

LICENSEE EVENT REPORT (LER)

(See reverse for required number of digits/characters for each block)

Estimated burden per response to comply with this mandatory information collection request: 50 hrs. Reported lessons learned are incorporated into the licensing process and fed back to industry. Forward comments regarding burden estimate to the Records Management Branch (T-6 F33), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, and to the Paperwork Reduction Project (3150-0104), Office of Management and Budget, Washington, DC 20503. If an information collection does not display a currently valid OMB control number, the NRC may not conduct or sponsor, and a person is not required to respond to, the information collection.

FACILITY NAME (1) THREE MILE ISLAND, UNIT 1		DOCKET NUMBER (2) 05000289	PAGE (3) 1 OF 9
--	--	-------------------------------	--------------------

TITLE (4)
POTENTIAL LOSS OF HIGH PRESSURE INJECTION DURING POSTULATED LOSS OF COOLANT ACCIDENT DUE TO MISAPPLICATION OR INTERPRETATION OF DESIGN INPUTS

EVENT DATE (5)			LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	MONTH	DAY	YEAR	FACILITY NAME	DOCKET NUMBER
08	20	98	98	-- 09 --	00	09	18	98	FACILITY NAME	DOCKET NUMBER

OPERATING MODE (9) N	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more) (11)			
POWER LEVEL (10) 100	20.2201(b)	20.2203(a)(2)(v)	50.73(a)(2)(i)	50.73(a)(2)(viii)
	20.2203(a)(1)	20.2203(a)(3)(i)	50.73(a)(2)(ii)	50.73(a)(2)(ix)
	20.2203(a)(2)(i)	20.2203(a)(3)(ii)	50.73(a)(2)(iii)	73
	20.2203(a)(2)(ii)	20.2203(a)(4)	50.73(a)(2)(iv)	OTHER
	20.2203(a)(2)(iii)	50.36(c)(1)	X 50.73(a)(2)(v)	Specify in Abstract below or in NRC Form 366A
20.2203(a)(2)(iv)	50.36(c)(2)	50.73(a)(2)(vii)		

LICENSEE CONTACT FOR THIS LER (12)

NAME BOB KNIGHT, TMI LICENSING ENGINEER	TELEPHONE NUMBER (Include Area Code) (717) 948-8554
--	--

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO EPIX	CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO EPIX

SUPPLEMENTAL REPORT EXPECTED (14)		X NO	EXPECTED SUBMISSION DATE (15)	MONTH	DAY	YEAR
YES (If yes, complete EXPECTED SUBMISSION DATE).						

ABSTRACT (Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines) (16)

On August 20, 1998 TMI-1 was operating at 100% power. In response to a question during an NRC inspection, it was recognized that operation within Makeup Tank (MUT) pressure and level limits may not prevent gas entrainment in the Makeup & Purification/High Pressure Injection (MU/HPI) Pumps during a postulated Loss of Coolant Accident with the most limiting single failure. This condition was reportable in accordance with 10 CFR 50.72(b)(2)(iii) and 10CFR 50.73(a)(2)(v) as "a condition that alone could have prevented the fulfillment of a safety function." The root cause of this event was misapplication or interpretation of design inputs. Analytical assumptions used for MU/HPI Pump gas entrainment limits are very conservative. Although the analysis assumes no operator action, operators would be alerted to the problem by an alarm or by verifying equipment operation following an Emergency Safeguards (ES) actuation. There would be at least one hour for operator action to either shut down a MU/HPI Pump, add water to the MUT, or isolate the tank before gas entrainment of the pump would occur. A revised operating limit was implemented immediately and the MUT pressure and level limits analysis was revised. Processes are being reviewed to determine the need for additional guidance.

9809280021 980918
PDR ADOCK 05000289 PDR
S

**REQUIRED NUMBER OF DIGITS/CHARACTERS
FOR EACH BLOCK**

BLOCK NUMBER	NUMBER OF DIGITS/CHARACTERS	TITLE
1	UP TO 46	FACILITY NAME
2	8 TOTAL 3 IN ADDITION TO 05000	DOCKET NUMBER
3	VARIES	PAGE NUMBER
4	UP TO 76	TITLE
5	8 TOTAL 2 FOR MONTH 2 FOR DAY 4 FOR YEAR	EVENT DATE
6	9 TOTAL 4 FOR YEAR 3 FOR SEQUENTIAL NUMBER 2 FOR REVISION NUMBER	LER NUMBER
7	8 TOTAL 2 FOR MONTH 2 FOR DAY 4 FOR YEAR	REPORT DATE
8	UP TO 18 -- FACILITY NAME 8 TOTAL -- DOCKET NUMBER 3 IN ADDITION TO 05000	OTHER FACILITIES INVOLVED
9	1	OPERATING MODE
10	3	POWER LEVEL
11	1 CHECK BOX THAT APPLIES	REQUIREMENTS OF 10 CFR
12	UP TO 50 FOR NAME 14 FOR TELEPHONE	LICENSEE CONTACT
13	CAUSE VARIES 2 FOR SYSTEM 4 FOR COMPONENT 4 FOR MANUFACTURER EPIX VARIES	EACH COMPONENT FAILURE
14	1 CHECK BOX THAT APPLIES	SUPPLEMENTAL REPORT EXPECTED
15	8 TOTAL 2 FOR MONTH 2 FOR DAY 4 FOR YEAR	EXPECTED SUBMISSION DATE

LICENSEE EVENT REPORT (LER)
TEXT CONTINUATION

FACILITY NAME (1)	DOCKET (2)	LER NUMBER (6)			PAGE (3)
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	
THREE MILE ISLAND, UNIT 1	05000289	98	-- 009	-- 00	2 OF 9

TEXT (If more space is required, use additional copies of NRC Form 366A) (17)

POTENTIAL LOSS OF HIGH PRESSURE INJECTION DURING A POSTULATED LOSS OF COOLANT ACCIDENT DUE TO MISAPPLICATION OR INTERPRETATION OF DESIGN INPUTS

I. Plant Operating Conditions before Event:

TMI-1 was operating at 100% reactor power.

II. Status of Structures, Components, or Systems that were Inoperable at the Start of the Event and that Contributed to the Event:

None. This event did not involve degraded or failed plant equipment.

III. Background:

The Makeup & Purification/High Pressure Injection (MU/HPI) System depicted in Figure 1 provides the operational support function of Reactor Coolant System (RCS) chemistry and volume control as well as the Emergency Core Cooling System (ECCS) function of HPI. The MU Pumps are normally lined up to take suction from the Makeup Tank (MUT). When engineered safeguards (ES) actuates, the Borated Water Storage Tank (BWST) outlet to MU/HPI suction header isolation valves, MU-V-14A and MU-V-14B, are opened automatically. The MUT outlet to the MU/HPI suction header isolation valve, MU-V-12, is not an engineered safeguards (ES) valve and thus remains open following an ES actuation.

Prior to October 1997, the MU/HPI suction header was maintained as two separate headers by normally closed isolation valves, MU-V-69A/B, between the suctions of "B" & "C" MU/HPI pumps, MU-P-1B/C.

In April 1997, the NRC Inspection Report (IR) for the NRC AE Design Inspection 50-289/96-201 identified concerns with the supporting analysis for the MU tank pressure limit in Open Item (OI) 96-201-04. Those concerns included whether the input assumption used for HPI flow was appropriately conservative. The analysis at the time of the design inspection assumed that the limiting case for the gas entrainment concern would occur with three HPI pumps operating, the MU suction cross connect valves closed between MU-P-1B/C, and therefore two HPI pumps taking suction through one of two MU-V-14 valves, MU-V-14-A/B. The analysis was questioned because if Makeup Pump MU-P-1C failed to start, the flow rate through MU-V-14A would be higher and therefore the MU/HPI suction header pressure and MU tank outlet pipe pressure would be lower. The MUT gas entrainment limit is based on the limiting MU/HPI suction header pressure. In response to this concern and others, the analysis which establishes the MUT pressure

LICENSEE EVENT REPORT (LER)
TEXT CONTINUATION

FACILITY NAME (1)	DOCKET (2)	LER NUMBER (6)			PAGE (3)
THREE MILE ISLAND, UNIT 1	05000289	YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	3 OF 9
		98	-- 009	-- 00	

TEXT (If more space is required, use additional copies of NRC Form 366A) (17)

and level limits was revised during the summer of 1997.

In addition, during the summer of 1997, in response to several concerns,¹ GPU Nuclear was evaluating a procedure change to require that all MU/HPI suction cross connect valves be normally open during plant operation.

As part of the task to revise the MUT pressure limit analysis, GPU Nuclear reevaluated which scenario would produce the limiting MU pump suction header pressure. Engineering was aware of the proposed procedure change to open the suction header cross connect valves and considered alternative scenarios with a common suction header. The analysis was revised based on the assumption that the limiting case is where two MU/HPI pumps were operating, the suction cross connect valve is closed (either between Makeup Pump "A" & "B" or between Makeup Pump "B" & "C") and the pump (either MU-P-1A or MU-P-1C respectively) fails to start. This case was considered to be more limiting than the case with a common suction header and all three Makeup Pumps operating. The revised analysis (C-1101-211-E610-066 Rev 0) was issued in October 1997.

A 10 CFR 50.59 safety evaluation (SE 000211-015 Rev 0) was prepared for the proposed change in the normal MU system lineup permitting both sets of pump suction cross connect valves open. The evaluation considered the effects on safety of operating with a common MU/HPI suction header compared to operation with isolated sections of the MU Pump suction header. The evaluation concluded that the analysis which established the operating limit to prevent gas entrainment would continue to be valid and was not adversely affected by operation with a common suction header.

The revised MUT pressure and level limits and the revised MU&P System normal lineup with MU Pump suction cross connect valves open were implemented by an operating procedure change during the TMI-1 Cycle 12 Refueling (12R) Outage (September - October, 1997).

IV. Event Description:

On August 20, 1998 it was recognized that operation within the defined operating limit for MUT pressure may not prevent the gas pressure within the MUT from expanding into the suction header of the MU/HPI Pumps for all postulated design basis scenarios.

In August 1998, an NRC inspection team was reviewing the resolution of the open items identified in the design inspection report. On August 19, 1998 one of the inspection team members

¹ Other concerns stemmed from LER 97-03 "Potential Overpressurization Of Makeup Pump Suction Piping Due To Inadequate Test And Operating Procedures," two NRC design inspection open items (96-201-02 and 96-201-03), and a recommendation from the "TMI Unit-1 Probabilistic Risk Assessment (PRA)," November, 1987.

LICENSEE EVENT REPORT (LER)
TEXT CONTINUATION

FACILITY NAME (1)	DOCKET (2)	LER NUMBER (6)			PAGE (3)
THREE MILE ISLAND, UNIT 1	05000289	YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	4 OF 9
		98	-- 009	-- 00	

TEXT (If more space is required, use additional copies of NRC Form 366A) (17)

postulated a scenario which had the potential to produce a more restrictive gas entrainment limit and questioned whether that scenario was required by the TMI-1 licensing basis. The new scenario assumed off site power was not lost, all three MU/HPI Pumps were operating in response to a Large Break Loss of Coolant Accident (LBLOCA), both sets of MUHPI suction cross connect valves were open, and one of the MU/HPI suction isolation valves from the BWST (MU-V-14A/B) failed to open. GPU Nuclear considered this issue and concluded that it was a valid scenario (i.e. only a single failure was assumed). The issue was entered into the Corrective Action Process (CAP) on August 20, 1998 as CAP# T1998-0695. That same day, the Plant Review Group (PRG) was convened to review the operability and reportability implications. The PRG concluded that based on the present operating conditions the MU/HPI pumps were operable but procedures would permit operation outside of the operating envelope for MUT pressure and level calculated to accommodate the scenario now postulated.

The PRG determined that based upon the information available at that time that the existing procedural limits on MUT pressure and level would not ensure that the MU Pumps remained operable under all postulated design basis accident scenarios. Therefore, this condition was reported via the NRC Emergency Notification System (ENS) as "a condition that alone could have prevented the fulfillment of a safety function" in accordance with 10 CFR 50.72(b)(2)(iii) and a written report is required in accordance with 10CFR 50.73(a)(2)(v).

V. Component Data:

There were no component failures applicable to this licensee event report.

VI. Identification of Root Cause

The root cause of this event has been categorized as "a misapplication or interpretation of design inputs." The preparer and the reviewers of the safety evaluation failed to recognize that the limiting single failure was not assumed in the gas entrainment analysis and that such an assumption was required if the MU/HPI System lineup were revised to operate with a common MU/HPI suction header.

VII. Assessment of the Safety Consequences and Implications of the Event:

In summary, the MUT pressure was outside of the revised operating limits for a small fraction of the operating time (< 3%). If a LOCA had occurred during those limiting times, then it is very likely that the event conditions would not require any additional actions to avert gas entrainment. However, if the specific single failure and other limiting initial conditions occurred as described

LICENSEE EVENT REPORT (LER)
TEXT CONTINUATION

FACILITY NAME (1)	DOCKET (2)	LER NUMBER (6)			PAGE (3)
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	
THREE MILE ISLAND, UNIT 1	05000289	98	-- 009	-- 00	5 OF 9

TEXT (If more space is required, use additional copies of NRC Form 366A) (17)

above, there is a high confidence that operator actions would successfully avert gas entrainment since the indications, time and tools would be available.

The operating limits for the MUT are provided to operators in the form of two curves. There is an upper limit to prevent gas entrainment (GE) and a lower limit to ensure design MU pump NPSH (see the "GE Limit Oct 97" and "NPSH Limit" curves in Figure 2). To simplify the operators task and provide additional margin of safety, the procedures specify that pressure and level should be maintained within an operating box as shown on Figure 2. The operating box is more conservative than the operating limit curves. The gas entrainment limit during the period from October 1997 through August 20, 1998 was based on an analysis which had not evaluated the case with all three MU/HPI Pumps operating and failure of MU-V-14A or MU-V-14B to open. When the appropriate case was analyzed on August 20, 1998 the operating limit was reduced (see the "GE Limit Aug98" curve in Figure 2).

An otherwise unrelated issue, which effects the probability of occurrence of MU Pump gas entrainment was considered by the GPU Nuclear PRG on September 4, 1998. The MUT level instrument calibration was reviewed in May 1997. At that time, an error was identified in the transmitter elevation correction used in the calibration. The effect of this error on the safety significance of the improper gas entrainment operating limit is shown on Figure 2 as "GE Limit AUG98 special." This curve shows the effect of the 1.25" level instrument calibration shift, discounted by the removal of an additional 1 psig of pressure instrument error normally included in the operating limit. It can be seen that this issue (calibration shift) had little safety significance.

The operating history (a data point for each 4 hours of operation shown as on Figure 2) was reviewed and it was determined that operation in the region where gas entrainment may have occurred, given the revised accident scenario, was limited to less than 3% of the time.

It is noteworthy that the analytical assumptions used for MU Pump [BQ/P]* gas entrainment limits are very conservative. The analysis assumes no operator action. In the postulated accident scenario where the safety function of the MU/HPI Pumps could have been threatened, gas entrainment would not have occurred until after the BWST [BP/TK] had reached its minimum level. This would allow the opportunity for prudent operator action to avert gas entrainment. The time available for these compensating actions would be expected to be much greater than one hour for events where continued HPI operation is required. For the largest Small Break Loss of Coolant Accidents (SBLOCAs), e.g., a Core Flood Line Break, it is expected that HPI would be turned off prior to reaching the minimum BWST level. Only for significantly smaller breaks would HPI remain operating after the BWST switchover point. For those "significantly smaller" break sizes, the BWST drawdown time is much greater than one hour.

In addition to having the time to perform compensating actions, the equipment needed to perform these actions can be expected to be operable. The limiting scenario for the MUT analysis assumes offsite power is available. Therefore, the Balance of Plant (BOP) equipment used to add water to

LICENSEE EVENT REPORT (LER)
TEXT CONTINUATION

FACILITY NAME (1)	DOCKET (2)	LER NUMBER (6)			PAGE (3)
THREE MILE ISLAND, UNIT 1	05000289	YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	6 OF 9
		98	-- 009	-- 00	

TEXT (If more space is required, use additional copies of NRC Form 366A) (17)

the MUT or isolate the tank suction (by closing MU-V-12) would have electrical power. When ES actuates, the proper operation of all actuated components is verified by the operator. If MU-V-14-A/B [BQ/V] failed to open as postulated, operators would attempt to open the valve and could be expected to take other compensatory actions such as closing the MUT outlet isolation valve (MU-V-12) or turning off the third MU/HPI Pump. In accordance with alarm response procedures, operators would attempt to maintain MUT level using the redundant MUT [BQ/TK] level indicators [BQ/LI] in response to the associated alarms [BQ/LA]. The normal addition source from a Reactor Coolant Bleed Tank (RCBT) is capable of adding water to the MUT at a sufficient rate to avoid gas entrainment for those events where HPI would be required.

VIII. Previous Events of a Similar Nature:

LERs since 1988 were reviewed and the following two were identified:

- A. LER 96-002-01 "Potential Loss of ECCS Pump Suction in the Accident Analysis Due to Failure to Recognize the Effect of Lower Reactor Building Pressure."
- B. LER 97-009-00 "Engineering Analysis of the Loss of 'A' Train DC Power with a Loss of Offsite Power and a Loss of Coolant Accident."

These events have the common error that design inputs were misapplied in the preparation of safety analyses to ensure proper ECCS operation.

IX. Corrective Actions:

A. Actions taken:

1. CAP T1998-0695 was initiated and the potential operability implications were discussed with the operating staff. The control room staff supervision were directed to avoid operation in the disputed region of the operating envelope pending a PRG determination.
2. A revised operating limit to prevent Makeup Pump gas entrainment during the postulated accident scenario was implemented immediately after the PRG meeting. Temporary Procedure Change (TCN) 1-98-0082 to operating procedure 1104-2 "Make Up and Purification System" was implemented on August 20, 1998.
3. MUT pressure and level limits analysis in support of the temporary procedure change was revised in Calculation C-1101-211-E610-066, Rev 2, dated September 3, 1998.

LICENSEE EVENT REPORT (LER)
TEXT CONTINUATION

FACILITY NAME (1) THREE MILE ISLAND, UNIT 1	DOCKET (2) 05000289	LER NUMBER (6)			PAGE (3) 7 OF 9
		YEAR 98	SEQUENTIAL NUMBER -- 009	REVISION NUMBER -- 00	

TEXT (If more space is required, use additional copies of NRC Form 366A) (17)

B. Actions Planned:

1. A permanent resolution, to either adopt the temporary change or to revise the MUT pressure/level limits analysis as appropriate along with establishing procedure controls to address the failure of MU-V-14A/B, will be determined and implemented by December 20, 1998.
2. A review of the configuration control process, including the calculation process, will be conducted to determine if improvements are necessary to ensure appropriate and consistent application of the single failure criteria. This review will be completed by July 1999 and any resulting recommendations will be implemented by December, 1999.
3. The guidance for the preparation of safety evaluations will be reviewed to determine if enhancements are necessary to improve quality and consistency. This review will be completed by July, 1999 and any resulting recommendations will be implemented by December, 1999.

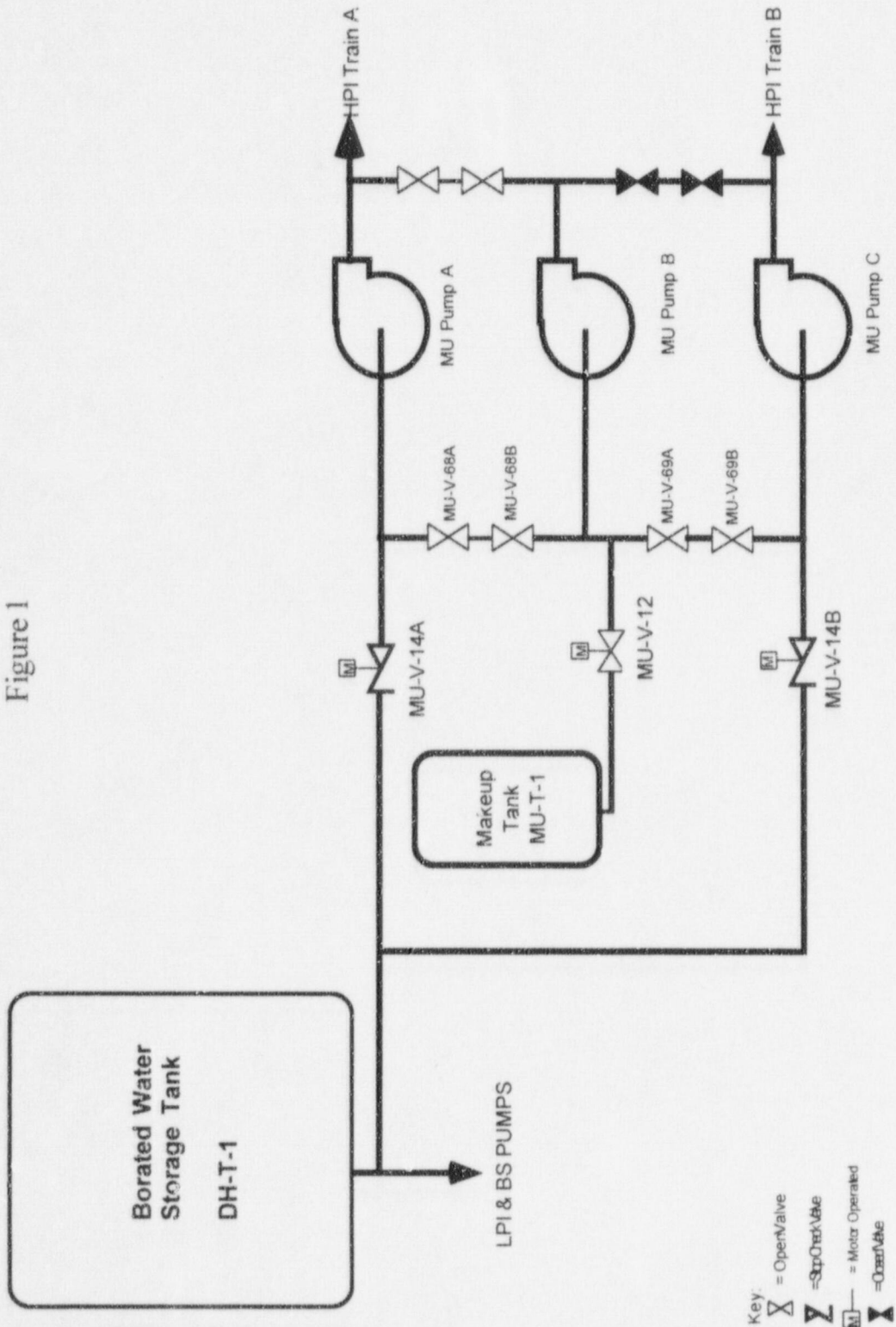
* The Energy Industry Identification System (EIS), System Identification (SI) and Component Function Identification (CFI) Codes are included in brackets, "[SI/CFI]," where applicable, as required by 10 CFR 50.73 (b)(2)(ii)(F).

LICENSEE EVENT REPORT (LER)
TEXT CONTINUATION

FACILITY NAME (1) THREE MILE ISLAND, UNIT 1	DOCKET (2) 05000289	LER NUMBER (6)		PAGE (3) 8 OF 9
		YEAR 98	SEQUENTIAL NUMBER -- 009 --	REVISION NUMBER 07

TEXT (If more space is required, use additional copies of NRC Form 366A) (17)

Figure 1



LICENSEE EVENT REPORT (LER)
TEXT CONTINUATION

FACILITY NAME (1) THREE MILE ISLAND, UNIT 1	DOCKET (2) 05000289	LER NUMBER (6)			PAGE (3) 9 OF 9
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	
		98	-- 009	-- 00	

TEXT (If more space is required, use additional copies of NRC Form 366A) (17)

Figure 2

TMI-1 Makeup Tank Level & Pressure Limits & Operating Data

