pump was assumed to deliver a total of 314 gpm flow to the steam generators at 1050 psig.

For the GL 81-14 LOFW reanalysis, acceptable results were obtained with the MDP delivering a total of 314 gpm flow to the steam generators at 1050 psig and 297 gpm to the steam generators at 1075 psig. The analysis demonstrated that the event acceptance criteria were met (i.e. no core uncovery, the reactor coolant system does not exceed 110% design pressure conditions, and no departure from nucleate boiling). Therefore, the TMI-1 UFSAR Chapter 14 LOFW hydraulic performance is the most limiting and continues to establish the acceptance criteria for the motor-driven EFW pumps.

Attachment II provides Framatome Technologies, Inc. (FTI) calculation Summary Report No. 86-5002073-03, dated October 15, 1999, as requested by NRC. This report provides the original TMI-1 SBLOCA analyses of record supporting the 20% SGTP amendment analyses. Appendix A to this FTI report demonstrates acceptable SBLOCA/seismic reevaluation at 314 gpm total EFW flow to the steam generators for GL 81-14. As described in Appendix A, FTI performed the reanalysis with full HPI flow (2 pumps) consistent with the previous GL 81-14 analysis with acceptable results. The analysis demonstrated that the event acceptance criteria were met (i.e. no core uncovery, and the reactor coolant system peak pressure remains below the pressurizer safety valve setpoint). Although not required for this event, FTI also performed a sensitivity analysis assuming one (1) HPI pump and a reduced EFW flow of 314 gpm to the steam generators. That sensitivity analysis showed that the Appendix K criteria are met. However, the analysis provided in support of the TMI-1 20% SGTP amendment (included in Attachment II) remains the analysis of record in accordance with 10 CFR 50.46 and 10 CFR 50 Appendix K.

In summary, the GL 81-14 commitment to adequately mitigate a LOFW or SBLOCA following a seismic event is maintained with a reduced EFW flow to the steam generators of 314 gpm. The pump performance required to deliver EFW flow during these events is bounded by the minimum EFW pump hydraulic performance criteria documented in Technical Specification Amendment No. 214, dated August 19, 1999.

If any additional information is needed, please contact Mr. David J. Distel, Nuclear Licensing and Regulatory Affairs at (973) 316-7955.

Sincerely,

James W. Langenbach

James W. Langenbach
Vice President and Director, TMI

/DJD
Attachments: 2

cc: Administrator, Region I
TMI-1 Senior Project Manager
TMI-1 Senior Resident Inspector
File No. 98195

1920-99-20573

METROPOLITAN EDISON COMPANY

JERSEY CENTRAL POWER AND LIGHT COMPANY

PENNSYLVANIA ELECTRIC COMPANY d/b/a

GPU ENERGY

GPU NUCLEAR, Inc.

Three Mile Island Nuclear Station, Unit 1
Operating License No. DPR-50
Docket No. 50-289
Generic Letter 81-14 Supplemental Response

COMMONWEALTH OF PENNSYLVANIA)
) SS:
COUNTY OF DAUPHIN)

This additional information is submitted in support of Three Mile Island Nuclear Station, Unit 1 response to NRC Generic Letter 81-14. All statements contained in this submittal have been reviewed, and all such statements made and matters set forth therein are true and correct to the best of my knowledge.

BY: James W Langenbach
Vice President and Director, TMI
GPU Nuclear, Inc.

Sworn and subscribed before me this

12 day of November, 1999.

Linda C. Witter
Notary Public

Notarial Seal
Linda C. Witter, Notary Public
Londonderry Twp. Dauphin County
My Commission Expires Sept. 25, 2000
Member, Pennsylvania Association of Notaries

Attachment I

Small Break Loss-of-Coolant Accident (SBLOCA) Following a Seismic Event

Assumptions:*

1. Only seismically capable EFW pumps available with a single active failure resulting in one(1) motor-driven pump operating
2. 314 gpm EFW is delivered to the OTSGs
3. EFWS automatically initiated by safety grade HSPS system on low OTSG level
4. Higher EFW flows resulting from lower OTSG pressures were not credited
5. Reactor at 102% of 2772 Mwt at start of event
6. Full HPI flow (2 pumps) initiated on low RCS pressure
7. 20% average steam generator tube plugging

Summary Results:*

1. Core remains covered throughout the transient with two (2) HPI pumps available for SBLOCA's significantly influenced by EFW flow.
2. RCS peak pressure remains below the pressurizer safety valve setpoint

*For detailed discussion of assumptions and results refer to FTI Report 86-5002073-03, dated October 15, 1999.

Attachment I (continued)

Loss of Feedwater (LOFW) Following a Seismic Event

Assumptions (See Table 1):

1. Only seismically capable EFW pumps available with a single active failure resulting in one (1) motor-driven pump operating.
2. EFWS automatically initiated by safety grade HSPS system on low OTSG level
3. HPI flow (2 pumps) initiated on loss of sub-cooling margin (Procedures ATP1210-2 and 1210-10). Two HPI pumps are assumed to be available since the worst single active failure, the failure of 1 EFW pump, has already been assumed with offsite power available.
4. 20% average steam generator tube plugging
5. Main feedwater was assumed to be lost in 2.0 seconds.
6. 1 RC pump per loop was tripped by operator action at 10 minutes (Abnormal Transient Procedure 1210-4).
7. All RCPs were tripped on loss of sub-cooling margin with a 2-minute delay (ATP 1210-2 and 1210-10).

Results:

A seismic event is assumed to occur while the reactor is at full power, steady-state operation resulting in a loss of feedwater to the SGs in 2.0 seconds. The loss of flow to the OTSGs causes an immediate reduction in OTSG inventory as shown on Figure 1. The loss of inventory in the tube region causes a reduction in heat transfer from the RCS causing temperature in the hot and cold legs to increase as shown on Figures 2 and 3.

Increasing RCS temperatures increase RCS liquid volume and, therefore, pressurizer level (Figure 4). Increasing level compresses the pressurizer steam bubble, increasing RCS pressure (Figure 5) until the reactor trips on the high RCS pressure trip signal at about 14 seconds (Figure 6). Reactor trip also initiates a turbine trip, so that steam flow out of the OTSGs is reduced, as is heat removal. Reactor power does not get higher than the initial value of 102% of 2568 MWt, and so thermal power will not exceed this value (Figure 6).

EFW is initiated when the OTSG low level setpoint (including instrument error) is reached, which occurs at about 50 seconds (Figure 8). A 20-second delay is assumed after the low level setpoint is reached, and so EFW is assumed to start delivering flow to the OTSGs at about 70 seconds. This is conservative, since the MDP can deliver flow as early as 15 seconds. Also as mentioned above, only one (1) seismically capable EFW MDP is assumed available in the analysis, and the total flow assumed to be delivered is shown in Table 3. As seen from Table 3, the EFW flow is modeled as a function of OTSG pressure (Figure 7). The OTSG pressure oscillates between the open and close setpoints of the small safety valve (including 3% setpoint error) as shown on Figure 9. The last column in Table 3 is the predicted flow from one (1) EFW MDP to both OTSGs (at 1065 psia). The predicted flowrate is based on a characteristic curve that passes through the single pump flow requirement (275 gpm/pump @ 2662 ft.) for the TMI-1 UFSAR Chapter 14 events which requires a total delivered flow of 550 gpm to both OTSGs (at 1065 psia). As seen from Table 3, the EFW flow assumed in this GL 81-14 analysis is less than the predicted flow. Therefore, the curve assumed for the TMI-1 Technical Specification Amendment No. 214 analyses bounds the curve assumed for the GL 81-14 analyses.

The EFW flow initially is not sufficient to remove decay and pump heat, and the system pressurizes with pressure relief through the pressurizer safety valves as shown on Figure 5. The PSVs cycle repeatedly as the increasing RCS temperature continues to increase the RCS pressure. At about 250 seconds, the pressurizer goes water solid (Figure 4). At 10 minutes, the operator is assumed to trip one (1) RC pump per loop to reduce the pump heat (Figure 11). At about 1070 seconds, the sub-cooling margin drops below 17°F (Figure 10). The operator initiates HPI and trips the remaining two (2) RCPs on a loss of sub-cooling margin. The RCP trip is conservatively assumed to be delayed by 2 minutes (Figure 11). With the cooling effect of HPI and without the RC pump heat, the heat transfer to the secondary is sufficient to balance the decay heat and the RCS temperatures begin to decrease (Figures 2 and 3). The cycling of the PSVs is becoming less frequent as seen on Figure 5. The RCS hot leg temperature reaches a peak value of about 648°F at 1066 seconds. However, the peak average metal temperature is 644°F as shown on Figure 12. No voids develop in the primary. Without the RCPs, RCS flow in the primary is maintained by natural circulation as seen in Figure 11. The peak RCS pressure (in the lower plenum) of 2660 psia is well below the acceptance criteria of 2765 psia. The sequence of events is shown on Table 4.

Based on these results, a total delivered EFW flow rate of 314 gpm to the OTSGs at 1065 psia is acceptable for mitigating this Generic Letter 81-14 event.

TABLE 1
SUMMARY OF ANALYSIS INPUT VALUES

PARAMETER	ANALYSIS VALUE
HFP BOC Moderator Temperature Coefficient, pcm/°F	0.0
HFP BOC Doppler Coefficient, pcm/°F	-1.17
HFP Delayed Neutron Fraction, β_{eff}	0.007
PSV Capacity, lbm/hr/valve	297,846
PSV Setpoint Drift, %	3
Initial Core Power, MWt	2619.36 (102% of 2568)
Decay Heat model	ANS 1979
Decay Heat multiplier	2 sigma
High Flux Trip, percent full power	112
High Flux Trip Delay Time, sec	0.4
High RCS Pressure Trip, psia	2402
High RCS Pressure Trip Delay Time, sec	0.6
RCS Inlet Temperature, °F	555.7
Initial RCS Pressure psia	2170
RCS Flow Rate, Mlbm/hr	133.8
EFW Flow Rate	Table 3
EFW initiation setpoint	10 ins
EFW Temperature, °F	135
HPI Initiation signal	LSCM
Initial Presssurizer Level, inches	232
RC Pump Trip initiation	LSCM
RC Pump Trip Delay time, sec	120
Subcooling margin (including error), °F	17

TABLE 2

SEISMIC LOFW ANALYSIS DESCRIPTION

Description	GL 81-14 (1984)	Re-analysis
Computer Software	CSMP	RETRAN
Initiating Condition	LOFW	LOFW
Feedwater Coastdown Time	0 s	2s
Reactor Trip	Simultaneous with LOFW	2402 psia
EFW Initiation	Manual @ 20 m	Auto @ Lo Lvl of 10 in
EFW Flow @ 1065 psia	350 gpm total	314 gpm total
RC Pumps	Not tripped	2 tripped at 10 minutes and 2 tripped on LSCM with a 2 minute delay
HPI Initiation	On low system pressure of 1600 psig	On LSCM
Reactor Power	102% of 2535 MWt	102% of 2568 MWt
EFW Temp	120F	135F
Offsite Power	Available	Available
Decay Heat	ANS 1971 (1.2 multiplier)	ANS 1979 (2 sigma multiplier)

TABLE 3

EMERGENCY FEEDWATER SYSTEM EVALUATION FOR GL 81-14

PUMP COMBINATION	OTSG PRESSURE PSIA		NET ASSUMED FLOW TO OTSG, GPM		TOTAL ASSUMED FLOW FOR GL 81-14, GPM	TOTAL PREDICTED FLOW[1], GPM
	A	B	A	B		
1 Motor Driven Pump	1065	1065	157	157	314	315
	1090	1090	148.5	148.5	297	298

[1] 1. The characteristic pump curve used in the TMI-1 Technical Specification Amendment No. 214 (20% tube plugging) analysis provides these flowrates. These flowrates bound those assumed for the GL 81-14 events.

Table 4

Sequence of Events Seismic LOFW

Event	Time, seconds
LOFW initiated	0.0
Main feedwater flow reaches zero	2.0
RCS high pressure trip setpoint reached	14.03
Turbine trip	14.53
PSV lift (first)	16.26
Peak RCS pressure (2659.83 psia)	17.0
OSTG low level setpoint reached	50.21
EFW flow initiated	70.21
Pressurizer goes water solid	253.0
1 RC Pump per Loop tripped – Operator action	600.0
Peak RCS hot leg temperature (648.47 °F)	1066.0
Loss of SCM (below 17°F)	1070.45
HPI initiated	1070.45
RC Pumps tripped on LSCM	1190.45
End of transient	1500.0

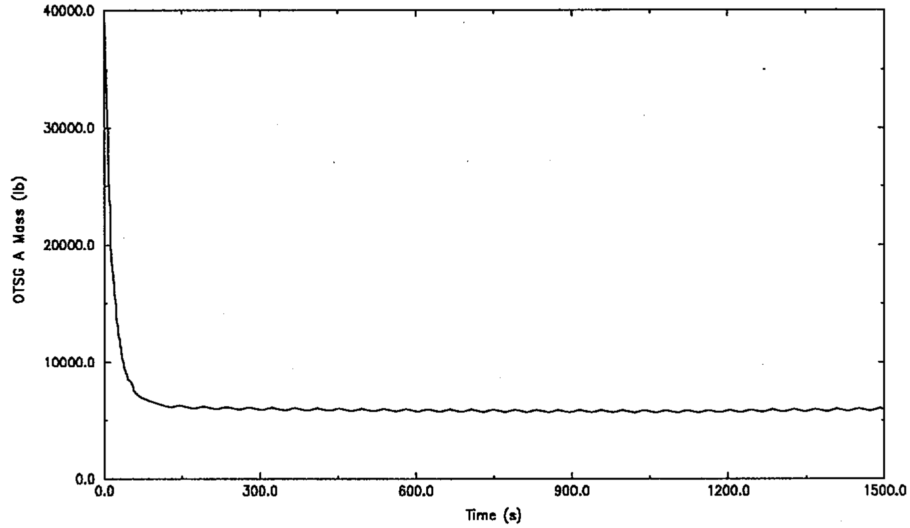

Figure 1: OTSG A Mass For LOFW At 2568MWt

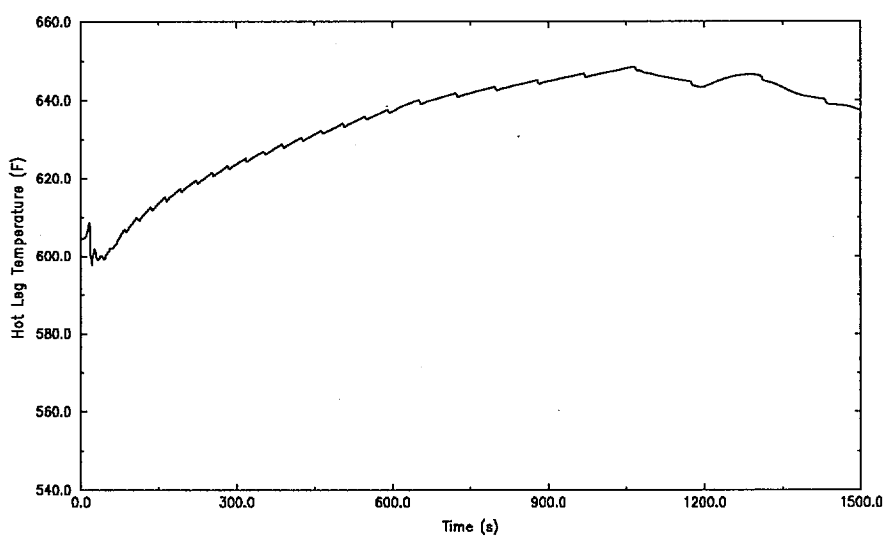

Figure 2: Hot Leg RCS Temperature for LOFW At 2568MWt

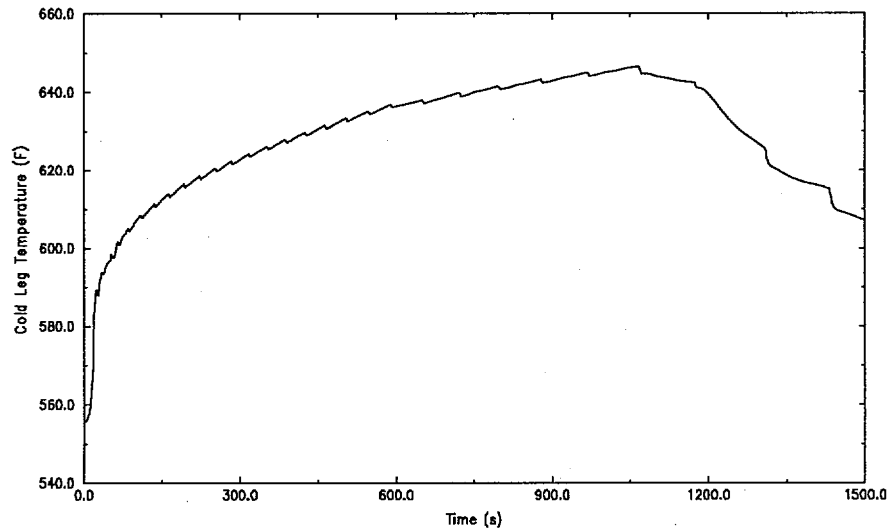

Figure 3: Cold Leg RCS Temperature for LOFW At 2568MWt

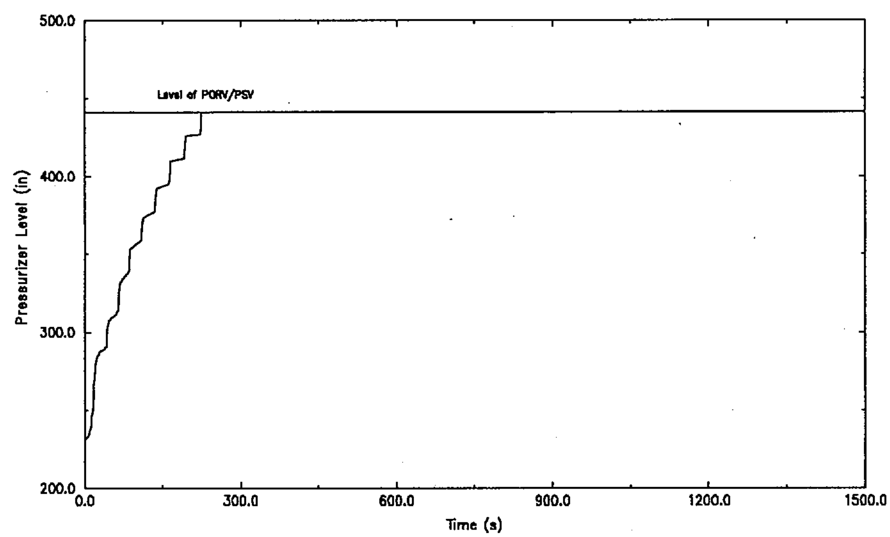

Figure 4: Pressurizer Level for LOFW At 2568MWt

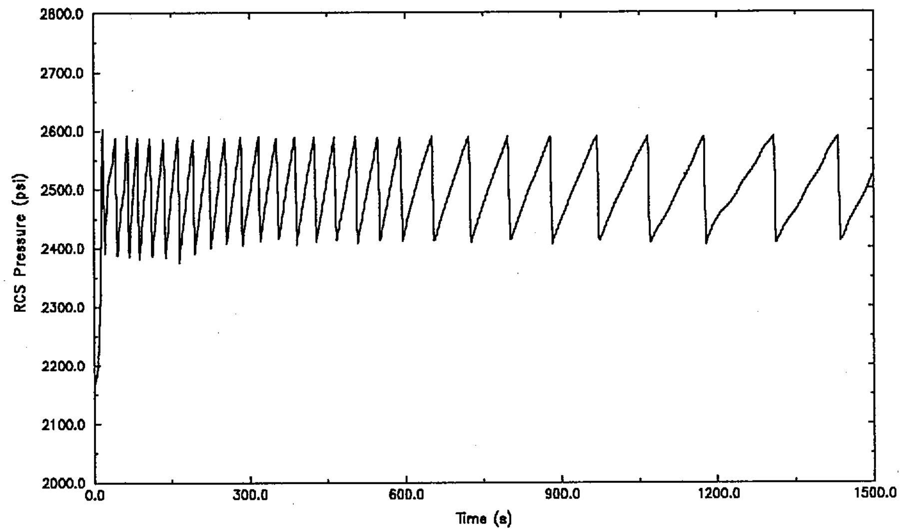

Figure 5: Hot Leg RCS Pressure for LOFW At 2568MWt

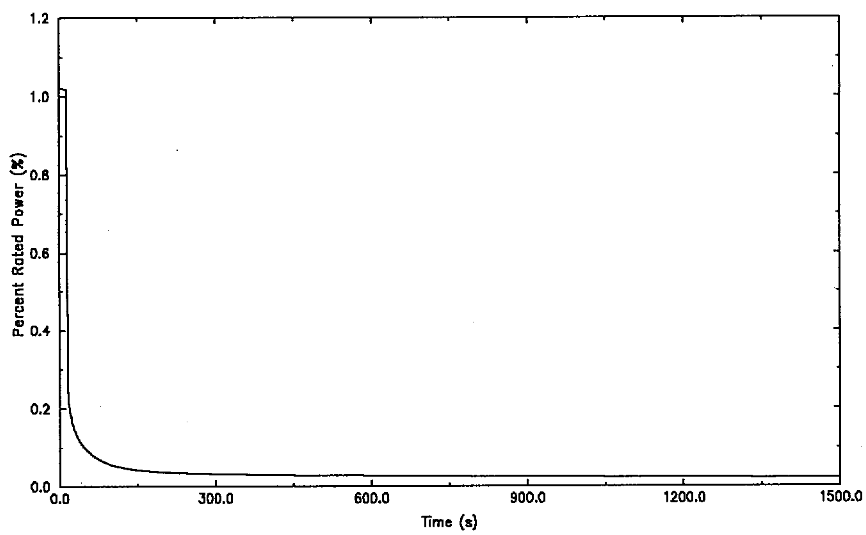

Figure 6: Percent of Rated Power for LOFW At 2568MWt

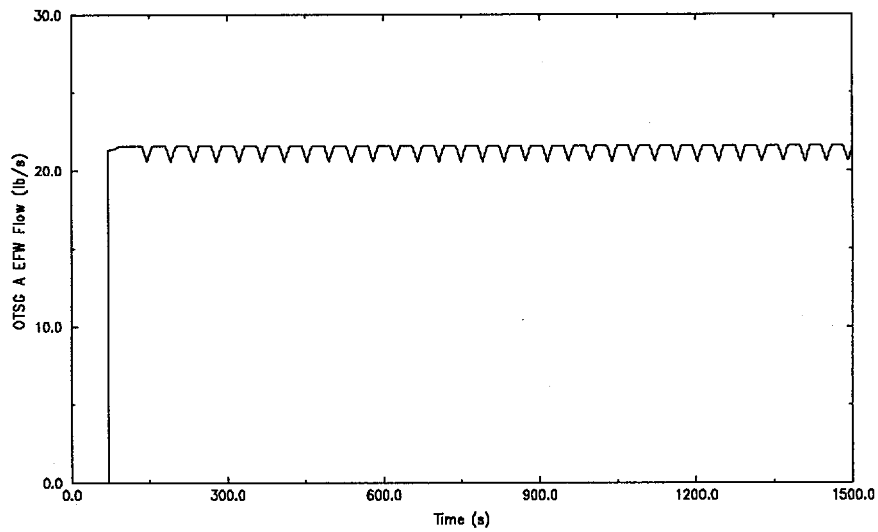

Figure 7: OTSG A EFW Flow for LOFW At 2568MWt

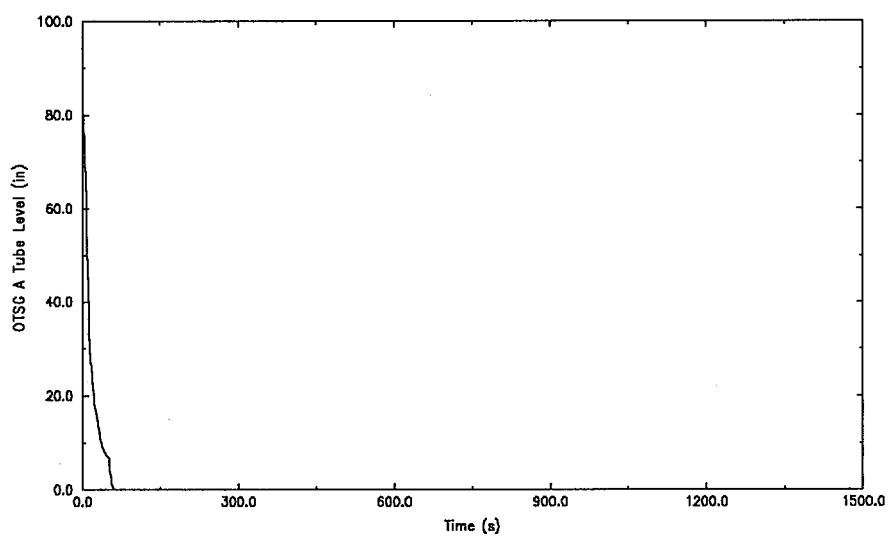

Figure 8: OTSG A Tube Level for LOFW At 2568MWt

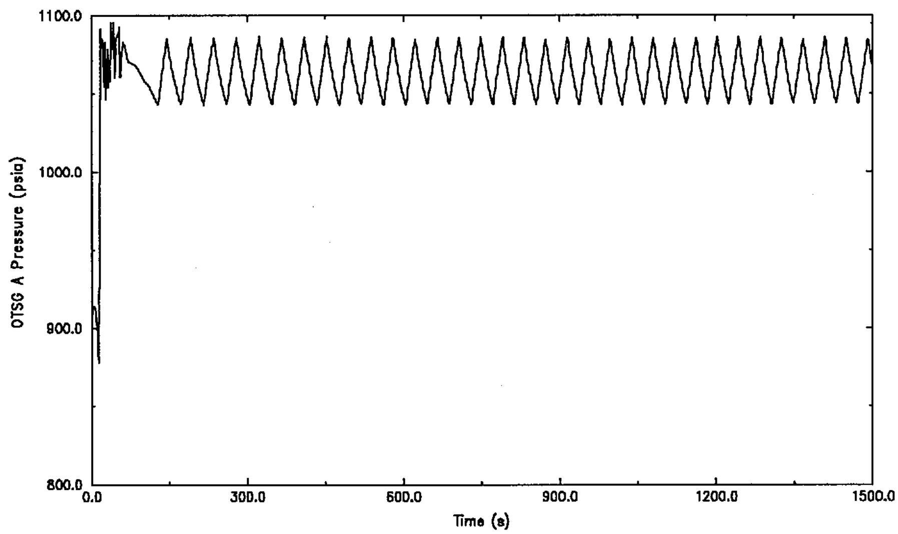

Figure 9: OTSG A Pressure for LOFW At 2568MWt

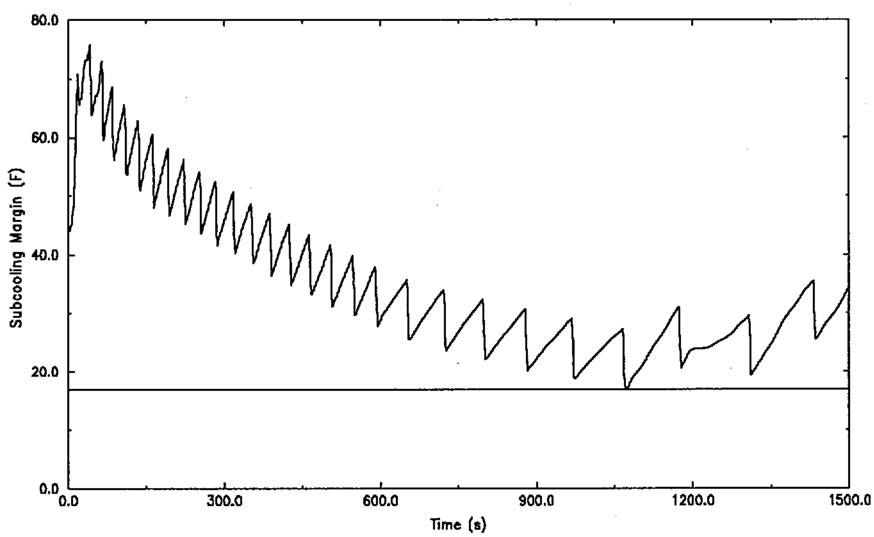

Figure 10: Subcooling Margin for LOFW At 2568MWt

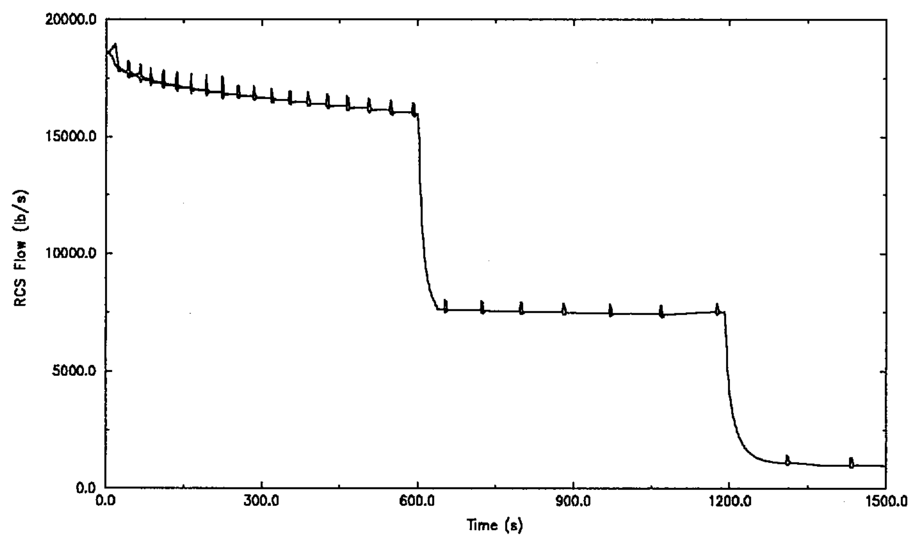

Figure11: RCS Flows for LOFW At 2568MWt

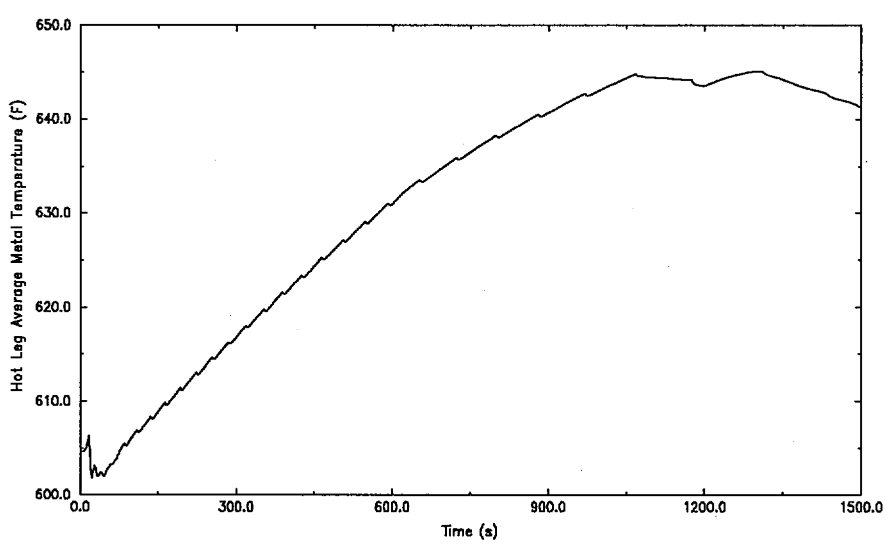

Figure 12: Hot Leg Average Metal Temperature for LOFW At 2568MWt

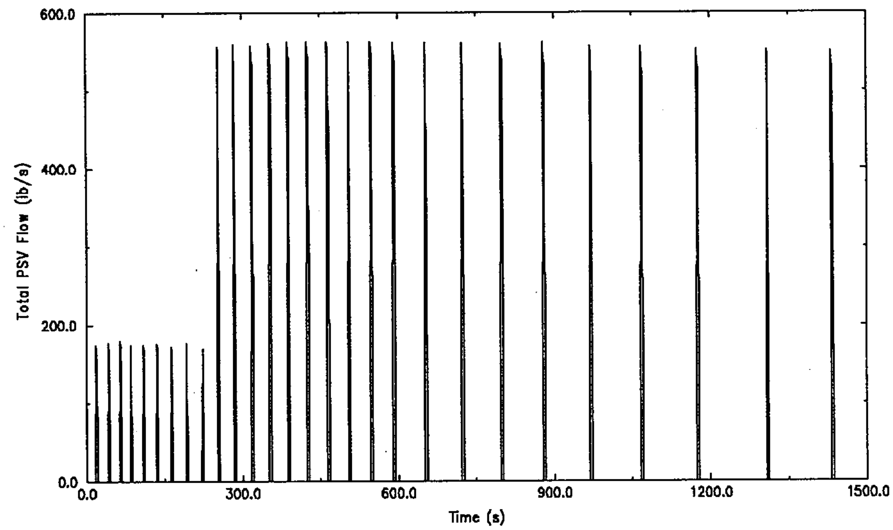

Figure 13: Total Flow through Pressurizer Safety Valves for LOFW At 2568MWt

Attachment II

Framatome Technologies, Inc.
Report No. 86-5002073-03