U.S. NUCLEAR REGULATORY COMMISSION

REGION III

Report No. 50-440/92004(DRS)

Docket No. 50-440 License No. NPF-58

Licensee: Centerior Service Company
c/o The Cleveland Electric Illuminating Co.
10 Center Road
Perry, OH 44081

Facility Name: Perry Nuclear Power Plant

Inspection At: Perry, OH 44081

Inspection Conducted: March 26 - June 23, 1992

Inspector: F. Maura (signature) 7/8/92
Date

Approved By: B. Burgess, Chief (signature) 7/9/92
Operational Programs Section Date

Inspection Summary

Inspection on March 26 - June 23, 1992 (Report No. 50-440/92004(DRS))

Areas Inspected: Routine, unannounced, inspection of the main steam lines (MSL) local leak rate testing (LLRT) procedures; witnessing portions of the LLRT, and troubleshoot testing to identify the source of the excessive leakage; and review of licensee actions on previous inspection findings. NRC modules used during this inspection included 92701, and 92702, 92720.

Results: The inspection resulted in one violation against 10 CFR Part 50, Appendix B, Criteria II and XVI. These criteria require the implementation of the quality assurance program (USAR Chapter 17.2), and require the cause of significant conditions adverse to quality be determined and corrective action taken to preclude repetition, respectively. The main steam lines have grossly failed their leakage rate tests for the last four outages and corrective actions have not been effective. This violation is described in Section 3 of the report.

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REPORT DETAILS

1. Persons Contacted

Cleveland Electric Illuminating Company

+ M. Lyster, Vice President - Nuclear, Perry
#+*V. Concel, Systems Engineering Manager
*D. Dervay, Supervisor, Systems Engineering Section
#+ K. Donovan, Manager, Licensing and Compliance
*R. Gaston, Compliance Engineer
T. Hardman, Contractor
*H. Hegrat, Supervisor, Compliance
#+*S. Kensicki, Director, Engineering Department
G. Osborne, System Engineer
*K. Pech, Manager, Outage Planning
S. Seaman, Systems Engineer
T. Shega, Systems Engineer
+ F. Von Ahn, MEU Supervisor

Welding Services Inc.

P. Amador, Program Manager

U.S. NRC

B. Burgess, Chief, OPS, DRS
+ R. Greger, Chief, Branch, 3, DRP, RIII
+ R. Hall, Licensing Project Manager, NRR
+*P. Hiland, Senior Resident Inspector
+ H. Miller, Director, DRS, RIII
+ C. Paperiello, Deputy Regional Administrator
+ J. Partlow, AD, Projects, NRR
+ J. Smith, Reactor Inspector, DRS
*T. Vegel, Resident Inspector
+ G. Wright, Chief, Operations Branch, DRS
+ J. Zwolinski, AD, Reactor Projects III, NRR

*Attended preliminary exit interview of March 31, 1992.
+Attended management meeting at RIII office on May 27, 1992.
#Attended telephone exit interview on June 23, 1992.

The inspector also interviewed other licensee employees including members of the operations and engineering organizations.

2. Licensee Action on Previous Inspection Findings

a. (Closed) Open Item (440/89012-01): Improve General Maintenance Instruction GMI-0096 to ensure all necessary MSIV data is obtained during disassembly and following repairs to perform a root cause analysis of future MSIV failures, and to establish a predictive maintenance program. The inspector reviewed GMI-0092, Rev. 2, including TCN-4 and determined that appropriate steps were added to control the waiving of data gathering steps. The responsible Perry Nuclear Engineering Department (PNED) system engineer, or designated alternate, is responsible to ensure all necessary data is obtained. In addition, the licensee has contracted to map the valve interior dimensions of any MSIV opened for repairs using an automatic data acquisition system. This item is considered resolved.

b. (Closed) Open Item (440/89012-02): USAR Tables 6.2.32 and 6.2.40 to be revised to indicate that RCIC turbine exhaust valve 1E51-F068 is to remain open during the CILRT so that check valve F040 is the containment boundary, and that both valves (F040 and F068) are to be Type C tested. The inspector reviewed the USAR and determined that the changes were made as part of Rev. 3 dated March 1991. This item is considered resolved.

c. (Closed) Violation (440-89012-04): Inadequate review of CILRT procedure SVI-T23-T0394 allowed water to leak out of the main steam lines thru an open drain flooding the drywell lower level. The inspector reviewed the licensee's corrective actions and determined that they were completed as stated in their response to the Notice of Violation, dated December 7, 1989. This item is considered resolved.

d. (Closed) Open Item (440-89012-05): Instruction OM8E: IMI-E2-20, Rev. 1. had no controls to ensure that the containment penetrations were tested at Pa regardless of leakage rate and hose length between the test instrumentation and the penetration. The inspector reviewed TCN Nos. 1 & 2 to the procedure. TCN No. 1 (1/30/90) required that the penetration pressure be verified to be between 11.31 and 12.44 psig. TCN No. 2 (5/15/90) limited the length of hose to 100 ft and a minimum outside diameter of 3/8 inch. The inspector witnessed portions of the leakage rate testing of the MSIVs and was satisfied with the licensee's monitoring of the penetration pressure. This item is considered resolved.

e. (Closed) Violation (440-90020-01): Failure to demonstrate adequate corrective action was taken to ensure that the main steam line penetrations leakage rates remain within the Technical Specifications limits throughout an entire fuel cycle. During the last refueling outage three of the four main steam lines again grossly failed their local leak rate tests. This issue will be tracked under I em No. 440/92004-01.

3. Leakage Rate Testing of the Main Steam Line Penetrations

a. Procedure

The inspector reviewed surveillance test procedures SVI-B21-T9124 and SVI-B21-9416 for penetrations P124 (main steam line A) and P-416 (main steam line B) respectively. The procedures, typical for all main steam line penetrations, systematically measured the overall leakage rate of each penetration. Additionally the procedures included steps to determine the specific leakage rate for each valve defining the penetration boundary. All inspector's comments were resolved satisfactorily.

b. Witnessing

The unit was shutdown for refueling on March 21, 1991. At a reactor pressure of approximately 125 psig the MSIVs were fast closed. They were reopened and fast closed for the second time at a pressure of approximately 77 psig. Leakage rate testing commenced on March 28, 1992, with all components at ambient temperature. Each main steam line penetration boundary consisted of an inboard MSIV (1B21-F022), an outboard MSIV (1B21-F028), an MSIV leakage control system valve (1E32-F001), and a main steam line drain valve (1B21-F067). The initial test included the entire MSL boundary with each boundary valve downstream volume vented to the atmosphere. Additional testing was performed on the three failed MSLs in an effort to identify the leaking boundary valves and quantify their leakage rate.

The inspector witnessed the measurement of the overall leakage rate for each main steam line penetration, and of selected troubleshooting tests. The licensee performed all measurements in accordance with the approved procedures. The inspector also reviewed selected instrumentation calibration records. No problems were identified.

c. Results

Th out of the four MSLs grossly exceeded the Tec ical Specifications allowable leakage rate (≤ 25 SCFH) by factors ranging from 24 to 66. Table 1 shows the history of MSL leakage rates.

Table 1 - History of MSL As-Found Leakage Rate

Leakage rate, in SCFH

	MSL A	MSL B	MSL C	MSL D
July 1987	>42.4	>42.4	32	>42.4
September 1987	Not tested	610	Not tested	Not tested
February/March 1989	261	64	265	45
September 1990	Indeterminate 610*	4360 3386*	14,453 1851*	73 95*
March 1992	1607	1642	8	602

*After valve cycling

The most recent test was the fourth time the MSLs have experienced gross leakage. Corrective actions taken by the licensee during previous outages have not been effective. Root cause identification following past failures has been poor, considering that the licensee has been a member of the Boiling Water Reactors Owners' Group (BWROG) which studied MSIV problems for the last decade. In addition, the licensee although aware of the valves' manufacturer recommended modifications to improve valve performance, did not implement those actions until the most recent outage. Throughout the fuel cycles, between the four MSL-LLRT failures, the licensee neither adjusted the LLRT surveillance testing, nor the preventive maintenance program of the MSLs to provide assurance that the MSL penetration valves were capable of performing their safety function. This is considered a violation of 10 CFR Part 50, Appendix B, Criteria II and XVI (440/92004-01(DRS)).

During previous outages no attempts were made to measure the leakage rate of the MSL boundary valves in order to better identify the significant leakage rate contributors. A change was made to the test procedure prior to the most recent outage to include these troubleshooting steps. Table 2 shows the leakage rates for each MSL penetration boundary valve based on the initial testing conducted in March, prior to any repairs or adjustments.

Table 2 - Approximate Leakage Rate For Each Boundary Valve

Leakage Rate, in SCFH

	Penetration	Drain Valve	LCS Valve	MSIV* Outboard	MSIV* Inboard
A MSL	1607	0	0	1200	408
B MSL	1642	0	108	983	551
C MSL	8	---	---	---	---
D MSL	602	0	0	362	240

*Based on the results of the tests performed with 10.5 psig backpressure on the outboard MSIV.

Inaccuracies in the leakage rate measurements could have masked leakage in excess of the 25 SCFH maximum acceptance limit in some of the boundary valves shown to have zero leakage in Table 2. In addition, packing leakage, such as that experienced on the "D" MSL LCS valve, could not be quantified, and became part of the MSIV leakage. While it may be possible to reduce these errors by additional testing performed at different stages during valve repairs, the overall inboard vs. outboard leakage rate results should remain close to the values given in Table 2.

d. Corrective Action

As discussed in Inspection Reports No. 50-440/89012(DRS) and No. 50-440/90020(DRP), prior repairs on the MSIVs consisted mostly of machining or lapping valve seats, replacing valve stems, and the repair of guide ribs. For the LCS and drain valves, repairs involved lapping of seats, replacement of discs, modifying the body to bonnet seal ring, repacking, and cleaning the debris found in the seating area. As stated before, the corrective actions were not effective in preventing gross MSL leakage. Industry studies have stated that the major contributors to MSIV leakage have been improper or poorly controlled lapping which failed to ensure proper mating angles, and resulted in distortions from the desired geometry (i.e., eccentric seat, or having undulations circumferentially or along a conical element in the surface).

A study of the MSL leakage problem performed by the licensee in 1991 identified the following causes as major contributor:

- For the MSIVs: Incomplete, inadequate, or incorrect valve maintenance which resulted in the seating geometry being changed. A contributing factor was insufficient valve internal measurements to identify when parameters were out of tolerance. The licensee stated that the latter was due to ineffective measuring devices.

- For the LCS and drain valves: Inadequate or incorrect maintenance as evidenced by the type of debris found in the drain valves, and packing leakage due to inadequate torquing. In addition, draining activities prior to testing were suspected of carrying crud into the drain valve seats.

During the most recent outage, the A, B, and D inboard and outboard MSIVs were modified to include an improved poppet nose guide, a poppet anti-rotation device, and a cover modification for the back seat of the poppet to minimize vibration when the MSIV is open. In addition, a computerized data acquisition tool was used to take valve bore, seats, and guide rib dimensions for the as-found and as-left condition. The licensee was documenting the tolerance requirements needed for the correct interpretation of these valve measurements.

With respect to the LCS and drain valves, the corrective action taken consisted of seat repairs and repacking. Modifications were being planned for the next refueling outage to improve the draining operations so that crud does not collect in the valve seat. Other hardware changes were being planned to facilitate the isolation of boundary valves during the local leak rate testing troubleshooting process.

4. Root Cause and Corrective Action

On May 27, the licensee presented their findings regarding the root cause of the MSLs excessive leakage and the corrective action to prevent recurrence. The slides used in the presentation are attached to this report as Enclosure 2. In summary, the excessive leakage experienced by the MSLs was MSIV leakage. The licensee evaluated several findings and determined that the probable root cause of MSIV leakage was excessive friction causing angular misalignment at the end of valve stroke resulting in a non 360° seat contact. This condition was aggravated by other contributing factors.

The licensee stated that the modifications performed on the failed MSIVs, improved machine tooling, and improved data acquisition of valve internal dimensions should prevent recurrence of the failures experienced during the last 5 years. The licensee presented data which showed good leakage rate performance at plants which had implemented the MSIV modifications. Future design changes being considered were also discussed.

The licensee presented the radiological effects, for offsite areas and the control room assuming LOCA design basis accident and the as-found MSL, minimum flow path, leakage rates. Only the control room doses exceeded the acceptance criteria of 10 CFR 50, Appendix A, GDC 19; however, it should be noted that the calculated doses are conservative.

5. Midcycle Testing

During the exit interview on June 23, 1992, the licensee committed to LLRT the unmodified "C" MSL, and one of the modified MSLs (A, B, or D). The LLRT would be performed at any time between January 1 and May 31, 1993, provided an outage expected to exceed, 7 days occurs. If the modified MSL failed its LLRT the other two modified MSLs will also be tested. If as a result of MSIV leakage the "C" MSL failed its LLRT, the failed MSIV(s) will be modified.

6. Exit Interview

A preliminary exit interview was held with licensee representative (denoted in Section 1) prior to leaving the site on March 31, 1992. A final telephone exit was held on June 23, 1992. During both exits the inspector summarized the scope and findings of the inspection. The inspector also discussed the likely informational content of the inspection report with regards to documents or processes reviewed by the inspector during the inspection. The licensee identified some drawings and procedures as proprietary. The inspector agreed to handle this information accordingly.

PNPP

NRC MANAGEMENT MEETING

MAY 27, 1992

MSIV PERFORMANCE PRESENTATION

I. INTRODUCTION

VIDEO / MODEL

MEETING GOALS

- REVIEW AS FOUND RF03 LLRT DATA

- REVIEW STATUS OF ROOT CAUSE ANALYSIS

- REVIEW DESIGN IMPROVEMENTS TO MSIV'S

- FUTURE EXPECTATIONS OF MSIV PERFORMANCE

10 CFR 100 CONSIDERATIONS

II. RF03 LLRT RESULTS

AS FOUND LLRT DATA

A & D MAIN STEAM LINES WORSE THAN RF02

B & C MAIN STEAM LINES BETTER THAN RF02

C MAIN STEAM LINE PASSED LLRT

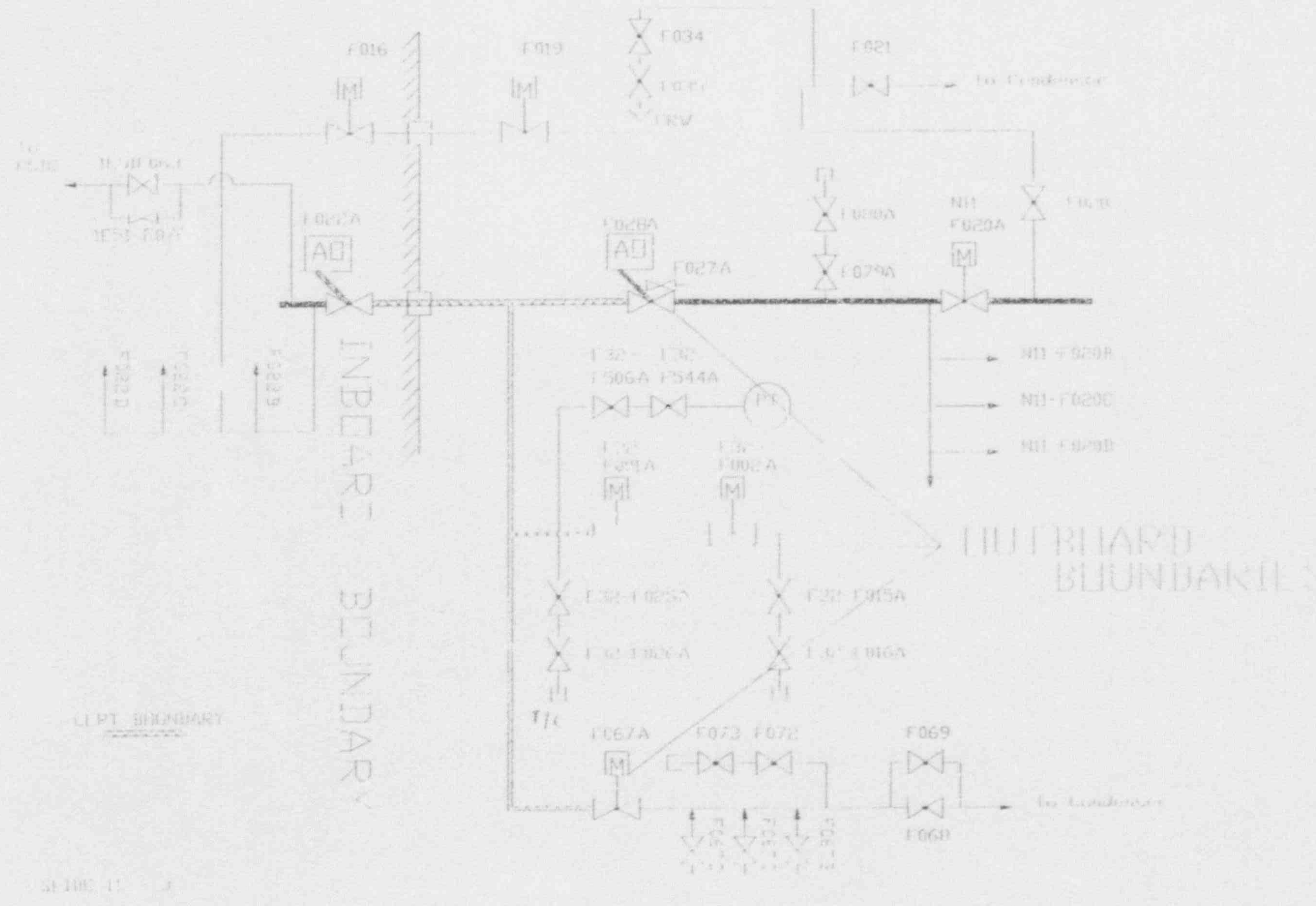
C MAIN STEAM LINE RESULTS

2 SUCCESSIVE PASSES (RF02, RF03) FOR INBD MSIV

OUTBD MSIV SEAT REBUILT DURING RF02

RF02 / RF03 AS FOUND & AS LEFT LLRT DATA

		RF02	RF03
MAIN STEAM LINE A	AS FOUND	288 SLM (610.6 SCFH)	758.98 SLM (1609 SCFH)
	AS LEFT	2.56 SLM (5.4 SCFH)	.65 SLM (1.4 SCFH)
MAIN STEAM LINE B	AS FOUND	1598 SLM (3387.8 SCFH)	774.8 SLM (1642.6 SCFH)
	AS LEFT	.42 SLM (.89 SCFH)	7.01 SLM (14.8 SCFH)
MAIN STEAM LINE C	AS FOUND	873 SLM (1850.8 SCFH)	3.86 SLM (8.2 SCFH)
	AS LEFT	1.75 SLM (3.7 SCFH)	3.86 SLM (8.2 SCFH)
MAIN STEAM LINE D	AS FOUND	45 SLM (95.4 SCFH)	284 SLM (602 SCFH)
	AS LEFT	2.8 SLM (5.9 SCFH)	9.8 SLM (20.8 SCFH)



F016
F019
F034
CRW
F021
to Condenser
F022A
AO
F028A
F027A
F080A
F079A
NH
F020A
F022B
F022C
F022D
INBOARD BOUNDARY
F506A F544A
N11 F020B
N11-F020C
N11 F020D
OUTBOARD BOUNDARIES
F067A
F073 F072
F069
F068
to Condenser
CLPT BOUNDARY

C MAIN STEAM LINE RESULTS

2 SUCCESSIVE PASSES (RF02, RF03) FOR INBD MSIV

OUTBD MSIV SEAT REBUILT DURING RF02

	RF02		RF03	
			AS FOUND	1.93 SLM (4.1 SCFH)
B21 F022C	AS LEFT	.88 SLM (1.86 SCFH)	AS LEFT	1.93 SLM (4.1 SCFH)
			AS FOUND	1.93 SLM (4.1 SCFH)
B21 F028C	AS LEFT	.88 SLM (1.86 SCFH)	AS LEFT	1.93 SLM (4.1 SCFH)

III. ROOT CAUSE ANALYSIS

DETERMINE PATHS DURING TEST

POSSIBLE CAUSES

- CONTRIBUTING FACTORS

AS FOUND INSPECTIONS

- VISUAL / DIMENSIONAL

- AS FOUND DATA VS CAUSES

ROOT CAUSE

EVALUATED CAUSES

ACTUATOR STEM BINDING

- INSUFFICIENT CLOSING FORCES
- BENT STEM / ROLLED METAL

VALVE SEAT DAMAGE

- EROSION
- GOUGES / SCRATCHES

CLOSING PROCEDURES

- TEST CLOSURE VS OPERATIONAL CLOSURE

POPPET ROTATION / VIBRATION

- DAMAGE TO SEATING SURFACES
- INCREASE IN VALVE CLEARANCES

INCORRECT SEAT CONTACT

- LACK OF SEAT MARK

EXCESSIVE COEFFICIENT OF FRICTION

- OXIDE LAYER BUILDUP

CONCENTRICITY

- BORE VS SEAT NON CONCENTRIC

VALVE CLEARANCES

- BEARING SURFACES OF VALVES WEAR
- TOLERANCES OPEN UP
- LATERAL MISALIGNMENT

AS FOUND CONDITION OF MSIV'S

	VALVE CLEARANCES GUIDE RIB WEAR >10 MILS	CONCENCTRICITY TIR >5 MILS	OXIDE LAYER B/U	INCORRECT SEAT CONTACT	POPPET VIBRATTION	POPPET ROTATION	CLOSING PROCEDURES	VALV SEAT DAMAGE	STEM BINDING
B21 F022A	X	X	X	X		X	X	X	
B21 F022B	X	X	X	X		X	X		
B21 F022C	PASSED LLRT								
B21 F022D	X		X			X	X		
B21 F028A			X			X	X		
B21 F028B	X		X	X	X		X	X	
B21 F028C	PASSED LLRT								
B21 F028D		X	X			X	X		

ROOT CAUSE

EXCESSIVE FRICTION (OXIDE BUILDUP) CAUSES END OF STROKE ANGULAR MISALIGNMENT WHICH RESULTS IN A NON 360^{0} SEAT. THIS SITUATION IS EXACERBATED BY MINOR DEVIATIONS IN CONCENTRICITY, INCREASE IN VALVE CLEARANCES AND CLOSURE WITHOUT STEAM ASSIST (TEST METHOD OF CLOSURE) .

IV. RF03 MAINTENANCE IMPROVEMENTS

IMPROVED MACHINE TOOLING

ONE STEP SETUP FOR

WELDING

MACHINING

MEASUREMENT

IMPROVED DATA ACQUISITION

INDEPENDANT VERIFICATION OF MEASUREMENTS

IMPROVED DETAIL

REPEATABILITY

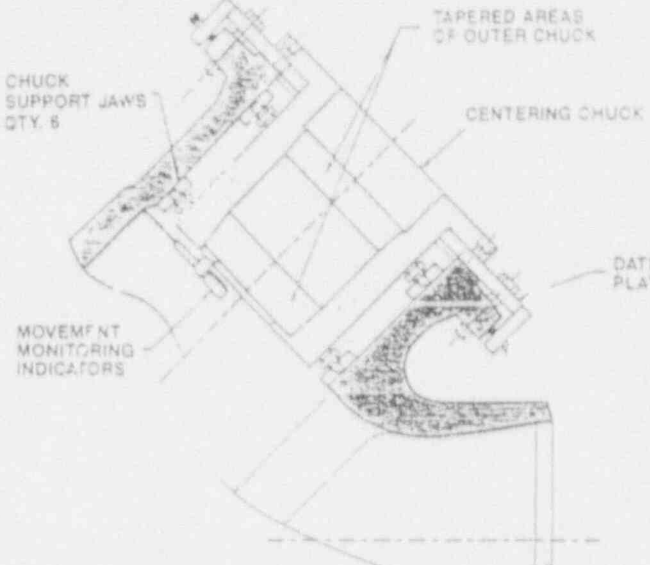
MINIMIZE HUMAN ERROR

IMPROVED ENGINEERING EVALUATION CAPABILITY

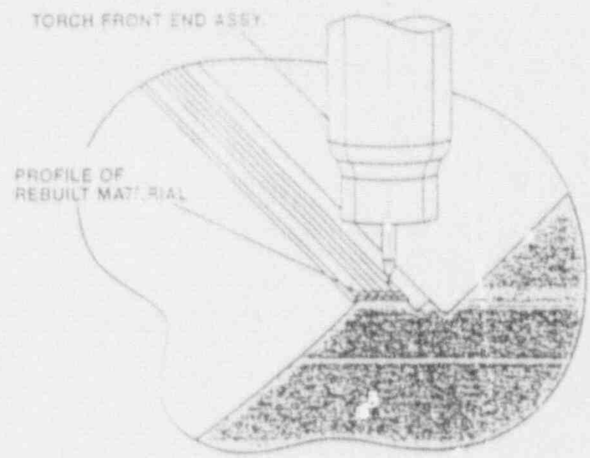
MODIFICATION OF FAILED VALVES

OUTER CHUCK INSTALLATION

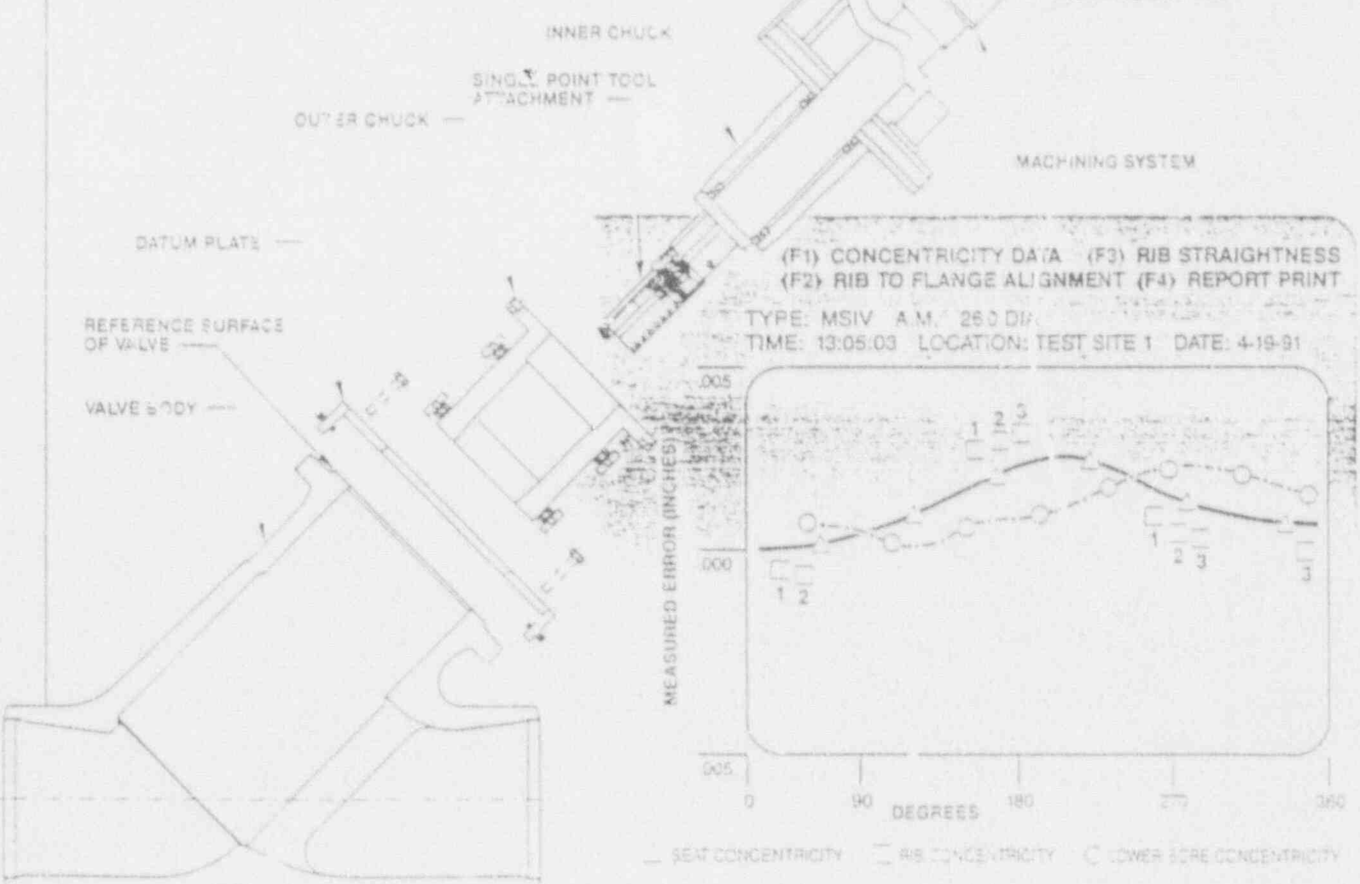
Only one set-up for all steps



REBUILD VALVE SEAT AREA USING GTAW PROCESS



INSERTION OF BORING MACHINE



V. MSIV ENHANCEMENTS

PERRY SPECIFIC ENHANCEMENTS

OTHER PLANT INFORMATION

MODIFICATION PERFORMANCE

FUTURE TESTABILITY FEATURES

10 CFR 100 CALCULATIONS

PERRY MSIV ENHANCEMENTS

MODIFIED NOSE CONE

ELIMINATES FRICTION EFFECTS

CENTERS VALVE FOR CLOSURE

POPPET ANTI ROTATION

ELIMINATES POPPET SPIN

REPEATED SEATING IN SAME ORIENTATION

LARGER STEM

POSSIBLE FUTURE AIR CYLINDER

STRENGHENS STEM

STEM ANTI ROTATION DEVICE

MINIMIZES STEM SEPARATION

MODIFIED COVER w/ STEM GUIDANCE

ELIMINATES VIBRATION

IMPROVES STEM SUPPORT

Installations of A&M's MSIV Enhancement Modification

	Browns Ferry 1,2,3	Hatch 1	Peach Bottom 2&3	Hope Creek	Pilgrim	Oyster Creek	Fermi	Clinton	Perry
Nose Guide Poppet		X	X	X	X	X	X	X	X
Poppet Anti Rotation Device	X	X		X	X	X	X	X	X
Floating Pilot Poppet		X		X	X	X			
High Pressure Cylinder & Controls									
Larger Stem for Future Use of Higher Pressure Air Cylinder	X	X			X	X	X	X	X
Ramp Flow Guide Kit	X								
Stem Anti Rotation Device		X	X	X	X	X	X	X	X
"Backseat Poppet"				X					
"Backseat" and Tensioner Cover with Improved Stem Guiding							X	X	X

MODIFICATION SUCCESS AT OTHER PLANTS

	MODIFICATION OUTAGE	POST MOD OUTAGE #1	POST MOD OUTAGE #2
CLINTON	1 OUTBD VALVE MODIFIED	OUTBDS ALL PASSED 2 INBDS FAILED & MODI-FIED	
FERMI	4 INBD VALVES MODIFIED	ALL INBDS PASSED 3 OUTBD VLVES FAILED & MODIFIED	
HATCH	'D' MSL IN/OUTBD MODIFIED	NO FAILURE MOD VLVES ALL 6 OTHER MSIVS DONE	
HOPE CREEK	2 MSIVS MODIFIED	2 MODIFIED VLVES PASS 2 OTHER VLVES FAIL & MODIFIED	4 MODIFIED VLVES PASS 2 OTHER VLVES FAIL & MODIFIED
PILGRIM	ALL 8 MSIVS MODIFIED	NO FAILURES	1 OUTBD MSIV FAILED

LOCA DESIGN BASIS ACCIDENT
RADIOLOGICAL EFFECTS

	WHOLE BODY GAMMA			INHALATION DOSE		
	USAR VALUE	AS FOUND	ACCEPT CRITERIA	USAR VALUE	AS FOUND	ACCEPT CRITERIA
OFFSITE DOSES						
EXCLUSION AREA (863 METERS)	3.63	17.28	25	141	273.6	300
LOW POPULATION ZONE (4,002 METERS)	1.86	6.54	25	97.7	134.1	300
CONTROL ROOM DOSES	1.76	6.05	5	29.2	39.21	30
BETA SKIN DOSE[1] (0 - 30 DAYS)	2.60+1	18.75+1				

ACCEPTANCE CRITERIA BASED ON 10CFR100, GDC 19, 10CFR 20, STD RVW PLAN

DOSES BASED ON DESIGN BASIS SOURCE TERM WITH FUEL FAILURE.

ALL DOSES IN REM

NOTE 1: UNPROTECTED BETA SKIN DOSE; NO CREDIT IS TAKEN FOR ANY REDUCTION AFFORDED BY CLOTHING.

FUTURE
DESIGN & OPERATING
CONSIDERATIONS

DESIGN CHANGES

- FLANGES TO IMPROVE TESTABILITY

- BWROG INITIATIVES

OPERATING CHANGES

- DIFFERENT OPERATION OF DRAINS

TESTING CHANGES

- INVESTIGATE OPTIMIZATION OF MSIV CLOSURE SEQUENCE