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July 3, 1997

2CAN079701

U. S. Nuclear Regulatory Commission
Document Control Desk
Mail Station OP1-17
Washington, DC 20555

Subject: Arkansas Nuclear One - Unit 2
Docket No. 50-368
License No. NPF-6
Licensee Event Report 50-368/97-005-00

Gentlemen:

In accordance with 10CFR50.73(a)(2)(i)(B), enclosed is the subject report concerning Main Steam Safety Valve as-found lift values.

Very truly yours,

Dwight C. Mims

Dwight C. Mims
Director, Nuclear Safety

DCM/tfs

enclosure

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NRC FORM 366 (5-92) U.S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB NO. 3150-0104
EXPIRES 5/31/95

ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS INFORMATION COLLECTION REQUEST: 50.0 HRS. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE INFORMATION AND RECORDS MANAGEMENT BRANCH (MNBB 7714), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555-0001, AND TO THE PAPERWORK REDUCTION PROJECT (3150-0104), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503.

LICENSEE EVENT REPORT (LER)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
Arkansas Nuclear One - Unit 2	05000368	1 OF 7

TITLE (4) Main Steam Safety Valve As-Found Lift Values Did Not Meet Technical Specification Requirements Due To A Combination Of Maintenance, Testing, And Design Factors

EVENT DATE (5)			LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	MONTH	DAY	YEAR	FACILITY NAME	DOCKET NUMBER
06	04	97	97	005	00	07	03	97	FACILITY NAME	DOCKET NUMBER

OPERATING MODE (9)	5	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR: (Check one or more) (11)							
POWER LEVEL (10)	0	20.402(b)		20.405(c)		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	
		20.405(a)(1)(iii)	X	50.73(a)(2)(i)		50.73(a)(2)(viii)(A)		Specify in Abstract Below and in Text	
		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 (Include Area Code)
Thomas F. Scott, Nuclear Safety and Licensing Specialist	501-858-4623

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

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 15 single-spaced typewritten lines) (16)

Prior to and during a scheduled refueling outage, testing revealed that eight of ten Main Steam Safety Valves (MSSVs) had as-found lift values exceeding the maximum of one percent above the setpoint allowed by Technical Specifications. A root cause evaluation team, including consultants and representatives from the MSSV vendor, conducted an extensive assessment of the condition. This included a significant number of tests and inspections of the MSSVs at an off-site test facility. Several potential contributing factors were identified and investigated. The team was unable to identify a conclusive root cause. The cumulative effect of a number of different maintenance, testing, and design factors was assigned as the most probable cause. Before startup from the outage, nine of the ten MSSVs were replaced with valves that had been fully inspected and tested at the off-site facility. Engineering evaluations demonstrated that the as-found lift values would have allowed the MSSVs to provide the required safety functions if events requiring those functions had occurred during the previous operating cycle.

A. Plant Status

At the time this condition was determined to be reportable, Arkansas Nuclear One Unit 2 (ANO-2) was in cold shutdown (Mode 5) conditions during a scheduled refueling outage.

B. Event Description

Eight of ten Main Steam Safety Valve (MSSV) [SB] as-found lift values were above the one percent tolerance allowed by Technical Specifications.

ANO-2 has ten MSSVs, five per header. During Modes 1, 2, and 3, Technical Specification (TS) 3.7.1.1 requires the valves to have as-found lift settings within plus 1 percent to minus 3 percent of the specified values. On May 9 and 10, 1997, seven of the valves were tested in place on the header at the start of a scheduled refueling outage. Six of the seven were found out of tolerance high. All of these valves were adjusted and/or re-tested until the final lift points were within TS requirements. The other three valves, 2PSV-1002, 2PSV-1055, and 2PSV-1056, were subsequently tested off-site at NWS Technologies to determine the as-found lift values. Two of these three were also found out of tolerance high. Seven of the valves, four that had been tested in place and three that had not, and all spare ANO-2 MSSVs were sent to the off-site testing facility for additional testing and evaluation. Three valves that had been tested in place, adjusted, and successfully re-tested to obtain acceptable final lift settings were retained on the main steam headers. Results of the initial lift tests are provided below. All pressures are psig.

Tag Number	Setpoint	As-Found	Percent Deviation
2PSV-1002	1078	1081	0.28 high
2PSV-1003	1105	1109.8	0.4 high
2PSV-1004	1105	1152.2	4.27 high
2PSV-1005	1132	1171.4	3.48 high
2PSV-1006	1132	1191	5.21 high
2PSV-1052	1078	1109.2	2.89 high
2PSV-1053	1105	1131.6	2.41 high
2PSV-1054	1105	1121.4	1.48 high
2PSV-1055	1132	1150	1.59 high
2PSV-1056	1132	1189	5.04 high

C. Root Cause

During the refueling outage in the fall of 1995, ANO-2 MSSV lift values were found out of tolerance because of their having previously been set at an off-site facility under ambient conditions different from those existing in the plant during operation. This condition was reported in Licensee Event Report (LER) 50-368/95-005-00 in ANO letter 2CAN119501 dated November 2, 1995. As part of the follow-up actions, detailed temperature profiles of the MSSV environment were obtained for all seasonal conditions. Spare MSSVs were tested at an off-site facility (Wyle Laboratories) to determine the effect of the actual temperature range upon lift pressures. Later testing was performed at another off-site facility (NWS Technologies in Spartanburg, SC) with spare valves. Results of these tests indicated that lift points were not as sensitive to minor ambient temperature changes as had been suspected. Data from these tests did not indicate any concerns regarding operability of valves installed in the plant.

Following the testing in May 1997, a root cause evaluation team was established. Assistance and independent assessments were provided to the team by representatives from MPR Associates, Crosby Valve and Gage Company (the original equipment manufacturer), and NWS Technologies. As part of this evaluation, a large number of lift tests of the MSSVs were conducted. Numerous industry documents were reviewed in an attempt to identify MSSV problems that might be factors in the ANO-2 condition. The team also evaluated design, maintenance, and testing differences between ANO-2 and another facility with MSSVs of a similar, but not identical, design. Several areas that might affect MSSV lift point variation were identified and investigated.

A Crosby air motor test device was used to perform in-place tests of the valves on the steam header. Several factors related to this testing method were evaluated, and some were considered to be potential contributors to the as-found lift values for some of the MSSVs. Inaccuracies and human factors related to the readability of the main steam header pressure and air motor test device supply pressure test gauges used during in-place tests may have been a contributor to some high lift values. As part of the investigation, it was verified that the gauges used during the in-place tests were calibrated as required. However, the scaling (i.e., gauge increments) was considered to be less than optimum for this type of test. As part of the testing performed at NWS, one of the MSSVs was lifted with live steam pressure alone and then subsequently lifted using the ANO air motor test device. Evaluation of the resulting lift values indicated a good correlation between the two test methods and an acceptable accuracy of the test device. Additionally, based on the off-site tests, potential inaccuracies in the vendor supplied curve used to convert air motor test device supply air pressure to force exerted on the valve were evaluated and discounted as a contributor to the observed conditions. The use of nitrogen in lieu of a compressed air supply for the air motor test device supply pressure was also eliminated as a potential contributor.

Since ANO uses maintenance personnel instead of valve vendor personnel for on-site testing, it is believed that experience of site personnel could have had some contribution; however, test results indicated that there was very little possibility of this factor having influenced all as-found data.

Past valve maintenance has been performed at off-site facilities by Crosby technicians. Some of the valves with high as-found lift points had been "jack and lapped" by these personnel during the last refueling outage without subsequent lift point verification testing, but some had not. This technique, used to correct seat leakage following setpoint verification, can disturb the natural alignment of the valve internals and increase the potential for a subsequent high lift point. Additionally, it was determined that if the lift setpoint is established with the MSSV having seat leakage and the valve is then "jack and lapped" to stop the leakage, the resulting lift value may be slightly higher. The "jack and lap" has not usually been followed by another lift of the valve. The potential effect of this maintenance practice on the as-found MSSV condition was determined to be minimal but could not be completely eliminated. As a compensatory action for this potential effect, any refurbishment of a valve during the most recent outage that could have caused a shift in lift point was followed by verification testing with steam or lifting the valve with nitrogen.

Valve seat leakage during plant operation can affect lift point by changing the effective seating area of the valve disc. This effect can increase the amount of seat area subjected to steam pressure. Since this increases the force on the disc resulting in a decreased lift pressure and ANO-2 has not operated with significant MSSV leakage, this was not a contributing factor for the as-found condition. All as-found lift values that were out of tolerance were above the specified setpoints.

The ASME Code, OM-1, requires two consecutive test lifts within tolerance for valve certification. Test results during the most recent outage and historical data indicate that some valves have been slow to respond to adjustments intended to change the setpoint, and two lifts may not be sufficient to detect the complete impact of the adjustments. This may be the result of several factors including internal friction, valve internal component alignment, or spring characteristics of individual valves. There is a possibility that this could have had some contribution to the as-found MSSV condition.

An important factor for accurately performing laboratory testing can be thermal stabilization at test temperatures. Based on evaluation of historical data, there is a possibility that the thermal stabilization criteria used during the previous off-site testing could have been a small contribution to the as-found condition. During the most recent outage, extra controls were established for testing to ensure that temperatures were stabilized and equalized to eliminate this factor.

It is believed that friction between certain valve parts can cause a high lift point. Measurement of valve internal parts has not been performed during past maintenance activities, and procedures used for refurbishment by Crosby technicians did not require verification of critical component dimensions. During

the off-site investigation of this condition, areas where tight tolerances could introduce friction between parts were evaluated. One specific area of concern was the clearance between the spindle and guide bearing. The Crosby-specified tolerance for the valve guide bearing was increased and some valves were machined accordingly.

Selective spring inspections were performed by the original MSSV spring designer. Results indicated that the springs were in good condition and were not expected to have contributed to the high lift values. Spring degradation is normally by relaxation that allows lift pressure to drift low. Since these valves are exercised infrequently, degradation due to usage was discounted.

Several other potential concerns were identified with the design of valve components. Based on discussions with MSSV vendor personnel, the relatively large MSSV springs create the potential for uneven side loading on some valve internals. This frictional load will not prevent the valve from opening and lifting but can contribute to a high opening pressure. It was also noted that the contact between the spring and spring washers was less than the desirable amount. Also, some spring washers were not parallel indicating the potential for side loading and increased friction.

The original design specifications for the ANO-2 MSSVs do not explicitly discuss the capability of the valves for lift setting accuracy or repeatability. Discussions with Crosby personnel during this investigation indicated that, based on industry experience, these types of MSSVs are usually considered to be plus or minus three percent devices. Combined with historical test data and numerous industry documents published during the last several years regarding large safety valve performance at nuclear plants, it appears that extensive maintenance and testing controls are necessary for such valves to achieve satisfactory performance.

The numerous investigations and evaluations of this condition did not reveal a conclusive root cause for the MSSV lift points being found high. The cumulative effect of a number of different maintenance, testing, and design factors is believed to be the most probable cause.

D. Corrective Actions

All MSSVs except 2PSV-1003 were replaced with valves that had been fully inspected and tested at NWS. As a result of information developed during the investigation and a review of historical test data, two of the valves that had been left on the header when others were sent to the off-site test facility were replaced with valves that had been inspected and certified at NWS. The one valve that was not removed from the header had a good lift history. Comparison of future test results for 2PSV-1003 with those from valves tested off-site may provide useful information.

A full inspection was completed on each valve sent to NWS. Critical valve clearances and tolerances were identified and verified. A full battery of testing was completed with a significant number of lifts on each valve to establish the lift value and ensure repeatability of the lift point. Valve temperatures during testing were strictly controlled to be consistent with in-plant operating conditions. Each valve was lifted with steam or nitrogen after maintenance to realign internals and minimize potential internal friction. Additional lifts were performed following setpoint adjustments to ensure that full response to the adjustment had been achieved. Valves tested at NWS were left with lift points in the lower range of the acceptable tolerance in order to allow more margin to the upper Technical Specification limit.

The test method used to perform on-site MSSV lift point testing will be evaluated to determine if enhancements can be made. Enhancements identified by this evaluation will be incorporated into maintenance procedures prior to the next MSSV testing. The next scheduled testing is during shutdown for a refueling outage beginning in January 1999.

The detailed inspection criteria developed as part of the root cause evaluation effort will be incorporated into maintenance procedures, as appropriate, prior to the next refueling outage.

A Technical Specification change request to increase the upper limit of the as-found tolerance to plus three percent of the setpoint is anticipated to be submitted approximately six months prior to the start of the next scheduled refueling outage.

E. Safety Significance

The as-found lift values of the MSSVs were evaluated for their significance with respect to analyzed accidents. The limiting secondary pressurization event, Loss Of Condenser Vacuum (LOCV), has been explicitly analyzed using all MSSV setpoints at the plus three percent value. This analysis met all acceptance criteria and bounds the as-found condition described above. Additionally, the LOCV analysis was re-performed with an engineering evaluation using the actual as-found lift values for the MSSVs and results were acceptable. The Small Break Loss Of Coolant Accident analysis for the limiting break size demonstrated satisfactory results using a plus one percent MSSV setpoint which, for this event, applies only to the first bank of MSSVs because secondary pressures do not result in lifting any more than the first bank of valves during the limiting portion of the event. For this event, the required relief capacity is met if only one of the lowest setpoint valves lifts within one percent of its setpoint value, and the as-found value of one those valves was within that tolerance. Based upon these conservative analyses demonstrating that margin existed to the safety limits with the as-found MSSV lift values, it was concluded that the MSSVs would have provided their required safety functions during periods of operation during the previous cycle. Therefore, this condition had minimal actual safety significance.

F. Basis for Reportability

When the initial as-found lift values were documented, reportability was dispositioned as "Indeterminate" to allow determination by the root cause evaluation if firm evidence existed as to the time the MSSV setpoints had exceeded the limits of Technical Specification 3.7.1.1. The basis for this decision was the response to question 2.3 in Supplement 1 to NUREG-1022 that states, "In general, for the purpose of evaluating the reportability of situations found during surveillance tests, it should be assumed that the situation occurred at the time of discovery, unless there is firm evidence to believe otherwise." On June 4, 1997, ANO was informed by NRC personnel in a telephone discussion that this guidance is considered to have been superseded by guidance in section 2.7 of the Revision 1 to NUREG-1022, Second Draft. The draft guidance states, "However, in the case of interest here, the existence of similar discrepancies in multiple valves is a good indication that the discrepancies arose over a period of time." Using this guidance requires concluding that the condition caused ANO-2 to have been operated in a condition prohibited by Technical Specifications. This condition is reportable in accordance with 10CFR50.73(a)(2)(i)(B).

G. Additional Information

At ANO-2, the MSSVs are model HA-65-FN, size 8T10x10, manufactured by Crosby Valve and Gage Company (Manufacturer Code C710). Though Waterford 3 has MSSVs of the same model number and size, no other nuclear or non-nuclear plants are known to have valves of this exact design.

There have been no previous similar events reported by ANO as Licensee Event Reports.

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