ARKANSAS POWER & LIGHT COMPANY

August 14, 1989

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SUBJECT: Arkansas Nuclear One - Unit 2
Docket No. 50-368
License No. NPF-6
Licensee Event Report No. 50-368/89-012-00

Gentlemen:

In accordance with 10CFR50.73(a)(2)(i)(B), 10CFR50.73(a)(2)(ii)(B) and 10CFR50.73(a)(2)(iv), attached is the subject report concerning a safety injection check valve malfunction due to missing internal parts resulting in reactor coolant system backleakage.

Very truly yours,

E. C. Ewing
General Manager,
Technical Support
and Assessment

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(9-83)

U.S. Nuclear Regulatory Commission
Approved OMB No. 3150-0104
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LICENSEE EVENT REPORT (LER)

FACILITY NAME (1) Arkansas Nuclear One, Unit Two

DOCKET NUMBER (2): 0|5|0|0|0| 3| 6| 8 | PAGE (3): 1 OF 0|7

TITLE (4) Safety Injection System Check Valve Malfunction Due to Missing Internal Parts Results in Reactor Coolant System Backleakage

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|6	2|6	8|9	8|9 --	0|1|2 --	0|0	0|8	1|4	8|9		0|5|0|0|0|
										0|5|0|0|0|

OPERATING MODE (9): 4

POWER LEVEL (10): 0|0|0

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more of the following) (11)

[ ] 20.402(b)	[ ] 20.405(c)	[X] 50.73(a)(2)(iv)	[ ] 73.71(b)
[ ] 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)	[ ] Other (Specify in Abstract below and in Text, NRC Form 366A)
[ ] 20.405(a)(1)(iii)	[X] 50.73(a)(2)(i)	[ ] 50.73(a)(2)(viii)(A)	
[ ] 20.405(a)(1)(iv)	[X] 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: Dana Millar, Nuclear Safety and Licensing Specialist

Telephone Number: Area Code 5|0|1 | 9|6|4|-|3|1|0|0

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
X	A|B	| | |V	A|5|B|5	Y					

SUPPLEMENT REPORT EXPECTED (14)

[ ] Yes (If yes, complete Expected Submission Date) [X] No

EXPECTED SUBMISSION DATE (15): Month | Day | Year

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

On June 26, 1989, during a plant heatup, reactor coolant system (RCS) backleakage through a safety injection system check valve occurred three times. Following each occurrence the valve was reseated by injecting water through the valve into the RCS using a High Pressure Safety Injection pump. Leakage was returned to within allowable limits and the plant heatup continued. On June 27, 1989, a plant cooldown was performed due to an unrelated problem. While shutdown, the check valve that had leaked was disassembled and inspected. Two rollpins which connect the valve disc to the valve disc shaft, making them one integral part, were found missing. This allowed a misalignment of the seating surfaces of the valve resulting in leakage as the RCS was pressurized. Based on these findings, another check valve of the same design was also disassembled and inspected. Both rollpins were present, however, one rollpin was found cracked and loose. The rollpins were replaced in both valves and the valves reassembled. A plant heatup was commenced and on July 3, 1989, a satisfactory leakage test was performed for each valve. The cause of the missing rollpins could not be determined. The cracked rollpin is undergoing metallurgical analysis to determine the cause of its failure. Inspections of additional check valves are planned for the next refueling outage.

A. Plant Status

At the time of occurrence of this event, Arkansas Nuclear One, Unit Two (ANO-2) was in Mode 4 (Hot Shutdown), with Reactor Coolant System (RCS) [AB] temperature approximately 276 degrees Fahrenheit and RCS pressure approximately 385 psia. A plant heatup was in progress to return the unit to power operations following a maintenance outage to repair a leaking flange on the RCS high point vent system.

B. Event Description

During cold shutdown conditions reactor decay heat removal is accomplished by aligning the Low Pressure Safety Injection (LPSI) [BP] system in a Shutdown Cooling (SDC) configuration and circulating reactor coolant through a heat exchanger which is cooled by service water [BI]. Suction is taken from the RCS hot leg piping and the coolant is returned to the core through four LPSI system injection headers (one header is connected to each RCS cold leg). The boron concentration in the coolant is maintained at a sufficient level to ensure required reactor shutdown margins. During a plant heatup, after securing from the SDC mode (at about 290 psia RCS pressure) and following realignment of the LPSI system in the emergency core cooling configuration, the system piping is flushed with borated water from the Refueling Water Tank (RWT) [TK]. A recirculation flowpath is established by operating a LPSI pump with suction supplied from the RWT and returning water to the RWT through the Safety Injection Tank (SIT) [BQ] drain line (see Figure 1). The headers are flushed one at a time by opening the appropriate SIT drain valves. This ensures the boron concentration in the headers is approximately the same as the concentration in the RWT. (Shutdown RCS boron concentration is usually less than the minimum RWT boron concentration of 2500 ppm.)

On June 26, 1989, at 1818 hours, with RCS pressure approximately 385 psia, after SDC was removed from service, a flush of the LPSI system piping was commenced. At approximately 1915 hours, while flushing the 'C' header, control room operations personnel observed a rapid decrease in pressurizer water level at an estimated rate of approximately 20 gpm. The LPSI header flush was secured by stopping the LPSI pump, closing the motor operated isolation valve (MOV) in the return to the RWT (2CV-5082) and closing the 'C' SIT drain valve (2SV-5041). The pressurizer water level decrease stopped and began to increase as the charging system restored water level. Pressurizer water level was allowed to stabilize and the 'C' LPSI header flush recommenced in order to determine the cause of the initial pressurizer water level decrease. Again, pressurizer water level decreased and the LPSI header flush was secured. At this time, an abnormally high pressure was indicated on the pressure indicator (2PIS-5040) located on the low pressure side of safety injection check valve 2SI-15C [BQ-INV], indicating that backleakage from the RCS through the check valve was occurring. The applicable Technical Specification Action Statement for excessive RCS leakage through the check valve was entered.

In an attempt to seat 2SI-15C, a High Pressure Safety Injection (HPSI) [BQ] pump was started and a HPSI MOV was throttled open to inject borated water into the RCS from the RWT through the leaking check valve. When the HPSI pump was secured and the MOV was closed, the pressure on 2PIS-5040 remained below RCS pressure indicating the check valve had seated. The LPSI header flush valve alignment was reestablished to create the same system alignment that was present when the valve was identified as leaking initially, and pressurizer water level did not decrease. Also, the pressure observed on 2PIS-5040 indicated the valve had reseated and was not leaking. The LPSI header flush was secured and the Technical Specification Action Statement was exited at approximately 2125 hours. The plant heatup continued and at about 2200 hours, Mode 3 (Hot Standby) was entered.

At 2156 hours, a HPSI pump was started and a small amount of makeup water was added to the SITs to increase water level in the tanks. At 2206 hours, the HPSI pump was secured. The SITs were unisolated (tank outlet MOV's opened) and placed in service prior to RCS pressure reaching 690 psia. At approximately 2340 hours, 2SI-15C was identified to be leaking again as indicated by the pressure on 2PIS-5040. RCS pressure at this time was approximately 784 psia. The Technical Specification Action Statement for RCS leakage through the check valve was again entered. On June 27, 1989, at 0020 hours, the 'C' SIT outlet valve (2CV-5043) was closed. At 0023 hours, a HPSI pump was started again and used to inject borated water into the RCS through 2SI-15C in an attempt to seat the check valve. When the HPSI pump was secured and the HPSI header MOV closed, the 'C' SIT drain valve and the MOV (2CV-5081) to the Reactor Drain Tank (RDT) [WD-TK] were opened to vent the line between the SIT outlet valve and 2SI-15C. Pressure on 2PIS-5040 decreased to approximately 50 psia indicating the check valve was probably seated. At 0029 hours, the 'C' SIT outlet valve was reopened. Pressure indicated by 2PIS-5040 increased to approximately 750 psia indicating that backleakage through 2SI-15C was occurring again.

At 0122 hours, with RCS pressure approximately 1070 psia, the 'C' SIT outlet valve was closed again. As in earlier attempts to seat 2SI-15C, the HPSI system was aligned to inject borated water into the RCS through the check valve. After the HPSI pump and alignment were secured the drain valve to the RDT was opened to vent the header, however, the pressure on 2PIS-5040 indicated the attempt to seat the check valve was unsuccessful. At approximately 0130 hours, mechanical maintenance personnel entered the containment building. These personnel tapped on the bonnet of 2SI-15C with a brass rod in an attempt to help seat the valve. At 0152 hours, two HPSI pumps were started, both HPSI header MOVs to the 'C' loop were opened and borated water was injected into the RCS through 2SI-15C. Both pumps were secured and the MOVs closed, 2SI-15C appeared to have seated by a pressure of approximately 50 psia indicating on 2PIS-5040. At 0205 hours, the 'C' SIT outlet valve was opened and the pressure indicated by 2PIS-5040 increased as expected to approximately 600 psia. (Normal operating pressure maintained by the nitrogen pressure on SIT is 612 ± 12 psig.) RCS pressure at this time was approximately 1200 psia. Also at this time, the Technical Specification Action Statement for RCS leakage was exited. The heatup of the RCS was continued.

On June 27, 1989, at 0705 hours, RCS average temperature was approximately 545 degrees and RCS pressure about 2250 psia. At 0730 hours, Control Room Operations personnel noted that the containment building sump water level had increased approximately twenty percent over a three hour period. At 0910 hours, a plant cooldown was commenced due to an estimated RCS unknown leakrate of about 9.77 gpm. At 0920 hours, a flange located on the reactor vessel head high point vent system in the containment was identified to be the source of the RCS leakage. The RCS leakrate was monitored and did not exceed 10 gpm throughout the RCS cooldown. At 1240 hours on June 27, 1989, Mode 4 (Hot Shutdown) was entered, and at 1616 hours Mode 5 (Cold Shutdown) was achieved.

While in cold shutdown 2SI-15C was disassembled and inspected. The inspection revealed that two rollpins used to connect the valve disc to the disc shaft were missing. Due to the problems found when 2SI-15C was disassembled, another similar check valve, 2SI-15A was opened for inspection. Although both rollpins were found to be installed in this valve, one rollpin was found loose and cracked, allowing the rollpin to slide back and forth. This discrepancy did not affect proper valve operation, since the disc was still adequately secured to the shaft. No other problems were identified, during these inspections.

C. Safety Significance

The design configuration of the ANO-2 safety injection system allows for continuous monitoring of RCS backleakage through the four check valves (2SI-15A, B, C and D) installed in the safety injection headers to each RCS cold leg. A Control Room pressure instrument with indication and audible alarm is located on the low pressure side of each of the check valves. Each time check valve 2SI-15C was noted to be leaking, the leakage flowpath was isolated and the check valve was subsequently reseated. Also, RCS pressure and pressurizer water level were restored and adequately maintained. High pressure to low pressure system interfaces were maintained during each leakage event by redundant check valves in the LPSI and HPSI injection headers. The capability of the check valve to open, if required for HPSI or LPSI injection, was not affected by the missing rollpins. In all, no significant impact on plant safety occurred as a result of 2SI-15C backleakage.

The potential safety concern associated with this event is related to the possibility for overpressurization of low pressure systems which are connected to the high pressure reactor coolant system and which penetrate the containment building. The Reactor Safety Study (RSS), Wash-1400, identified an intersystem loss of coolant accident (LOCA) in a PWR as a significant contributor to risk associated with core melt accidents. This type of accident (designated as EVENT V) involved system designs containing two in-series check valves isolating the high pressure RCS from system piping with a lower design pressure (e.g., LPSI). The scenario which leads to the EVENT V accident is initiated by the failure of these check valves to function as a pressure isolation barrier. This can cause an overpressurization and rupture of the low pressure piping resulting in a LOCA that bypasses containment. A review of the ANO-2 system design shows that an EVENT V isolation valve configuration (e.g., (1) two check valves in series, or (2) two check valves in series with a MOV) does exist and two piping system are of concern. The HPSI and LPSI systems are connected to the RCS by a single common line to each of the cold legs. Both the HPSI and LPSI systems have two check valves and a motor operated valve in series with the high pressure/low pressure interface on the upstream side of the MOVs (see Figure 1). (Although a high pressure/low pressure interface also exist on the SIT outlet lines and the potential exists for over pressurization of this piping, this is not considered to be an EVENT V valve configuration because the piping does not penetrate the containment building.)

During the check valve backleakage events which occurred on June 26, 1989, 2SI-15C was successfully reseated following each occurrence of backleakage. However, based upon the observed response of the valve during the events combined with the subsequent discovery that the rollpins were missing, it is probable that the valve would not have reseated and prevented backleakage if it were ever challenged to open. During plant operation, reasonable conditions can be postulated to occur which would require the valve to open and then subsequently close. For example, certain sizes of main steam line breaks or malfunctions of plant equipment may cause an RCS overcooling transient and depressurization to the setpoint for automatic actuation of HPSI which could open the valve as water is injected into the RCS. Subsequently, RCS pressure may recover and increase back to normal operating system pressure (approximately 2250 psia). Under such a postulated scenario protection of the high pressure/low pressure system interface would be dependent upon satisfactory operation of the redundant single check valve in each piping system. Under worst case conditions if this check valve were to also fail or leak excessively, overpressurization of portions of the HPSI and/or LPSI system could occur potentially creating an Event V accident.

It is important to note that the discussion above is intended to represent a worst-case scenario. Although the consequences of such an event would be significant, the probability of occurrence at this facility is considered to be small Specifically, at ANO-2, as indicated on Figure 1, the HPSI header 1 piping upstream of the injection MOVs has a design pressure of 2485 psig. Therefore, even a concurrent failure of the redundant HPSI check valve(s) under the conditions postulated above would not be expected to overpressurize this piping. HPSI header 2 piping upstream of the injection MOVs has a design pressure of approximately 1950 psig. Exposure of this piping to pressures greater than design does not inherently imply a postulated rupture of the piping due to the margins incorporated as part of the design of piping systems. The LPSI piping upstream of the injection MOVs has a design pressure of 500 psig, therefore, this piping would be most susceptible to potential failure due to overpressurization. However, the ANO-2 Technical Specifications require periodic monitoring and measurement of backleakage through the redundant check valves protecting this piping (2SI-14A, B, C and D) and provide specific limits on allowable leakage thereby providing a high level of confidence of the functional capability of these valves to prevent backleakage.

D. Root Cause

The safety injection check valves (2SI-15A, B, C and D) are designed with a swinging disc connected by two rollpins to a large diameter shaft, which in turn, rotates in hardened stainless steel bushings. The shaft ends which fit into the bushings are asymmetrical to the shaft. The rollpins are used to attach the disc arm to the shaft so they will move together as one integral piece. When 2SI-15C was disassembled and inspected, rollpins were found to be missing and also the disc shaft had rotated 180 degrees from its proper position. Since the shaft has asymmetrical ends, the disc arm movement with the shaft located 180 degrees out resulted in misalignment of the seating surfaces and valve leakage.

The root cause of the missing rollpins in 2SI-15C could not be conclusively determined. A review of the maintenance history records for the check valve indicated that the rollpins had been removed when the valve was disassembled during initial plant construction in 1977. The valve internals had been removed in order to perform the initial RCS hydrostatic test. It is known that the valve internals (disc, shaft, etc.) were reinstalled following this evolution and the records indicated that the rollpins had also been reinstalled. Based on this information, it is suspected at this time that the rollpins subsequently failed due to some mechanism and became dislocated.

The root cause of the cracked rollpin found in 2SI-15A is not known at this time. The rollpins are manufactured from 420 stainless steel.

E. Basis for Reportability

The discovery of the missing rollpins from 2SI-15C was considered to be a condition that was outside the design basis of the plant and reportable per 10CFR50.73(a)(2)(ii)(B). The design basis of the plant includes design provisions such that for postulated credible events single failures of components will not result in the loss of the capability of a system to perform its safety function. With respect to the discrepancy with check valve 2SI-15C, the applicable safety function of importance is the maintenance of adequate isolation barriers between the high pressure RCS and the connected lower pressure systems (i.e., HPSI, LPSI and SIT outlet piping) to ensure the low pressure systems are not exposed to pressures greater than their design pressures during postulated events.

The ANO-2 system design incorporates two redundant check valves located in series (2SI-15C and 2SI-13C or 2SI-14C) in each affected piping system. Due to the missing rollpins in 2SI-15C, it could not be assured that this valve would function properly as an isolation barrier during certain plant conditions. Therefore, for a limited period of time the plant was susceptible to a loss of this safety function if a single failure of either of the redundant check valves were to occur.

The manual actuations and use of the HPSI pumps and MOVs to inject water through 2SI-15C during efforts to reseat the valve and stop the backleakage were considered to be manual actuations of an Engineered Safety Feature that were not part of a preplanned sequence during testing or reactor operation and are reportable per 10CFR50.73(a)(2)(iv).

ANO-2 Technical Specification 3.4.6.2 specifies a maximum allowable value for backleakage through certain safety injection system check valves including valve 2SI-15C. If leakage greater than the allowable value occurs, Technical Specification 3.4.6.2 Action Statement 'C' requires isolation of the high pressure portion of the affected system from the low pressure portion within four hours by the use of at least two valves in each high pressure line having a non-functional valve. Isolation valves may include check valves for which the leakage rate has been verified, manual valves or automatic valves. If manual or automatic valves are used to comply with the isolation requirements of the Action Statement the Specification requires tagging the valves closed to preclude inadvertent opening. Considering the discovery that the rollpins were not installed in the valve internals and the failure of the valve to limit backleakage within the allowable limits during the plant heatup, on June 26, 1989, it was concluded that 2SI-15C was not operable (i.e., non-functional). The requirement of Technical Specification 3.4.6.2 to isolate the valve within four hours was not met, therefore, this event is also considered to be reportable per 10CFR50.73(a)(2)(i)(B), as a condition prohibited by the plant's Technical Specifications.

The NRC was notified of the occurrence and details of these events per the requirements of 10CFR50.72(b)(2)(i) and 10CFR50.72(b)(2)(ii) on August 4, 1989, at 1620 hours.

The length of time between occurrence of the events discussed in this report and the submittal date for this report is greater than 30 days as specified in 10CFR50.73. Initially, the malfunction and backleakage through check valve 2SI-15C was evaluated and determined not to constitute a reportable occurrence. However, Arkansas Power and Light Company elected to submit a voluntary report due to the potential generic applicability of the event and recent industry problems with safety related check valve malfunctions. Based on the additional information concerning the cause of the check valve failure which was obtained following disassembly of 2SI-15C, and detailed reviews performed while developing the voluntary report, reportability of the event was reevaluated and it was concluded the occurrence should be determined reportable per the criterion discussed above.

F. Corrective Actions

The rollpins in 2SI-15C and the cracked rollpin in 2SI-15A were replaced, and the valves reassembled. Proper operation of the valves was verified when a leak test was performed on the check valve during the plant heatup on July 3, 1989.

The cracked rollpin removed from 2SI-15A has been shipped to a laboratory for metallurgical analysis to determine the root cause of the rollpin failure.

With respect to the loop check valves (2SI-15B and D) that were not inspected during the outage in June 1989, several factors were evaluated in reaching a decision to defer internal inspection of these valves. A review of the operational history of these valves did not reveal any significant indication of backleakage through the valves. Monitoring for the presence of backleakage is conducted during each plant heatup and periodic measurement of valve backleakage is performed. The pressure indicators located on the low pressure side of the valves also provide continuous monitoring capability for detection of valve backleakage. These valves are located in areas of relatively high radiation levels warranting consideration of the personnel exposures necessary to perform maintenance on the valves. Also, the short period of plant operating time remaining until the next refueling outage was scheduled to begin was considered to be a factor.

Futher investigations revealed that the check valves located on the SIT outlet lines (2SI-16A, B, C and D) were of the same design as 2SI-15C. The maintenance and operational history related to these valves was reviewed. Based on these reviews it was determined that no significant backleakage had been observed through these valves during previous plant operation. Additionally, the valves were noted to be included in the plant's Inservice Testing Program (IST) and have been opened and inspected several times during previous refueling outages. Although, the IST inspections were oriented primarily toward verification of the valve's capability to stroke to a full open position if required and did not specifically require an inspection of the rollpins, there is a level of confidence that any significant degradation of the valves functional capability to prevent backleakage would have been detected during these inspections. Based on these considerations and other factors (e.g., environmental and operating conditions of the SIT outlet checks are significantly different than those of the 2SI-15 check valves), it was concluded that disassembly and inspection of these valves could also be deferred.

Notwithstanding the above factors and considerations, check valves 2SI-15B, 2SI-15D and the SIT outlet check valves (2SI-16A, B, C and D) will be disassembled and inspected during the next ANO-2 refueling outage currently scheduled to begin in September 1989.

The location of other safety related check valves, manufactured by Atwood and Morrill Company, which are similar in design to the 2SI-15s with the use of rollpins, have been identified. A program to periodically inspect some of these valves already exists.

Evaluations are to be conducted regarding the failure to initially recognize the significance of the check valve performance behavior on plant operation and the associated reportability implications.

G. Additional Information

A similar event, which occurred at ANO-1, related to RCS backleakage due to the malfunction of a safety related check valve was previously reported in LER 50-313/89-004-00 (1CAN058911).

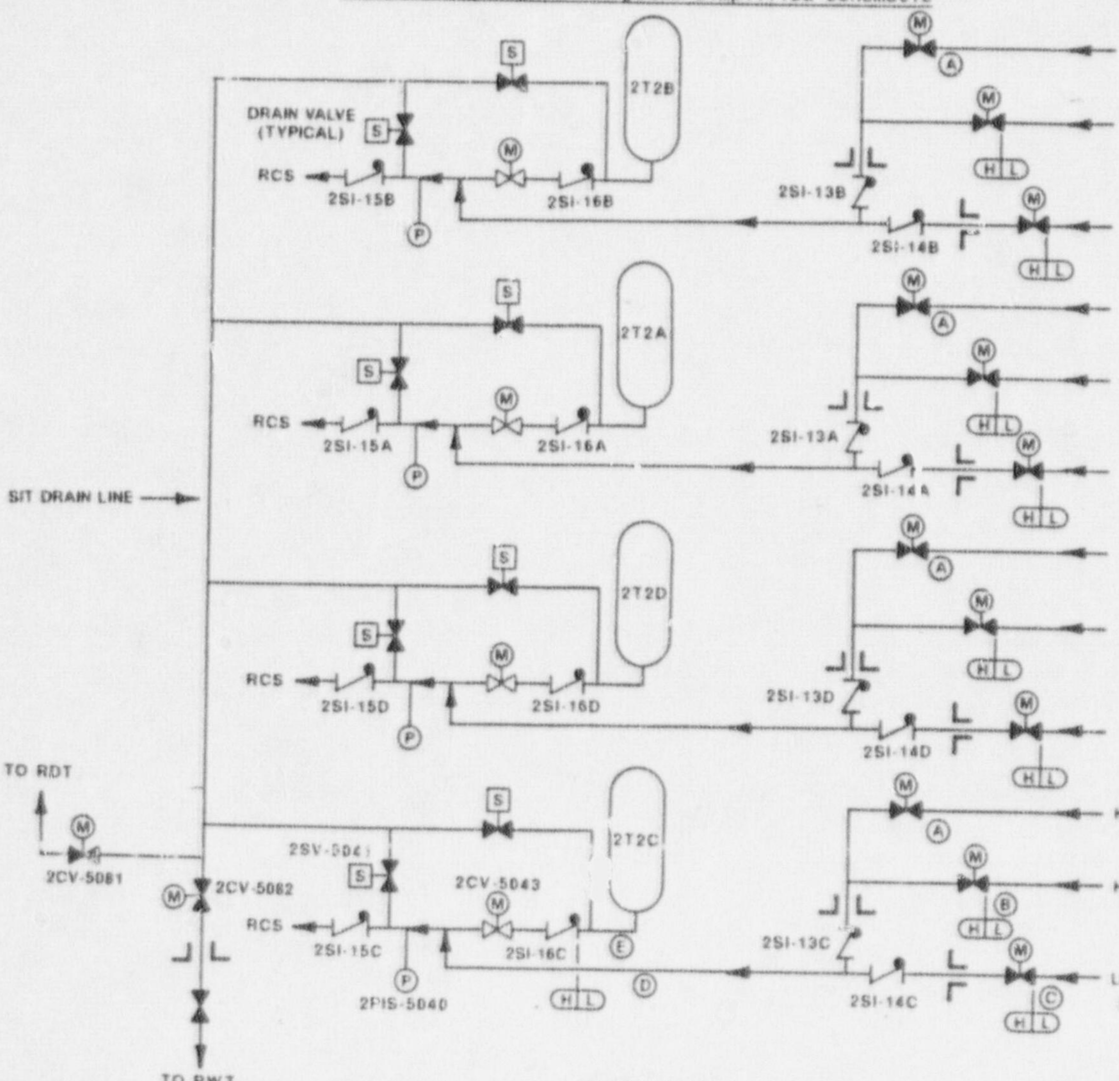
Energy Industry Identification System (EIIS) codes are identified in the text as [XX].

FACILITY NAME (1)	DOCKET NUMBER (2)	LER NUMBER (6) Year	Sequential Number	Revision Number	PAGE (3)
Arkansas Nuclear One, Unit Two	0|5|0|0|0| 3| 6| 8	8| 9	0| 1| 2	0| 0	0|7 OF 0|7

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

Figure 1

ANO-2 Safety Injection System Simplified Schematic



DRAWING LEGEND:

- (H|L) = HIGH PRESSURE / LOW PRESSURE
- (A) = DESIGN PRESSURE FOR HPSI HEADER 1 UPSTREAM OF MOVS IS 2485 PSIG.
- (B) = DESIGN PRESSURE FOR LOW PRESSURE SIDE IS 1950 PSIG.
- (C) = DESIGN PRESSURE FOR LOW PRESSURE SIDE IS 500 PSIG.
- (D) = DESIGN PRESSURE IS 2350 PSIG.
- (E) = DESIGN PRESSURE IS 700 PSIG.
- HPSI = HIGH PRESSURE SAFETY INJECTION
- LPSI = LOW PRESSURE SAFETY INJECTION
- RDT = REACTOR DRAIN TANK
- RWT = REFUELING WATER TANK
- RCS = REACTOR COOLANT SYSTEM
- SIT = SAFETY INJECTION TANK