Docket File

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555

July 30, 1992

Docket No. 50-219

LICENSEE: GPU Nuclear Corporation

FACILITY: Oyster Creek Nuclear Generating Station

SUBJECT: SUMMARY OF MEETING REGARDING INSPECTION OF THE FEEDWATER NOZZLES AND CONTROL ROD DRIVE RETURN LINE NOZZLES

On Thursday, July 23, 1992, a meeting was held at One White Flint North, Rockville, Maryland with GPU Nuclear Corporation (GPUN/the licensee) to discuss the inspection of the feedwater nozzles and control rod drive return line nozzle. Enclosure 1 is the list of individuals participating in the discussion. Enclosure 2 is the licensee's agenda. The following is a summary of the significant items discussed.

With respect to the inspection of the feedwater nozzles and the control rod drive return line nozzle the licensee proposed the following inspection plan:

1. Utilize the phased-array ultrasonic test (UT) technique as a primary method to detect, characterize and monitor flaws in the feedwater and control rod drive return line nozzles.

2. Eliminate routine liquid penetrant (PT) examinations of feedwater and control rod drive return line nozzles.

   Defer feedwater nozzle UT from 14R (November 1992) to 15R (October 1994) so feedwater and control rod drive return line nozzles are inspected in the same outage with a fully Appendix VIII Section XI, ASME qualified procedure.

4. Following successful Appendix VIII UT qualification, demonstration of adequate sensitivity for Oyster Creek specific assumed flaw sizes and successful 15R examination with no cracks, perform UT inspections once each Inservice Inspection (ISI) interval (every 10 years) in accordance with the ASME Code.

As a result of detailed discussions, the staff advised GPUN that a decision regarding this matter could not be made during this meeting since the issues involved have generic implications. The staff also advised GPUN that we require the following information:

1. The inspections GPUN has performed on the feedwater nozzles and control rod return line nozzle including safe ends and to what extent they were inspected. The inspections performed should be compared to NUREG-0619. In addition, the number of startup and shutdown cycles Oyster Creek has experienced during its operation since Cycle 7 should also be included.

2. Provide the results of the phase-array UT performed on the Oyster Creek mock-up including thermal fatigue cracks.

The licensee indicated that they would provide the requested information as soon as it is available and requested that we make a decision regarding the deferment of the 14R feedwater nozzle inspections as soon as the staff's review is complete.

/s/

Alexander W. Dromerick, Senior Project Manager
Project Directorate I-4
Division of Reactor Projects - I/II
Office of Nuclear Reactor Regulation

Enclosures:
As stated

cc w/enclosures:
See next page

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Oyster Creek Nuclear
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ENCLOSURE 1

OYSTER CREEK NUCLEAR GENERATING STATION

DOCKET NO. 50-219

MEETING - JULY 23, 1992

ATTENDANCE LIST

NAME	ORGANIZATION
A. W. Dromerick	NRR/PD I-4
B. D. Liaw	NRR/DET
M. R. Hum	NRR/DET
D. G. Siear	GPUN/Engr. and Design
D. W. Covill	GPUN/NDE/ISI
S. D. Leshnoff	GPUN/Engr. and Design
E. Pagan	GPUN/Licensing
M. Laggart	GPUN/Licensing
W. Bateman	NRR/DET/EMCB
George Johnson	NRR/DET/EMCB
Frank Ammirato	EPRI NDE Center
John Tsao	NRR/DET/EMCB
Thomas K. McLellan	NRR/DET/EMCB
John Stolz	NRR/PD I-4/DRPE
Gary Stevens	GE Nuclear Energy
Michael H. Dalichow	Siemens Nuclear Power Srvc

GPUN/NRC MEETING

INSPECTION OF THE FEEDWATER NOZZLES

AND

CONTROL ROD DRIVE RETURN LINE NOZZLE

JULY 23, 1992

AGENDA

I.	INTRODUCTION • PROPOSAL • JUSTIFICATION	D. SLEAR
II.	OC DESIGN AND ANALYSIS • THERMAL SLEEVE PHYSICAL DESIGN • THERMAL SLEEVE PERFORMANCE • BASIS FOR INSPECTION INTERVAL • THERMAL TRANSIENT MONITORING SYSTEM	S. LESHNOFF
III.	ULTRASONIC EXAMINATION • NUREG 0619 • UT EXAMINATION - THEN AND NOW • MOCK-UP PROFILES • THERMAL FATIGUE CRACK DETECTION • INSPECTIONS PERFORMED • PLANS FOR 15R	D. COVILL
IV.	CONCLUSION	D. SLEAR

WHAT DID GPUN PROPOSE?

- UTILIZE THE PHASED-ARRAY UT TECHNIQUE AS PRIMARY METHOD TO DETECT, CHARACTERIZE AND MONITOR FLAWS IN FW & CRDRL NOZZLES.

- ELIMINATE ROUTINE PT EXAMINATIONS OF FW & CRDRL NOZZLES.

- DEFER FW NOZZLE UT FROM 14R (NOV. '92) TO 15R (OCT. '94) SO FW & CRDRL NOZZLES ARE INSPECTED IN SAME OUTAGE WITH A FULLY APPENDIX VIII QUALIFIED PROCEDURE

- FOLLOWING SUCCESSFUL APPENDIX VIII UT QUALIFICATION, DEMONSTRATION OF ADEQUATE SENSITIVITY FOR OC SPECIFIC ASSUMED FLAW SIZES AND SUCCESSFUL 15R EXAMINATION WITH NO CRACKS. PERFORM UT INSPECTIONS ONCE EACH ISI INTERVAL (EVERY 10 YEARS) IN ACCORDANCE WITH ASME B & PV CODE SECTION XI.

WHY IS THIS PROPOSAL JUSTIFIED?

- OC FW NOZZLE IS "LEAKAGE INSENSITIVE" DUE TO UNIQUE THERMAL SLEEVE/BAFFLE DESIGN.
- OC CRDRL NOZZLE THERMAL SLEEVE PERFORMS SIMILARLY TO FW NOZZLE AND HAS NEVER SUSTAINED CRACKING.
- PHASED-ARRAY UT TECHNIQUE HAS BEEN DEMONSTRATED TO BE CAPABLE OF DETECTING AND SIZING FLAWS WITH ADEQUATE SENSITIVITY, REPEATABILITY AND ACCURACY.
- DETECTION OF THERMAL FATIGUE CRACKS WILL BE INCLUDED IN PROGRAM.
- NRC ENCOURAGED DEVELOPMENT OF UT TECHNIQUES AND INDICATED THAT SUCH IMPROVEMENTS COULD FORM BASIS FOR MODIFYING NUREG-0619 INSPECTION CRITERIA.

WHY IS THIS PROPOSAL JUSTIFIED?

(CONTINUED)

- GPUN HAS APPLIED CONSERVATIVE ASME B & PV CODE SECTION XI FRACTURE MECHANICS FLAW GROWTH ANALYSIS TO DEMONSTRATE THAT A 10 YEAR INSPECTION INTERVAL ASSURES STRUCTURAL INTEGRITY OF FW & CRDRL NOZZLES.

- THERE IS PRECEDENCE FOR NRC GRANTING PERMANENT PT DEFERRAL CONTINGENT UPON UT RESULTS.

WHY AVOID PT?

- AVOID 400 PERSON REM EXPOSURE TO RADIATION WORKERS.
- AVOID RISK OF PEOPLE WORKING IN THE REACTOR VESSEL DOING AN EVOLUTION FOR WHICH THERE IS LITTLE INDUSTRY EXPERIENCE.
- AS MANY AS 300 RADIATION WORKERS WOULD BE REQUIRED TO SUPPORT INTERNAL REACTOR VESSEL NOZZLE PT INSPECTION.
- AVOID DAMAGING EXISTING THERMAL SLEEVE, NOZZLE AND SPARGER IN ORDER TO GAIN ACCESS TO PERFORM PT.

WHY AVOID PT?

(CONTINUED)

- AVOID GENERATING APPROXIMATELY 250 CU. FT. AND 200,000 CURIES OF IRRADIATED COMPONENTS.

- PT WON'T SIZE THE FLAW. THEREFORE, WILL NOT PROVIDE USEFUL INFORMATION FOR ASME FRACTURE MECHANICS EVALUATION.

- PT DOES NOT CHARACTERIZE SURFACE FLAWS. PT WILL FIND NON-RELEVANT INDICATIONS (e.g., SCRATCHES, NICKS, ETC.) WHICH ARE NON-RELEVANT AND WOULD REQUIRE ADDITIONAL WORK IN A HIGH-DOSE AREA.

- EXTENDS THE REFUELING OUTAGE BY APPROXIMATELY 45 DAYS AND COSTS APPROXIMATELY $7 MILLION TO ACCOMPLISH.

OYSTER CREEK DESIGN AND ANALYSIS

THERMAL SLEEVE PHYSICAL DESIGN

- Flow baffles are the key design feature the intent of which is to eliminate the high cycle fatigue damage mechanism. Spring loaded baffles are secured by crimp-locked studs. The entire sparger and thermal sleeve assembly are spring loaded against locking pins.

- The force necessary for removal of the assembly will probably damage it and the machined inside nozzle surface. Re-use of the assembly is doubtful and re-machining will probably be necessary.

- The CRDR thermal sleeve design also contains a baffle. No leakage is expected. To disassemble for inspection the thermal sleeve must be cooled in order to release the interference fit that keeps it in place.

THERMAL SLEEVE PERFORMANCE

- The quantitative basis showing the adequacy of the Oyster Creek thermal sleeve is the result of testing by GE. Over a range from normal through degraded piston ring conditions testing with the gap sealed showed that the metal thermal cycling is below 30% of the maximum available, which is the level, determined by analysis, that will initiate thermal fatigue cracks. The Oyster Creek thermal sleeve is such that leakage past the piston ring will not initiate thermal fatigue cracks at the nozzle surface during the intended service life of the plant.

- In NUREG 0619 Oyster Creek, along with identical Nine Mile Point, Unit #1, were specifically exempted from the leak detection instrumentation requirement that is necessary to avoid PT.

- The overall performance of the Oyster Creek single sleeve/single piston ring thermal sleeve is equivalent to the GE triple sleeve/double piston ring thermal sleeve.

BASIS FOR INSPECTION INTERVAL

- Section XI provides the basis for continued operation, without repair, with known flaws, as per IWB-3500 and IWB-3600.

  For the FW nozzle, a 0.172" detection sensitivity was determined using methods of linear regression analysis of phased array UT process performance data obtained from full scale mock-up testing.

  The generic thermo-mechanical stress analysis results of low frequency transients as well as linear elastic fracture mechanics (LEFM) presented in GE NEDE-21821-02 were used to develop the basis for the UT inspection interval.

- Oyster Creek specific results were developed also considering only differences in the number of thermal cycles occurring at Oyster Creek and nothing else.

- Considering the generic results alone and using the 0.172" detection sensitivity, ten years is an appropriate inspection interval. Considering the Oyster Creek specific results, a ten year inspection interval is very conservative.

- For the CRDR nozzle, a 0.132" detection sensitivity was determined as above using a CRDR mock-up.

- Oyster Creek specific thermo-mechanical stress analysis results coupled with established LEFM methods where used to establish the UT inspection interval for the CRDR nozzle. These results show that ten years is a very conservative inspection interval.

THERMAL TRANSIENT MONITORING SYSTEM

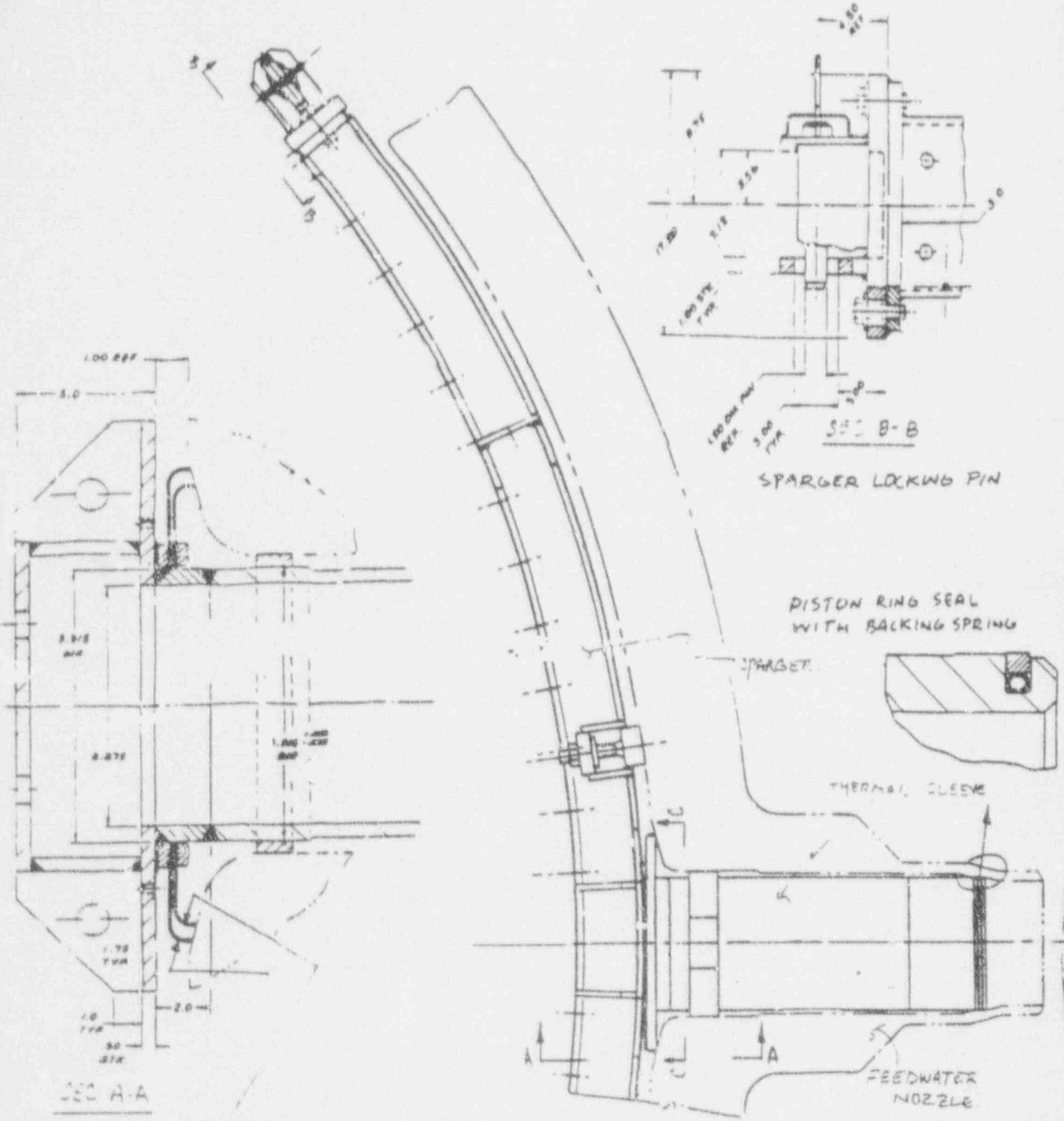
- The Thermal Transient Monitoring System (TTMS) installed at Oyster Creek during 12R was intended to address engineering concerns about actual operating conditions. The TTMS was not used for leakage detection primarily, but rather:

  - verified reliable, undegraded performance of the thermal sleeves; and

  - showed that actual fatigue usage calculated on line from data for actual transients does not exceed 0.001 per cycle.

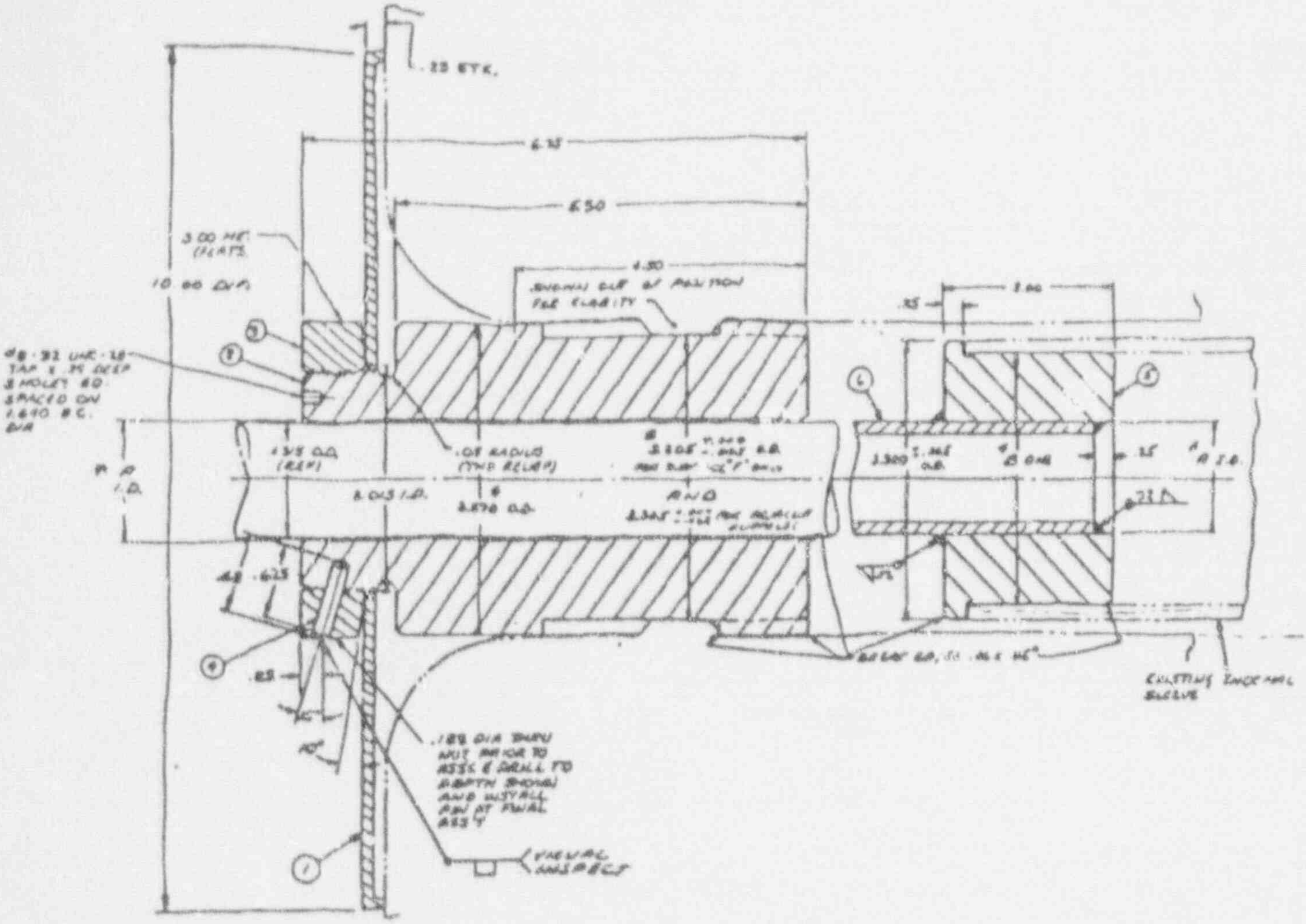
- TTMS is a modified version of EPRI's "Fatigue Pro". Presently, it is not operable.

- TTMS is also a means to disposition a UT indication in order to continue operation with known flaws. The indicated depth can be tracked by the TTMS which has the capability to generate the same kind of combined stress and fracture mechanics analyses on-line as used to establish the inspection interval.



FLOW BAFFLES

FEEDWATER NOZZLE THERMAL SLEEVE
AND FEEDWATER SPARGER ASSEMBLY



CRDR NOZZLE THERMAL SLEEVE

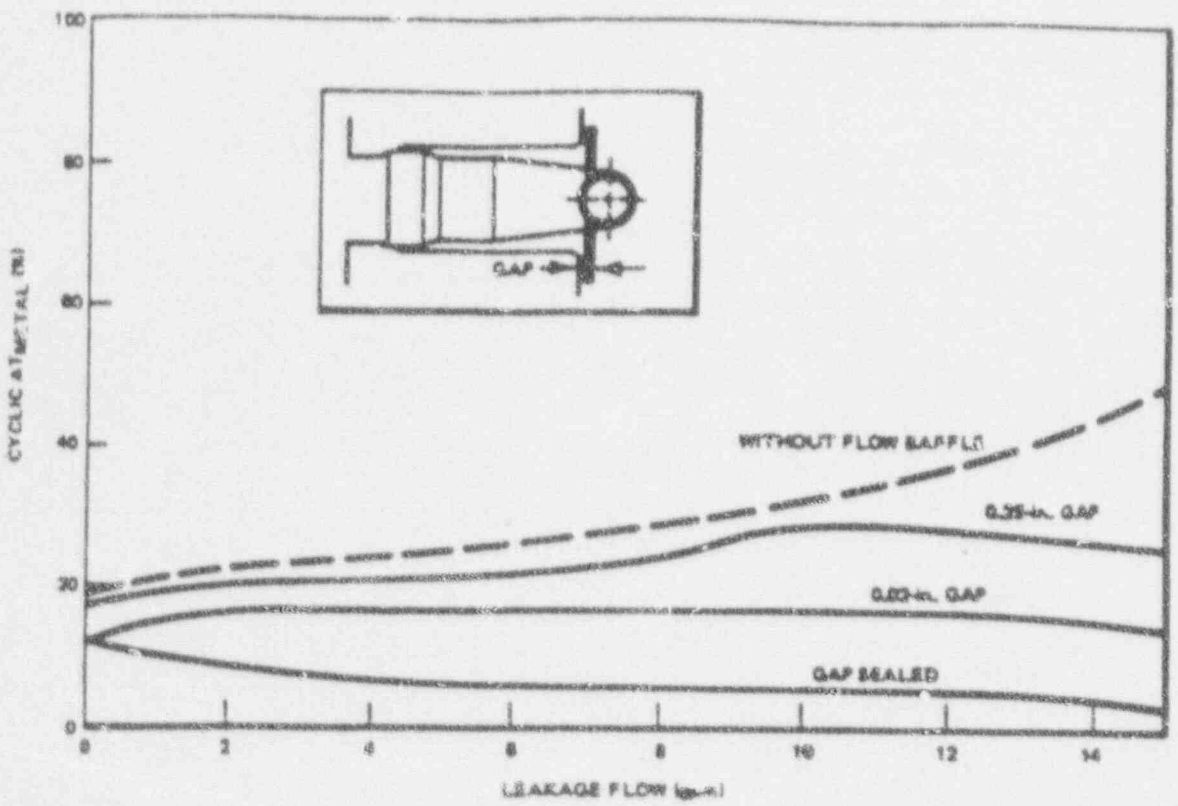
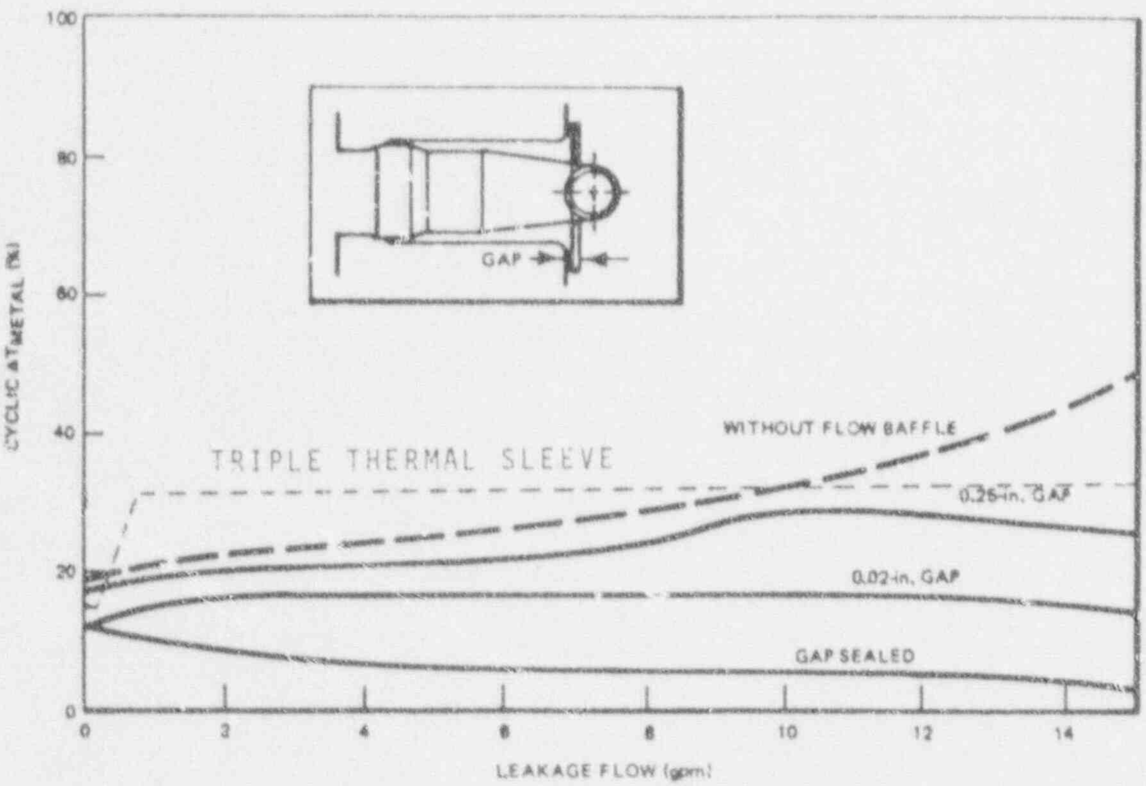


Figure 4 Metal Temperature Cycling at Nozzle Blend Radius with Flow Baffle



COMBINED FIGURES 4-33 AND 4-95

OCNGS FW NOZZLE BLEND RADIUS CRACK PROPAGATION

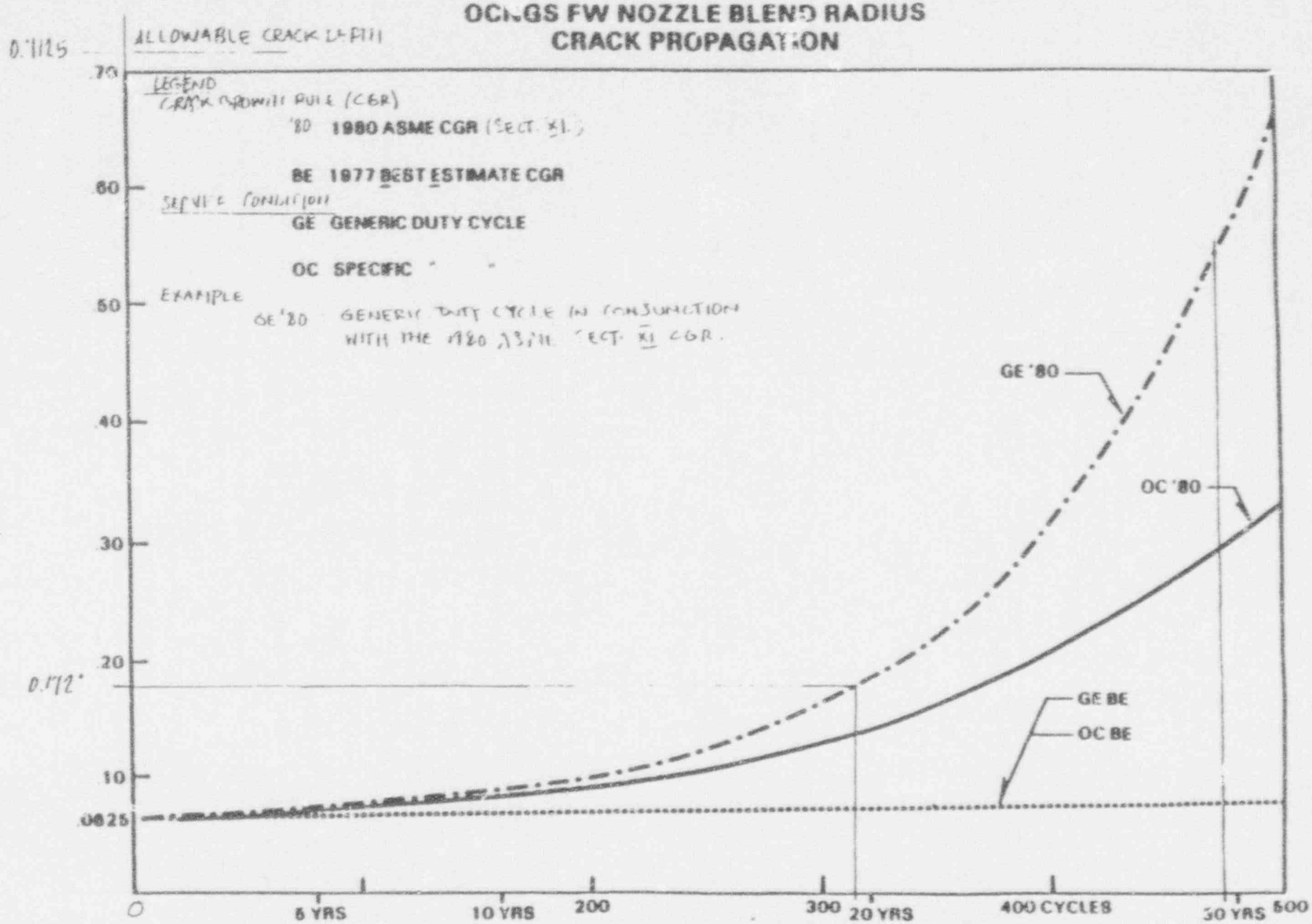


FIG 1

CRDR NOZZLE

CRACK DEPTH VS. NUMBER OF YEARS

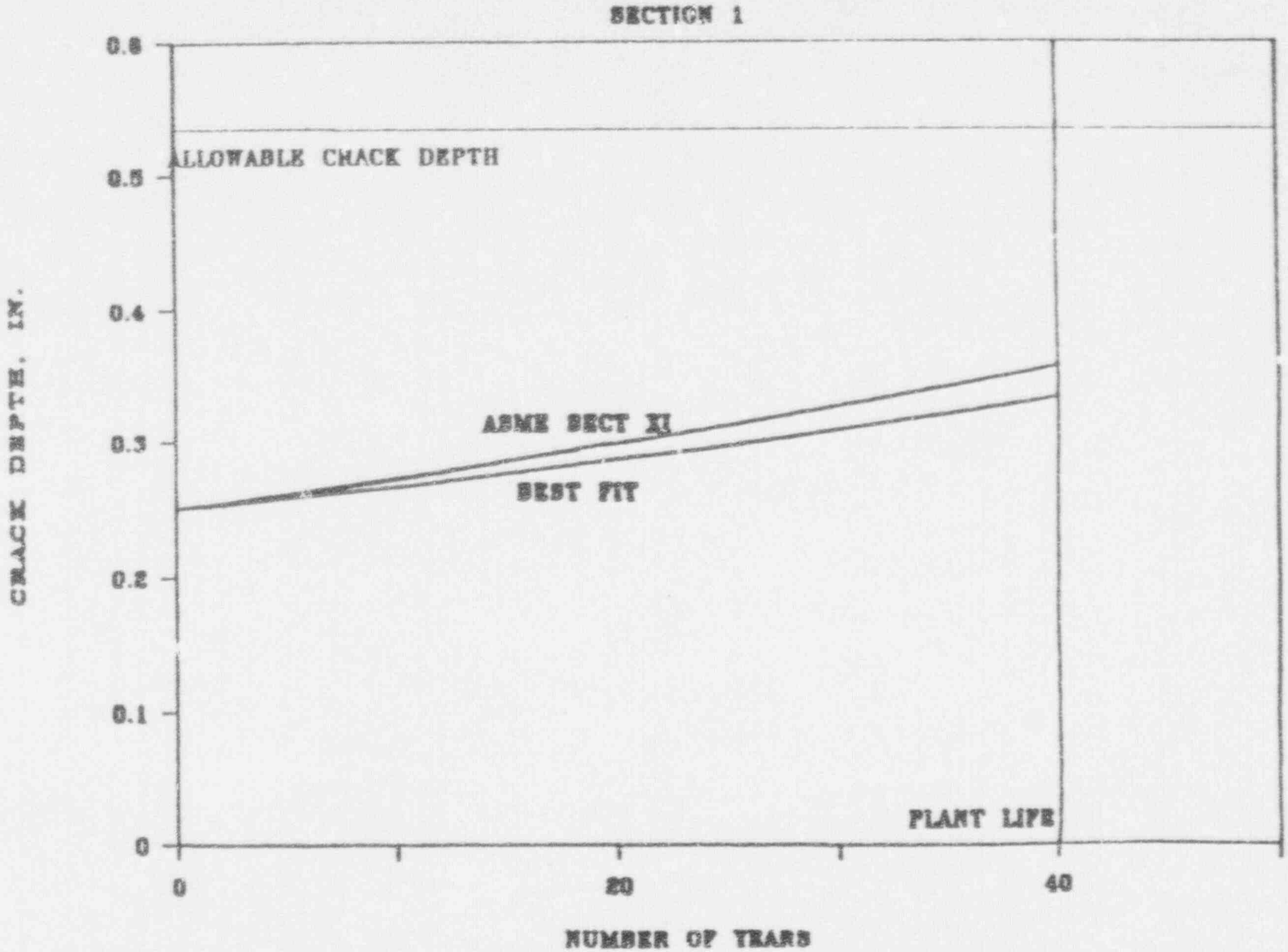


FIGURE 2 Crack Depth Versus Number of Years

GPU NUCLEAR CORPORATION
OYSTER CREEK NUCLEAR GENERATING STATION

FEEDWATER AND CONTROL ROD DRIVE RETURN LINE NOZZLES

ULTRASONIC EXAMINATION

JULY 23, 1992

PRESENTED BY:
DANA W. COVILL
MANAGER, NDE/ISI SERVICES

NUREG-0619

PARAGRAPH 4.3.1

"THE STAFF ENCOURAGES THE CONTINUED DEVELOPMENT OF UT TECHNIQUES FOR THE FEEDWATER NOZZLE EXAMINATIONS. SHOULD FUTURE DEVELOPMENTS AND THE RESULTS OF INSERVICE UT EXAMINATIONS DEMONSTRATE THAT UT TECHNIQUES CAN DETECT SMALL NOZZLE THERMAL FATIGUE CRACKS WITH ACCEPTABLE RELIABILITY AND CONSISTENCY, THESE TECHNIQUES COULD THEN FORM THE BASIS FOR MODIFICATION OF THE INSPECTION CRITERIA THAT FOLLOW."

NUREG-0619
(Continued)

- GPUN HAS SHOWN STATISTICAL RELIABILITY AND CONSISTENCY WITH OUR MOCKUPS

- WITH THE DETECTION OF THERMAL FATIGUE CRACKS, WE WILL ESSENTIALLY HAVE GONE BEYOND SECTION XI, APPENDIX VIII

  - APPENDIX VIII MERELY "QUALIFIES" A PROCESS; WE HAVE "QUANTIFIED"

- CONCLUSION: GPUN AND SIEMENS HAVE INVESTED A SUBSTANTIAL AMOUNT OF RESOURCES AND EFFORT TO "QUALIFY" PHASED ARRAY FOR NOZZLE EXAMINATIONS

  (TO OUR KNOWLEDGE, NO ONE HAS FOUND NEW FATIGUE CRACKING IN BWR FW OR CRDR NOZZLES AFTER REPAIRS)

ULTRASONIC EXAMINATION
THEN AND NOW

1. PREVIOUS UT WAS HANDS ON (I.E., HANDS ON TRANSDUCER AND PART, EYES ON SCOPE)

2. PREVIOUS UT WAS CALIBRATED ON ASME BLOCKS, THEN HAND-SCANNED IN FIELD (USUALLY 45°, SOME OTHER ANGLES)

NOW WITH 3D MODELLING AND AUTOMATED SCANNING, WE CAN DETERMINE OPTIMUM ANGLES, FOR AS COMPLETE COVERAGE AS CAN BE OBTAINED, BEFORE WE SET UP ON PART IN FIELD

DATA IS COLLECTED AND STORED ON MAGNETIC OR OPTICAL DISK

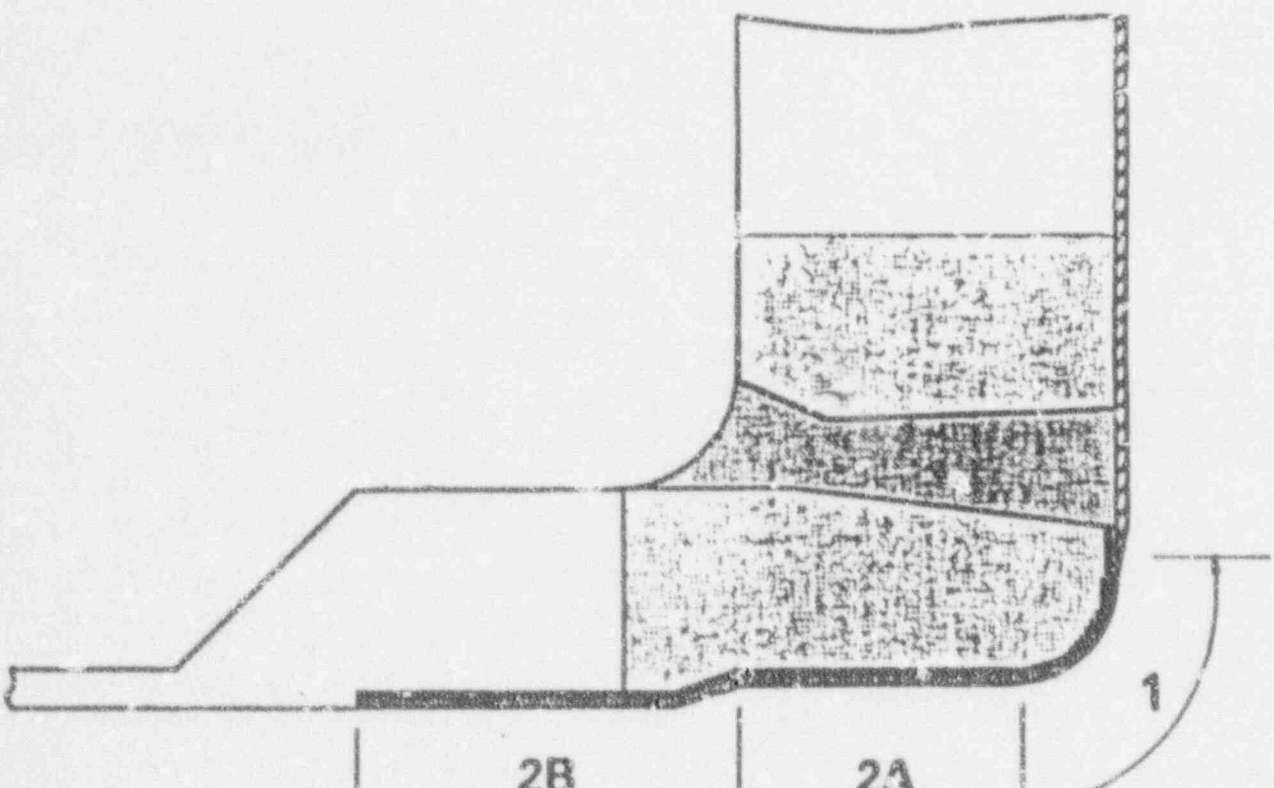
ALL INFORMATION IS SAVED FOR FUTURE EVALUATION

- A SCAN - RECTIFIED WAVEFORM
- B SCAN - SIDE VIEW/END VIEW
- C SCAN - TOP VIEW

AUTOMATED NOZZLE INSPECTION

- ASME SECTION XI REQUIREMENTS FOR THE ENTIRE VOLUME: 

- NUREG-0619 REQUIREMENTS FOR ZONES 1 + 2A + 2B FOR FEEDWATER AND CRDRL NOZZLES:



BWR FEEDWATER NOZZLE EXAMINATION REGIONS

CODE REQUIREMENTS (INSPECTION AREAS)

MOCK-UP PROFILES

- NOZZLE MOCK-UPS WERE FABRICATED FOR QUALIFICATION OF TECHNIQUES

- WE SELECTED PHASED-ARRAY (UTL/KWU) OVER TWO OTHERS BASED ON RESULTS

- FEEDWATER MOCK-UP - FULL SIZE NOZZLE, CENTERED IN 7' X 7', 7 1/8" THICK CURVED PLATE

  NOTCH LOCATIONS

  - ZONE 1 - 13 NOTCHES (DEPTHS 0.030"-0.488") TWO NOTCHES WERE INSTALLED IN GROUNDED OUT AREAS

  - ZONE 2A - 9 NOTCHES (DEPTHS 0.070"-0.340") TWO NOTCHES WERE INSTALLED IN GROUNDED OUT AREAS

  - ZONE 2B - 11 NOTCHES (DEPTHS 0.091"-0.380")

MOCK-UP PROFILES
(Continued)

- CRDR MOCK-UP - FULL SIZE NOZZLE, CENTERED IN 5' X 5', 7 1/8" THICK CURVED PLATE

  NOTCH LOCATIONS

  - ZONE 1, 6 NOTCHES (DEPTHS 0.100"-0.500")
  - ZONE 2A, 5 NOTCHES (DEPTHS 0.100"-0.525")
  - ZONE 2B, 5 NOTCHES (DEPTHS 0.100"-0.500")
  - PLATE, 6 NOTCHES (DEPTHS 0.125"-0.7125")

- SUBSTANTIAL AMOUNT OF WORK AFTERWARDS BY KWU IMPROVED PROCESS

- RESULTS DOCUMENTED ON DOCKET AND IN PUBLISHED PAPERS

- IMPLANTED THERMAL FATIGUE CRACKS - 1992

MOCK-UP PROFILES
(Continued)

- MOCK-UP FOR COOPER DEMONSTRATION
  - 14 NOTCHES, .130" - .375" DEEP
  - 2 MECHANICAL FATIGUE CRACK IMPLANTS, .159" AND .250" DEEP
  - NOT BLIND TEST
- GPUN AND SIEMENS HAVE AND WILL HAVE DEMONSTRATED THE CAPABILITY OF PHASED-ARRAY TO THE EXTENT AT LEAST EQUIVALENT TO OTHERS TO WHOM NRC HAS GRANTED RELIEF FROM PT

THERMAL FATIGUE CRACK DETECTION

- DEVELOPED SPECIFICATION FOR INSTALLATION OF THERMAL FATIGUE CRACKS IN BOTH MOCK-UPS
- MEET THE INTENT OF ASME SECTION XI, APPENDIX VIII
- CRACK DIMENSIONS SUPPORT FRACTURE MECHANIC CALCULATIONS
- APPENDIX VIII SPECIFICALLY PERMITS THE USE OF NOTCHES IN THE QUALIFICATION FOR DETECTING AND SIZING FLAWS ON NOZZLE INNER RADII
- WILL PERFORM FIRST TEST "BLIND" (BEYOND WHAT NRC RECOMMENDED)
- IF NO DETECTION, GPUN WILL SPECIFY LOCATION
- IF NO DETECTION, THEN WE WILL IMPLANT DEEPER CRACKS, BUT STILL LESS THAN 10% WALL
- SCHEDULED FOR AUGUST 1992

INSPECTIONS PERFORMED

- REFUELING OUTAGE 12R
  ULTRASONIC EXAMINATION OF FOUR FW NOZZLES

  VENDOR: UTL/KWU (PHASED-ARRAY TECHNIQUE)
  RESULTS: NO REPORTABLE INDICATIONS

- REFUELING OUTAGE 13R
  ULTRASONIC EXAMINATION OF CRDR NOZZLE

  VENDOR: UTL/KWU (PHASED-ARRAY TECHNIQUE)
  RESULTS: NO REPORTABLE INDICATIONS

PLANS FOR 15R

- FULLY QUALIFIED PER APPENDIX VIII (PDI)

- COMBINED WITH OUR EARLIER WORK ON OUR MOCK-UPS, WE WILL FAR EXCEED REQUIREMENTS