CENTERIOR ENERGY

PERRY NUCLEAR POWER PLANT
10 CENTER ROAD
PERRY, OHIO 44081
(216) 259-3737

Mail Address:
P.O. BOX 97
PERRY, OHIO 44081

Michael D. Lyster
VICE PRESIDENT - NUCLEAR

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U.S. Nuclear Regulatory Commission
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Perry Nuclear Power Plant
Docket No. 50-440
Main Steam Isolation Valve Leakage

Gentlemen:

Detailed information concerning the Perry Main Steam Isolation Valve (MSIV) leakage problems experienced during the 1990 refueling outage is contained in several documents, including License Event Report (LER) 90-025, and its revisions (Ref. 1, 2 and 3), and our response to Notice of Violation 50-440/90020-01 (Ref. 4). Information was also provided during NRC/CEI management meetings on October 17, 1990, November 28, 1990 and February 7, 1991 at which the MSIV's were discussed. The purpose of this letter is to collect and summarize the information contained in these documents as well as that presented in the meetings with your staff and to update this information where possible. Our conclusion that the MSIV's are fully capable of performing their intended function within Technical Specification limits remains unchanged and is supported in this submittal.

If you have any questions, please feel free to call.

Sincerely,

M. D. Lyster

Michael D. Lyster

MDL:SC:njc

Attachment

cc: NRC Project Manager
NRC Resident Inspector Office
NRC Region III

A001
1/1

References:

1. LER 90-025, dated October 14, 1990
2. LER 90-025-01, dated November 23, 1990
3. LER 90-025-02, dated February 19, 1991
4. Response to Notice of Violation 50-440/90020-01, dated January 14, 1991.
5. NRC/CEI Management Meeting, October 17, 1990.
6. NRC/CEI Management Meeting, November 28, 1990
7. NRC/CEI Management Meeting, February 7, 1991.

INTRODUCTION

Following shutdown for the second refueling outage (RF02) in September, 1990, it was determined that the primary containment leakage rate through the four main steam lines (MSL) was in excess of that allowed by Technical Specifications. An initial set of local leak rate test (LLRT) measurements were made on September 16 and 17 with reactor coolant temperature between 85 and 98 degrees F at atmospheric pressure. Prior to these initial measurements, the MSIV's had been stroked as follows on September 7 in order to control plant cooldown:

1B21-F0022 (Inboard MSIV's)
A - slow closed - opened - slow closed
B - slow closed
C - slow closed - failed to remain closed* - closed later on 9/8/90, speed unknown
D - fast closed - opened - slow closed

1B21-F028 (Outboard MSIV's)
A - slow closed - opened - slow closed - opened - slow closed
B - slow closed - failed to remain closed* - closed later, fast closed
C - slow closed
D - fast closed - opened - slow closed - opened - slow closed

* The failures of 1B21-F022C and -F028B to remain closed are described in LER 90-021-01 (Reference 2).

The results of the initial leak rate testing completed on September 17, are presented in Table 1. All four of the MSL penetrations exceeded their Technical Specification 3.6.1.2(c) limit of 25 scfh, which is equivalent to 11.8 SLM, when tested at P_a (11.31 psig). During this initial testing it was determined that the MSIV Leakage Control System (LCS) isolation valves in MSL's B and D were leaking as was the A outboard MSIV drain valve.

MSL LLRT's are normally performed following single fast closures of the MSIV's while the plant is still hot, which is representative of a post-accident closure. Because of the various methods used to close the MSIV's prior to the initial round of testing, all eight of the MSIV's were reopened and fast closed, and a second round of MSL LLRT's was performed between September 28 and 30. For these subsequent tests, a nitrogen pressure of 145 psig (approx. 25 psig over that of normal closing instrument air pressure) was applied to the actuators of the inboard MSIVs to counteract the upward force placed upon the inboard MSIV poppets when the volume between the two MSIV's is pressurized for testing. Additionally, the leaking MSIV-LCS valves (1E3?-F001 E and N) on the B and D MSL's were plugged to eliminate this variable from the LLRT measurements.

The results of the second round of testing are presented in Table 1 along with those of the initial tests. This second round testing again indicated that all four MSL's leaked in excess of their Technical Specification limits.

VALVE INSPECTION AND REPAIR RESULTS

Each MSL penetration is bounded by four isolation valves: the inboard (F022) and outboard (F028) MSIV's, the MSIV-LCS steam tunnel isolation valve (E32-F001) and the outboard MSIV drain valve (F067). Total penetration leakage is a combination of the leakage from all four of these valves.

The B and C inboard MSIVs displayed acceptable Technical Specification leak tightess and did not require any rework. The A and D inboard MSIV's (F022) leaked through the pilot poppet seats. All four outboard MSIV's (F028) visually displayed poor seating contact between their poppets and valve seats. The upper one-third to one-half of the valve seat was not in contact with the poppet on any of the outboard valves. All MSIV's inspected displayed a slight oxide layer on the valve seating surfaces. A concerted effort was made to restore the six MSIV's that required disassembly to as near their original condition as possible. Repairs to these six valves included replacing the poppet on one valve and replacing the stems on five valves. The seats on two of the MSIV's (F028 B and C) were completely removed and replaced, resulting in as-left leakage being the lowest ever achieved for these valves. The guide ribs on three of the valves were rebuilt and the seating surfaces on all of the valves were cleaned and/or lapped as appropriate. The pilot seat contact areas were examined on all six valves and three of them were reworked.

While replacing the seats on the two MSIV's discussed above, extra effort was taken to counterbore the areas below the seats in preparation for future modifications. Additionally, a new, more accurate type of machine was used to perform the seat repairs. This machine (Climax) was chosen because other plants have reported better success with it than with the machines previously used. In addition to these repairs, all of the springs from one MSIV were tested to verify their spring constants. They all performed satisfactorily. Internal measurements were taken of all critical dimensions on the six MSIV's that were disassembled including radial clearances between the valve bore and the disc/piston assembly (with the exception of the "A" outboard MSIV).

In addition to the MSIV deficiencies, several other factors contributed to the leak rate test failures of the MSL penetrations. All four outboard MSIV drain valves (F067) leaked by their seats and the B and D MSL MSIV-LCS isolation valves (E32-F001) leaked by their seats. The MSIV-LCS isolation valves have a history of leaking. During the last outage, a seal ring modification was made to correct body to bonnet leakage following an evaluation of the leakage. This modification has proven effective. A similar evaluation is now being performed to improve the seat leak tightness of these valves. The outboard MSIV drain valves required no repairs until 1989 when F067A was found to have seat indications and a damaged disc and F067B had a nick in the seat. All four of the F067 valves required refurbishment this outage.

The MSIV's and other penetration boundary valves discussed above were all repaired and followup LLRT's were satisfactorily performed between November 1 and 12, 1990. Table 1 provides a tabulation of the as-found and the as-left LLRT results.

Table 2 provides a breakdown of the inspection results and the repairs made to each valve to restore it to specification.

10CFR100 CONSIDERATIONS

Following discussions with the NRC staff at the NRC/CEI Management Meeting on February 7, 1991, a re-evaluation of the impact of the leaking MSIV's on the 10CFR100 design basis analysis from a loss of coolant accident as presented in Table 15.6-15 of the USAR was performed.

In performing this re-evaluation a conservative estimate of total MSIV leakage was made by assigning 50% of the as-found leakage for main steam line penetrations A and D to each of the MSIV's in these lines and 100% of the as-left leakage in main steam line penetrations B and C to the valves which were not reworked in main steam lines B and C. This re-evaluation showed that the whole body and the inhalation doses at the site boundary are still well within the 10CFR100 limits of 25 rem and 300 rem, respectively. Control room doses are regulated by General Design Criteria, GDC-19, "Control Room" which limits exposure to 5 rem whole body. The control room whole body dose remains well within the actual GDC-19 limit of 5 rem. NUREG-0800 "Standard Review Plan," provides guidance for control room inhalation doses. The calculated control room inhalation dose increases to 31.18 rem, which is an incremental increase of only 5.8% over the design basis analysis value presented in USAR Table 15.6-15 and only 1.18 rem greater than the NRC staff guidance of 30 rem for inhalation dose. Since the design basis calculation of control room inhalation dose is very conservative, control room exposure would actually be lower, and established plant procedures for protection of control room personnel will continue to ensure exposures are minimized. Based upon this re-evaluation, the as-found leakage from the six MSIV's requiring rework, although not acceptable to CEI, is not considered to be safety significant.

CORRECTIVE ACTIONS TO BE TAKEN TO ENHANCE PENETRATION LEAK TIGHTNESS

Because of the repeated LLRT failures associated with the MSL penetrations, and in order to respond conclusively to all aspects of the MSL penetration leakage, a multi-discipline task force was established in November 1990, immediately following the valve repair efforts from the outage. The Main Steam Line Penetration Leakage Task Force is an extension of the organization that directed valve repair efforts during the outage and consists of personnel intimately familiar with the Perry MSIV leakage problems

The Task Force is performing a Kepner-Tregoe (KT) type analysis of the past MSL penetration LLRT failures in order to accurately determine the root causes involved and to effectively determine appropriate corrective actions. While the KT analysis progresses, the Task Force is concentrating efforts in areas which are known to have contributed to past failures. These include oxide layer buildup on valve seating surfaces, inadequate control of valve closing conditions, testing methodology and penetration valve design. The Task Force is also represented on the BWR Owners Group MSIV Maintenance Committee. Each of these areas is discussed below.

Oxide Layer Buildup

The potential for oxide layer build-up on valve seating surfaces, and its effect on valve leak tightness have been discussed extensively within the industry. The Perry MSIVs have experienced this oxide buildup. It is believed that periodic stroking of the MSIV's aids in maintaining the cleanliness of the seating surfaces, thereby minimizing frictional effects during valve closure. There was no provision for stroking these valves during the previous fuel cycle. Procedures have been revised to require the quarterly cycling of the MSIV's during this operating cycle. The first stroking of these valves under this new guidance occurred on March 31, 1991. For the longer term, the design modifications planned for the MSIV's are expected to be effective in overcoming the frictional effects of the oxide layer, eliminating the necessity for continued valve stroking during future cycles.

Control of Valve Closing Conditions

During this previous outage, a controlled fast closure of all MSIV's was not performed prior to the LLRT. Although it was intended to fast close all of the MSIV's while hot and to not disturb their position until testing was completed, operational conditions and communication problems resulted in only two of the MSIV's being fast closed and six of the MSIV's (including these two) being reopened and closed again during the cooldown. It is believed that the failure to obtain and preserve the post-accident conditions for the MSIV's (i.e., fast closed at normal operating temperature) contributed to the inconsistent data obtained during the LLRT's. Procedure changes are being made to control valve closure during future LLRT shutdowns and cooldowns to optimize the leak tightness of the valves.

Testing Methodology

As described above, the MSL penetration is bounded by four valves: two MSIV's, an outboard MSIV before seat drain valve and an MSIV-LCS isolation valve. Testing of the penetration is accomplished by pressurizing the penetration and determining overall leakage from all four valves. Testing conditions and methodology are being evaluated for possible improvements, such as being able to isolate the outboard MSIV before seat drain valve and the MSIV-LCS isolation valve from the LLRT boundary. Although these testing methodology improvements will not specifically improve valve performance, they will allow us to more accurately determine valve leakage rates and to thus assign the leakage to the appropriate valves. This will enable us to identify significant problems if they do indeed exist and to make appropriate design changes if they are needed.

Penetration Valve Design Improvement

Other plants have achieved successful LLRT results with our present MSIV design and our own data suggests that this design can be made to work. In fact, the four inboard MSIV's displayed no obvious seat leakage this cycle. Two of the inboard valves required no rework at all and the other 2 inboard valves experienced leakage only because of burrs on the pilot poppet seat.

The burrs are believed to have been the result of a testing situation in which the valves were stroked in a flooded condition, providing the opportunity for corrosion products/foreign material to be forced past the pilot seat during valve closure.

Although we believe the present design can successfully pass future LLRTs, the modifications described below are being made to further enhance valve performance. The modifications include poppet and stem anti-rotation devices, an improved nose guide poppet, and a cover modification for the top seat of the poppet to minimize vibration of the poppet when the MSIV is open. Although previously described corrective actions are expected to significantly improve valve performance, these modifications are being purchased and will be installed on any valves requiring rework for leakage problems during future outages. In addition to the MSIV's, the other valves within the MSL penetrations (which may be major contributors to overall penetration leakage independent of the MSIV's) are being evaluated by the Main Steam Line Penetration Leakage Task Force to determine design or operational changes that can be made to improve their leak tightness. These potential modifications include the installation of crud traps/clean-outs, and/or re-orientation of piping to prevent debris from accumulating in the seats of the MSIV-LCS isolation valves and the outboard MSIV before seat drain valves. These and other potential modifications will be evaluated upon completion of the KT type analysis. This analysis is expected to be completed by about June 30, 1991.

BWR Owners Group MSIV Maintenance Committee

In addition to these Task Force activities, Perry representatives are actively participating on the BWR Owners Group MSIV Maintenance Committee. This participation should provide additional insight and benefit to Perry as well as to the other involved BWR Owners.

Conclusion

As a result of the work performed during the last refueling outage, all MSL penetrations were determined to be in full compliance with Technical Specification requirements by leak rate testing between November 1 and November 12, 1990.

As discussed at the February 7, 1991 NRC/CEI management meeting, specific repairs made to several of the individual MSIV's during previous outages have proven successful during the ensuing cycle. With the extra effort expended this outage in refurbishing these valves, including the use of the Climax machine, we believe that the MSIV's can successfully remain within Technical Specification leakage limits during this next cycle. These repairs along with quarterly valve cycling, control of valve closing conditions, and the anticipated recommendations from our Task Force on testing methodology are expected to yield results that are within Technical Specification limits during the next performance of the LLRTs. In the longer term, we believe that the MSIV modifications being planned, along with other possible design change recommendations from our Task Force, will eliminate the conditions which are contributing to our valve leakage problems.

TABLE 1

LLRT Results

	As-Found		As-Left
	Sept. 16 & 17, 1990	Sept. 28-30, 1990	Nov. 1-12, 1990
A -	Unable to measure	288 (estimated)	2.556
B -	2058 (estimated)	1598 (estimated)	0.417
C -	6822 (estimated)	873 (estimated)	1.748
D -	34.35	45	2.778

Leakage rates in Standard Liters per Minute (SLM)

TABLE 2

Valve Problems and Corrective Actions

Penetration	Identified Problems	Corrective Actions
MSL A		
F022A	- Minor valve seat depressions	- Lapped valve body seat
	- Raised metal on pilot seat	- Lapped pilot poppet seat
	- Guide rib wear	- Weld repaired lower guide rib
	- Stem and spring retaining ring wear	- Replaced stem and spring retaining ring
F028 A	- Stem exceeded TIR	- Replaced stem
F067 A	- Inadequate seat contact	- Lapped seat and replaced disc
MSL B		
F028 B	- Crack in valve seat	- Removed and replaced valve seat
	- Stellite layer not complete on poppet	- Replaced poppet
F067 B	- Inadequate seat contact	- Lapped seat and replaced disc
E32-F001 E	- Inadequate seat contact	- Lapped seat and replaced seal ring
MSL C		
F028 C	- Indications on seat/bore	- Removed and replaced valve seat
	- Scratched stem	- Replaced stem
	- Guide rib wear	- Weld repaired lower guide rib
F067 C	- Inadequate seat contact	- Lapped seat and replaced disc

TABLE 2
(Continued)

Penetration	Identified Problems	Corrective Actions
MSL D		
F022 D	- Valve seat angle incorrect	- Machined and lapped valve seat
	- Raised metal on pilot seat	- Lapped pilot seat
	- Guide rib wear	- Weld repaired lower and upper left guide ribs
	- Stem and spring retaining ring worn and scratched	- Replaced stem and spring retaining ring
	- Stuck stud	- Drilled stud out and replaced
F028 D	- Pilot bore damage	- Lapped pilot seat
	- Star plate stuck	- Removed and replaced star plate & stanchions
	- Stem scratched	- Replaced stem
F067 D	- Inadequate seat contact, scored seat and disc.	- Lapped seat and replaced disc
E32-F001 N	- Inadequate seat contact	- Lapped seat and replaced seal ring