December 23, 1996

Mr. George A. Hunger, Jr.
Director-Licensing, MC 62A-1
PECO Energy Company
Nuclear Group Headquarters
Correspondence Control Desk
P.O. Box No. 195
Wayne, PA 19087-0195

Dear Mr. Hunger:

SUBJECT: FINAL ACCIDENT SEQUENCE PRECURSOR ANALYSIS OF EVENT AT LIMERICK GENERATING STATION, UNIT 1

Enclosed for your information is a copy of the final Accident Sequence Precursor analysis of the operational event at Limerick Generating Station, Unit 1, reported in Licensee Event Report No. 352/95-008. This final analysis (Enclosure 1) was prepared by our contractor at the Oak Ridge National Laboratory based on review and evaluation of your comments on the preliminary analysis and comments received from the NRC staff and from our independent contractor, Sandia National Laboratories. Enclosure 2 contains our responses to your specific comments. Our review of your comments employed the criteria contained in the material which accompanied the preliminary analysis. The results of the final analysis indicate that this event is a precursor for 1995.

Please contact me at (301) 415-1447 if you have any questions regarding the enclosures. We recognize and appreciate the effort expended by you and your staff in reviewing and providing comments on the preliminary analysis.

Sincerely,
/S/ J. Shea for
Frank Rinaldi, Project Manager
Project Directorate I-2
Division of Reactor Projects - I/II
Office of Nuclear Reactor Regulation

Docket No. 50-352

Enclosures: As stated

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LER No. 352/95-008

Event Description: Safety/relief valve fails open, reactor scram, suppression pool strainer fails

Date of Event: September 11, 1995

Plant: Limerick 1

Event Summary

Limerick Unit 1 was manually scrammed frcm 100% power after a safety/relief valve (SRV) failed open. Residual heat removal (RHR) pump A was in the suppression pool cooling (SPC) mode of operation and was being used to remove heat from the suppression pool to compensate for various SRV steam leaks when an SRV failed open, forcing the manual scram. RHR pump A was secured and declared inoperable after oscillations in the pump motor current and decreasing pump flow were observed. Subsequent examination revealed that the pump suction strainer had become obstructed with debris from the suppression pool. The conditional core damage probability (CCDP) estimate for the one-year potential unavailability of the Emergency Core Cooling Systems (ECCS) dependent upon the suppression pool is 1.3×10^{-5}. This is an increase of 9.0×10^{-6} over the nominal core damage probability (CDP) of 4.0×10^{-6} for the same period. The CCDP for the actual transient event is 2.5×10^{-6}.

Event Description

Limerick 1 was operating at 100% power at 1245 hours on September 11, 1995, when SRV "M" failed open. When plant operators were unable to reclose the valve within 2 min., they manually scrammed the reactor in accordance with technical specification requirements. At the time of the SRV failure, RHR pump A was in service to remove heat from the suppression pool to compensate for various SRV steam leaks.

After the scram, operators aligned RHR B pump for SPC as well. At 1307 hours, the pressure in the reactor had decreased from 1005 psig to 410 psig. Even though a closed indication was received for the "M" SRV, reactor pressure continued to decrease. Typically, technical specifications for boiling water reactors (BWRs) require a controlled depressurization if the temperature in the suppression pool exceeds 120°F. In such a case, the cooldown rate is typically limited to less than 100°F/h. During this event, however, the uncontrolled depressurization resulted in a cooldown rate of approximately 130°F/h and the temperature in the suppression pool peaked at 124°F.

At 1320 hours, operators observed a decrease and fluctuations in flow from the A RHR pump as well as oscillations in its motor current. Operators, attributing these signs to suction strainer fouling, secured the A RHR pump and declared it inoperable. After it was checked, the A pump was restarted but at a reduced flow rate of 2,000 gpm. No problems were observed so the flow rate was gradually increased to 8,500 gpm and no problems were observed. A pressure gauge located on the pump suction was observed to have a gradually lower reading, which was believed to be indicative of an increased pressure drop across the pump suction strainers located in the suppression pool. At 0227 hours on September 12, 1995, reactor pressure was reduced below 75 psig, with one loop of shutdown cooling in service. By 0430 hours, the unit was in cold shutdown with a reactor coolant temperature of 194°F.

Additional Event-Related Information

SRV "M" was removed and sent to a laboratory for testing, where it was found to have been damaged by steam erosion of the pilot valve seat. Failure of the pilot valve caused a pressure differential across the SRV main disk, which resulted

ENCLOSURE 1

in spurious operation of the main SRV valve. The SRV was reported to have been leaking for more than a year before its failure. Four other SRVs were found to have seat damage and were also replaced.

During an inspection of the A RHR pump suction strainer assembly, a mat of brown, fibrous material and a sludge of oxide corrosion products were found covering most of the assembly. The sludge material was determined to have come from the suppression pool. Upon inspection, personnel discovered that most of the suction strainer assembly for the B RHR pump was covered with a thinner layer of the same material. However, the B RHR pump ran normally during and after the event. The other strainers in the suppression pool for the pumps which were not employed during this event also had minor sludge accumulations. It is not known to what extent the blowdown caused by the SRV opening increased the rate of debris accumulation on the strainers. Approximately 1,400 lb of debris (wet weight, dry weight would be less) was removed from the suppression pool. A similar amount of material had been removed previously from the Unit 2 suppression pool.

Modeling Assumptions

Two assessments were required to analyze this event. First, a transient event assessment was performed to analyze the actual event. Second, a condition assessment was performed because of the prolonged potential unavailability of those ECCS system which are dependent on the suppression pool.

Transient event assessment

This event was modeled as a scram with one SRV failed open and one train of RHR unavailable in all modes except SDC because RHR train A was declared inoperable and secured when debris from the suppression pool clogged its suction strainer assembly. Similar debris was found on other strainers, and 1,400 lb of debris (wet weight) was later removed from the suppression pool. Reference 4 indicates that, under some circumstances, debris could have migrated and caused obstruction of additional pump strainers. This effect could depend on a number of factors, including the amount of suppression pool agitation caused by shock waves from SRV discharge; the amount of debris in the suppression pool; which specific pumps were placed in service; what flow rates were demanded; how long the pumps were operated, etc.

The potential for common-cause failure of all strainers was modeled by adding an additional basic event to the model for each appropriate system. The event "RHRSTRAINERS" was added to the suppression pool cooling models (SPC, SPC/L), the low pressure coolant injection models (LCI/L), and the containment spray system models (CSS/L). In addition, this event was added to the low pressure core spray system models (LCS/L), as core spray is also dependent upon the suppression pool for water. No change was made to the high pressure coolant injection (HPCI) or reactor core isolation cooling (RCIC) system models, which may take suction from the suppression pool, because these systems also are provided with an alternate water supply from the condensate storage system.

The CCDP calculated for this event is dependent upon assumptions made regarding the likelihood that the foreign matter in the suppression pool could cause failure of additional ECCS pumps. Research cited in Reference 4 indicates that the debris concentrations present in the Limerick suppression pool (1400 lb sludge/135,000 ft^3 suppression pool water volume × 62.4 lb ft^3= 0.02% wt % sludge) were easily sufficient to obstruct multiple ECCS system strainers. Based on Reference 5, a common-cause strainer failure probability of 0.135 was used in the analysis. A sensitivity analysis also was performed, assuming a common-cause strainer failure probability of 1.0.

Condition assessment

In addition to the analysis of the reported transient event, an analysis was made of the prolonged potential unavailability of the ECCS systems that are dependent upon the suppression pool for water. The debris in the suppression pool was assumed to have been present throughout the operating year (6132 h, assuming a 70% availability), and it was assumed to have the potential to cause failure of LCI, LCI/L, LCS/L, SPC/L, and CSS/L. This event was modeled with one train of RHR unavailable because, during the actual demand, train A of RHR was declared inoperable and secured when debris from the suppression pool clogged its suction strainer assembly. A common-cause strainer failure probability of 0.135 was used in this analysis (RHRSTRAINERS), and a sensitivity case was evaluated for a common-cause failure probability of 1.0. Potential recovery of the power conversion system (PCS) was credited with event PCS-LONG, as it was in the transient assessment.

Analysis Results

The CCDP estimate for the one-year potential unavailability of ECCS systems dependent upon the suppression pool is 1.3×10^{-5}. This is an increase of 9.0×10^{-6} over the nominal CDP for the same period of 4.0×10^{-6}. The CCDP for the actual transient event is 2.5×10^{-6}. In both cases, the dominant sequence, highlighted as sequence number 4 on the event tree in Fig. 1, involves

- the reactor successfully scrams,
- the PCS initially fails,
- RHR system fails,
- personnel fail to recover PCS in the long term, and
- containment venting fails.

Sequence number 4 is still the dominant sequence if a common-cause strainer failure probability of 1.0 is assumed (versus the 0.135 probability used for the actual event analysis). A CCDP of 7.1×10^{-5} with an importance of 6.7×10^{-5} is estimated for the long-term unavailability of the ECCS. The importance increased 7 times for this sensitivity analysis (from 9.0×10^{-6} to 6.7×10^{-5}). The CCDP for the sensitivity analysis for the transient event is 1.4×10^{-5}, or an increase of about 6 times over the CCDP for the actual transient event of 2.5×10^{-6}.

It should be noted that main feedwater success coincident with PCS failure is possible in the Limerick model because some failures which render the PCS incapable of functioning as a sink for reactor decay heat do not render it incapable of supporting main feedwater (e.g., turbine trips or load rejections with failures of the turbine bypass valves).

Definitions and probabilities for selected basic events are shown in Table 1. Table 2 describes the system names associated with the dominant sequences for both the condition assessment and the initiating event assessment. The conditional probabilities associated with the highest probability sequences for the condition assessment are shown in Table 3. Table 4 lists the sequence logic associated with the sequences listed in Table 3. Minimal cut sets associated with the dominant sequences for the *condition assessment* are shown in Table 5. The conditional probabilities associated with the highest probability sequences for the initiating event assessment are shown in Table 6. Table 7 lists the sequence logic associated with the sequences in Table 6. Minimal cut sets associated with the dominant sequences for the *initiating event assessment* are shown in Table 8.

Acronyms

ADS	automatic depressurization system
BWR	boiling water reactor
CCDP	conditional core damage probability
CDP	core damage probability
CSS	containment spray system
ECCS	emergency core cooling system
EHC	electro-hydraulic control
HPCI	high pressure coolant injection
LOCA	loss-of-coolant accident
LOOP	loss of offsite power
LPCI	low pressure coolant injection
LPCS	low pressure core spray
MFW	main feedwater
PCS	power conversion system
RCIC	reactor core isolation cooling
RHR	residual heat removal
RHRSW	residual heat removal service water
RPS	reactor protection system
SDC	shutdown cooling
SLC	standby liquid control
SPC	suppression pool cooling
SRV	safety/relief valve
TRANS	transient
US NRC	united states nuclear regulatory commission

References

1. Licensee Event Report 352/95-008 from PECO Energy to USNRC: "Unusual Event and RPS actuation when the reactor was manually shutdown due to the inadvertent opening of a main steam safety relief valve caused by pilot valve seat leakage," 10/10/95.

2. NRC Bulletin 95-02: "Unexpected clogging of a residual heat removal (RHR) pump strainer while operating in a suppression pool cooling mode" USNRC, 10/17/95.

3. NRC Information Notice 95-47: "Unexpected opening of a safety/relief valve and complications involving suppression pool cooling strainer blockage" USNRC, 10/4/95.

4. Parametric Study of the Potential for BWR ECCS Strainer Blockage Due to LOCA Generated Debris, NUREG/CR-6224, Zigler, et al., Science and Engineering Associates for USNRC, 1995.

5. Common-Cause Failure Data Collection and Analysis System, Vol Common-Cause Failure Parameter Estimations, INEL-94/0064, Marshall and Rasmuson, Idaho National Engineering Laboratory for USNRC, 1995.

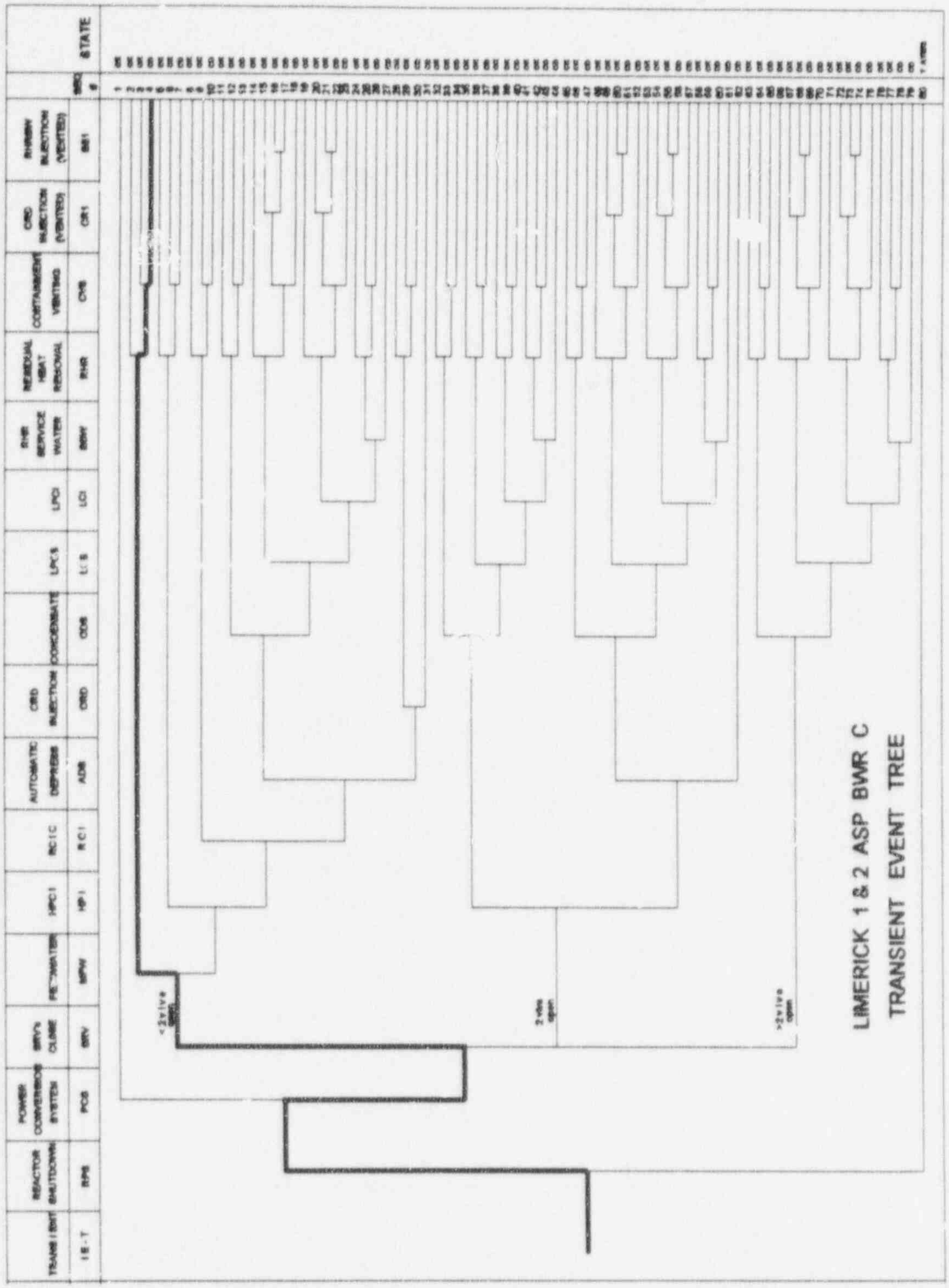

Fig. 1. Dominant core damage sequence for the initiating event assessment and the condition assessment for LER No. 352/95-008.

Table 1. Definitions and Probabilities for Selected Basic Events for LER No. 352/95-008

Event name	Description	Base probability	Current probability	Type	Modified for this event
IE-TRAN	Transient Initiator	4.5 E-004	1.0 E+000		Yes[a]
ADS-SRV-CC-VALVS	Automatic Depressurization System (ADS) Valves Fail to Open	3.7 E-003	3.7 E-003		No
ADS-XHE-XE-ERROR	Operator Error Prevents Depressurization	1.0 E-002	1.0 E-002		No
ADS-XHE-XE-NOREC	Operator Fails to Recover ADS	7.1 E-001	7.1 E-001		No
ADI-XHE-XE-ERROR	Operator Fails to Inhibit ADS and Control Level	1.0 E-002	1.0 E-002		No
CDS-SYS-VF-COND	Condensate Hardware Components Fail	3.4 E-001	3.4 E-001		No
CDS-XHE-XE-NOREC	Operator Fails to Recover Condensate	1.0 E+000	1.0 E+000		No
CVS-XHE-XE-VENT	Operator Fails to Vent Containment	1.0 E-002	1.0 E-002		No
EPS-DGN-FC-DGC	Diesel Generator Failure	1.9 E-002	1.9 E-002		No
EPS-XHE-[illegible]OREC	Operators Fail to Recover Electric Power System	5.0 E-001	5.0 E-001		No
HCI-TDP-FC-TRAIN	High Pressure Coolant Injection (HPCI) Train Level Failures	8.6 E-002	8.6 E-002		No
HCI-XHE-XE-NOREC	Operator Fails to Recover HPCI	7.0 E-001	7.0 E-001		No
LCI-MOV-CC-LOOPB	Low Pressure Coolant Injection (LPCI) Train B Injection Valves Fail to Open	3.1 E-003	3.1 E-003		No
LCI-XHE-XE-NOREC	Operator Fails to Recover LPCI	1.0 E+000	1.0 E+000		No
LCS-XHE-XE-NOREC	Operator Fails to Recover Low Pressure Core Spray System	1.0 E+000	1.0 E+000		No
MFW-SYS-VF-FEEDW	Main Feedwater System (MFW) Hardware Components Fail	4.6 E-001	4.6 E-001		No

Table 1. Definitions and Probabilities for Selected Basic Events for LER No. 352/95-008

Event name	Description	Base probability	Current probability	Type	Modified for this event
MFW-XHE-XE-NOREC	Operators Fail to Recover MFW	3.4 E-001	3.4 E-001		No
PCS-LONG	Operators Fail to Recover the Power Conversion System (PCS) in the Long Term	3.9 E-001	3.9 E-001		No
PCS-SYS-VF-MISC	PCS Hardware Components Fail	1.7 E-001	1.7 E-001		No
PCS-XHE-XE-NOREC	Operator Fails to Recover PCS	1.0E+000	1.0 E+000		No
PPR-SRV-OO-1VLV	One or Less Safety/relief Valves (SRVs) Fail to Close	1.0 E+000	1.0 E+000	TRUE	Yes[a]
PPR-SRV-OO-2VLVS	Two SRVs Fail to Close	2.0 E-003	0.0 E+000	FALSE	Yes[b]
PPR-SRV-OO-3VLVS	More Than Two SRVs Fail to Close	2.0 E-004	0.0 E+000	FALSE	Yes[b]
RCI-TDP-FC-TRAIN	Reactor Core Isolation Cooling System (RCIC) Train Component Failures	8.3 E-002	8.3 E-002		No
RCI-XHE-XE-NOREC	Operator Fails to Recover RCIC	7.0 E-001	7.0 E-001		No
RHR-MDP-CF-MDPS	Common Cause Failure of Residual Heat Removal (RHR) Pumps	3.0 E-004	3.0 E-004		No
RHR-MDP-FC-TRNA	RHR Train A Components Fail	3.8 E-003	1.0 E+000	TRUE	Yes[c]
RHR-MOV-OO-BYPSB	RHR Loop B Valve to Bypass Heat Exchangers Fails	3.0 E-003	3.0 E-003		No
RHRSTRAINERS	Common Cause Failure of All Strainers	0.0 E+000	1.4 E-001		Yes[c]
RPS-NONREC	Nonrecoverable Reactor Protection System (RPS) Trip System Failures	2.0 E-005	2.0 E-005		No
RPS-SYS-FC-MECH	Mechanical Failures of the RPS	1.0 E-005	1.0 E-005		No
RRS-XHE-XE-ERROR	Operator Fails to Trip the Recirculation Pumps	1.0 E-002	1.0 E-002		No
SDC-MOV-CC-SUCT	Shutdown Cooling System (SDC) Suction Valves Fail to Open	6.0 E-003	6.0 E-003		No
SDC-XHE-XE-ERROR	Operator Fails to Align/Actuate the SDC	1.0 E-002	1.0 E-002		No
SDC-XHE-XE-NOREC	Operator Fails to Recover the SDC	1.0 E+000	1.0 E+000		No

Table 1. Definitions and Probabilities for Selected Basic Events for LER No. 352/95-008

Event name	Description	Base probability	Current probability	Type	Modified for this event
SLC-CKV-CC-INJEC	The Injection Check Valves in the Standby Liquid Control System (SLC) Fail	2.0 E-004	2.0 E-004		No
SLC-EPV-CF-VALVS	The Explosive Valves in the SLC Fail From Common Cause	2.6 E-004	2.6 E-004		No
SLC-MDP-CF-MDPS	The Motor-Driven Pumps in the SDC Fail From Common Cause	6.3 E-004	6.3 E-004		No
SLC-XHE-XE-ERROR	Operator Fails to Start/Control the SDC	1.0 E-002	1.0 E-002		No
SLC-XHE-XE-NOREC	Operator Fails to Recover SDC	1.0 E+000	1.0 E+000		No
SRV	One or Less SRVs Fail to Close	2.2 E-003	2.2 E-003		No
SSW-MOV-CC-FLOOD	Valve Fails to Open	6.1 E-003	6.1 E-003		No
SSW-XHE-XE-ERROR	Operator Fails to Align RHR Service Water (RHRSW)	1.0 E-002	1.0 E-002		No
SSW-XHE-XE-NOREC	Operator Fails to Recover RHRSW	1.0 E+000	1.0 E+000		No

[a] Applicable to the initiating event assessment only.

[b] The probability was set to 0.0 E+000 (FALSE) for the initiating event assessment. For the conditional event assessment, the base probability was not changed in the model.

[c] The base probability was changed for both the initiating event assessment and the conditional event assessment.

Table 2. System Names for LER No. 352/95-008

System name	Logic
AD1	Failure to Inhibit ADS and Control Reactor Level
ADS	Automatic Depressurization Fails
CDS	Failure of the Condensate System
CVS	Containment (Suppression Pool) Venting
EPS	Emergency Power System Fails
HCI	HPCI Fails to Provide Sufficient Flow to the Reactor Vessel
LCI	Low Pressure Coolant Injection Fails
LCIL	Low Pressure Coolant Injection Fails During a LOOP
LCS	Low Pressure Core Spray Fails
LCSL	Low Pressure Core Spray Fails During a LOOP
MFW	Failure of the Main Feedwater System
P2	Two SRVs Fail to Close
PCS	Power Conversion System
RCI	RCIC Fails to Provide Sufficient Flow to RCS
RHRL	Residual Heat Removal System Fails During a LOOP
RHRPCS	Residual Heat Removal System Fails
RP1	Reactor Shutdown Fails
RPS	Reactor Shutdown Fails
RRS	Recirculation Pump Trip
SLC	Standby Liquid Control Fails
SRV	One or Less SRVs Fail to Close
SSW	RHR Service Water Makeup Fails
SSWL	RHR Service Water Makeup Fails During a LOOP

Table 3. Sequence Conditional Probabilities for the Condition Assessment for LER No. 352/95-008

Event tree name	Sequence name	Conditional core damage probability (CCDP)	Core damage probability (CDP)	Importance (CCDP-CDP)	Percent contribution[a]
TRANS	04	4.6 E-006	5.7 E-007	4.0 E-006	44.6
LOOP	03	1.9 E-006	2.4 E-007	1.7 E-006	19.1
TRANS	44	8.3 E-007	0.0 E+000	8.3 E-007	9.2
LOOP	20	7.2 E-007	0.0 E+000	7.2 E-007	7.9
TRANS	07	7.1 E-007	8.7 E-008	6.2 E-007	6.9
LOOP	34	4.1 E-007	0.0 E+000	4.1 E-007	4.5
TRANS	27	2.2 E-007	0.0 E+000	2.2 E-007	2.5
LOOP	06	1.1 E-007	1.4 E-008	1.0 E-007	1.1
Condition Assessment Total (all sequences)		**1.3 E-005**	**4.0 E-006**	**9.0 E-006**	

[a] Percent contribution to the total importance.

Table 4. Sequence Logic for Dominant Sequences for the Condition Assessment for LER 352/95-008

Event tree name	Sequence name	Logic
TRANS	04	/RPS, PCS, /SRV, /MFW, RHRPCS, CVS
LOOP	03	/RP1, /EPS, /SRV, /HCI, RHRL, CVS
TRANS	44	/RPS, PCS, P2, /HCI, CDS, LCS, LCI, SSW
LOOP	20	/RP1, /EPS, /SRV, HCI, RCI, /ADS, LCSL, LCI/L, SSWL
TRANS	07	/RPS, PCS, /SRV, MFW, /HCI, RHRPCS, CVS
LOOP	34	/RP1, /EPS, P2, /HCI, LCSL, LCIL, SSWL
TRANS	27	/RPS, PCS, /SRV, MFW, HCI, RCI, /ADS, CDS, LCS, LCI, SSW
LOOP	06	/RP1, /EPS, /SRV, HCI, /RCI, RHRL, CVS

Table 5. Conditional Cut Sets for Higher Probability Sequences for the Condition Assessment for LER No. 352/95-008

Cut set no.	Percent contribution	Conditional probability[a]	Cut sets
TRANS Sequence 04		4.6 E-006	
1	54.5	2.5 E-006	PCS-LONG, PCS-SYS-VF-MISC, PCS-XHE-XE-NOREC, /SRV, SDC-XHE-XE-ERROR, RHRSTRAINERS, CVS-XHE-XE-VENT
2	32.4	1.5 E-006	PCS-LONG, PCS-SYS-VF-MISC, PCS-XHE-XE-NOREC, /SRV, RHRSTRAINERS, SDC-MOV-CC-SUCT, SDC-XHE-XE-NOREC, CVS-XHE-XE-VENT
3	12.0	5.6 E-007	PCS-LONG, PCS-SYS-VF-MISC, PCS-XHE-XE-NOREC, /SRV, RHR-MDP-CF-MDPS, SDC-XHE-XE-NOREC, CVS-XHE-XE-VENT
LOOP Sequence 03		1.9 E-006	
1	53.6	1.0 E-006	/SRV, RHRSTRAINERS, SDC-XHE-XE-ERROR, CVS-XHE-XE-VENT
2	32.2	6.1 E-007	/SRV, RHRSTRAINERS, SDC-MOV-CC-SUCT, SDC-XHE-XE-NOREC, CVS-XHE-XE-VENT
3	11.9	2.4 E-007	/SRV, RHR-MDP-CF-MDPS, SDC-XHE-XE-NOREC, CVS-XHE-XE-VENT
4	1.1	2.3 E-008	/SRV, RHR-MOV-OO-BYPSB, EPS-DGN-FC-DGC, EPS-XHE-XE-NOREC, SDC-XHE-XE-NOREC, CVS-XHE-XE-VENT
TRANS Sequence 44		8.3 E-007	
1	52.1	4.3 E-007	PCS-SYS-VF-MISC, PCS-XHE-XE-NOREC, PPR-SRV-OO-2VLVS, CDS-SYS-VF-COND, CDS-XHE-XE-NOREC, RHRSTRAINERS, LCS-XHE-XE-NOREC, LCI-XHE-XE-NOREC, SSW-XHE-XE-ERROR
2	31.8	2.6 E-007	PCS-SYS-VF-MISC, PCS-XHE-XE-NOREC, PPR-SRV-OO-2VLVS, CDS-SYS-VF-COND, CDS-XHE-XE-NOREC, RHRSTRAINERS, LCS-XHE-XE-NOREC, LCI-XHE-XE-NOREC, SSW-MOV-CC-FLOOD, SSW-XHE-XE-NOREC
3	16.1	1.3 E-007	PCS-SYS-VF-MISC, PCS-XHE-XE-NOREC, PPR-SRV-OO-2VLVS, CDS-SYS-VF-COND, CDS-XHE-XE-NOREC, RHRSTRAINERS, LCS-XHE-XE-NOREC, LCI-MOV-CC-LOOPB, LCI-XHE-XE-NOREC, SSW-XHE-XE-NOREC
LOOP Sequence 20		7.2 E-007	
1	51.6	3.7 E-007	/SRV, HCI-TDP-FC-TRAIN, HCI-XHE-XE-NOREC, RCI-TDP-FC-TRAIN, RCI-XHE-XE-NOREC, RHRSTRAINERS, LCS-XHE-XE-NOREC, LCI-XHE-XE-NOREC, SSW-XHE-XE-ERROR
2	31.5	2.3 E-007	/SRV, HCI-TDP-FC-TRAIN, HCI-XHE-XE-NOREC, RCI-TDP-FC-TRAIN, RCI-XHE-XE-NOREC, RHRSTRAINERS, LCS-XHE-XE-NOREC, LCI-XHE-XE-NOREC, SSW-MOV-CC-FLOOD, SSW-XHE-XE-NOREC

Table 5. Conditional Cut Sets for Higher Probability Sequences for the Condition Assessment for LER No. 352/95-008

Cut set no.	Percent contribution	Conditional probability[a]	Cut sets
3	16.0	1.2 E-007	/SRV, HCI-TDP-FC-TRAIN, HCI-XHE-XE-NOREC, RCI-TDP-FC-TRAIN, RCI-XHE-XE-NOREC, RHRSTRAINERS, LCS-XHE-XE-NOREC, LCI-MOV-CC-LOOPB, LCI-XHE-XE-NOREC, SSW-XHE-XE-NOREC
TRANS Sequence 07		7.1 E-007	
1	54.9	3.9 E-007	PCS-LONG, PCS-SYS-VF-MISC, PCS-XHE-XE-NOREC, /SRV, MFW-SYS-VF-FEEDW, MFW-XHE-XE-NOREC, RHRSTRAINERS, SDC-XHE-XE-ERROR, CVS-XHE-XE-VENT
2	32.9	2.3 E-007	PCS-LONG, PCS-SYS-VF-MISC, PCS-XHE-XE-NOREC, /SRV, MFW-SYS-VF-FEEDW, MFW-XHE-XE-NOREC, RHRSTRAINERS, SDC-MOV-CC-SUCT, SDC-XHE-XE-NOREC, CVS-XHE-XE-VENT
3	12.2	8.7 E-008	PCS-LONG, PCS-SYS-VF-MISC, PCS-XHE-XE-NOREC, /SRV, MFW-SYS-VF-FEEDW, MFW-XHE-XE-NOREC, RHR-MDP-CF-MDPS, SDC-XHE-XE-NOREC, CVS-XHE-XE-VENT
LOOP Sequence 34		4.1 E-007	
1	52.1	2.1 E-007	PPR-SRV-CO-2VLVS, RHRSTRAINERS, LCS-XHE-XE-NOREC, LCI-XHE-XE-NOREC, SSW-XHE-XE-ERROR
2	31.8	1.3 E-007	PPR-SRV-OO-2VLVS, RHRSTRAINERS, LCS-XHE-XE-NOREC, LCI-XHE-XE-NOREC, SSW-MOV-CC-FLOOD, SSW-XHE-XE-NOREC
3	16.1	6.6 E-008	PPR-SRV-OO-2VLVS, RHRSTRAINERS, LCS-XHE-XE-NOREC, LCI-MOV-CC-LOOPB, LCI-XHE-XE-NOREC, SSW-XHE-XE-NOREC
TRAN Sequence 27		2.3 E-007	
1	52.1	1.2 E-007	PCS-SYS-VF-MISC, PCS-XHE-XE-NOREC, /SRV, MFW-SYS-VF-FEEDW, MFW-XHE-XE-NOREC, HCI-TDP-FC-TRAIN, HCI-XHE-XE-NOREC, RCI-TDP-FC-TRAIN, RCI-XHE-XE-NOREC, CDS-SYS-VF-COND, CDS-XHE-XE-NOREC, RHRSTRAINERS, LCS-XHE-XE-NOREC, LCI-XHE-XE-NOREC, SSW-XHE-XE-ERROR
2	31.8	7.3 E-008	PCS-SYS-VF-MISC, PCS-XHE-XE-NOREC, /SRV, MFW-SYS-VF-FEEDW, MFW-XHE-XE-NOREC, HCI-TDP-FC-TRAIN, HCI-XHE-XE-NOREC, RCI-TDP-FC-TRAIN, RCI-XHE-XE-NOREC, CDS-SYS-VF-COND, CDS-XHE-XE-NOREC, RHRSTRAINERS, LCS-XHE-XE-NOREC, LCI-XHE-XE-NOREC, SSW-MOV-CC-FLOOD, SSW-XHE-XE-NOREC
3	16.1	3.7 E-008	PCS-SYS-VF-MISC, PCS-XHE-XE-NOREC, /SRV, MFW-SYS-VF-FEEDW, MFW-XHE-XE-NOREC, HCI-TDP-FC-TRAIN, HCI-XHE-XE-NOREC, RCI-TDP-FC-TRAIN, RCI-XHE-XE-NOREC, CDS-SYS-VF-COND, CDS-XHE-XE-NOREC, RHRSTRAINERS, LCS-XHE-XE-NOREC, LCI-MOV-CC-LOOPB, LCI-XHE-XE-NOREC, SSW-XHE-XE-NOREC
LOOP Sequence 06		1.1 E-007	

Table 5. Conditional Cut Sets for Higher Probability Sequences for the Condition Assessment for LER No. 352/95-008

Cut set no.	Percent contribution	Conditional probability[a]	Cut sets
1	54.9	6.0 E-008	/SRV, HCI-TDP-FC-TRAIN, HCI-XHE-XE-NOREC, RHRSTRAINERS, SDC-XHE-XE-ERROR, CVS-XHE-XE-VENT
2	32.9	3.6 E-008	/SRV, HCI-TDP-FC-TRAIN, HCI-XHE-XE-NOREC, RHRSTRAINERS, SDC-MOV-CC-SUCT, SDC-XHE-XE-NOREC, CVS-XHE-XE-VENT
3	12.2	1.3 E-008	/SRV, HCI-TDP-FC-TRAIN, HCI-XHE-XE-NOREC, RHR-MDP-CF-MDPS, SDC-XHE-XE-NOREC, CVS-XHE-XE-VENT
Condition Assessment Total (all sequences)		**1.3 E-005**	

[a] The conditional probability for each cut set is determined by multiplying the probability that the portion of the sequence that makes the precursor visible (e.g., the system with a failure is demanded) will occur during the duration of the event by the probabilities of the remaining basic events in the minimal cut set. This can be approximated by $1 - e^{-p}$, where p is determined by multiplying the expected number of initiators that occur during the duration of the event by the probabilities of the basic events in that minimal cut set. The expected number of initiators is given by λt, where λ is the frequency of the initiating event (given on a per-hour basis), and t is the duration time of the event (in this case, 6132 h). This approximation is conservative for precursors made visible by the initiating event. The frequencies of interest for this event are: $\lambda_{TRANS} = 4.57 \times 10^{-4}$/h, and $\lambda_{LOOP} = 1.29 \times 10^{-5}$/h.

Table 6. Sequence Conditional Probabilities for the Initiating Event Assessment for LER No. 352/95-008

Event tree name	Sequence name	Conditional core damage probability (CCDP)	Percent contribution
TRANS	04	1.6 E-006	65.3
TRANS	07	2.6 E-007	10.2
TRANS	80-15	2.2 E-007	8.7
TRANS	80-16	2.0 E-007	8.0
TRANS	27	8.2 E-008	3.2
TRANS	80-14	3.4 E-008	1.3
IE Assessment Total (all sequences)		**2.5 E-006**	

Table 7. Sequence Logic for Dominant Sequences for the Initiating Event Assessment for LER 352/95-008

Event tree name	Sequence name	Logic
TRANS	04	/RPS, PCS, /SRV, /MFW, RHRPCS, CVS
TRANS	07	/RPS, PCS, /SRV, MFW, /HCI, RHRPCS, CVS
TRANS	80-15	RPS, /RRS, SLC
TRANS	80-16	RPS, RRS
TRANS	27	/RPS, PCS, /SRV, MFW, HCI, RCI, /ADS, CDS, LCS, LCI, SSW
TRANS	80-14	RPS, /RRS, /SLC, PCS, AD1

Table 8. Conditional Cut Sets for Higher Probability Sequences for the Initiating Event Assessment for LER No. 352/95-008

Cut set no.	Percent contribution	Conditional probability[a]	Cut sets
TRANS Sequence 04		1.6 E-006	
1	53.7	8.9 E-007	PCS-LONG, PCS-SYS-VF-MISC, PCS-XHE-XE-NOREC, /SRV, SDC-XHE-XE-ERROR, RHRSTRAINERS, CVS-XHE-XE-VENT
2	32.2	5.3 E-007	PCS-LONG, PCS-SYS-VF-MISC, PCS-XHE-XE-NOREC, /SRV, RHRSTRAINERS, SDC-MOV-CC-SUCT, SDC-XHE-XE-NOREC, CVS-XHE-XE-VENT
3	11.9	1.9 E-007	PCS-LONG, PCS-SYS-VF-MISC, PCS-XHE-XE-NOREC, /SRV, RHR-MDP-CF-MDPS, SDC-XHE-XE-NOREC, CVS-XHE-XE-VENT
TRANS Sequence 07		2.6 E-007	
1	53.7	1.4 E-007	PCS-LONG, PCS-SYS-VF-MISC, PCS-XHE-XE-NOREC, /SRV, MFW-SYS-VF-FEEDW, MFW-XHE-XE-NOREC, RHRSTRAINERS, SDC-XHE-XE-ERROR, CVS-XHE-XE-VENT
2	32.2	8.3 E-008	PCS-LONG, PCS-SYS-VF-MISC, PCS-XHE-XE-NOREC, /SRV, MFW-SYS-VF-FEEDW, MFW-XHE-XE-NOREC, RHRSTRAINERS, SDC-MOV-CC-SUCT, SDC-XHE-XE-NOREC, CVS-XHE-XE-VENT
3	11.9	3.1 E-008	PCS-LONG, PCS-SYS-VF-MISC, PCS-XHE-XE-NOREC, /SRV, MFW-SYS-VF-FEEDW, MFW-XHE-XE-NOREC, RHR-MDP-CF-MDPS, SDC-XHE-XE-NOREC, CVS-XHE-XE-VENT
TRANS Sequence 80-15		2.2 E-007	
1	89.5	2.0 E-007	RPS-NONREC, SLC-XHE-XE-ERROR
2	5.6	1.2 E-008	RPS-NONREC, SLC-MDP-CF-MDPS, SLC-XHE-XE-NOREC
3	2.3	5.2 E-009	RPS-NONREC, SLC-EPV-CF-VALVS, SLC-XHE-XE-NOREC
4	1.7	4.0 E-009	RPS-NONREC, SLC-CKV-CC-INJEC, SLC-XHE-XE-NOREC
TRANS Sequence 80-16		1.0 E-007	
1	97.6	2.0 E-007	RPS-NONREC, RRS-XHE-XE-ERROR
TRANS Sequence 27		8.2 E-008	
1	51.7	4.2 E-008	PCS-SYS-VF-MISC, PCS-XHE-XE-NOREC, /SRV, MFW-SYS-VF-FEEDW, MFW-XHE-XE-NOREC, HCI-TDP-FC-TRAIN, HCI-XHE-XE-NOREC, RCI-TDP-FC-TRAIN, RCI-XHE-XE-NOREC, CDS-SYS-VF-COND, CDS-XHE-XE-NOREC, RHRSTRAINERS, LCS-XHE-XE-NOREC, LCI-XHE-XE-NOREC, SSW-XHE-XE-ERROR

Table 8. Conditional Cut Sets for Higher Probability Sequences for the Initiating Event Assessment for LER No. 352/95-008

Cut set no.	Percent contribution	Conditional probability[a]	Cut sets
2	31.5	2.6 E-008	PCS-SYS-VF-MISC, PCS-XHE-XE-NOREC, /SRV, MFW-SYS-VF-FEEDW, MFW-XHE-XE-NOREC, HCI-TDP-FC-TRAIN, HCI-XHE-XE-NOREC, RCI-TDP-FC-TRAIN, RCI-XHE-XE-NOREC, CDS-SYS-VF-COND, CDS-XHE-XE-NOREC, RHRSTRAINERS, LCS-XHE-XE-NOREC, LCI-XHE-XE-NOREC, SSW-MOV-CC-FLOOD, SSW-XHE-XE-NOREC
3	16.0	1.3 E-008	PCS-SYS-VF-MISC, PCS-XHE-XE-NOREC, /SRV, MFW-SYS-VF-FEEDW, MFW-XHE-XE-NOREC, HCI-TDP-FC-TRAIN, HCI-XHE-XE-NOREC, RCI-TDP-FC-TRAIN, RCI-XHE-XE-NOREC, CDS-SYS-VF-COND, CDS-XHE-XE-NOREC, RHRSTRAINERS, LCS-XHE-XE-NOREC, LCI-MOV-CC-LOOPB, LCI-XHE-XE-NOREC, SSW-XHE-XE-NOREC
TRANS Sequence 80-14		3.4 E-008	
1	99.5	3.4 E-008	RPS-NONREC, PCS-SYS-VF-MISC, PCS-XHE-XE-NOREC, AD1-XHE-XE-ERROR
IE Assessment Total (all sequences)		**2.5 E-006**	

[a] The conditional probability for each cut set is determined by multiplying the probability of the initiating event by the probabilities of the basic events in that minimal cut set. The probability of the initiating events are given in Table 1 and begin with the designator "IE." The probabilities for the basic events also are given in Table 1.

LER No. 352/95-008

Event Description:	Safety/relief valve fails open, reactor scram, suppression pool strainer fails
Date of Event:	September 11, 1995
Plant:	Limerick 1

Licensee Comments

Reference: Letter from G. A. Hunger, Jr., Director - Licensing, PECO Nuclear, to U. S. Nuclear Regulatory Commission, "Limerick Generating Station, Unit 1, Comments Concerning Preliminary Accident Sequence Precursor Analysis of Suction Strainer Clogging Event," July 25, 1996.

Comment 1: First paragraph in the **Event Summary**, third sentence—Change "RHR pump A was declared inoperable when . . ." to "RHR pump A was <u>secured and</u> declared inoperable when . . ."

Response 1: Word change was made as requested.

Comment 2: Third paragraph in the **Event Summary**, first sentence—Change "operators observed a decrease in flow from the A RHR pump . . ." to "operators observed a decrease and fluctuations in flow from the A RHR pump . . ."

Response 2: The sentence was changed to "operators observed a decrease and fluctuations in flow from the A RHR pump . . ."

Comment 3: First paragraph in the **Event Description**, third and forth sentences—delete ". . . at low flow rates. As operators increased flow through the A RHR pump, they observed a pressure drop across the pump's suction strainer." Per the text of the LER, page 2 of 5, "At 1345 hours, following initial evaluation by the System Manager, Shift Supervision directed a restart of the "A" RHR pump (i.e. in SPC mode), and **no abnormal indications** were observed." [emphasis added]. In addition, plant records indicate that the RHR 'A' pump was restarted and ramped up to 8500 gpm and returned to SPC mode, which is not a "low flow rate". Finally, pressure drop across the pump's suction strainer would be expected with increasing flow rate, but did not hinder operation of the "A" RHR pump.

Response 3: This section was based on information in the LER and also on information in NRC Bulletin (NRCB) 95-02. NRCB 95-02 indicates (p. 2, second paragraph):

[. . .] Approximately 30 minutes later, fluctuating motor current and flow was observed on the "A" loop. Cavitation was believed to be the cause, and the loop was secured. After it was checked the "A" pump was restarted, but at a reduced flowrate of 8kl/m [2,000 gpm]. No problems were observed, so the flow rate was gradually increased back to 32kl/m [8,500 gpm], the full flowrate for the RHR pumps when operating in suppression pool cooling mode. Again, no problems were observed, so the pump continued to be operated at a constant flow. A pressure gauge located on the pump suction was observed to have a gradually lower reading, which was believed to be indicative of an increased pressure drop across the pump suction strainers located in the suppression pool. After about 30 minutes of additional operation, the suction pressure remained constant.

The sentence in the **Event Description**, "At about 1345 hours, operators restarted the A RHR pumps and it appeared to operate normally at low flow rates." is believed to be consistent with this information from NRCB 95-02. The quoted section of NRCB 95-02 also appears to suggest that increasing suction strainer differential pressure was observed during pump operation, but the passage may be subject to other interpretations. In order to avoid interpretation error, portions of the subject paragraph in the **Event Description** have been replaced with verbatim excerpts from NRCB 95-02.

Comment 4: Second paragraph in **Additional Event-Related Information**—After the third sentence starting, "Upon inspection, personnel . . ." Add the sentence "However, the B RHR pump ran normally during and after the event."

Response 4: The sentence was added. Note that this specific information was not given in the LER.

Comment 5: Second paragraph in **Additional Event-Related Information**—Reword the fifth sentence from "Utility personnel reported that they were unable to determine if effects attributable to the SRV blowdown increased the rate of accumulation of debris on the strainers." to "Utility personnel reported that the SRV blowdown resulted in deposition of additional material on the strainer." per the first paragraph of page 5 of 5 of the LER 352/95-008.

Response 5: This statement was based upon the following information from NRC Information Notice 95-47 (p. 3, para. 4): [. . .] Whether the blowdown caused by the SRV opening increased the rate of accumulation on the strainer is not known.

Because the source of this information is unclear, the sentence in question has been revised to say, "It is not known to what extent the blowdown caused by the SRV opening increased the rate of debris accumulation on the strainers."

Comment 6: Second paragraph in **Additional Event-Related Information**—Finally, second to last sentence, change "Approximately 1,400 pounds of debris was removed from the suppression pool." to

"Approximately 1,400 pounds (wet weight, dry weight is roughly 1/3 of wet weight) of debris was removed from the suppression pool." The 1,400 pounds reported was a net weight value. BWROG investigations have shown that the dry weight is roughly one-third of the wet weight.

Response 6: It would seem likely that the ratio of dry weight to wet weight would be dependent upon the type of debris encountered. Presumably this ratio would be smaller for fibrous material and larger for metal oxides. The dry weight of the debris was not reported in the LER and the comment implies that the net weight of the debris found in the Limerick suppression pool was not actually measured. Therefore it would seem difficult to determine what the ratio of dry weight to wet weight might have been for this event. However, a sentence has been added to indicate that the dry weight could be expected to be less than the wet weight.

Comment 7: Second paragraph in **Modeling Assumptions**—Change the first sentence "and one train of RHR unavailable in all modes because. . ." to "and one train of RHR unavailable in all modes except SDC because. . ."

Response 7: This change has been incorporated.

Comment 8: Second paragraph in **Modeling Assumptions**—Also change second sentence "Similar debris was found on other strainers and 1,400 pounds of debris . . ." to "Debris was also found on other strainers and 1,400 pounds (wet weight, dry weight is roughly 1/3 of wet weight) of debris . . ." for the same explanation as given above.

Response 8: Consistent with the response to comment 6, the sentence in question has been revised to indicate that the 1,400 pounds was wet weight.

Comment 9: Second paragraph in **Modeling Assumptions**, last sentence—Finally, add "the amount of debris in the suppression pool" to the list of factors in the last sentence.

Response 9: This change has been incorporated.

Comment 10: Third paragraph in **Modeling Assumptions**—The low pressure core spray (LPCS) system should not be grouped with the RHR system since LPCS can also take suction from the CST, similar to the RCIC and HPCI systems (see Figures 6.3-7 and 6.3-9 in the Limerick Generating Station's Updated Final Safety Analysis Report). The standard LPCS system operating procedure provides direction for alignment of LPCS to the CST. Thus the "RHRSTRAINERS" event should not be added to the LPCS model.

Response 10: The LPCS system is normally aligned to the suppression pool and a number of operator actions would be required to align the system to the CST, including the opening of manual valves which are normally closed (and may even be locked closed). Therefore, it may be inappropriate to model the system as being unaffected by the potential strainer failure. Switching to take suction on the CST could be incorporated into the LPCS model as a recovery, but a typical non-recovery probability estimate for a non-routine ex-control room action such as this would be relatively large and the change would not materially affect the analysis results.

Comment 11: Fourth paragraph in **Modeling Assumptions**—The common cause strainer failure probability should be modeled as two populations of two strainers each, RHR A and B, and RHR C and D, rather than as a single group which contains all four strainers. This is due to the distinctly different operating histories of the two groups. RHR A and B are normally used for suppression pool cooling in routine operations, whereas RHR C and D are only run for required pump, valve, and flow tests. As the failure mode is dependent upon the collection of material on the strainers over time as the pumps are used, these different profiles would clearly separate the two groups from common cause perspective. The analysis for both the event and condition assessment should be reperformed with the increased common cause value affecting only the A and B strainers, and with a much lower common cause failure value affecting the C and D strainers (e.g. $\alpha_2 Qt \approx 0.2 \times 1E\text{-}4$, or $\approx 2E\text{-}5$. Each group of RHR, the RHR A and B group and the RHR C and D group, can be used in each mode of RHR operation, LPCI, SPC, SDC, and Containment Spray.

Response 11: The Licensee Event Report for this event indicates that the strainer fouling was due in part to the SRV discharge. ("The 'M' SRV discharge resulted in deposition of additional material on the strainer.") The belief that turbulence from suppression pool blowdown would increase the suspension of debris and thereby the deposition of debris on pump suction strainers is consistent with experimental data such as that described in NUREG/CR-6224 (*Parametric Study of the Potential for BWR ECCS Strainer Blockage due to LOCA Generated Debris*, G. Zigler, et. al, SEA Inc., October 1995).

It is believed that any pump taking suction from the suppression pool would have been subjected to a common increased chance of failure, had it been operated, due to the suspended debris. Neither the the Licensee Event Report nor the licensee's comments on the preliminary analysis provided sufficient information to permit estimation of the relative importance of the different mechanisms leading to the RHR pump suction strainer fouling.

Comment 12: Fourth paragraph in **Modeling Assumptions**, second sentence—The statement "Research cited in Reference 4 indicates that the sludge concentration ... were easily sufficient to obstruct multiple ECCS system strainers" is incorrect. Sludge by itself cannot cause the failure of an ECCS strainer due to the small particle size relative to the hole size of the strainer. A layer of fiber must be present to trap the sludge. From the results of diver inspections, it was found that no strainers other than the A and B RHR had any fiber matting the strainer surfaces. Therefore, initially, the strainers could not have plugged. A preliminary BWROG report indicates that appreciable settling of corrosion products could be expected in as little as 15 to 30 minutes following the end of a LOCA blowdown. Based on this analysis, it would be expected that by the time a fiber bed formed on any other strainers, the corrosion products required to foul the bed would have largely settled out. Therefore, no other ECCS suction strainers would be expected to plug. Therefore, a common cause strainer failure could not occur.

Response 12: The word "debris" has been substituted for "sludge" in the subject sentence, since both fibrous material and oxide/sludge material were present.

The referenced report apparently pertains to large or medium-break LOCA events and may not apply directly to events such as the one modeled in the analysis. Note that in the discussion above, blowdown to the suppression pool is assumed to suspend corrosion products. This would tend to support the assumption that a single common hazard could potentially impact some or all of the pumps taking suction from the pool.

In the actual event, the 'M' SRV remained stuck open over a prolonged period, which is believed to have increased the amount of debris suspended in the suppression pool. In addition, experimental evidence indicates that "[i]nitiation of suppression pool cooling ... can induce high levels of turbulence in the suppression pool [which] may result in resuspension of debris." (NUREG/CR-6224, p. B-6)

The ASP analysis assumed that the same fibers and corrosion products which caused A RHR pump to be declared inoperable and which were found in lesser amounts on the B pump strainers could have led to failure of the B pump and then the other exposed pumps as well. Presumably, failure of B pump would have cued operators to start C or D pump, failure of that pump would have prompted them to start the remaining unaffected pump, and so on.

Comment 13: Fourth paragraph in **Modeling Assumptions**, third sentence—The alpha factor used from Reference 5 should be recalculated for the event assessment using the actual failure situation found a the plant (i.e. 1 failed (A), 1 could fail (B), and with the remaining two strainers (C and D) having an extremely low likelihood of failing in the same manner).

Response 13: The Licensee Event Report for this event indicates that the SRV discharge increased the deposition of debris on the operating pump strainers. As previously discussed, the same material which obstructed the A pump strainers, causing the pump to be declared inoperable, did deposit to a lesser extent on the B pump strainers and could have deposited on the C and D pump strainers had these pumps operated. Therefore, the modeling of the event assumed that the one pump which was reported to be inoperable was inoperable and it was assumed that the other pumps could have failed with a common-cause failure probability of 0.135. [The probability that 3 or more pumps might fail due to a common cause given that two failed due to that cause should be approximately unity.]

Comment 14: Fifth paragraph in **Modeling Assumptions**, last sentence—The common cause strainer failure probability should not be the same as in the event assessment, unless the A strainer is considered to be clogged in the condition assessment as well. The common cause strainer failure probability should be $0.135 \times Qt$, Qt being the random failure probability for the strainers. Unless the A RHR is assumed to be failed (as in the event assessment), Qt is less than 1.

Response 14: During the actual event, the A strainer did obstruct sufficiently to cause the A pump to be declared inoperable. The Licensee Event Report attributed the strainer fouling to buildup of debris during operation and to deposition of additional material due to the SRV discharge. There was not sufficient information to permit estimation of the relative importance of the different mechanisms leading to the strainer fouling. Since the A pump was declared inoperable when demanded, it was assumed in the condition assessment that that the A pump was inoperable.

Comment 15: **Analysis Results**—Considering the previous comments of,

a) the appropriate use of the debris dry weight to estimate the strainer failure probability.

b) the grouping of LPCS with HPCI and RCIC instead of with RHR since LPCS can also take suction from the CST, and

c) modeling the common cause strainer failure probability as two populations of two strainers each (RHR A and B, and RHR C and D) with a much lower common cause failure value affecting the RHR C and D strainers of 2E-5.

a more realistic core damage probability for the transient event assessment below the current value would be obtained, and a more realistic core damage probability for the condition assessment would be less than 1.0E-5.

Response 15: These comments have been addressed as noted

a) see Responses 6 and 8,

b) see Response 10,

c) see Responses 11 and 13.

The CCDP estimate for the one-year potential unavailability of ECCS systems dependent upon the suppression pool is 1.3×10^{-5}, an increase of 9.0×10^{-6} over the nominal CDP of 4.0×10^{-6}. The CCDP for the actual transient event is 2.5×10^{-6}.
