ENCLOSURE 2

SUBTASK REPORT

ISSUE: Accumulator Fill Line Failure

Action Plan Item No. : A.2.i

TITLE: Kerotest Valve Flow Test

SCOPE:

Determine flow rate at which Kerotest Valve becomes unstable and "chatters" during reverse flow. Duplicate the Trojan SIS accumulator fill line geometry from accumulator "A" to valve CV8878A as closely as practical but using available materials. Use a water source at Boardman Plant which has sufficient head and flow for the test.

RESULTS/CONCLUSIONS:

The Boiler Deslagging Water System has two pumps, each rated at 400 gpm and 60 psi. We chose this system for the test. Boardman Plant personnel closely replicated the geometry of the Trojan piping system from SIS Accumulator "A" to valve CV8878A. Carbon steel, 4-inch schedule 40, was used instead of stainless steel.

We established steady state flow conditions at 10, 13, 37, 40 and 63 gpm without valve chatter. We increased flow until chatter started and then reduced flow slightly. We measured a steady state flow of 58 gpm without chatter. When we increased flow again, chatter began and the piping broke, stopping the test, before a measurement could be taken.

Pipe motion during valve chatter was violent, affecting the deslagging system piping about 75 feet away. This piping, however, was very flexible. The noise was loud. The frequency did appear to depend on flow rate as it did sound lower at the threshold than at higher flows. The tabs on the lateral restraint at H-226 location were significantly bent outward. The anchor at location CV8878A did not move.

It is clear to us that the valve chatters violently at high reverse flow rates (about 70 gpm) and that the resulting water hammer can cause rapid failure of the piping at the location corresponding to the accumulator connection. I estimate that the number of cycles to failure was in the vicinity of 100. The piping motion and sound were clearly recorded on videocassette.

ATTACHMENTS:

1. Test Procedure
2. Flowmeter Check Sheet
3. Test Data Sheet
4. As-built Isometric of Test Piping
5. Trojan Storeroom Material Issue Sheet

COMPLETED BY: Drew E. Mayer DATE: 6/4/87

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P PDR

KEROTEST VALVE FLOW TEST

(SIS Accumulator Tank Connections)

APPROVED BY Gary van Bladeren 6/1/87
Gary N. Van Bladeren

1. References

1.1 Trojan Isometric Drawing Number SI-601R-1-690, Rev. 6

1.2 Kerotest Valve Drawing Number W-D-9915-(2), Rev. B

1.3 Boardman P&ID 1-M-116, Sh 2, Rev. 7

1.4 Maintenance Request _____

2. Scope

Investigate flow conditions which are believed to have caused unstable operation of the Kerotest Valve in the Trojan Safety Injection Accumulator Fill Line. Using a piping system in the Boardman Plant with suitable head and flow, install a piping arrangement similar to that between accumulator and valve, a Kerotest valve, and verify flow conditions for onset of valve disk chatter.

3. Design

3.1 Use the Sootblower Deslagging Water Pumps as the water source. The test engineer has the authority to use a different source if field conditions don't allow using these pumps.

3.2 Between the plant piping system and the 1-inch line to the Kerotest valve, install a short section of larger diameter piping to simulate a vessel. The size of piping will be determined based on availability of material. If suitable material is not available, the test engineer may direct attaching the 1-inch line directly to the plant system.

3.3 Anchor the simulated vessel securely to withstand expected pipe whip. If the connection is direct to the plant piping system, anchor the 1-inch line securely to prevent any damage to the plant piping.

3.4 Duplicate the arrangement shown for the 1-inch line as shown on Reference 1 as closely as practical. Use schedule 40 carbon steel pipe. Anchor the pipe coming out of the Kerotest valve at the location which CVS878A would normally occupy. Install a lateral restraint at location H226. Do not install H224. If

required by field conditions. this design may be modified by the test engineer.

3.5 Direct or divert the flow from the pipe outlet to a safe location.

4. Test Equipment

4.1 Flow meter installed in deslagging water piping.

4.2 Tape recorder.

4.3 Video recorder, if available.

4.4 Communications between pump control station, valve operator, and observers.

4.5 Stopwatches.

5. Test Procedure

5.1 Fully open Kerotest valve.

5.2 Close drain/vent piping supplying water to test piping. Start one deslagging water pump and establish recirculation flow. Use drain/vent valve in supply line to control test flow rate. Establish a flow rate of about 15 gpm. Increase flow rate slowly until valve chatter begins. Stop at increments to record flow rate and make observations of flow/equipment interaction.

5.4 Start tape recorder to record sounds of valve at beginning of test and record complete test. If video recorder is available, record entire test.

5.5 Start second deslagging water pump if more flow is needed.

5.6 Determine flow rate at onset of valve chatter. Trip pump if piping begins to whip. Trip pump at first indication of potential danger to personnel or equipment.

6. Documentation

6.1 Enter data on attached data sheet.

6.2 Prepare report

KEROTEST VALVE FLOW TEST DATA SHEET

(SIS Accumulator Tank Connections)

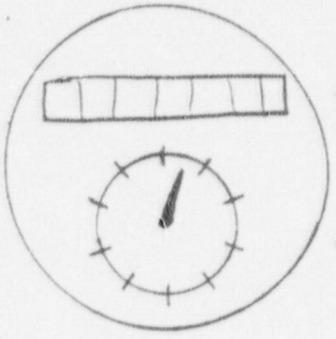
Flow, gal.	Time Interval	Flow Rate	Observations

Performed by: _____ Date: _____
Loren E. Mayer - Test Engineer

Witnessed by: _____ Date: _____

Flowmeter is permanently installed in Boardman plant piping system

Manufacturer - Trident
Size - 2"



← Reads in 100 gal.

← Dial has 10 gal/division

Flowmeter Face

Flowmeter was checked for operation prior to testing by filling two 55 gal drums with tops removed.

Drum dimension : 22¼" ϕ by 34¼" deep
= 57.6 gal/each

1st test : Flowmeter read about 115 gal.
2nd test : Flowmeter read about 120 gal.

The drums were right at overflow on 2nd test. On first test, they were slightly below the top. I consider the readings to be essentially the same for both tests, considering the difficulties in reading down to for 2 gal and the small differences in drum level between the two tests.

KEROTEST VALVE FLOW TEST DATA SHEET

(SIS Accumulator Tank Connections)

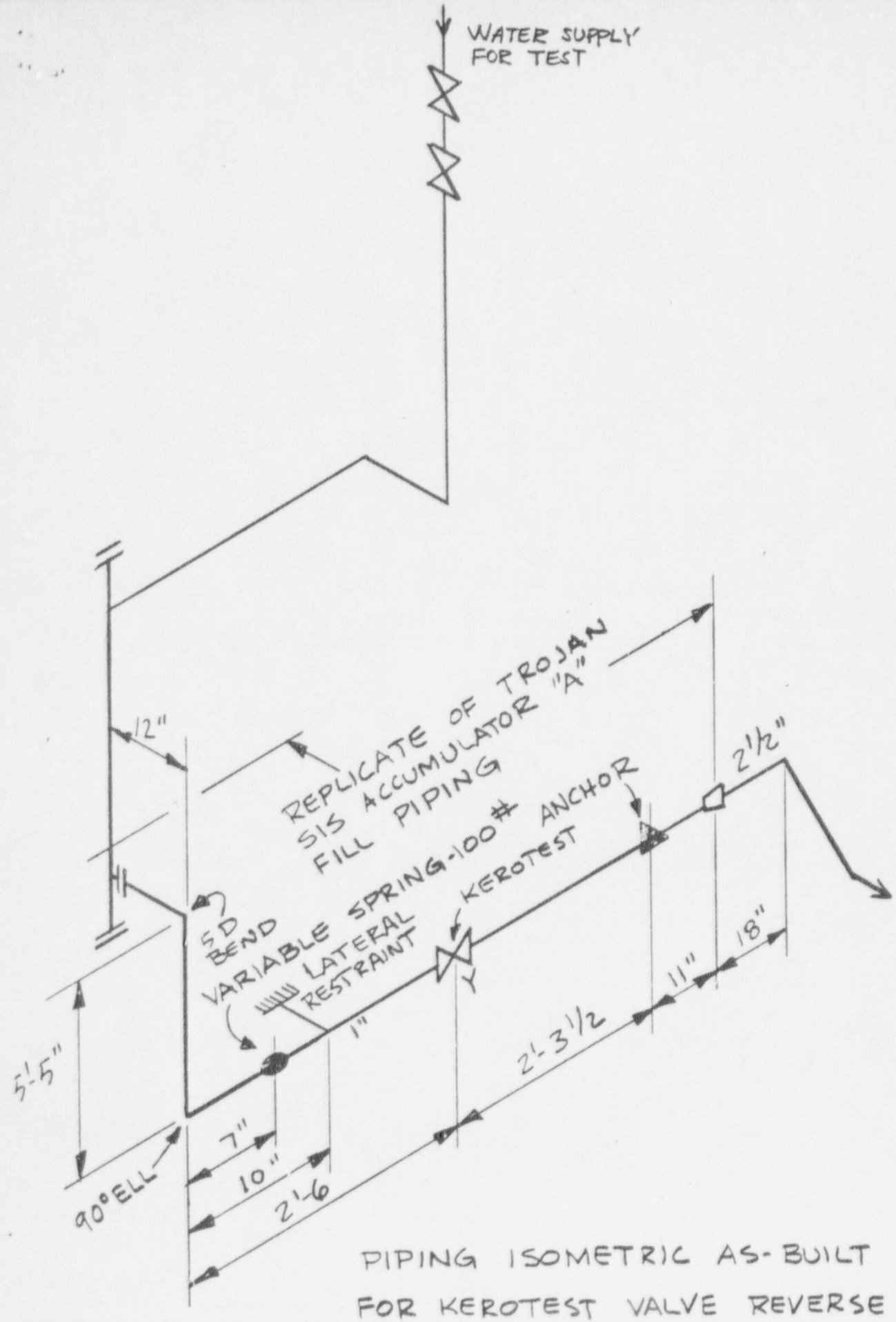
Flow, gal.	Time Interval	Flow Rate	Observations
 20	2 min	10 gpm	stable
 40	3 min	13	stable
37	1 min	37 gpm	stable
40	1 min	40	stable
 63	1 min	63 gpm	stable
Pipe began to chatter slightly while increasing flow. Reduced flow then started to increase slowly just below chatter point			
 68	1 min	68 gpm	

Pipe broke just above 68 gpm. Did not have time to measure flow rate.

Pump supply pressure ~ 350 psi
Kerotest Valve Serial No. NAH 20-2

Performed by: Loren E Mayer P.E. Date: 6/3/87
Loren E. Mayer - Test Engineer

Witnessed by: G H Bernard P.E. Date: 6/3/87



PIPING ISOMETRIC AS-BUILT FOR KEROTEST VALVE REVERSE FLOW TEST

JCK 6-4-87
6-4-87

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TROJAN NUCLEAR PLANT
STOREROOM MATERIAL ISSUES/RETURNS

☒ Issued (01) ☐ Returned (04)	TRANSACTION CODE 01-2	YEAR 87	MONTH 6	DAY 1	DEPARTMENT/WORK GROUP MAINT

ENTITY	LEDGER ACCOUNT	CE	RC	JOB NUMBER	ACTIVITY CODE	MR	RDC/DCP
911	N52411	31	062	00000	VLVPM	—	—

DESCRIPTION OF MATERIAL		ENVIRONMENTAL QUAL REQD (YES/NO)		
1500# 1" Kerotest Y-Type PMD Globe Valve		NON Q ☐ Q ☒ SAFETY RELATED ☒		
VENDOR PART # (FROM DWG. VENDOR MANUAL) WD-9916		QLIST STS ETS FIRE SEC RP RMP EP RWMS OTHER:		
PLANT EQUIP # (FROM INDEX, MECH EQUIP LIST, ETC)	EXP DATE	PART ID 7797076	QTY 1	UNIT EA
NAME OF PLANT EQUIP WHERE USED	HEAT #	PO NUMBER N-25557	QA CODE A	

DESCRIPTION OF MATERIAL		ENVIRONMENTAL QUAL REQD (YES/NO)		
		NON Q ☐ Q ☐ SAFETY RELATED ☐		
VENDOR PART # (FROM DWG. VENDOR MANUAL)		QLIST STS ETS FIRE SEC RP RMP EP RWMS OTHER:		
PLANT EQUIP # (FROM INDEX, MECH EQUIP LIST, ETC)	EXP DATE	PART ID	QTY	UNIT
NAME OF PLANT EQUIP WHERE USED	HEAT #	PO NUMBER	QA CODE	

DESCRIPTION OF MATERIAL		ENVIRONMENTAL QUAL REQD (YES/NO)		
		NON Q ☐ Q ☐ SAFETY RELATED ☐		
VENDOR PART # (FROM DWG. VENDOR MANUAL)		QLIST STS ETS FIRE SEC RP RMP EP RWMS OTHER:		
PLANT EQUIP # (FROM INDEX, MECH EQUIP LIST, ETC)	EXP DATE	PART ID	QTY	UNIT
NAME OF PLANT EQUIP WHERE USED	HEAT #	PO NUMBER	QA CODE	

DESCRIPTION OF MATERIAL		ENVIRONMENTAL QUAL REQD (YES/NO)		
		NON Q ☐ Q ☐ SAFETY RELATED ☐		
VENDOR PART # (FROM DWG. VENDOR MANUAL)		QLIST STS ETS FIRE SEC RP RMP EP RWMS OTHER:		
PLANT EQUIP # (FROM INDEX, MECH EQUIP LIST, ETC)	EXP DATE	PART ID	QTY	UNIT
NAME OF PLANT EQUIP WHERE USED	HEAT #	PO NUMBER	QA CODE	

DESCRIPTION OF MATERIAL		ENVIRONMENTAL QUAL REQD (YES/NO)		
		NON Q ☐ Q ☐ SAFETY RELATED ☐		
VENDOR PART # (FROM DWG. VENDOR MANUAL)		QLIST STS ETS FIRE SEC RP RMP EP RWMS OTHER:		
PLANT EQUIP # (FROM INDEX, MECH EQUIP LIST, ETC)	EXP DATE	PART ID	QTY	UNIT
NAME OF PLANT EQUIP WHERE USED	HEAT #	PO NUMBER	QA CODE	

RECEIVED BY	ISSUED BY	QUALITY-RELATED AUTHORIZED BY
GARY VAN BLADEREN	C. Nelson	Gary van Bladeren

PGE 2345 (Oct 86) PLEASE PRINT

ENCLOSURE 3

CHRONOLOGY OF ACCUMULATOR FILL LINE FAILURE

On May 12, 1987, while transferring water from the "A" accumulator to the "D" accumulator by sluicing through the fill lines, a rupture of the "A" fill line at the accumulator nozzle-to-pipe weld occurred. The differential pressure between the accumulators at the time was 583 psid.

On May 13, Nuclear Plant Engineering commenced an investigation/ evaluation of the failure.

On May 16, the weld was repaired and the clearance on the system was released on May 18.

On May 22, a metallurgical evaluation, which had begun following the rupture on May 12, was completed, revealing a low-cycle fatigue failure had occurred. Preliminary conclusions reached were a fatigue crack could have initiated during construction of a platform near the "A" fill line. The workers may have used the pipe as a platform from which to work during construction. The effect of the sluicing operation would have been to propagate the crack. This hypothesis was being evaluated by Nuclear Plant Engineering.

The system was hydrostatically tested satisfactorily on May 23. Later in the afternoon on May 23 after the pressure in the accumulator was reduced to approximately 650 psig, operations tried to repeat the sluicing operation. A loud banging noise was heard, and the operation was stopped. A second attempt was made and the loud banging noise continued. Following a valve line-up check, the operation was started again, and the fill line nozzle weld for the "A" accumulator failed again.

A metallurgical evaluation has been completed on the second failure with the determination the failure is again low-cycle fatigue. Evaluations have been conducted to determine the cause of the failure and the source of the loud banging noise. It has been determined the noise came from the packless, diaphragm valve in the "A" fill line when exposed to backflow with a very high differential pressure. This conclusion has been verified through vendor and industry contacts. A backflow test across a packless, diaphragm valve has been performed and has verified the valve chatter under backflow conditions.

Inspections of system piping, supports, valves, and welds have been conducted on a selected basis for each of the four accumulators. An independent evaluation of the sluicing operation and past sluicing operations has also been performed.

SAB/kpw
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II. ACCUMULATOR FILL LINE FAILURE ACTION PLAN

Updated as of: June 14, 1987

Action	Action Party	Status	Comments/Results
A. Failed Line (NCR 87-163).			
1. First failure (Event Report 87-084).			
a. Perform metallurgical evaluation.	Jeff Carter (Analytical Lab)	Complete.	Low cycle fatigue (<400 cycles). ASD-2806-87M (6/1/87).
b. Inspect pipe supports.	Roger Lewis NPE	Complete.	Pipe supports meet specification.
c. Repair weld.	Maintenance	Complete.	Not applicable.
d. Nondestructively exam weld.	Maintenance/ Quality Control	Complete.	Satisfactory.
e. Hydrostatically test system.	Plant Engineering	Complete.	Satisfactory.
2. Second failure (Event Report 87-091).			
a. Perform metallurgical evaluation.	Jeff Carter	Complete.	Results indicate low cycle fatigue. ASD-2806-87M (6/1/87). ASD-2812-87M (6/4/87).
*b. Perform dynamic analysis.	Bechtel	Complete.	
*1) Calculate flow rate through fill lines from "A" to "D" accumulator during sluicing.	Jeff Wheeler NPE	Complete.	Calculated 95 gpm.

* Analyses provided to NRR.

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II. ACCUMULATOR FILL LINE FAILURE ACTION PLAN

Updated as of: June 14, 1987

Action	Action Party	Status	Comments/Results
*2) Calculate flow rate through sample lines from "A" to "D" accumulator during sluicing.	Jeff Wheeler NPE	Complete.	Calculated 45 gpm.
*3) Calculate flow rate through "A" fill line while draining to the holdup tanks.	Jeff Wheeler NPE	Complete.	Calculated 26 gpm.
c. Perform surface examination of all nozzle-to-pipe welds and pipe welds on accumulator fill line back to the second support upstream of the control valve.	Don Wheeler Quality Control	Complete.	Welds are satisfactory.
d. Inspect control valve (CV 8878A).	Mike Niman Scott Miller	Complete.	Some minor damage observed. High spots on cage removed and valve reassembled. LAB-013-87T and LAB-016-87T. NCR 87-195.
e. Inspect pipe supports.	Chris Dieterle Nuclear Plant Engineering (NPE)	Complete.	Report complete. REF-300-87 (6/1/87).
*f. Calculate nozzle stresses.	Alan Pierce NPE	Complete.	Calculation submitted for NRR review.

* Analyses provided to NRR.

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II. ACCUMULATOR FILL LINE FAILURE ACTION PLAN

Updated as of: June 14, 1987

Action	Action Party	Status	Comments/Results
g. Perform ultrasonic examination of nozzle-to-vessel weld.	Arlen Wogen NPE	Complete.	Weld satisfactory.
h. Evaluate need for examination of tank.	Alan Pierce NPE	Complete.	Based on results of calculation for Item A.2.f, load on tank is insignificant. Examination of tank not necessary.
i. Perform backflow test of packless, diaphragm valves.	Loren Mayer	Complete.	Line failed. Critical flow determined to be ~ 70 gpm.
j. Repair nozzle-to-pipe weld.	Gary Van Bladeren Al Cohlmeyer	Complete.	Hydrotest completed satisfactorily.
B. Packless, Diaphragm Valves.			
1. Contact vendor to determine if valve application correct (ie, for backflow with high differential pressure).	Larry Battaglia NPE	Complete.	Vendor manual indicates valves may act as check valves in some backflow conditions. Backflow tests performed by vendor did not bound Trojan application.
2. Inspect valves on sample (ie, SI-031, -032, -033, and -034) and fill (ie, 8934A, B, C, D) lines.	Mike Himan Scott Miller	Complete.	8934A inspected and damage observed. Sample valves inspected and no damage observed. Results as expected due to lower flow through these lines. SI-033 not inspected due to interference. Inspection not necessary based on results of other sample valves. NCR 87-195.

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II. ACCUMULATOR FILL LINE FAILURE ACTION PLAN

Updated as of: June 14, 1987

Action	Action Party	Status	Comments/Results
3. Evaluate industry experience with backflow through these valves.	Frank Rogan Pacific Engineering	Complete.	
4. Evaluate other valve applications for backflow concerns.	Greg Kent Trojan Engineering	In progress.	Completed for safety-related systems. Other valves by 8/15.
C. Other Components.			
1. Evaluate wetted components for boric acid attack concerns.	Maintenance	In progress.	Inspection plan developed. Plan is to wash down effected area with demin water just prior to Containment closeout. Electrical evaluation complete, no adverse consequences expected.
2. Examine nozzle-to-pipe welds on other accumulators.	Don Wheeler Quality Control Roger Lewis BPR	Complete.	Three indications discovered. NCR 87-190.
a. Evaluate scab on B accumulator outlet line.	Don Wheeler Roger Lewis	Complete.	Indication has been eliminated. NCR 87-190.
b. Evaluate indication on lower weld on B injection line.	Don Wheeler Roger Lewis	Complete.	Indication has been eliminated. NCR 87-190.
c. Evaluate indication on fill line for B accumulator.	Don Wheeler Roger Lewis	Complete.	Indication has been eliminated. NCR 87-190.

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II. ACCUMULATOR FILL LINE FAILURE ACTION PLAN

Updated as of: June 14, 1987

Action	Action Party	Status	Comments/Results
3. Perform ultrasonic and surface examination of ridges on C accumulator fill line to determine wall thickness and if surface indications exist (Item 6 on isometric SI-601R-1-690).	Arleo Wogen Don Wheeler	Complete.	Results satisfactory.
4. Inspect pipe supports on B, C, and D accumulator lines.	Chris Dieterle NPE	Complete.	One deficiency noted on H-227 on D fill line. NCR 87-212. REF-300-87 (6/1/87).
5. Inspect small piping inside Containment containing packless, diaphragm valves.	Chris Dieterle NPE	Complete.	REF-300-87 (6/1/87).
6. Evaluate bent sample/drain line on D accumulator (NCR 87-177).	Rodger Wehage	Complete.	Use as is.
7. Inspect control valves on B, C, and D accumulator lines (CV-88788, C, and D).	Mike Nimon Scott Miller	Complete.	No problems noted.
8. Evaluate repeating inspections of nozzle welds on B and C accumulator.	Rodger Wehage NPE	Complete.	Examinations determined to be unnecessary.
9. Repeat nondestructive examinations of Accumulator D nozzle welds.	Don Wheeler	Complete.	Linear indications found on 10-in. outlet nozzle. NCR 87-202.

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II. ACCUMULATOR FILL LINE FAILURE
ACTION PLAN

Updated as of: June 14, 1987

Action	Action Party	Status	Comments/Results
a. Evaluate indications on D accumulator outlet nozzle.	Arlen Wogen HPE	Complete.	Indication eliminated. Reexamination satisfactory. MR 87-3613.
10. Perform surface examination of welds on fill line for Accumulator D along pathway where sluicing occurred.	Don Wheeler	Complete.	All welds acceptable.
11. Perform surface examination of pipe welds about 10 feet either side of sample line packless, diaphragm valves.	Don Wheeler	Complete.	All welds acceptable.
D. Design Modifications.	HPE	Complete.	No modifications necessary.
E. PM/RA Investigation.			
1. Operating Procedures (transfer of water between accumulators).	R. C. Jarman	Complete.	Investigation and evaluation complete.
a. Determine if this operation is covered by procedure.	G. J. Stein	Complete.	NCAR written. Operation was not covered by a procedure.
b. Develop a history of "sluicing" operations.	G. J. Stein	Complete.	Logs are incomplete and accurate history cannot be developed. Log keeping recommendation will be made in final report.
c. Perform change analysis (MORT analysis technique).	G. J. Stein	Complete.	

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II. ACCUMULATOR FILL LINE FAILURE
ACTION PLAN

Updated as of: June 14, 1987

Action	Action Party	Status	Comments/Results
2. Quality Control.			
a. Investigate use of system after initial failure.	C. H. Brown/ G. J. Stein	Complete.	
b. Determine integrity of first weld repair.	Don Wheeler/ E. Curtis	Complete.	Weld was satisfactory.
c. Evaluate quality control procedure (QCP-6) which allows conditioning of weld defects discovered to determine if defects should first be evaluated by an engineer.	C. H. Brown/ Don Wheeler	Complete.	
3. Investigate history of previous problems with packless, diaphragm valves at Trojan.	R. C. Jarman	Complete.	Problems with backflow through packless diaphragm valves identified in OAR Program.
a. Determine why the evaluation of OARs 83-14 and 83-169 did not identify this backflow condition.	G. J. Stein M. N. Malaros	Complete.	Inadequate scope of review of the identified problem.
4. Conduct independent review of event reports.	R. C. Jarman	Closed.	To be complete as part of the normal event report process in accordance with NDP 600-3.

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II. ACCUMULATOR FILL LINE FAILURE ACTION PLAN

Updated as of: June 14, 1987

Action	Action Party	Status	Comments/Results
F. Reporting.			
1. Write LER.	B. L. Kershul	Complete.	
G. Procedure Changes.	MP&/Plant Operations		
1. Revise OI 5-2 to prohibit sluicing between accumulators through the fill or sample lines.	R. L. Russell	Complete.	OI 5-2, Rev. 18 issued 5/29.
H. Operator Issues.			
1. Resolve operator concerns.	C. A. Olmstead	In progress.	
2. Submit letter to NRC discussing resolution.	C. A. Olmstead D. L. Nordstrom	In progress.	To be submitted 6/15.

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