NIAGARA MOHAWK POWER CORPORATION

NINE MILE POINT UNIT 1
NUCLEAR POWER STATION

REPORT

OF

REACTOR PRESSURE VESSEL
FEEDWATER
AND
CONTROL ROD DRIVE RETURN LINE
NOZZLE EXAMINATIONS

performed for

NUREG 0619
BWR FEEDWATER NOZZLE AND CONTROL ROD DRIVE RETURN LINE NOZZLE CRACKING

at the culmination of
REFUELING OUTAGE NO. 13
which ended on April 4, 1995

This document completed
SEPTEMBER 29, 1995

NMP1 RPV FEEDWATER AND CRDRL
NOZZLE EXAMINATIONS
1995 REFUELING OUTAGE (RFO-13)

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NMP1 RPV FEEDWATER AND CRDRL NOZZLE EXAMINATIONS 1995 REFUELING OUTAGE (RFO-13)

I. INTRODUCTION

This report provides the information required by NUREG-0619, "BWR Feedwater Nozzle and Control Rod Drive Return Line Nozzle Cracking" (November 1980). The report includes: A summary of methods used, the results of the inservice inspections of the feedwater and control rod drive return line (CRDRL) nozzles and feedwater sparger flow holes and welds in sparger arms and tees, the effects of modifications or system changes on feedwater flow or temperature, the number of startup/shutdown cycles, and a discussion of thermal sleeve leakage monitoring.

The inspections were performed by the General Electric Nuclear Energy Corporation (GE-NE) of San Jose, California.

II. BACKGROUND

Nine Mile Point Unit 1 is a 620 Mwe Boiling Water Reactor (BWR) which began operation in November 1969 and has been in service for approximately 26 years. During the 1977 Refueling Outage, Niagara Mohawk (NMPC) removed the originally-installed loose-fit feedwater spargers and replaced them with an improved design (single-piston ring/flow baffle seal). The four feedwater nozzles were ultrasonically (UT) examined from the reactor vessel exterior using procedures and techniques developed by General Electric (GE). This UT examination established a baseline for subsequent nozzle examinations.

As required by NUREG-0312, "Interim Technical Report on BWR Feedwater Nozzle and Control Rod Drive Return Line Nozzle Cracking," an inservice UT and dye penetrant (PT) examination of the four feedwater nozzles was performed by GE during the 1979 refueling outage. No significant changes from the baseline examinations were observed. In addition, the Reactor Water Cleanup (RWCU) return line was rerouted to the feedwater lines.

In Niagara Mohawk's response to NUREG-0619, dated December 29, 1980, we committed to a program of periodic inspections of the feedwater and control rod drive return line nozzles. The feedwater nozzle UT inspection was to be performed every other refueling outage and the visual inspection (VT) of the feedwater spargers was to be performed every fourth refueling outage, commencing with the 1981 outage. The PT inspection of the feedwater and control rod drive return line nozzles was to be performed every sixth refueling outage or every 90 startup/shutdown cycles, whichever occurred first. The PT Inspection intervals commenced with the 1979 refueling outage, during which the baseline feedwater nozzle PT inspections were made.

II. BACKGROUND (Cont'd)

During the 1988 Refueling Outage (RFO-11), the NMPC Nuclear Quality Assurance Department generated Corrective Action Request 88.2039-01 to document and resolve discrepancies in previous outages' feedwater nozzle examination data. Also generated during the 1988 outage was the Restart Action Plan (RAP). One of the RAP specific issues addressed the lack of full volume coverage on feedwater nozzles as required by NUREG-0619. All of the corrective actions for both of these issues were identified and implemented during the 1988 outage. The 1988 UT examinations of the feedwater nozzles performed by the Nuclear Energy Services Co. (NES) revealed indications that would require monitoring during the following refueling outage.

The UT examinations conducted during RFO-12 in 1993 of feedwater nozzle "A" were performed by General Electric Nuclear Energy (GE-NE). The results of these examinations were presented in NMPC's submittal of August 25, 1993 (NMP1L 0777) which indicated no recordable indications and resolved those indications identified in 1988 during RFO-11 as requiring additional monitoring.

Visual examinations (VT) of the feedwater sparger flow holes and welds in sparger arms and tees were performed by GE-NE during RFO-11 in 1988 and again during RFO-12 in 1993. These examinations indicated no reportable indications.

III. RESULTS OF EXAMINATIONS

The inspections conducted during RFO-13 in 1995 were performed with the Ultrasonic Test (UT) method by GE-NE which indicated no reportable indications. These UT examinations utilized the GERIS 2000 automated system and manual UT pickups of the RPV nozzles on four (4) feedwater and the control rod drive return line nozzles. The results of these examinations and a summary of all previous examinations are presented in Appendix A of this report.

IV. MODIFICATIONS

NUREG-0619 requires licensees to report all modifications or system changes that affect feedwater flow or temperature and to consider these changes in predicting future cracking tendencies. Since our 1988 outage NUREG-0019 report, there have been no modifications or system changes that affect feedwater flow or temperature. Appendix B to this report summarizes all applicable physical and procedural modifications implemented at Nine Mile Point Unit 1 since 1977 which affect feedwater flow or temperature.

V. STARTUP/SHUTDOWN CYCLES

The feedwater and control rod drive return line nozzles have experienced 171 startup/shutdown cycles since initial plant operation. The control rod drive return line nozzle has experienced only 63 startup/shutdown cycles since the PT examination in 1979. Table 1 provides further data on the number of startup/shutdown cycles from outage to outage since 1977.

VI. LEAKAGE MONITORING

Niagara Mohawk has not installed an on-line bypass leakage monitoring system at Nine Mile Point Unit 1 (NMP1). The thermal sleeve design includes flow baffles that prevent mixing of the hot reactor water and the colder feedwater in the nozzle annulus. NUREG-0619, Section 4.3.2.4 specifically exempts NMP1 from this requirement.

VII. SUMMARY

The nondestructive examinations performed during the 1995 Refueling Outage, RFO-13, identified no reportable indications that will require monitoring in accordance with NUREG-0619. NMPC anticipates to continue utilizing an automated inspection method such as the GE GERIS 2000 automated system for future outages as described in NMPC's submittal of June 23, 1994 (NMP1L 0829).

NMP1 RPV FEEDWATER AND CRDRL
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TABLE I

NUMBER OF STARTUP/SHUTDOWN CYCLES AT NINE MILE POINT UNIT 1

PERIOD	NUMBER OF CYCLES DURING PERIOD	CUMULATIVE
1969 Initial Startup- 1977 Refueling Outage	95	95
1977 Refueling Outage- 1979 Refueling Outage	13	108
1979 Refueling Outage- 1981 Refueling Outage	17	125
1981 Refueling Outage- 1983 Safe-End Outage	2	127
1983 Safe-End Outage- 1986 Refueling Outage	14	141
1986 Refueling Outage- 1987 Feedwater Transient Outage (1988 Refueling Outage)	8	149
1988 Refueling Outage RFO-11 1993 Refueling Outage RFO-12	17	166
1993 Refueling Outage RFO-12 1995 Refueling Outage RFO-13	5	171

VIII. REFERENCES

1. BWR Feedwater Nozzle and Control Rod Drive Return Line Nozzle Cracking, NUREG-0619, U. S. Nuclear Regulatory Commission, November 1980.

2. NMPC Letter, D. P. Dise to R. C. Haynes, U. S. Nuclear Regulatory Commission, dated January 4, 1982 (Subject: Inservice Inspections of Feedwater Nozzles and Spargers Performed During the 1981 Refueling Outage).

3. NES Letter, T. J. Koch to T. W. Roman, dated March 4, 1983 (Subject: February, 1983 Feedwater Nozzle Inner Radius Exams).

4. NES Letter, W. R. Downs to T. W. Roman, dated June 27, 1984 (Subject: April, 1984 Feedwater Nozzle Inner Radius Exams).

5. NMPC submittal to the NRC, dated December 23, 1986, letter number NMP1L 0119 (Subject: 1986 RFO-10 Feedwater Nozzle Examination Results).

6. NMPC submittal to the NRC, dated March 21, 1989, letter number NMP1L 0374 (Subject: 1988 RFO-11 Feedwater Nozzle Exam Results/NMPC Plans for Future Examinations and Evaluation of Identified Indications).

7. NRC Letter, dated May 1, 1989, (TAC No. 72944) (Subject: Summary of April 18, 1989 Meeting to Discuss Feedwater Indications at NMP1).

8. NMPC submittal to the NRC, dated May 5, 1989, letter number NMP1L 0394 (Subject: Feedwater Nozzle Indication Fracture Mechanics Analysis).

9. NRC Safety Evaluation of Ultrasonic Test Indications in the Feedwater Inlet Nozzle "A" Near a Nozzle Safe End (TAC 72944), dated 9/26/89.

10. NMPC submittal to the NRC, dated January 11, 1991, letter number NMP1L 0560 (Subject: 1988 RFO-11 Feedwater Nozzle Examination Results).

11. NMPC Internal Correspondence to Unit 1 Licensing File from N. A. Spagnoletti, dated March 1, 1993, File Code 003631GG (Subject: Notes of Telecon with NRC Regarding Feedwater Nozzle "A" UT Inspection).

12. NMPC submittal to the NRC, dated August 25, 1993, letter number NMP1L 0777 (Subject: 1993 RFO-12 Feedwater Nozzle "A" Examination Results).

VIII. REFERENCES (Cont'd)

13. NMPC Nuclear Engineering Report No. NER-IM-006 "Nine Mile Point Unit 1 Feedwater Nozzle Fatigue Evaluation," dated May 1994, (Reference MPR-1484, Revision 0).

14. NMPC Nuclear Engineering Report No. NER-IM-007 "Nine Mile Point Unit 1 Control Rod Drive Return Nozzle Fatigue Evaluation," dated May 1994, (Reference MPR-1485, Revision 0).

15. NMPC submittal to the NRC, dated June 23, 1994, letter number NMP1L 0829 (Subject: Amend NUREG 0619 Commitment from PT to Automated UT Inspection).

16. NRC Letter, dated January 12, 1995, (TAC No. M89792) (Subject: Amend NMPC's NMP1 NUREG 0619 Commitment utilizing the GERIS 2000 System from Automated UT Inspection).

IX. APPENDICES

APPENDIX A
FEEDWATER NOZZLE INSPECTION RESULTS

As stated in Niagara Mohawk's letter of December 29, 1980, the Nine Mile Point Unit 1 Feedwater and control rod drive return line nozzles will be periodically reinspected at the following intervals:

- Feedwater Nozzle UT - every other refueling outage, commencing with the 1981 outage.

- Feedwater Nozzle VT - every fourth refueling outage, commencing with the 1981 outage.

- Feedwater and CRD Nozzle PT - every sixth refueling outage or every 90 startup/shutdown cycles, commencing with the 1979 refueling.

During the 1981 refueling outage (RFO-8), an inservice UT examination of the four feedwater nozzles was performed by NES and also by GE. An apparent change from the baseline examination was observed. Further evaluation required removal of the sparger from the southeast nozzle. Based on the results of the additional nondestructive examinations, Niagara Mohawk concluded that the UT indication was caused by a geometric reflector and not by a crack in the nozzle. A new feedwater sparger was installed in the southeast nozzle. The design of the new sparger was the same as the replacement spargers installed during the 1977 refueling outage.

During the 1983 safe-end outage, inservice inspections of the feedwater nozzles were not required by NUREG-0619 schedule commitment. However, the nozzles were examined by NES for information only. An increase in the amplitude of the signal from the geometric reflector in the southeast nozzle was noted. A more rigorous evaluation of this indication was performed during the 1984 refueling outage clearly identifying and documenting that this reflector is geometric and has exhibited no growth or change.

During the 1986 refueling outage (RFO-10), inservice UT examinations of the four feedwater nozzles were performed by NES. No significant changes from the previous examinations were identified.

During the 1988 refueling outage (RFO-11), inservice UT examinations of the four feedwater nozzles were performed by NES. These examinations identified approximately 25 indications in the vicinity of the nozzle to safe-end weld of the northeast nozzle "A" at 45 degrees. Although these indications might have been caused by scratch marks made during sparger installation, we conservatively evaluated them as cracks. NUREG 0619, Section 4.3.2.3 states, "if recordable indications are interpreted to be cracks in any nozzle, proceed with sparger removal, PT of the nozzle bore and nozzle blend radius, and repair." Eighteen of the twenty-five indications were observed at 20 to 25% of the distance amplitude correction

curve (DAC). However, the applicable ASME Code recording criteria is 50% DAC. Therefore, these indications were not "recordable" and did not require further evaluation.

The remaining indications appeared to be two separate flaws, one located in the nozzle and one located in the safe end weld. The indications appeared at approximately 50% DAC. The flaws were axially oriented and their size well within the ASME Section XI acceptance criteria (a/t-4.7% and 7% versus allowable of 11.02% and 11.23%).

The examination was performed using a 45 degree shear wave transducer calibrated on a nozzle mock-up with a 5% T-notch reflector. The Code permits calibration on notches up to 10% T (T is the nominal thickness of the calibration block). Consequently, the examination sensitivity exceeds the Code required sensitivity. If a 10% T notch had been used, these indications may not have been recordable per ASME Section XI.

Considering that the examination was performed at a higher sensitivity than required by Code, that the indications are at the threshold of the recording criteria, and that the indications will remain within allowable size for at least the next two operating cycles, Niagara Mohawk determined that further evaluation of these indications was not required.

A fracture mechanics evaluation of these two flaws was performed. The results of the analysis predicted growth of the flaws not to exceed 0.001 inches over a 40-year period. Therefore, the conclusion was made that the flaws were not significant and should not affect continued plant operation. Additionally, Niagara Mohawk committed to examine feedwater nozzle "A" during the next refueling outage (1993).

During the 1993 refueling outage (RFO-12), inservice UT examinations of feedwater nozzle "A" (N4A) Zones 1, 2, 3, and 4 were performed by General Electric Nuclear Energy (GE-NE). Note the indications identified in 1988 (RFO-12) were contained in Zone 4 of N4A. The same ultrasonic techniques were employed as used during the 1988 refueling outage (RFO-11) examinations, other than, the calibration standard was modified to include Code allowable 10% notches as well as the previously used 5% notches. The examinations indicated no reportable indications.

The Zone 4 indications detected in the 1988 outage were seen but not at recordable levels based on either the 5% or 10% notch calibrations. Electric Power Research Institute (EPRI) sizing techniques were then attempted to see if an adequate through-wall dimension could be attained on the previously recorded indications. Although a base signal could be seen, no tip signals were noted with either the Relative Arrival Time technique or the Absolute Arrival Time technique. Since no tip could be resolved, the source of these reflectors was determined to be from scratches or inside diameter (ID) surface irregularities and not from ID cracking. These inservice inspection results have been reviewed and approved by a Niagara Mohawk Level III examiner.

APPENDIX A
FEEDWATER NOZZLE INSPECTION RESULTS (Cont'd)

By letter dated June 23, 1994 (NMP1L 0820), NMPC informed the Commission, and provided technical basis for, utilization of the GE GERIS 2000 automated system (UT) for future examinations in lieu of performing a PT. This amended our prior NUREG 0619 commitment. In a letter dated January 12, 1995, the NRC determined that it was acceptable for NMPC to proceed with the described commitment changes and that NMPC would be advised of the final results of the NRC review.

During the 1995 refueling outage (RFO-13), inservice examinations were performed on four (4) feedwater and the control rod drive return line nozzles. The Ultrasonic Test (UT) examinations were performed by GE-NE and indicated no reportable indications were recorded. These UT examinations utilized the GERIS 2000 automated system and manual UT pickups. All of these examination results have been reviewed and approved by a Niagara Mohawk Level III examiner.

APPENDIX A

FEEDWATER NOZZLE INSPECTION RESULTS

N4A NOZZLE 45 DEGREES NORTHEAST

RESULTS	1977 (1)	1979	1981	1983*	1984*	1986 (RFO-10)
UT	NRI	NRI	GEOMETRIC REFLECTORS	GEOMETRIC REFLECTORS	GEOMETRIC REFLECTORS	GEOMETRIC REFLECTORS
PT	NRI	NRI				
VT	NRI		WELD REPAIRED CRACK IN BRACKET PIN			

RESULTS	1988 (RFO-11)	1993 (RFO-12)	1995 (RFO-13)
UT	GEOMETRIC & NON-GEOMETRIC REFLECTORS	NRI	NRI
PT			AMENDED METHOD PERFORMED UT
VT	NRI	NRI	

NOTES:

* NOT REQUIRED BY NUREG-0619. PERFORMED FOR INFORMATION ONLY. THE 1983 SAFE-END REPLACEMENT OUTAGE IS NOT CONSIDERED A REFUELING OUTAGE BY NIAGARA MOHAWK.

NRI = NO REPORTABLE INDICATION
UT = ULTRASONIC TESTING
PT = DYE PENETRANT TESTING
VT = VISUAL TESTING
(1) = NO REPORTABLE INDICATIONS EITHER BEFORE OR AFTER SPARGER REPLACEMENT

APPENDIX A

FEEDWATER NOZZLE INSPECTION RESULTS

N4B NOZZLE 135 DEGREES SOUTHEAST

RESULTS	1977 (1)	1979	1981 (2)	1983*	1984*	1986 (RFO-10)
UT	NRI	NRI	1-1/2" LONG X 3/4" DEEP GEOMETRIC	5-1/2" LONG X 0.8" DEEP AMPLITUDE INCREASE OF 30%	DISPOSITIONED AS GEOMETRIC	GEOMETRIC REFLECTORS
PT	NRI	NRI	8 INDICATIONS DISPOSITIONED AS MINOR SURFACE IRREGULARITIES			
VT	NRI		NRI			

RESULTS	1988 (RFO-11)	1993 (RFO-12)	1995 (RFO-13)
UT	GEOMETRIC REFLECTORS		NRI
PT			AMENDED METHOD PERFORMED UT
VT	NRI	NRI	

NOTES:

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NRI = NO REPORTABLE INDICATION
UT = ULTRASONIC TESTING
PT = DYE PENETRANT TESTING
VT = VISUAL TESTING
(1) = NO REPORTABLE INDICATIONS EITHER BEFORE OR AFTER SPARGER REPLACEMENT
(2) = SPARGER PULLED FOR EVALUATION OF INDICATIONS. NEW SPARGER INSTALLED.

APPENDIX A

FEEDWATER NOZZLE INSPECTION RESULTS

N4C NOZZLE 225 DEGREES SOUTHWEST

RESULTS	1977 (1)	1979	1981	1983*	1984*	1986 (RFO-10)
UT	NRI	NRI	GEOMETRIC REFLECTORS	GEOMETRIC REFLECTORS	ACCEPTABLE INCLUSION	GEOMETRIC REFLECTORS
PT	NRI	NRI				
VT	NRI		NRI			

RESULTS	1988 (RFO-11)	1993 (RFO-12)	1995 (RFO-13)
UT	GEOMETRIC REFLECTORS & ACCEPTABLE NON-GEOMETRIC REFLECTORS		NRI
PT			AMENDED METHOD PERFORMED UT
VT	NRI	NRI	

NOTES:

* NOT REQUIRED BY NUREG-0619. PERFORMED FOR INFORMATION ONLY. THE 1983 SAFE-END REPLACEMENT OUTAGE IS NOT CONSIDERED A REFUELING OUTAGE BY NIAGARA MOHAWK.

NRI = NO REPORTABLE INDICATION
UT = ULTRASONIC TESTING
PT = DYE PENETRANT TESTING
VT = VISUAL TESTING
(1) = NO REPORTABLE INDICATIONS AFTER COMPLETION OF REPAIR ACTIVITIES AND REPLACEMENT OF SPARGER.

APPENDIX A

FEEDWATER NOZZLE INSPECTION RESULTS

N4D NOZZLE 315 DEGREES NORTHWEST

RESULTS	1977 (1)	1979	1981	1983*	1984*	1986 (RFO-10)
UT	NRI	NRI	GEOMETRIC REFLECTORS	TWO INDICATIONS NOT GEOMETRIC 25% FSH	NRI	GEOMETRIC REFLECTORS
PT	NRI	NRI				
VT	NRI		NRI			

RESULTS	1988 (RFO-11)	1993 (RFO-12)	1995 (RFO-13)
UT	GEOMETRIC REFLECTORS		NRI
PT			AMENDED METHOD PERFORMED UT
VT	NRI	NRI	

NOTES:

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NRI = NO REPORTABLE INDICATION
UT = ULTRASONIC TESTING
PT = DYE PENETRANT TESTING
VT = VISUAL TESTING
(1) = NO REPORTABLE INDICATIONS AFTER COMPLETION OF REPAIR ACTIVITIES AND REPLACEMENT OF SPARGER.

APPENDIX A

CONTROL ROD DRIVE RETURN LINE NOZZLE INSPECTION RESULTS

N9 NOZZLE 44.1-WD-017/018-IR

RESULTS	1977 (1)	1979	1981	1983*	1984*	1986 (RFO-10)
UT		NRI				
PT	NRI					

RESULTS	1988 (RFO-11)	1993 (RFO-12)	1995 (RFO-13)
UT			NRI
PT			AMENDED METHOD PERFORMED UT

NOTES:

* NOT REQUIRED BY NUREG-0619. PERFORMED FOR INFORMATION ONLY. THE 1983 SAFE-END REPLACEMENT OUTAGE IS NOT CONSIDERED A REFUELING OUTAGE BY NIAGARA MOHAWK.

NRI = NO REPORTABLE INDICATION
UT = ULTRASONIC TESTING
PT = DYE PENETRANT TESTING
VT = VISUAL TESTING
(1) = NO REPORTABLE INDICATIONS EITHER BEFORE OR AFTER SPARGER REPLACEMENT

APPENDIX B
MODIFICATION OR SYSTEM CHANGES
AFFECTING FEEDWATER FLOW OR TEMPERATURE

1977 Feedwater nozzle cladding removed and spargers replaced with improved design.

1979 Reactor Water Cleanup return line rerouted to the feedwater line in accordance with Section 4.2 of NUREG-0619.

1981 Replaced southeast sparger after evaluation of UT indications.

1983 The feedwater low flow control valves were replaced with new valves designed to improve control at low flow conditions. In addition, a six-inch recirculation line was installed to provide improved flow control of the feedwater system. These modifications were previously described in our letter dated 9/8/81.

1984 In response to NUREG 0737, Action Item II.D. 1, instrument and control equipment were installed to provide a high reactor level trip of the motor-driven feedwater pumps. In addition, the HPCI control system was modified to add annunciator alarms for loss of HPCI failure signal in standby mode.

1986 The following changes were made to improve the reliability of the feedwater system:

1. Modified high level trip circuit seal in logic.
2. Modified main flow valve lockup circuits to withstand momentary power interruptions.
3. Modified logic to close 6-inch recirculation valve on pump start signal for runout protection.
4. Modified logic to close low flow control valves on HPCI initiation.

1988 No additional modifications or system changes that affect feedwater flow or temperature.

1993 Turbine driven feedwater pump flow control valves were replaced by a single flow control valve; this change had no affect on feedwater flow or temperature.

1995 No additional modifications or system changes that affect feedwater flow or temperature.

APPENDIX C
DESCRIPTION OF
ULTRASONIC EXAMINATION PROCEDURES

A. NES PROCEDURE

The NES feedwater nozzle UT examination procedure was first used at Nine Mile Point Unit 1 in 1981. This procedure divided the nozzle inner radius and bore surfaces into two zones. NES Zone 1 examinations are performed from the reactor vessel shell; NES Zone 2 examinations are performed from the nozzle barrel. NES Zone 1 and Zone 2 examinations overlap at the inside radius surface of the nozzle.

Examinations performed from the reactor vessel shell are performed by attaching a specially designed lucite wedge, which conforms to the reactor vessel outside radius, to an ultrasonic transducer such that the longitudinal beam angle is fixed.

Examinations performed from the nozzle barrel are performed using compound angle beam shear wave techniques. In this case, a number of specially designed fixed compound angle lucite wedges which conform to the outside radius of the nozzle barrel are used.

In 1988, additional scans and scanning angles were used on the safe-end bore, nozzle bore, and the inner radius to ensure optimal interrogation of the required volumes. Recording criteria was updated for more uniformity when comparing data from each outage. A new template was designed and built to facilitate shell-side exams.

B. GE PROCEDURE

The GE feedwater nozzle UT examination procedure was used for the 1977 baseline and the 1979 inservice inspections at Nine Mile Point Unit 1. This procedure divides the nozzle inner radius and bore surfaces into three zones.

The GE Zone 1 examination is performed by attaching an ultrasonic transducer to a specially designed lucite wedge, which conforms to the reactor vessel outside radius, such that the longitudinal beam angle and the circumferential beam angle are fixed.

The GE Zone 2 examination is performed by attaching an ultrasonic transducer to a specially designed lucite wedge, which conforms to the outer diameter blend radius of the nozzle, such that the longitudinal beam angle and the circumferential beam angle are fixed.

The GE Zone 3 examination is performed by attaching an ultrasonic transducer to a specially designed lucite wedge, which conforms to the outside radius of the nozzle barrel, such that the circumferential beam angle is fixed.

APPENDIX C
DESCRIPTION OF
ULTRASONIC EXAMINATION PROCEDURES

C. NMPC PROCEDURE

Niagara Mohawk NDE Procedure (No. NDEP-UT-6.07) was used to UT examine feedwater nozzle "A" (N4A) Zones 1, 2, 3, and 4 during the 1993 refueling outage (RFO-12). This procedure utilized manual techniques and equipment which are similar and equivalent to those used by NES during the 1988 refueling outage (RFO-11). The ultrasonic techniques employed are the same as those used for the RFO-11 examinations, other than, the calibration standard was modified to include Code allowable 10% notches as well as the previously used 5% notches for the safe-end bore examination. These examinations were performed by General Electric Nuclear Energy (GE-NE) personnel.

D. DESCRIPTION OF GE-NE GERIS-2000 AUTOMATED UT INSPECTION SYSTEM (RFO-13)

The GERIS-2000 UT Imaging System is an automated ultrasonic data acquisition and imaging system. Automated scanners interfaced to the GERIS-2000, moved UT transducers radially and circumferentially around the outside surface of the nozzle and adjacent surfaces of the safe-end and reactor pressure vessel. UT data was collected and stored in digital format. The complete RF waveform was digitized and recorded on optical disks for analysis.

The GERIS-2000 UT subsystem is a multiplexed logarithmic UT flaw detection instrument. For each channel, the complete RF A-scan was digitized and stored on optical disks. The system stores the RF signal in logarithmic format that has an instantaneous dynamic range that is greater than 85 dB. The logarithmic UT system allows the recording of the peaks of low and high amplitude UT signals at the same time without clipping UT signals, such as would occur with linear systems that have an instantaneous dynamic range generally less than 45 dB.

The analysis of the GERIS-2000 data utilized advanced interactive color graphics to evaluate and assist in characterizing indications from service, fabrication and geometric related UT reflectors. Coordinated A-, B-, C-, volumetric side-view-, volumetric end-view-, and 3D- scans are provided on a high resolution (1280 by 1024 pixels) color display. Several channels may be displayed at one time to correlate indications from different channels. These graphic displays have an adjustable color scale that provides the best resolution of flaw detection and characterization down to the material noise.

NMPC submittal of June 23, 1994 [Reference #13] included Enclosure 1, Section II, "Ultrasonic Inspection Techniques", which provided a description of the GERIS UT techniques, UT instrumentation and scanning equipment in detail.

D. DESCRIPTION OF GE-NE GERIS-2000 AUTOMATED UT INSPECTION SYSTEM (Cont'd)

Amplitude-based recording and reporting criteria is not used with the GERIS-2000 for nozzle inner radius and bore examinations. All UT data is recorded and evaluated. Any UT data that has signal-to-noise ratios of greater than 2-to-1, has echo-dynamic characteristics of cracking and can be confirmed from 2 directions or accompanied by tip-diffracted signals are called cracks.

The GERIS-2000 system is capable of detecting and sizing axial flaws 0.250 inches or less in depth in feedwater nozzle inner radius and bore regions. The capability of the GERIS-2000 system for defect detection and sizing was demonstrated and included in NMPC submittal June 23, 1994 [Reference #13] in Enclosure 1, Section III, "Ultrasonic Technique Qualification Plan", which provided a detailed description of the EDM notches and fatigue-crack implants that are used to demonstrate the capability of the GERIS-2000 system.

When obstructions limited automated scanning coverage, supplemental manual examinations were performed. In both cases, full ID coverage was obtained from at least one direction. When automated scanning cannot be performed from both directions, manual techniques utilizing the same techniques as the automated examinations were used. The entire ID surface of zones 1 through 5 (see Figure 1 below) were examined for axial flaws from at least 1 direction with either automated or manual techniques. Areas examined were fully documented in the inspection results.

The method used to ensure that the NMP1 feedwater nozzles are examined with equivalent techniques is through the use of modeling. The modeling used was where the UT beam paths are predicted using ray tracing algorithms with predetermined beam angle parameters. The beam paths are used to determine the incident angles of the beam on the ID surfaces. The incident angles of the UT beam on the ID surfaces used on the NMP1 feedwater nozzle were comparable to the GE qualification mockups. Multiple angle-beam transducers designed from "as built" and fabrication were used to fully examine zones 1 through 5.

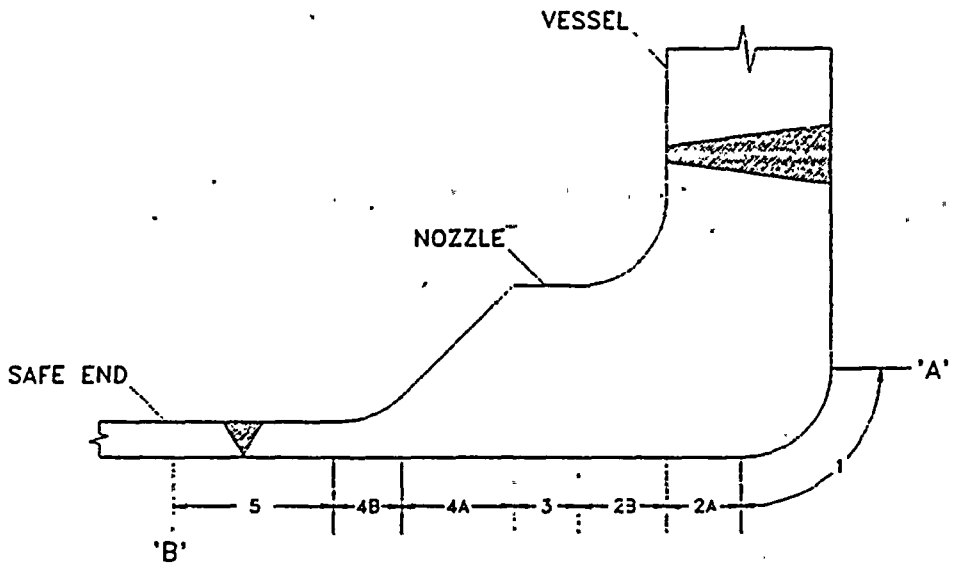

Figure 1- Nozzle Examination Zones