NRC Form 366
(9-83)

U.S. NUCLEAR REGULATORY COMMISSION
APPROVED OMB NO. 3150-0104
EXPIRES: 8/31/88

LICENSEE EVENT REPORT (LER)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
Wolf Creek Generating Station	0 5 0 0 0 4 8 2	1 OF 0 6

TITLE (4) Hydraulic 4-Way Valve Failures on Main Steam Line Isolation Valve Actuators

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 NAMES	DOCKET NUMBER(S)
										0 5 0 0 0
1 0 2 4 8 5			8 5	0 7 5	0 1	0 9 2 9 8 8				0 5 0 0 0

OPERATING MODE (9)	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more of the following) (11)			
1	20.402(b)	20.405(c)	50.73(a)(2)(iv)	73.71(b)
POWER LEVEL (10) 1 0 0	20.405(a)(1)(i)	50.36(c)(1)	50.73(a)(2)(v)	73.71(c)
	20.405(a)(1)(ii)	50.36(c)(2)	50.73(a)(2)(vii)	X OTHER (Specify in Abstract below and in Text, NRC Form 366A)
	20.405(a)(1)(iii)	50.73(a)(2)(i)	50.73(a)(2)(viii)(A)	Voluntary Report
	20.405(a)(1)(iv)	50.73(a)(2)(ii)	50.73(a)(2)(viii)(B)	
	20.405(a)(1)(v)	50.73(a)(2)(iii)	50.73(a)(2)(x)	

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER
Merlin G. Williams - Manager Plant Support	AREA CODE 3 1 6 — 3 6 4 - 8 3 1 1

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

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS		CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS	
B	S B	F S V	T 1 0 3	Y							

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

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

On January 6, 1985, a Main Steam Line Isolation Valve (MSLIV) with a cracked piston slide was first discovered in a hydraulic 4-way valve [FSV]. On June 7 and June 11, 1985, decreasing MSLIV accumulator pressure led to the identification of two additional "N" position 4-way valves that had failed resulting in hydraulic fluid leaks. This event was voluntarily reported as a Licensee Event Report (LER) 85-075-00. Revision 1 of LER 85-075 provides the results of additional investigation of the 4-way valves and revises the corrective actions discussed in Revision 0.

Following replacement of slides during the first refueling, Fall, 1986, additional slide failures occurred. Two of the failed slides were removed and metallurgically examined, one by the manufacturer and one by an independent consultant. Both drew conclusive results that crack initiation occurred during the heat treating cycle of the manufacturing process. Based on the initiation of the flaw during the manufacturing process and the rapid propagation of the flaw to the slide surface (i.e. brittle fracture), a slide that has not failed during the initial service pressure cycles is not likely to fail thereafter. Preservice bench testing under pressure, dimensional tolerance fit up checks and radiography, has been done for the slides which are currently in service. Continued service of the currently installed slides should not be detrimental to the operability/reliability of the MSLIV.

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INTRODUCTION

On January 6, 1985, a Main Steam Line Isolation Valve (MSLIV) [SB-ISV] with a cracked piston slide was first discovered in a hydraulic 4-way valve [FSV]. The MSLIV was then rebuilt during preoperational testing. The significance of the failure was not understood at that time. On June 7 and June 11, 1985, decreasing MSLIV accumulator pressure led to the identification of two additional "N" position 4-way valves that had failed resulting in hydraulic fluid leaks. Although this event did not meet the reporting criteria of 10CFR50.73, it was voluntarily reported as Licensee Event Report (LER) 85-075-00, as an event that may be of interest to others. Following replacement of slides during the first refueling, Fall 1986, additional slide failures occurred. Revision 1 of LER 85-075 provides the results of additional investigation of the 4-way valves. Revision 1 also revises the corrective actions discussed in Revision 0. The supplier has made a separate notification in August, 1988, pursuant 10CFR21.

DESCRIPTION OF MSLIV AND MFIV ACTUATORS

The 4-way valves control the application of hydraulic fluid to the hydraulic actuators [84] on the MSLIV's during normal valve positioning and during Engineered Safety Features Actuation. Although the failures have occurred only on the MSLIV's, identically manufactured, smaller capacity, 4-way valves perform the same functions on the Main Feedwater Isolation Valves (MFIV)[SJ-ISV].

Each MSLIV and MFIV has two redundant hydraulic trains supplying actuation fluid to the valve hydraulic actuator. Each train consists of an accumulator [ACC] charged to 5000 pounds per square inch, gauge (psig), a 4-way valve ("N" position) controlling the accumulator discharge flow and a 4-way valve ("M" position) directing the hydraulic fluid to the appropriate open or close ports on the hydraulic actuator (see figure 1). The accumulators are charged via a common air operated hydraulic pump [P] which takes suction from the hydraulic reservoir [RVR].

For normal valve positioning (slow mode of operation), the output of the hydraulic pump is directed to the valve actuator by the "M" or "M1" 4-way valve. During this mode of operation, the "N" or "N1" 4-way valve is centered, isolating the accumulator from the hydraulic circuit. During an Engineered Safety Features Actuation Signal (ESFAS) (fast closure), the precharged accumulators are discharged through the "N" position 4-way valves and the hydraulic fluid is directed to the valve actuator by the "M" position 4-way valves. The 4-way valves installed in the "N" positions are continually subjected to accumulator pressure of 5000 psig. Any leakage of hydraulic fluid from these valves is detectable as decreasing accumulator pressure which is displayed and alarmed in the Control Room.

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

DESCRIPTION OF EVENTS AND INITIAL INVESTIGATION

Cracked piston slides were first discovered in an "N" position 4-way valve on January 6, 1985, when an MSLIV was rebuilt during preoperational testing. The significance of this failure was not understood at that time. On June 7 and June 11, 1985, decreasing MSLIV accumulator pressure led to the identification of two additional "N" position 4-way valves that had failed resulting in hydraulic fluid leaks. On-site investigations identified that the hydraulic leakage was due to cracking of the 4-way valve piston slides similar to the cracking discovered in January, 1985.

The failed 4-way valves were sent to the supplier, Anchor/Darling, who forwarded them to the manufacturer, Teledyne/Republic, for inspection and evaluation. The results of their efforts, received on October 24, 1985, confirmed that the leakage was due to piston slide cracking. It was postulated that the probable cause of the crack initiation was due to stresses induced by the combined effects of the brazing and heat treatment processes used in manufacturing coupled with subjecting the valves to greater than rated operating pressures (5000 psig). The 4-way valves were factory hydrostatic tested to 7500 psig.

Revision Ø of this LER stated that piston slide cracking was limited to 4-way valves of serial numbers less than 1198. Corrective action identified in revision Ø involved replacement of the piston slide assemblies in all 4-way valves having a serial number lower than 1198. This replacement was to be accomplished at Anchor/Darling's facilities and was to be done on a batch basis consistent with the availability of available spare 4-way valves.

ADDITIONAL TESTING AND REVISED CORRECTIVE ACTIONS

The basis for replacing the MSLIV 4-way slides as indicated in LER 85-Ø75, Revision Ø, was to assure the operability and reliability of the MSLIV's with slides manufactured and heat treated under controlled conditions. It was orginally postulated by the manufacturer, Teledyne Republic and the supplier, Anchor/Darling, that control of the specified brazing and heat treating process would prevent the materials' susceptibility to cracking under hydraulic pressure and thus eliminate the inservice failures of the MSLIV/MFIV actuators.

Following replacement of slides during the first Refueling, Fall 1986, additional slide failures occurred. Subsequent bench testing, valve preservice testing, and radiography of the slides during the first Refueling proved control of the brazing and heat treat process alone was not sufficient to ensure integrity of the slides. MSLIV slide cracking of an identical failure mode to those seen in the original failures continued to be experienced.

Two failed slides were removed and metallurgically examined, one by the manufacturer and one by an independent consultant. Both drew conclusive results that crack initiation occurred during the heat treating cycle of the manufacturing process. Due to the nature of the subsurface flaw, detection by the standard shop magnetic particle examination was not possible. Subsequent exposure of the slide to additional stress from high internal hydraulic pressure of approximately 5000 psig, as seen in actual service, resulted in rapid crack propagation to the surface. The extreme hardness (57 HRC) of the Type 440F Se slide body provided little resistance to fracture propagation from the forces generated by the internal hydraulic pressure. This was demonstated by the predominately brittle, intergranualar appearance of the fracture faces.

The supplier of the 4-way valves has been testing various mock-ups of the 4-way valve slides in a variety of furnaces to better control the brazing and heat treatment process and thus preclude the failure of slides that has been experienced at WCGS. The testing is complete and a new procedure is being reviewed. This additional testing also supports the conclusion that the manfacturing process initiates the subsurface flaws and that subsequent high internal hydraulic pressure propagates the failure quickly.

Based on the initiation of the flaw during the manufacturing process and the rapid propagation of the flaw to the slide surface (i.e. brittle fracture), a slide that has not failed during the initial service pressure cycles will likely not fail thereafter. This is because either an internal flaw does not exist or the internal flaw is of insufficient size and/or orientation such that the material stresses are below the energy threshold for crack propagation. Preservice bench testing under pressure, dimensional tolerance fit up checks and radiography have been done for the slides which are currently installed. Therefore, continued use of these slides should not be detrimental to the operability/reliability of the MSLIV/MFIV.

ADDITIONAL INFORMATION

During this event, the plant operated in Mode 1, Power Operation, at Reactor power levels up to 100 percent. There have been no previous similar occurrences.

The 4-way valves were manufactured by Teledyne/Republic Manufacturing as part number 23304-7001-2853 and were supplied by Anchor/Darling Valve Company as part number W-19595 on the Anchor/Darling Valve Hydraulic Actuators for the MSLIVs. The part numbers for the 4-way valves on the MFIVs are 23104-7001-2853 and W-19488 respectively.

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As described above, leakage of 4-way valves installed in the "N" positions is easily detectable. However, leakage of 4-way valves installed in the "M" positions is not easily detectable since these valves are not subjected to pressure unless the MFIVs and MSLIVs are being operated. During normal valve positioning (single train operation), these 4-way valves experience approximately 2500 psig when the MFIVs and MSLIVs reach the end of their stroke. Upon Engineered Safety Features Actuation, these 4-way valves are pressurized to approximately 3500 psig for a maximum duration of 5 seconds.

Evaluation by Anchor/Darling concluded that the likelihood of piston slide cracking occurring in an "M" position valve is very low since "M" position valves are not subjected to pressures at or near rated operating pressure (5000 psig). Anchor Darling has indicated that the maximum hydraulic fluid inventory that a worst case cracked "M" or "M1" valve could lose during an ESFAS would be approximately 1 quart. The total hydraulic fluid inventory required for an ESFAS is approximately 13 quarts and each accumulator contains approximately 14 quarts of fluid. With an ESFAS actuation of one train containing a worst case cracked "M" position valve, Anchor/Darling indicated that MSLIV or MFIV closure could be marginal. With an ESFAS actuation of two trains, each train containing a worst case cracked "M" position valve, MSLIV or MFIV closure would be accomplished within the 5 second time requirement.

The evaluation of the consequences of 4-way valve failures coupled with the precautionary measures which have been taken, provide a high degree of confidence that the MSLIVs and MFIVs will perform their Engineered Safety Features functions even assuming the highly unlikely failure of an "M" position 4-way valve. Consequently, this event has no impact on the health or safety of the public.

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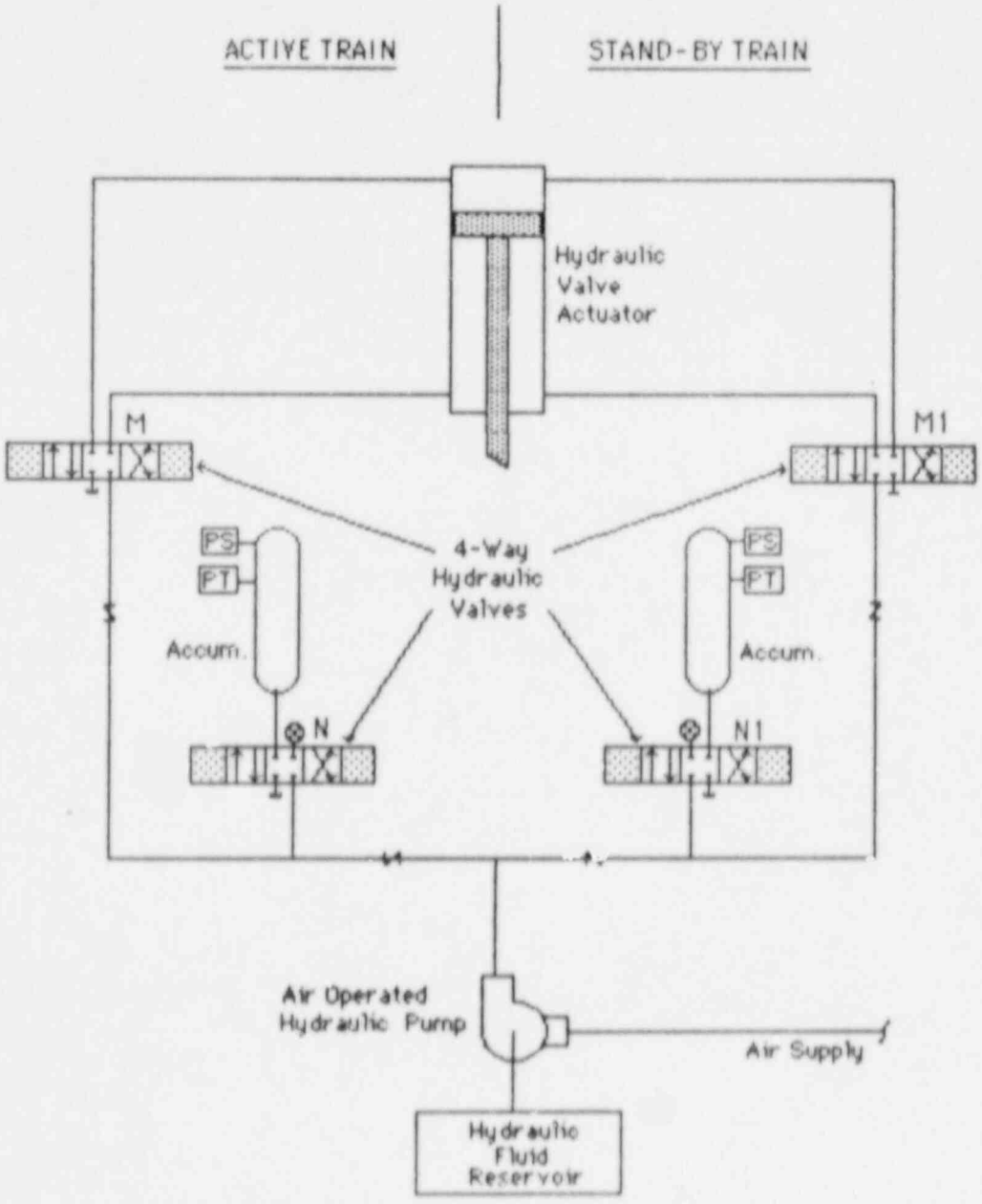
Figure 1

MAIN STEAM LINE and MAIN FEEDWATER
ISOLATION VALVES



WOLF CREEK
NUCLEAR OPERATING CORPORATION

Bart D. Withers
President and
Chief Executive Officer

September 29, 1988

WM 88-0242

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Mail Station P1-137
Washington, D. C. 20555

Subject: Docket No. 50-482: Licensee Event Report 85-075-01

Gentlemen:

The attached Licensee Event Report is submitted as a voluntary report concerning the results of additional investigation of the Main Steam Line Isolation Valve piston slides. This report is a revision to LER 85-075-00 which was submitted December 10, 1985.

Very truly yours,

Bart D. Withers
President and
Chief Executive Officer

BDW/jad

cc: B. L. Bartlett (NRC), w/a
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