SEQUOYAH NUCLEAR PLANT

RESOLUTION OF PRESSURIZER SAFETY VALVE SEAT LEAKAGE CONCERNS

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1.0 INTRODUCTION

This document provides an update, for the time period from February '88 (unit 2 restart) to present, of efforts being made to resolve seat leakage problems with the pressurizer safety valves. Efforts to resolve this issue prior to February '88 were reported in the attached letter from R. Gridley to the U.S. Nuclear Regulatory Commission dated June 24, 1988, "Sequoyah Nuclear Plant (SQN) - Performance Testing Of Reactor Relief and Safety Valves".

2.0 SUMMARY OF LEAKAGE OCCURRENCES SINCE RESTART

Since restart of units 1 and 2 there have been seven identified incidences of pressurizer safety valve seat leakage associated with steam service (drained loop seal). Two of these leaks were corrected with the valve successfully operating with no detectable leakage until the next refueling outage. A summary of these leaks follows and Attachment 1 graphically depicts incidences of pressurizer safety valve leakage.

UNIT	VALVE S/N	POSITION	OPERATING CYCLE
1	SPARE C	A	Cycle 3
1	RV-1-8010A[1]	A	Cycle 3
1	RV-1-8010C	A	Cycle 4
2	RV-2-8010B	B	Cycle 2
2	SPARE B	A	Cycle 2
2	SPARE C[2]	A	Cycle 3
2	RV-1-8010B	C	Cycle 3

3.0 PAST CORRECTIVE ACTION TO RESOLVE LEAKAGE CONCERN

Because of continued leakage concerns a task force was formed in January, 1989 to identify potential causes of the leakage and recommend appropriate short and long-term corrective actions. This task force consisted of representatives from Sequoyah Engineering, Sequoyah Systems, Corporate Maintenance, Corporate Engineering, Gilbert Commonwealth (G/C) and Stone

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[1] Leakage started immediately upon unit start-up, but quit after problems were corrected with ambient temperature and thermal binding of a strut. The pressure was dropped and the valve gagged while these problems were resolved. No further leakage was detected during the remainder of the operating cycle; however, disassembly of the valve during the outage indicated that slight leakage may have been present.

[2] Leakage began when the pressurizer enclosure hatch was removed to allow access during unit operation. Leakage quit after valve was temporarily gagged and the temperature allowed to restabilize.

and Webster (SWEC). Valve sensitivities and corrective action options were discussed. The following is a list of the options which were considered:

SENSITIVITY	POSSIBLE SOLUTION
NOZZLE LOADS	Stronger valve, piping configuration change, support rearrangement, bellows/flex-hose, ball joints, support the valves off the pressurizer, check for binding, rework the loop seals, relocate the valves, Westinghouse ring header, quantify loading sensitivity through special test at Wyle
AMBIENT TEMPERATURE	Operational specification changes, refrigeration coils, independent or dedicated HVAC or redesign of existing HVAC, R&D testing to quantify sensitivity
INLET GAS MIXTURE	Water loop seal
RCS HEAT-UP RATE	Operational specification change
RAPID PRESSURE INCREASE	No identified solution, other than slow pressure increase
SET PRESSURE	Set at high end of allowable, increase the Technical Specification set pressure

The end product of the task force was a set of short and long-term recommendations. The short-term recommendations addressed several valve sensitivities since a singular root cause for leakage was not identified and were intended to minimize the possibility of leakage. The long-term recommendations were to be considered in the event that seat leakage continued to be a plant concern.

3.1 SHORT-TERM CONSIDERATIONS

The following are the actions which were performed to address the short-term recommendations of the task force:

S1. Modifications were implemented for the unit 2 tailpipes to minimize nozzle flange loading. Modification of the unit 1 tailpipe was placed on hold pending evaluation of the success of the modification for unit 2.

S2. Each safety valve was adjusted within the upper half of the acceptable set pressure range in order to provide the maximum margir between operating pressure and valve set pressure.

S3. Walk-downs were performed of the valve piping to assess other causes that may be contributing to leakage. A thermal interference was located and corrected on the unit 1, "A" position tailpipe.

S4. Post maintenance acceptance criteria for leakage was enhanced to add a steam seat leakage test following the existing nitrogen seat leakage test.

S5. A study was performed to document the valve positions where leakage had occurred in the past and the serial number of the valve which had leaked. At this time, the leakage appeared to be position related and no clear trend could be identified to indicate a problem with individual valves.

S6. Maintenance proced'-es were reviewed by Crosby during rework of a valve in order to ensure that appropriate repair techniques were in place. The maintenance procedure was enhanced to include comments by Crosby.

S7. Administrative controls were implemented to ensure a consistent temperature in the pressurizer enclosure during operation.

S8. Pressurizer heat-up rate was administratively limited to 50 degrees F per hour.

S9. An action plan was established to try to correct leakage as soon as it was identified (e.g. gagging of valve, lowering of pressurizer pressure, cooling of the pressurizer enclosure).

S10. All valves were removed during each outage. Seat leakage testing was performed with any required maintenance performed prior to reinstalling the valves on the unit.

S11. A preliminary assessment was obtained from Westinghouse on raising or staggering valve set pressure. The possibility of operating the plant with two valves available was also discussed.

S12. Valve temperatures were measured during normal operation with the "A" position on both units identified as running significantly hotter than the

other two positions. Modifications were initiated to provide additional cooling to the "A" position valve.

3.2 LONG-TERM CONSIDERATIONS

The following long-term possibilities were identified for future consideration.

L1. Revise primary loop analysis to raise the set pressure of the pressurizer safety valves.

L2. Install Watts Bar valves which have a forged body and are less sensitive to tailpipe loading.

L3. Install a flexible joint in the safety valve tailpipe to minimize tailpipe loading.

L4. Install Sebim valves (perceived as a better valve design for the application)

L5. Support valves off pressurizer.

L6. Relocate valves and install "halo" header (removes piping loads from valves)

L7. Return to wet loop seal with smaller water volume.

L8. Operate with gagged valve (obtain Westinghouse Probabilistic Risk Assessment justifying operation at full power with two valves).

L9. Initiate HVAC design changes and operation procedures to control ambient temperature excursions.

L10. Purchase custom designed valves (investigate alternate vendors and expand steam trim user survey).

4.0 RESULTS OF SHORT-TERM CORRECTIVE ACTIONS

Implementation of the short-term actions identified in the previous section of this report met with limited success. Pressurizer safety valve leakage has not resulted in a forced outage; however, periodic seat leakage has still been an operational concern. Leakage of these valves results in increased operator attention and a large amount of rad-waste being processed to cool the pressurizer relief tank.

While a singular root cause of pressurizer safety valve leakage was never clearly pinpointed in the past, the

combination of corrective actions performed to date has improved seat leakage performance by attempting to address all possible root causes.

5.0 FOLLOW-UP CORRECTIVE ACTION TO RESOLVE LEAKAGE CONCERN

Because of the continued concern with pressurizer safety valve leakage a task force was again established in 1990 consisting of Sequoyah Engineering, Sequoyah Technical Support, Sequoyah Maintenance, Corporate Maintenance, and Crosby.

5.1 VALVE MODIFICATION

The task force reviewed the long-term actions from the previous meetings and reviewed additional options based upon recent operating history and current industry technology. It was learned at this time that Crosby was developing a new design for the disc insert which could improve seat leakage performance. This new disc insert incorporates a more exaggerated undercut design than the current disc insert and is better able to compensate for thermal effects and other valve sensitivities that could result in seat leakage. TVA met with Crosby to discuss this new disc insert and witnessed a steam test demonstration of the disc in a pressurizer safety valve similar to Sequoyah's (the test valve was identical except for a forged instead of a cast body). After evaluating this valve design change against the previously determined long-term corrective actions it was determined that the disc insert modification provided the best option from a cost/benefit standpoint to resolve the continued seat leakage problem. However, before committing to implement this modification, TVA formed a partnership with Crosby to test the new disc insert design at Wyle Labs in two spare pressurizer safety valves which had never passed a seat leakage test since the test media had been changed from nitrogen to steam. A portion of the testing also simulated the effects of tailpipe loading and uneven temperature distribution across the valve. The spare valves passed all testing and were leak tight in excess of 95 percent of their set pressure. A valve modified with the new disc insert will be installed on unit 1 in the "A" position during the cycle 5 refueling outage scheduled for October of this year.

5.2 SETPOINT INCREASE

The possibility of increasing the valve set pressure has also been identified as a creditable solution to the seat leakage problem. This fix would supplement the

improvement in valve performance provided by the new disc insert design. If the disc insert modification by itself does not completely resolve the leakage problem, it is believed an increase in set pressure will provide the additional margin between operating pressure and set pressure needed to resolve the seat leakage issue. The study of increasing the valve set pressure by three percent will be pursued if necessary based upon a performance evaluation of the new disc insert design in the unit 1 "A" position during the next operating cycle.

5.3 LEAKAGE ROOT CAUSE UPDATE

Based upon the results of steam leak testing at Wyle Labs and a history of leakage for valve position versus valve serial number since restart of both units, some additional insight has been gained regarding the root cause of the continuing seat leakage problems. Two observations can be made regarding this leakage.

5.3.1 Leakage continues to occur almost every operating cycle in the "A" position for both units. A significant difference between this position and the other two valve positions is the ambient temperature profile. The original design of the HVAC duct for the pressurizer enclosure directs the majority of the air flow toward the "B" and "C" valve positions. Temperatures have been recorded at the valve locations during operation which indicate that the "A" valve has been much hotter than the other two valves. It can be postulated that hotter ambient temperatures cause higher valve body temperatures, which can cause additional thermal growth and distortion with subsequent detrimental effects on the internal valve clearances and disc to seat alignment. A significant increase in the ambient temperature can also cause a reduction in valve set pressure resulting in a greater potential for seat leakage at normal operating pressure. The effect of uneven temperature distribution has recently been reduced by installing a baffle in the existing air duct to direct air to the "A" valve position. This modification was implemented on unit 2 during the cycle 4 outage, with no seat leakage identified since unit restart. The modification has also been implemented on unit 1, but not until the "A" position valve had already started leaking. Therefore, the value of this modification for unit 1 is still unknown.

5.3.2 Leakage which has occurred at positions other than the "A" position have been on valves which

have subsequently had diffulculty passing a steam seat leakage test. Steam seat leakage testing had previously been performed using nitrogen, but a steam test was identified as a short-term corrective action to better ensure seat tightness at actual system conditions. It is evident from the change in seat leakage testing requirements that the process of heating up a valve can cause thermal effects which result in seat leakage. This type problem cannot be detected by a nitrogen seat leakage test.

Installation of the new design disc insert and a careful rework of pressurizer safety valves ensuring appropriate guiding clearances is expected to solve the problems with those valves which have had difficulty passing a steam seat leakage test. It should be noted that the research and development testing of the new disc insert design which was performed by TVA and Crosby was performed on two of these problem valves with satisfactory results. Another point worth mentioning is that the pressure at which seat leakage testing is performed for valves with the new disc insert design has been increased from 90 to 95 percent of nameplate set pressure. This more stringent seat leakage test futher ensures seat tightness when installed on the plant by demonstrating that the valve is capable of zero leakage at 5 percent above normal operating pressure.

5.3.3 Further modification of the tailpipes for unit 1 to reduce flange loading is not considered cost effective at this time. This modification had been performed for unit 2 with inconclusive results. Flange loadings based on the current piping analysis are below vendor recommended maximums for both units.

5.4 INDEPENDENT REVIEW OF VALVE DESIGN

An independent review of the Crosby pressurizer safety valve design for Sequoyah was solicited from Siemens Nuclear Power Services in order to factor European valve design and testing experience into solution of the leakage problem. If leakage continues after the disc insert modification, Siemens has provided possibilities for further modification of the existing valve or replacement with a qualified valve of a different design that may be more suitable for the application.

6.0 ACTIONS TAKEN TO ADDRESS CONTROL ROOM ANNUNCIATION

Leakage of pressurizer safety valves can cause annunciation in the main control room of the tailpipe temperature monitoring system. This last occurred for unit 1 on 9/17/91 and for unit 2 on 5/31/91. In order to clear these annunciators, the pressurizer relief tank (PRT) temperature high alarm setpoint was increased to 155 degrees F on 7/28/91 (unit 1) and 8/7/91 (unit 2) in accordance with temporary alteration control forms 1-91-35-068 and 2-91-36-068, and their associated 10 CFR 50.59 evaluations (including evaluation by Westinghouse). To meet this temperature limit, the unit 1 PRT was cooled approximately every seven hours.

Separate annunciation for PRT temperature, level and pressure would occur and subsequent operator actions are initiated in accordance with the annunciator response instructions. Additionally, a pressurizer back-up heater bank would energize more often to compensate for the increased energy loss. As a result of the present condition, operators have increased attention to tailpipe temperature indicators. Permanently installed acoustic monitors in the pressurizer safety valve tailpipes provide annunciation in the control room and light illumination on 0-M-27 in front of the Shift Operating Supervisor desk if a valve opens. A recorder has been installed to monitor selected pressurizer safety valve activity.

7.0 SUMMARY

In summary, key actions which have already been completed include:

- Fine tuning and/or modification of tailpipe supports was implemented for both units to minimize safety valve flange loading.
- Administrative controls were implemented to ensure a consistent temperature in the pressurizer enclosure.
- An action plan was created to try to correct leakage as soon as it was identified.
- The pressurizer enclosure HVAC duct was modified to provide additional cooling at the "A" valve position.
- Post maintenance testing was enhanced to add a steam seat leakage test following the existing nitrogen seat leakage test.

- The pressurizer heat-up rate was administratively limited to 50 degrees F per hour.

Remaining outstanding action:

- A modified valve which contains a new disc insert design will be installed during the unit 1, cycle 5 outage. Evaluation of the results of this modification will dictate whether additional valves are modified.

- The feasibility of increasing the safety valve set pressure will be reviewed if the disc insert modification does not resolve seat leakage concerns.

8.0 CONCLUSION

TVA is continuing to take an aggressive approach toward resolving the seat leakage concern with the pressurizer safety valves. This is evidenced by the level of commitment and funding which has already been dedicated to this effort. Leadership in solving this industry-wide problem is evident by the partnership formed with Crosby, and the affiliation with Siemens Nuclear Power Service to factor in European valve design and testing experience. Discussions and meetings with other utilities who are experiencing this problem also are continuing.

Current plans are to further evaluate the performance of the new disc insert design in the "A" position on unit 1. Upon satisfactory performance in the test application plans are to implement the modification for the remaining valves, including spares. Contingency plans are in place to further address the issue in the event that the most recent modification is not successful.

ATTACHMENT 1
SEQUOYAH NUCLEAR PLANT
PRESSURIZER SAFETY VALVE LEAKAGE HISTORY