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DATE OF MEETING

06/17/2003

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Docket Number(s) 50-368

Plant/Facility Name Arkansas Nuclear One, Unit 2 (ANO-2)

TAC Number(s) (if available) MB8927

Reference Meeting Notice 06/04/03 (ML031560682)

Purpose of Meeting
(copy from meeting notice) To discuss the licensee's May 8, 2003, request for

relaxation from NRC's vessel head inspection Order.

NAME OF PERSON WHO ISSUED MEETING NOTICE

Tom Alexion

TITLE

Project Manager

OFFICE

Nuclear Reactor Regulation

DIVISION

Division of Licensing Project Management

BRANCH

Project Directorate IV

Distribution of this form and attachments:

Docket File/Central File

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DF01

ANO-2 Bare Metal Visual Relaxation Request

Entergy Operations, Inc.

Date – June 17, 2003

Introduction

Bill James

Purpose of Meeting

- ▶ BMV Hardship
- ▶ RVH Inspection Plans
- ▶ Diverse and Complementary Inspections
- ▶ Relaxation Requests
- ▶ Answer Questions

Agenda

Introduction

Bill James

Hardship Review

Doug Edgell

Inspection Plans

William Sims

Other Relaxation Requests

William Sims

Closing Remarks

Craig Anderson

Feb 11, 2003 Order Requirements for BMV

- ▶ IV.C (1) plants in the High category, RPV head inspections shall perform:
 - 1)** (a) Bare metal visual examination of 100% of the RPV head surface (including 360° around each RPV head penetration nozzle), AND
 - (b) Either:
 - (i) Ultrasonic testing of each RPV head penetration nozzle and an assessment to determine if leakage has occurred into the interference fit zone,
 - OR
 - (ii) Eddy current testing or dye penetrant testing of the wetted surface of each J-Groove weld and RPV head penetration nozzle base material.

Feb 11, 2003 Order

- ▶ A request for relaxation shall address:
 - (1) The proposed alternative(s) for inspection of specific nozzles will provide an acceptable level of quality and safety, or
 - (2) Compliance with this Order for specific nozzles would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

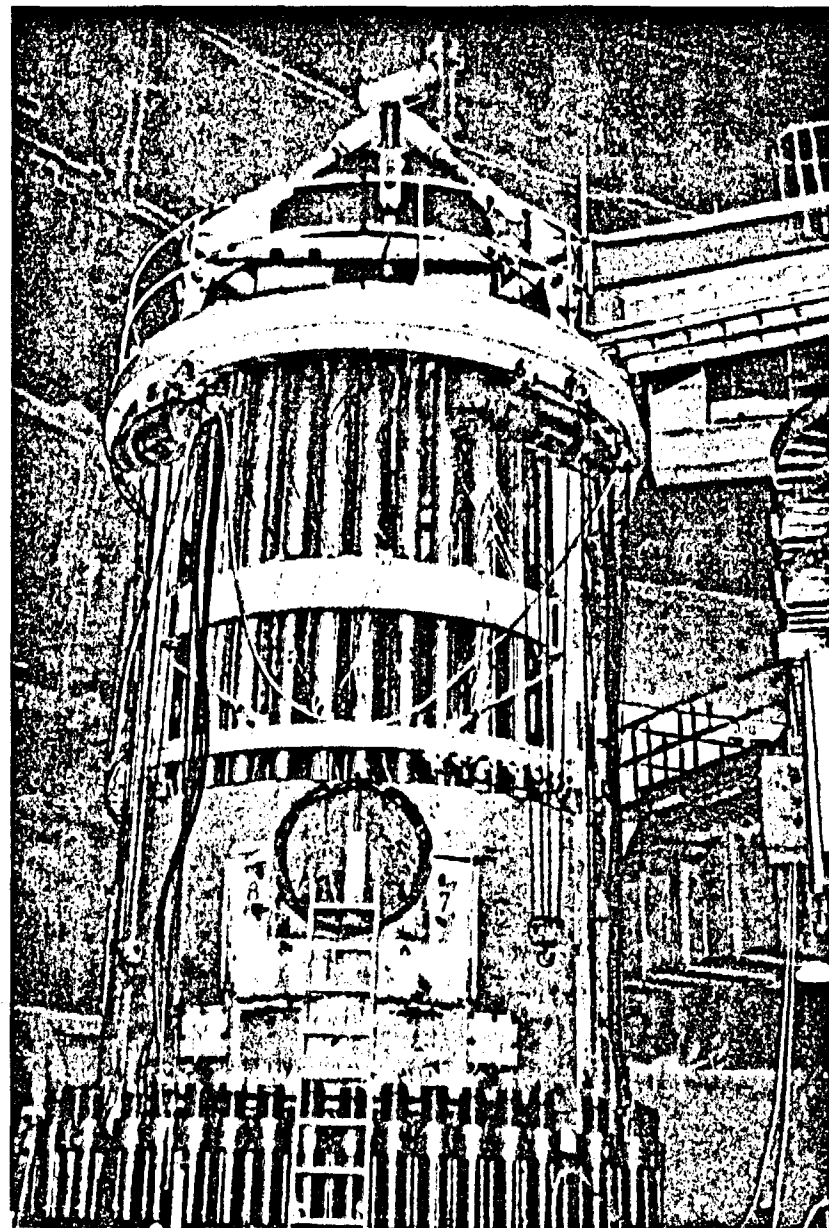
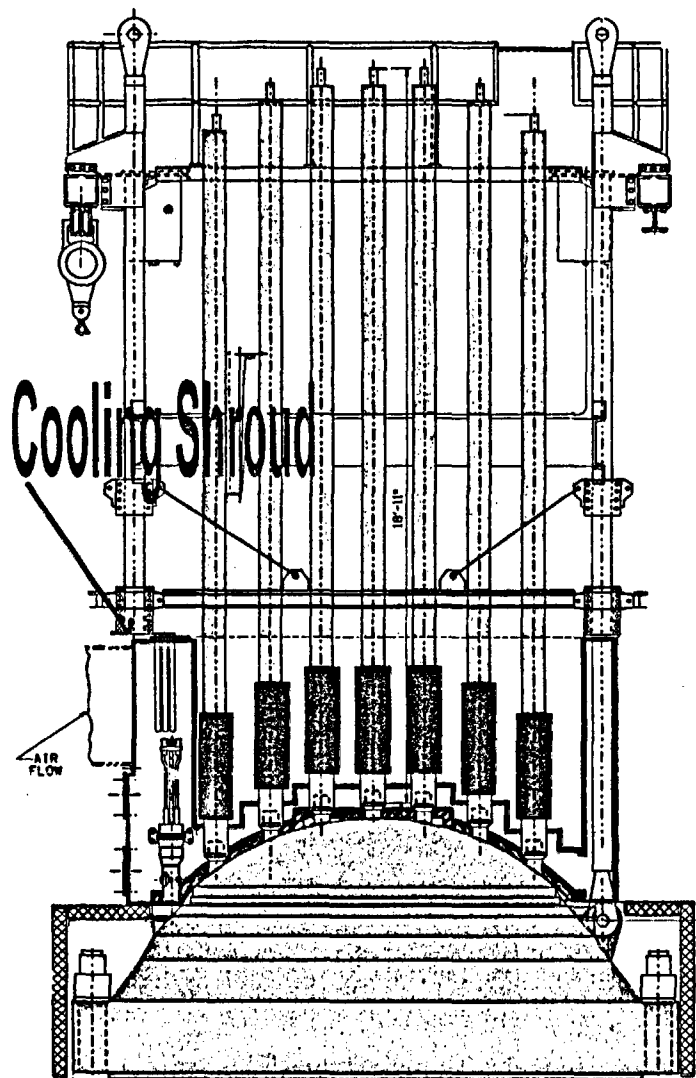
Entergy Relaxation for ANO-2

APPROACH: Two-fold

1. Hardship in Performing BMV
2. Complementary inspections that ensure quality and safety

ANO-2 Relaxation Request

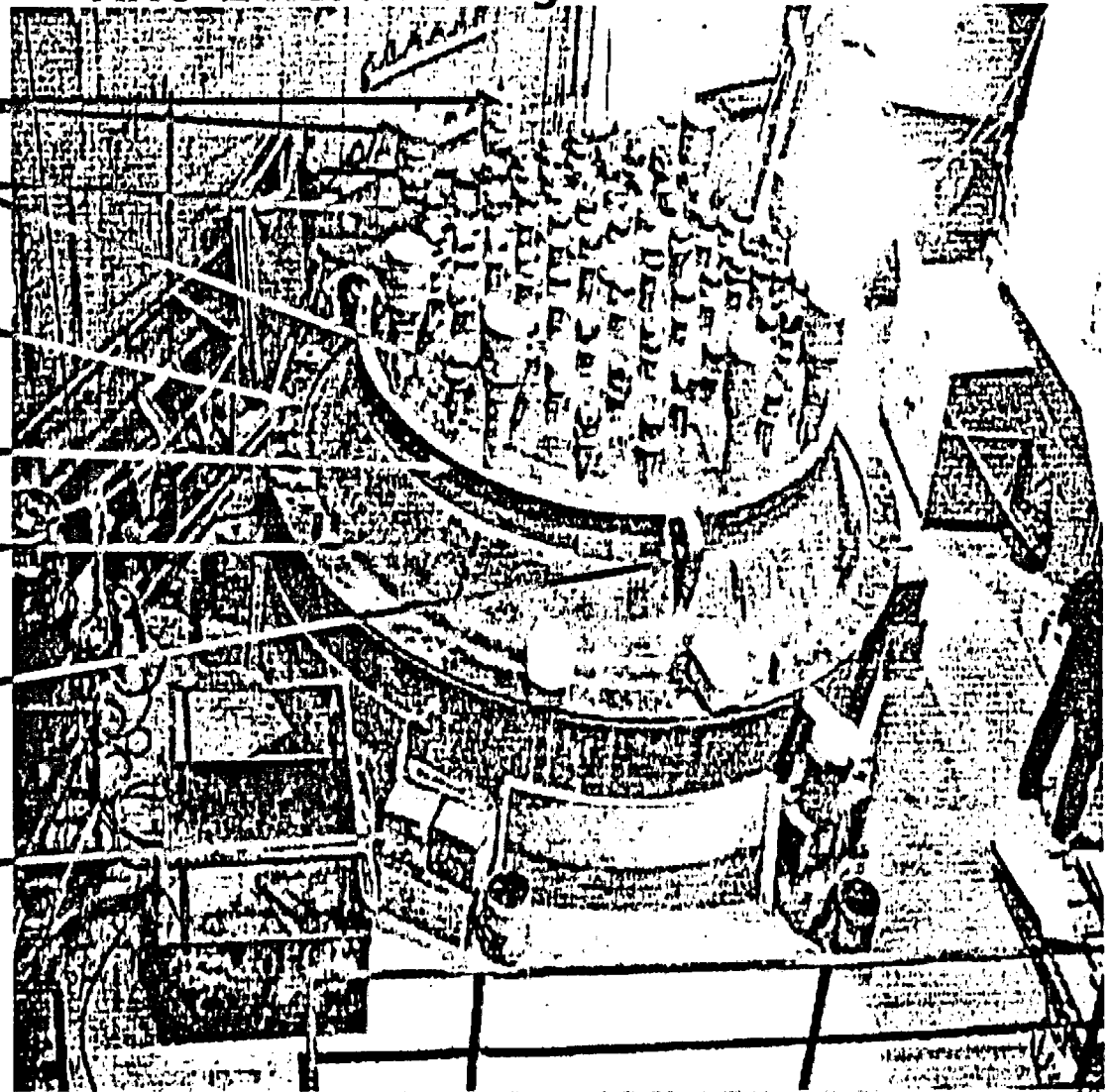
- ▶ May 8th Submittal: Believed to provide for both BMV hardship as well as a diverse and complementary approach to BMV
- ▶ Retrospect: Additional technology can provide supplemental level of diversity



Reactor Vessel Head Design

ANO-2 Head During Plant Construction

- ▶ ICI Nozzles (8)
- ▶ CEDM Nozzles (81)
- ▶ RVH Flange
- ▶ Insulation Retainer Ring
- ▶ Accessible Area for BMV
- ▶ Lifting Trunion
- ▶ Head Stand

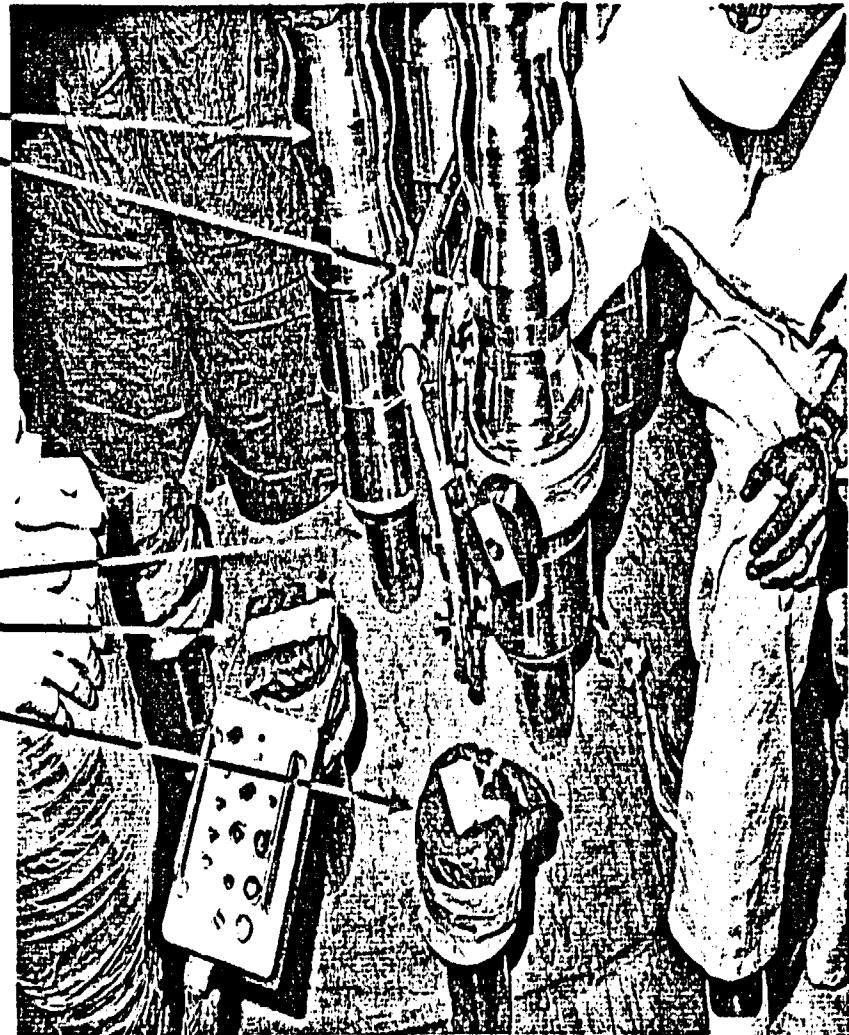


Reactor Vessel Head Fabrication

ANO-2 Head During Plant Construction

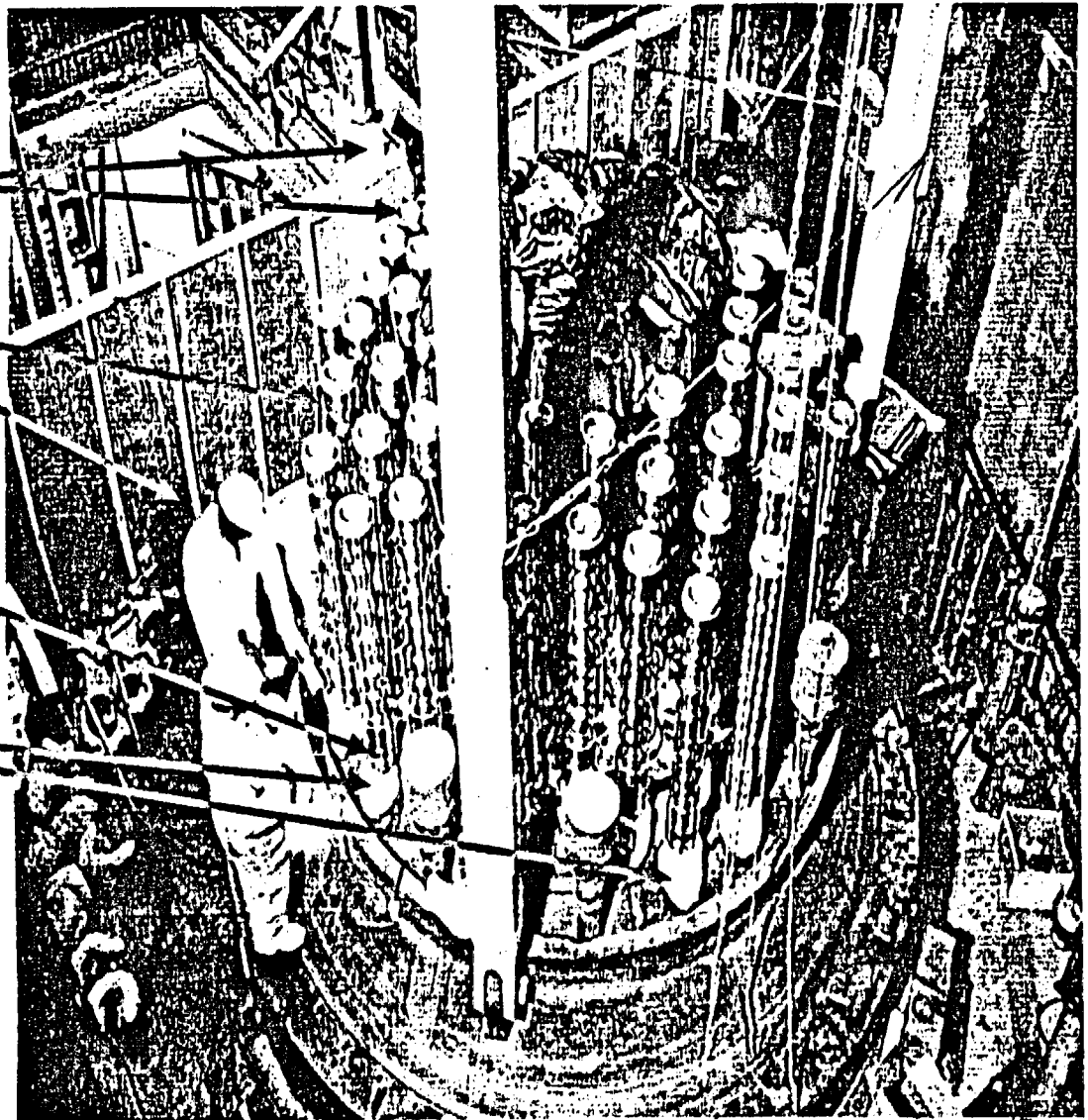
- ▶ CEDM Motor Housings
- ▶ Motor housing and insulation collars were installed from the center out due to the restricted access
- ▶ CEDM Nozzles
- ▶ ICI Nozzles

Note: Nozzle to CEDM connection follow head contour



Reactor Vessel Head Fabrication

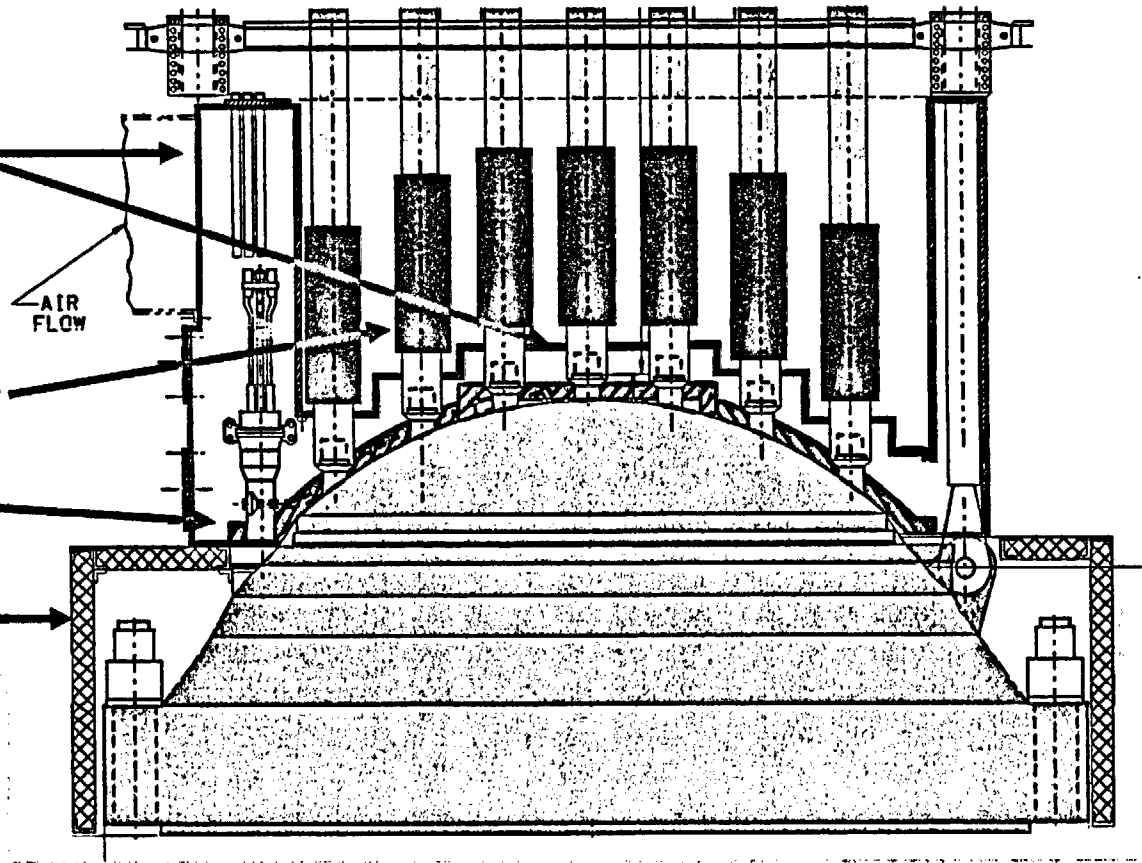
- ▶ **Lift Rig Columns**
- ▶ **CEDM Motor Housings**
- ▶ **ICI Nozzles**
- ▶ **CEDM Insulation Collars**



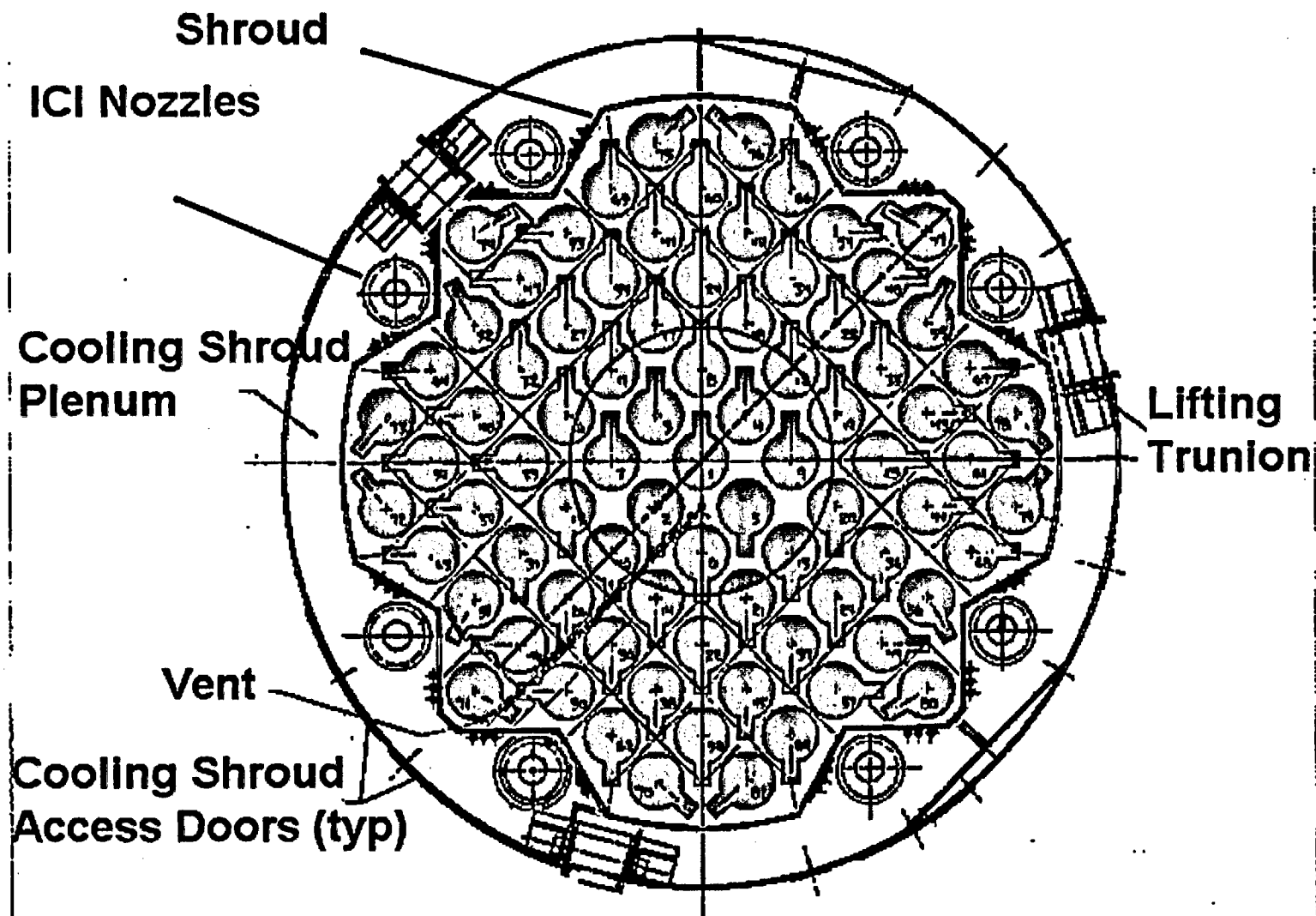
6/17/2003

RVH Cooling Shroud and Insulation

- ▶ **Cooling Shroud**
- ▶ **ICI Access Doors**
- ▶ **CEDM Coil Stacks**
- ▶ **Panel Insulation**
- ▶ **Removable Insulation**

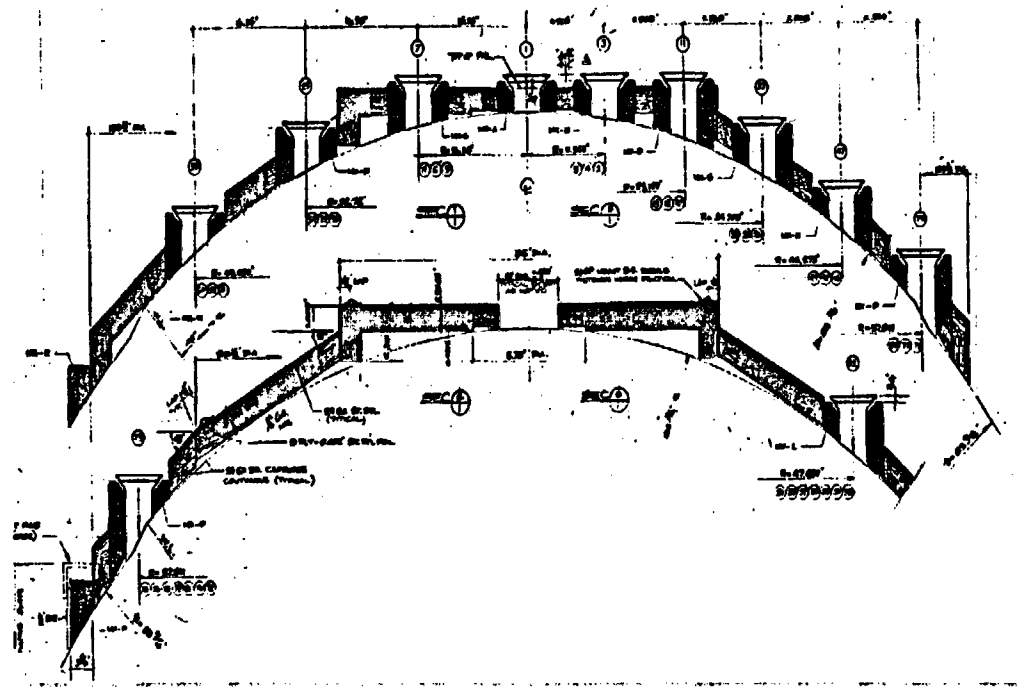


RVH Cooling Shroud and ICI BMV



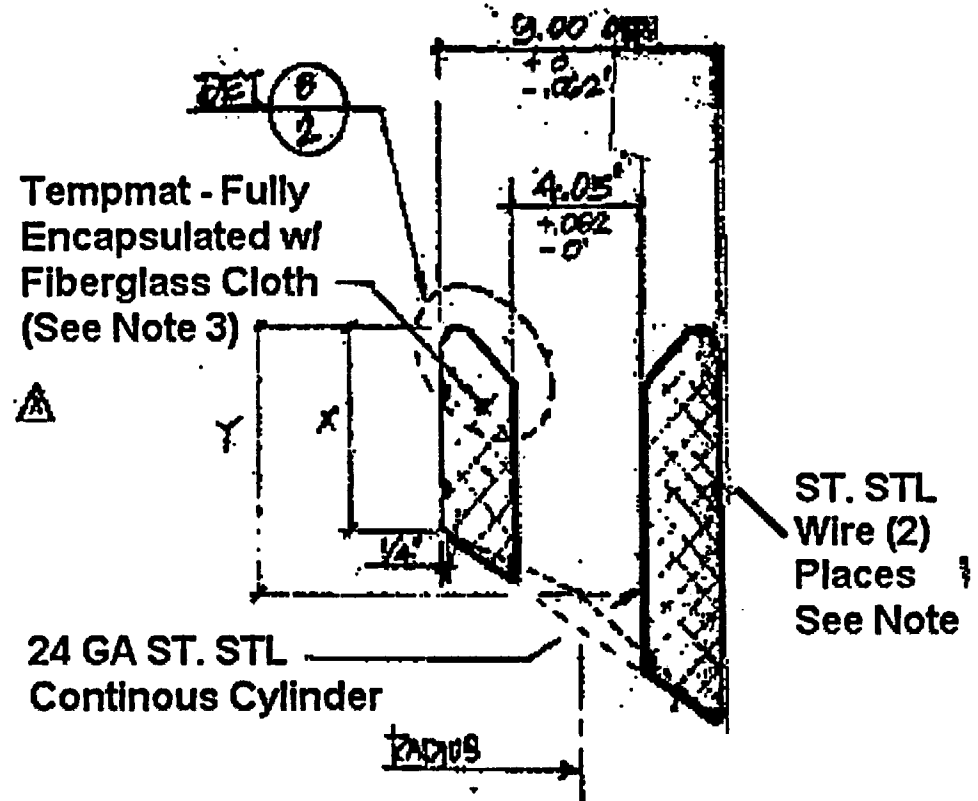
Panel Insulation

- ▶ Collars are enclosed by prefabricated Stainless Steel reflective insulation panels
- ▶ Panels are sized to closely fit around the collars
- ▶ 56" diameter dome panel and 16 panels around the radius



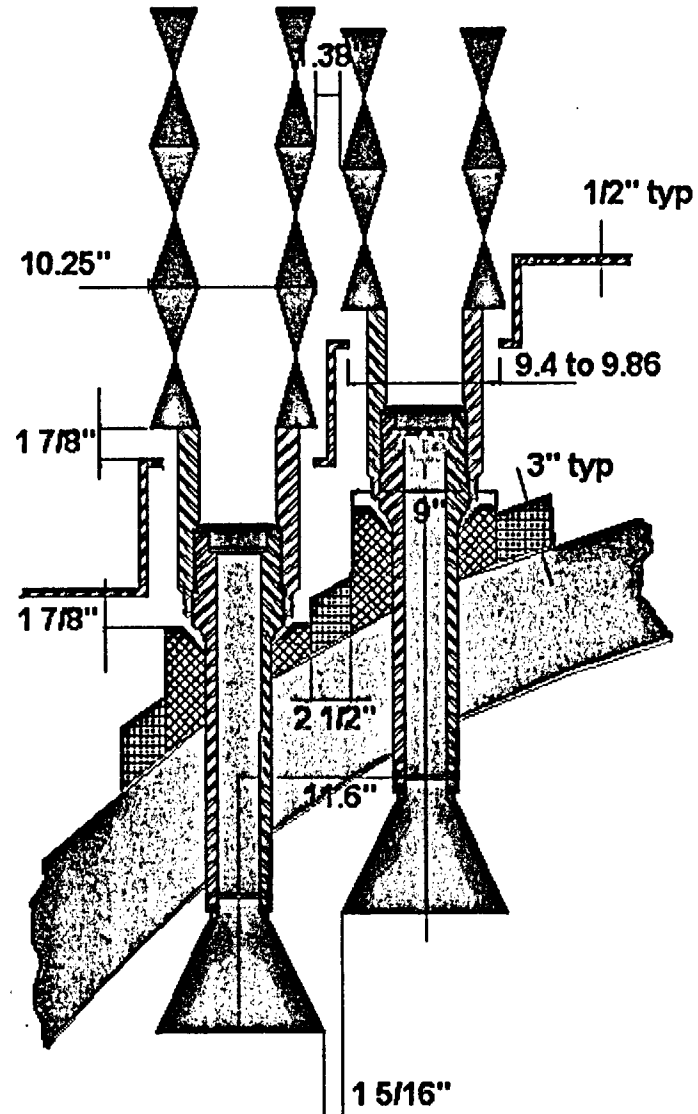
Nozzle Insulation Collars

- ▶ 81 CEDM and 8 ICI collars
- ▶ Collars are custom fit to vessel contour
- ▶ Collars are Pittsburgh Corning TempMat insulation covered with fiberglass cloth lagging and held in place by stainless steel (SS) wire.
- ▶ Each collar contains a 24 GA SS Continuous Cylinder



Interferences to BMV

- ▶ CEDM collars cannot be removed with panels installed
- ▶ Cooling Shroud to Coil Stack Interference
- ▶ Openings in Cooling Shroud are part of the cooling system design
- ▶ Nozzle spacing limits access
- ▶ Limited access between cooling shroud and insulation



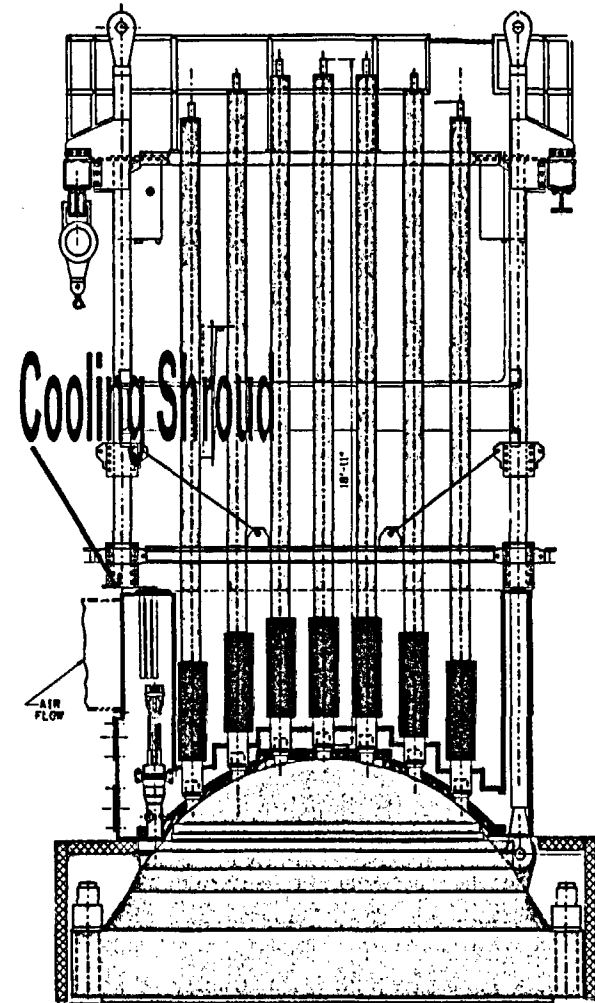
What's Unique About ANO-2

- ▶ **CEDM Motor Housings follows the RVH contour**
- ▶ **Stepped shroud design severely limits access for BMV**
- ▶ **All Coil Stack/RSPTs must be removed to support a BMV**



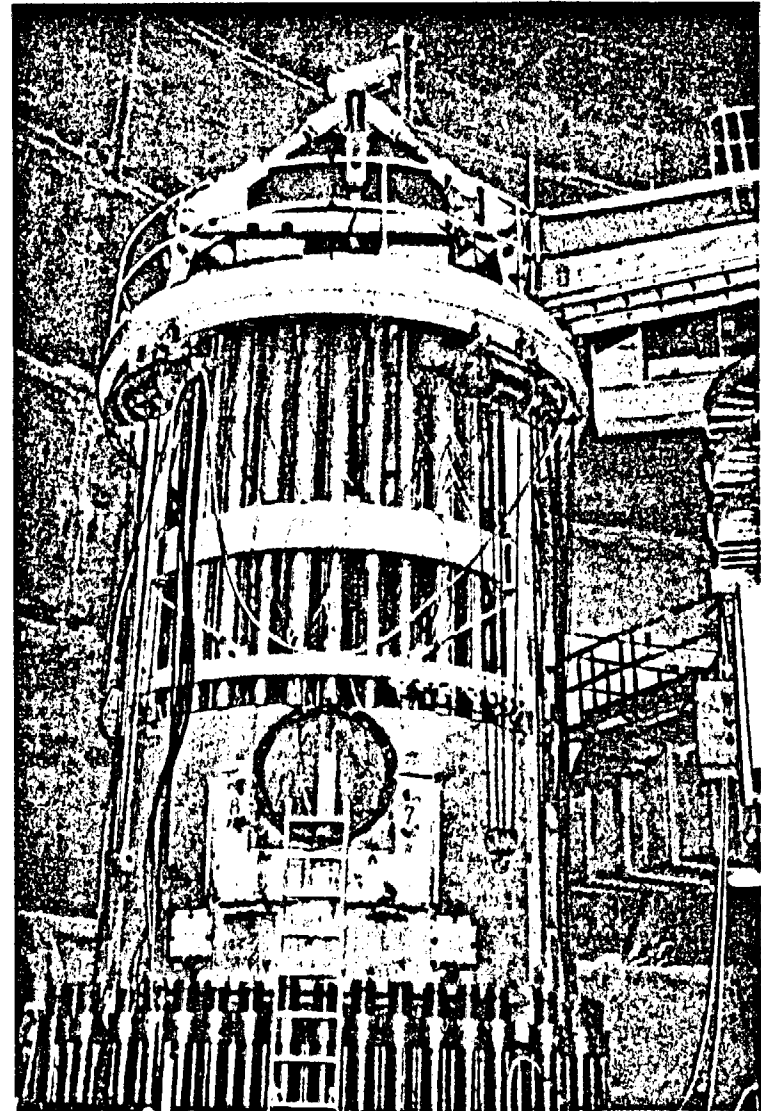
Disassembly Sequence

- ▶ **Remove & Store 162 RSPTs**
- ▶ **Remove & Store 81 CEDM Coil Stacks**
- ▶ **Disconnect, Rig and Store Superstructure**
- ▶ **Remove 17 Insulation Panels**
- ▶ **Remove 81 CEDM Insulation Collars**



Assembly Sequence

- ▶ **Install 81 re-designed Insulation Collars**
- ▶ **Re-install insulation Panels**
- ▶ **Re-install superstructure**
- ▶ **Re-install and test 81 CEDM coils stacks**
- ▶ **Re-install and test 162 RSPTs**



Risk Summary

- ▶ **Damage to RSPTs**
- ▶ **Damage to CEDM Coil Stacks**
- ▶ **Damage to the CEDM Motor Housings
During Removal of Lift Rig (Blind Lift /
Tight Clearances)**
- ▶ **No qualified CEDM motor or pressure
housing repair available**

Hardship Summary

- ▶ The CEDM Cooling/Insulation System was not designed to allow access to RV head nozzles
- ▶ ANO-2 Cooling System Design is unique
- ▶ Significant Dose (23 Rem) impact
- ▶ Risk of damage to equipment

Inspection Plans

William Sims

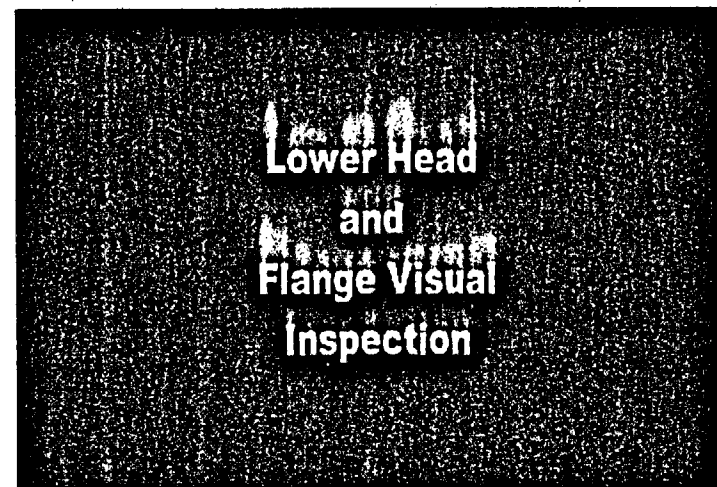
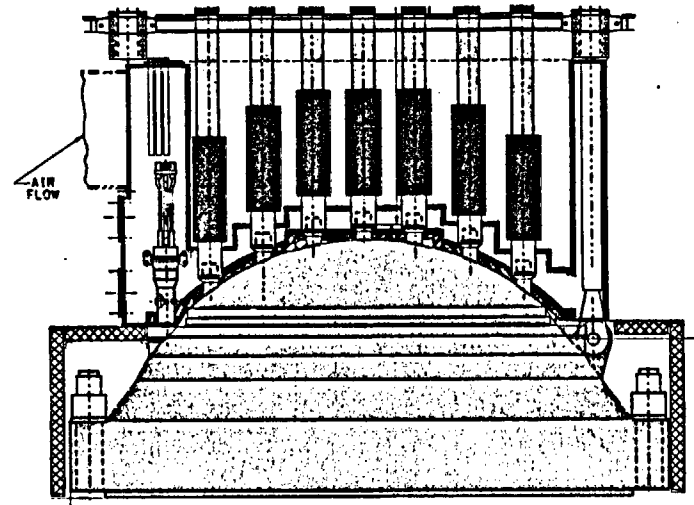
Last Outage - 2R15

Volumetric Inspection Results

- ▶ 90 reactor vessel head penetrations examined by Ultrasonic techniques
- ▶ 81 CEDM, 8 ICI Nozzles
 - UT through wall of the nozzle, J-weld fusion area including the triple point, and Riverbed.
- ▶ 1 Vent
 - UT 45 degree shear waves looking in axial and circ directions
- ▶ Special interest examinations
 - CEDM 43 & 59 Liquid Penetrant of portions of J-weld. No indications identified.
 - CEDM 30 Eddy Current of portion of nozzle OD. No indications identified.

2R15 - Supplemental Visual Inspection Above Insulation

- ▶ Performed visual exam above shroud, around all ICI nozzles, and some outboard CEDM nozzles
- ▶ No boron found



2R15 Inspection Results

- ▶ **NO LEAK PATH THROUGH TRIPLE POINT**
- ▶ **NO LEAKAGE PATH INDICATIONS FOUND IN ANNULUS**
- ▶ **NO PWSCC INDICATIONS FOUND IN NOZZLE OR WELD**
- ▶ **NO BORON FOUND ON HEAD PERIPHERY, INSULATION, OR SHROUD**

ANO-2 Head Integrity Verified

2R16 Inspection Plan

- ▶ CEDM/ICI nozzles
 - UT Through wall
 - Triple point
 - Riverbed
 - Supplemental Visual
 - BMV ICI
 - Low Frequency Eddy Current Vessel Exam (CEDM)
- ▶ Vent Line
 - Wetted Surface Inspection
 - Supplemental Visual
 - Low Frequency Eddy Current Vessel Exam



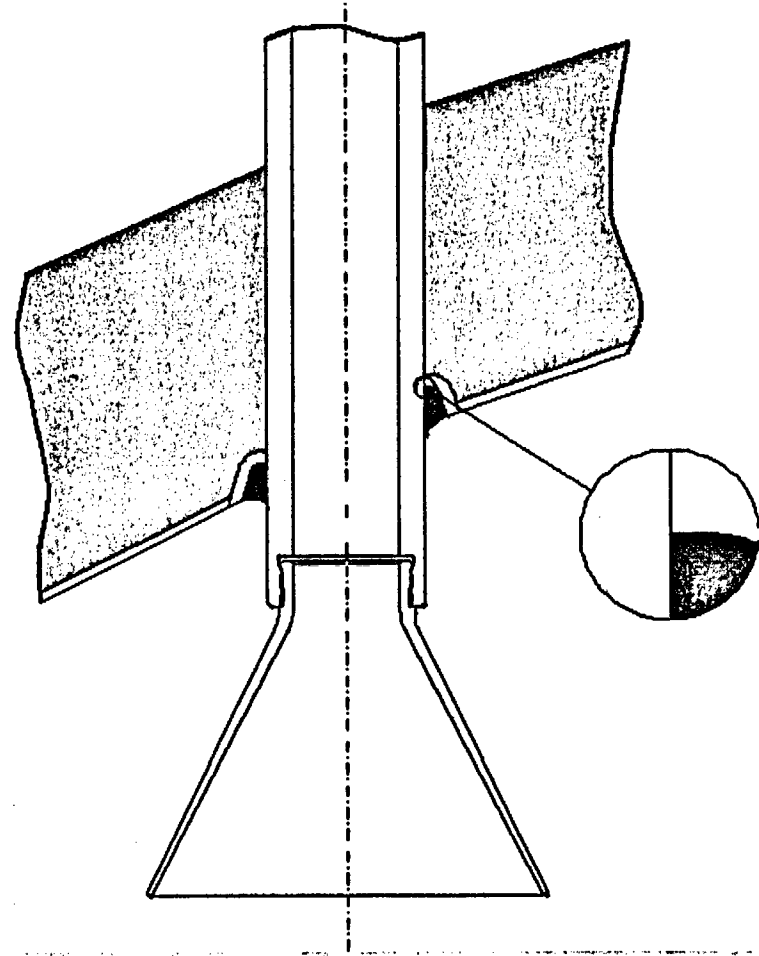
Demonstration of Triple Point

Entergy Demonstration

- ▶ Demonstrated detection of flat-bottomed holes up to 0.200" in depth, on Entergy/MRP Mock-up in 2002.
- ▶ Detected Circ Flaws extending to approximately 0.050" deep in Entergy/MRP Mock-up in 2002.

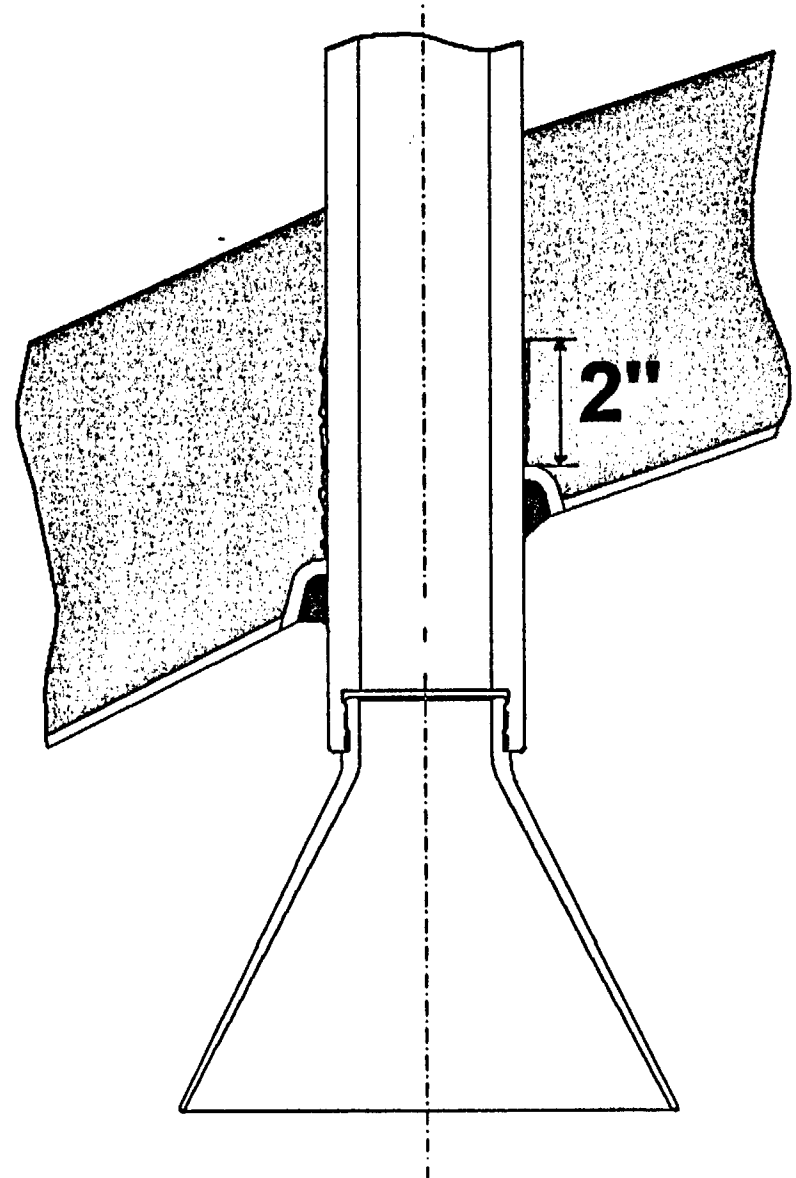
Phase 2 MRP Demonstration

- ▶ Detected a pure axial/radial squeezed notch that extended thru-weld to the Triple Point (0.060").

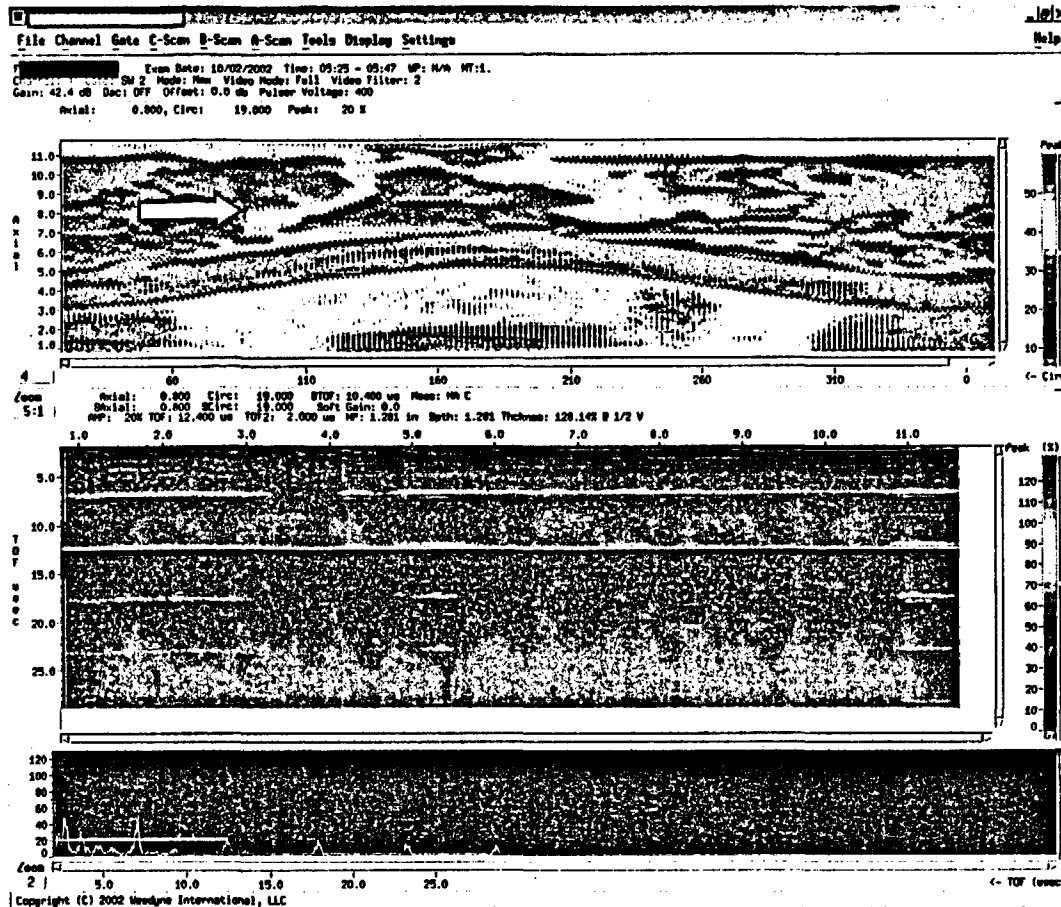


Riverbed Exam

- ▶ Proceduralized process
- ▶ Performed with 2.25 MHz, 0 degree Transducer
- ▶ Highly sensitive to amplitude changes in tube backwall signal
- ▶ Effective for detection of leakage in annulus



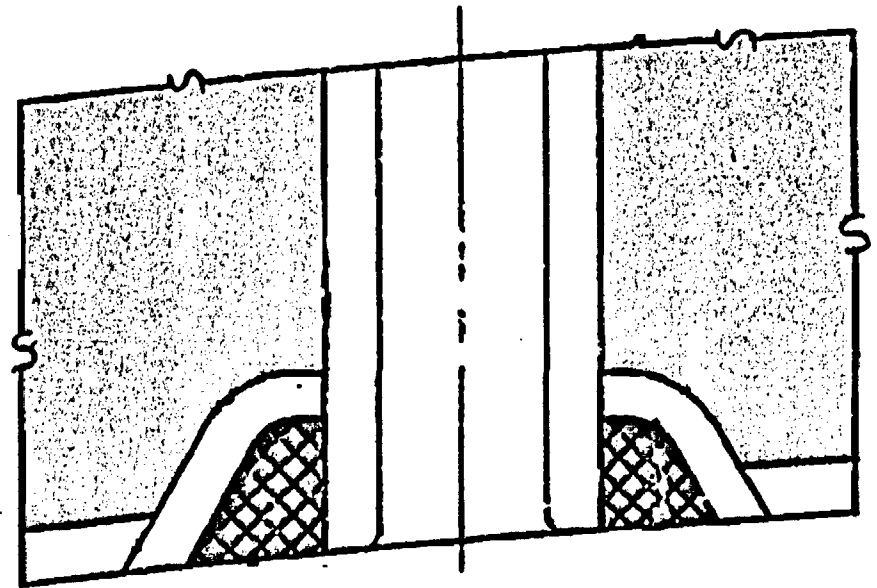
Riverbed Identification



- ▶ Leak path identified with straight beam ultrasonics
- ▶ Leak path leads to loss of shrink fit integrity and a resulting increase in reflectivity

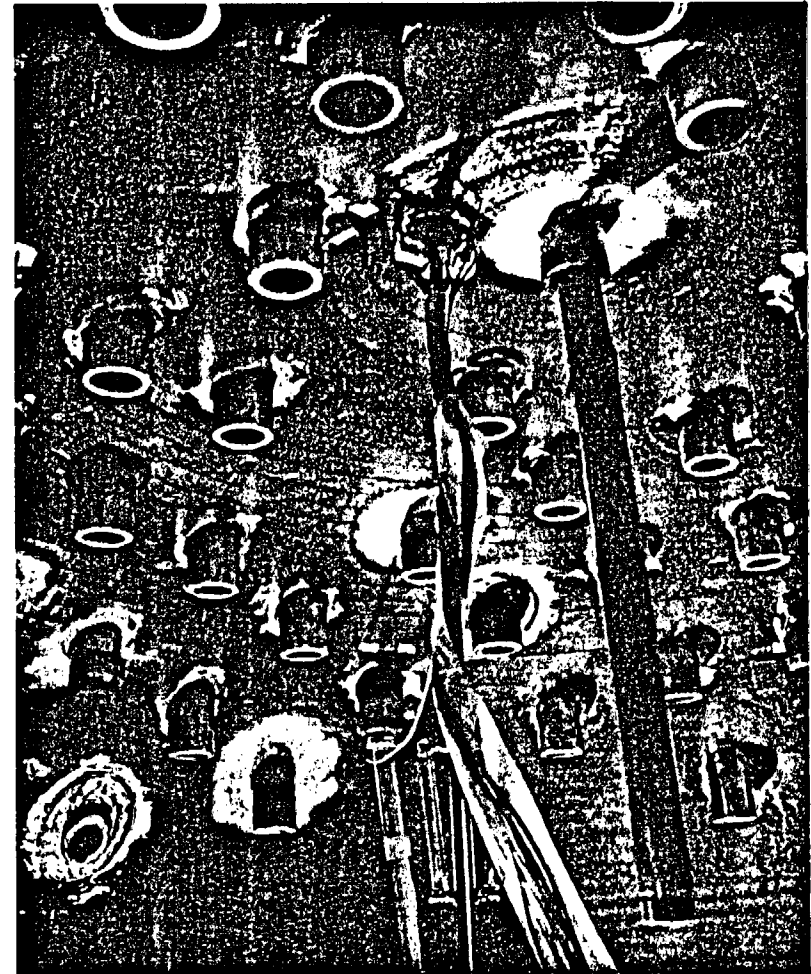
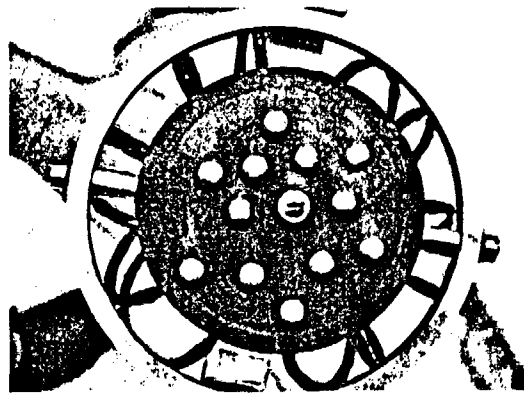
Vent Line Wetted Surface Exam

- ▶ Complete wetted surfaces examination
 - ECT examination at tube ID surface
 - ECT array examination of J-weld surface



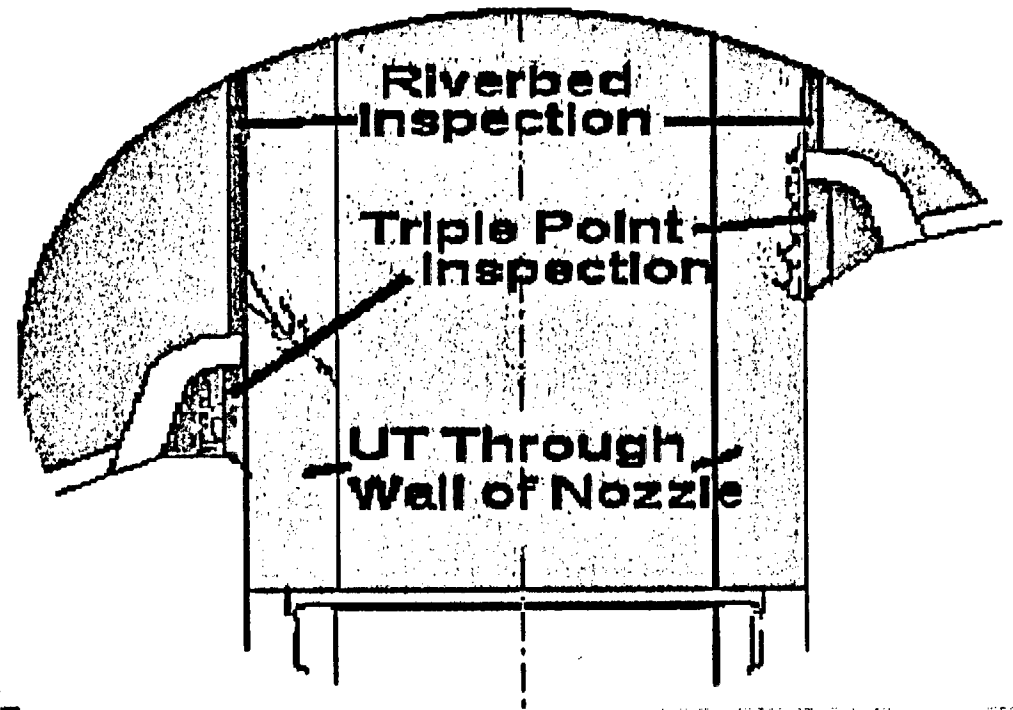
Reactor Vessel Vent Line J-Groove Weld ECT Examination

- ▶ Manual delivery, low dose
- ▶ 12-coil array
 - 100, 250 and 600 kHz
- ▶ Coils offset to provide coverage in one rotation



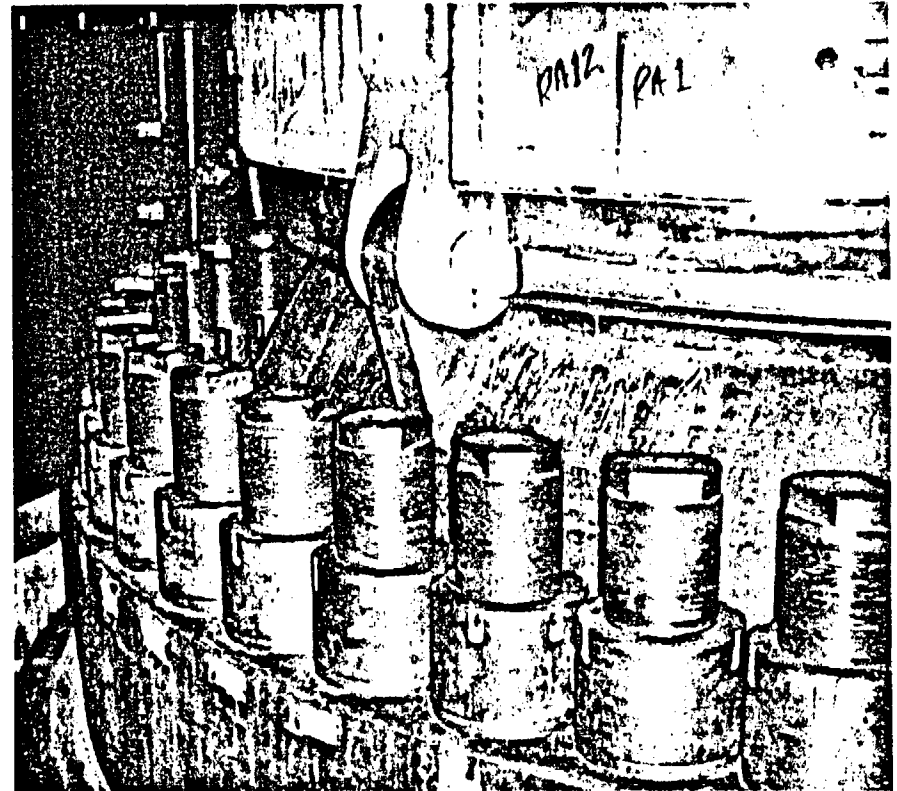
CEDM/ICI Volumetric Summary

- ▶ Axial and Circ TOFD
- ▶ 0 degree UT
- ▶ Triple Point
- ▶ 0 degree "Riverbed" examination for leakage assessment



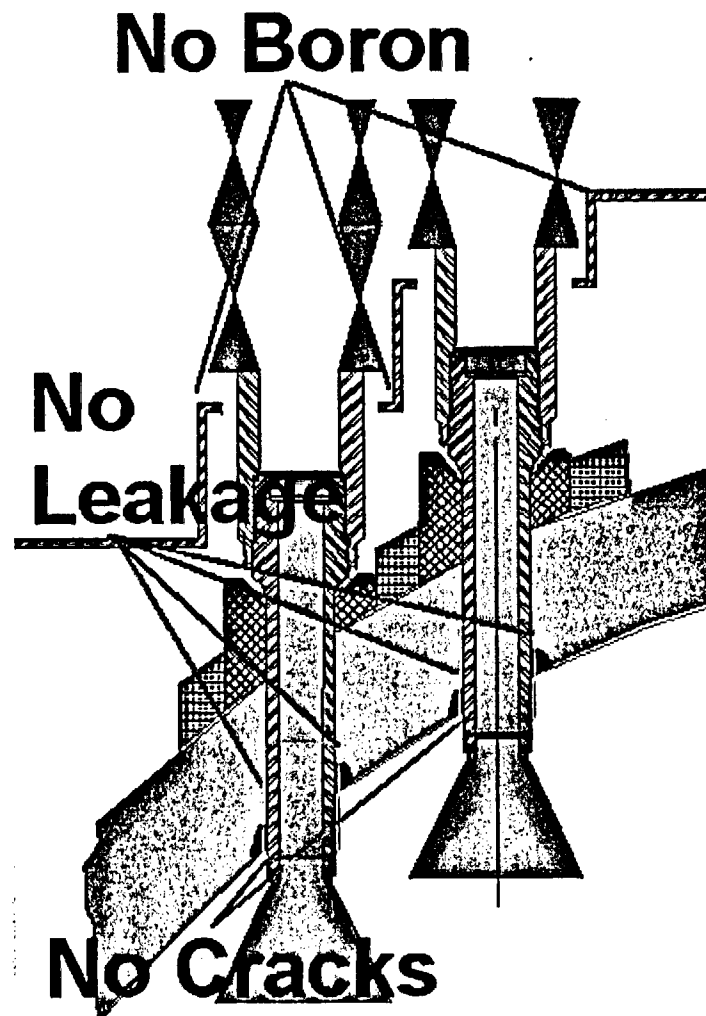
Supplemental Visual

- ▶ Above shroud
- ▶ Around flange
- ▶ Through doorways



2R16 Inspection Plan

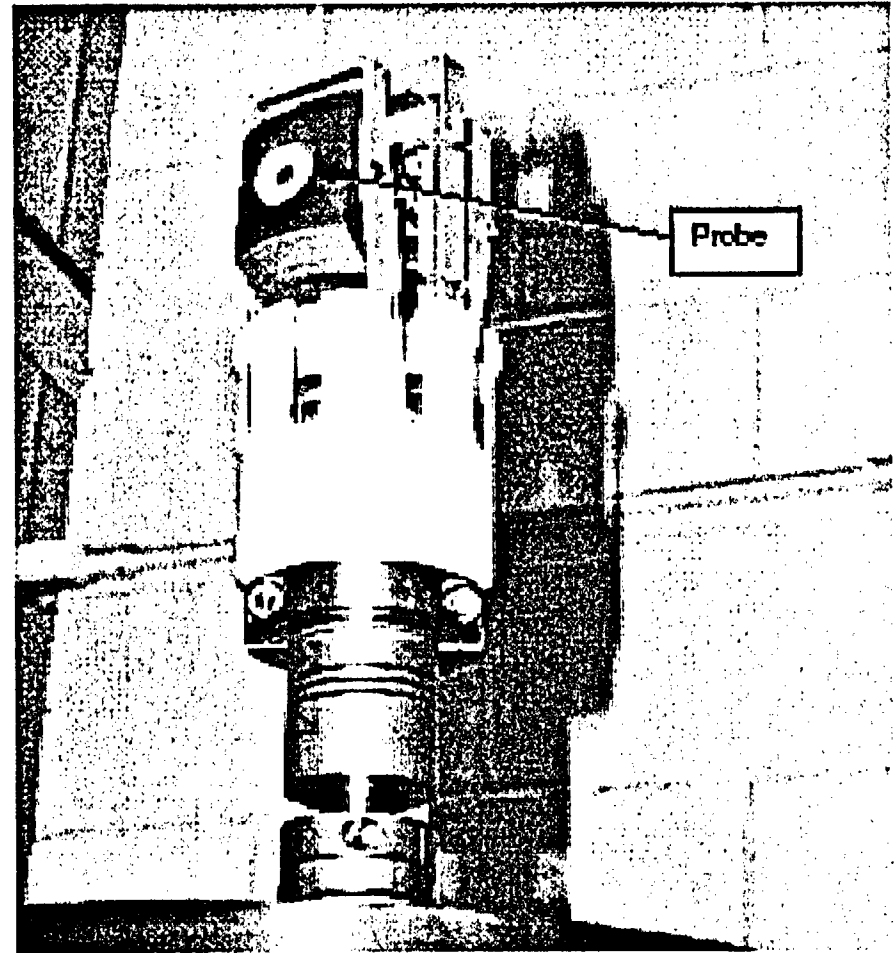
- ▶ CEDM/ICI nozzles
 - UT Through wall
 - Triple point
 - Riverbed
 - Supplemental Visual
 - BMV ICI
 - Low Frequency Eddy Current Vessel Exam (CEDMs)
- ▶ Vent Line
 - Wetted Surfaces Inspection
 - Supplemental Visual
 - Low Frequency Eddy Current Vessel Exam



Low Frequency Eddy Current Exam for CEDM and Vent Locations

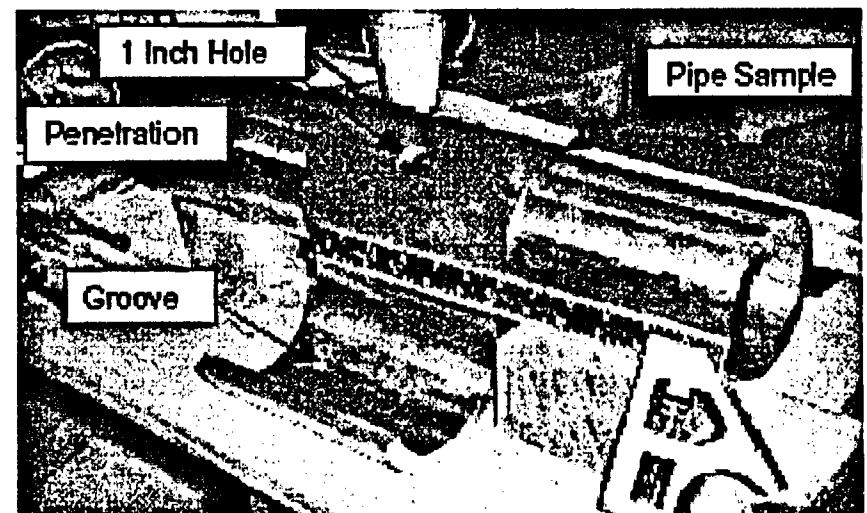
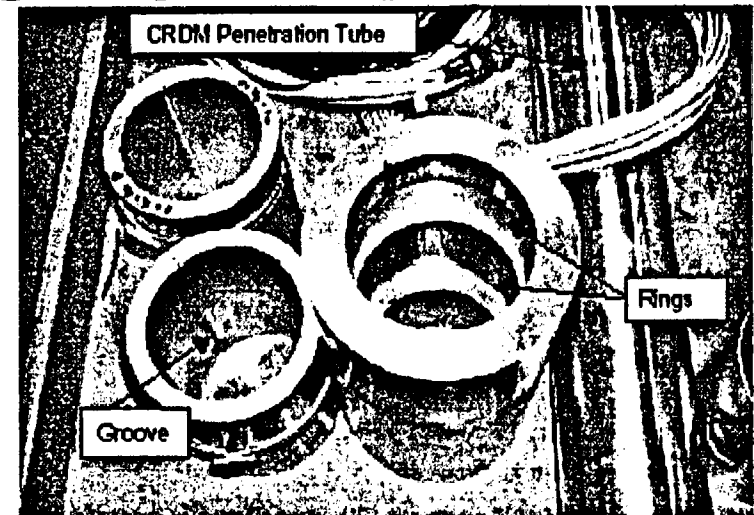
Development of Low Frequency EC Vessel Leakage/Integrity Inspection

- ▶ Developed in Spring of 2002, as diagnostic tool
- ▶ Designed to detect leakage/degradation of carbon steel in head penetration annulus region
- ▶ Utilizes $\frac{3}{4}$ " Driver/Pick-up probe, operating at 200 Hz



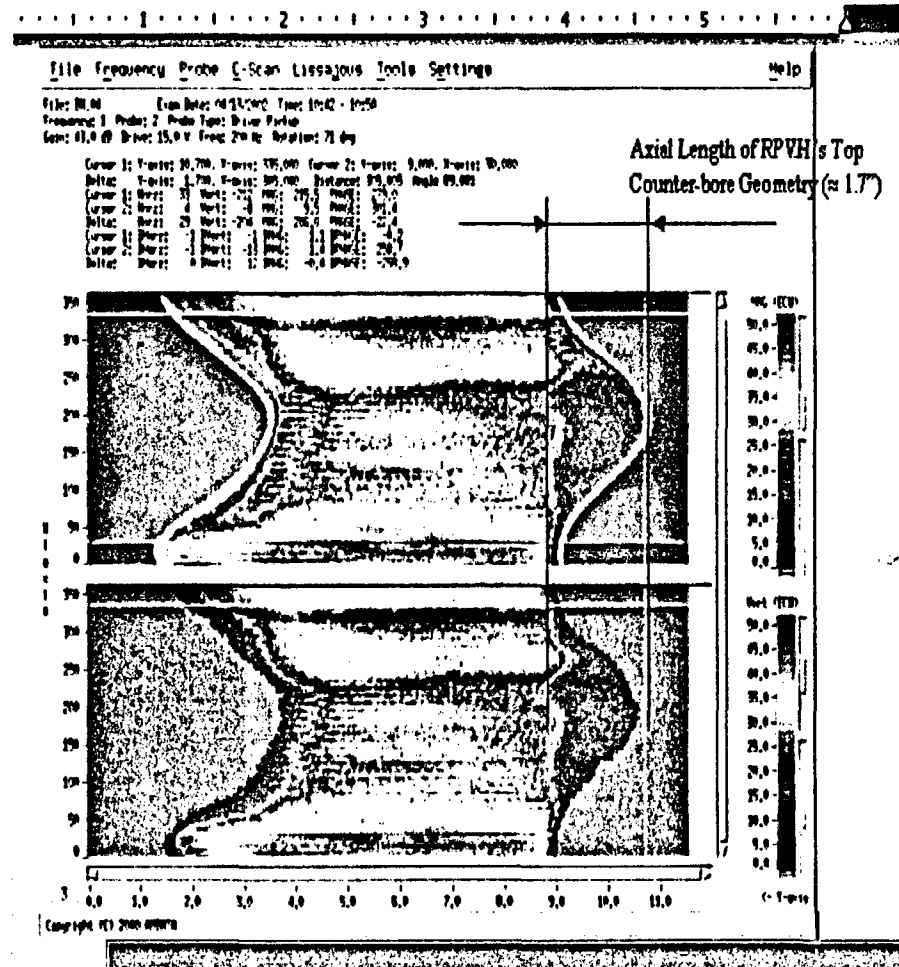
Development of Low Frequency Vessel Leakage/Integrity Inspection

- ▶ Evaluated using machined samples, representing various degradation morphologies (rings, grooves, drilled holes)
- ▶ Tests performed both on a test stand, and on an actual reactor vessel head at the Waltz Mill facility

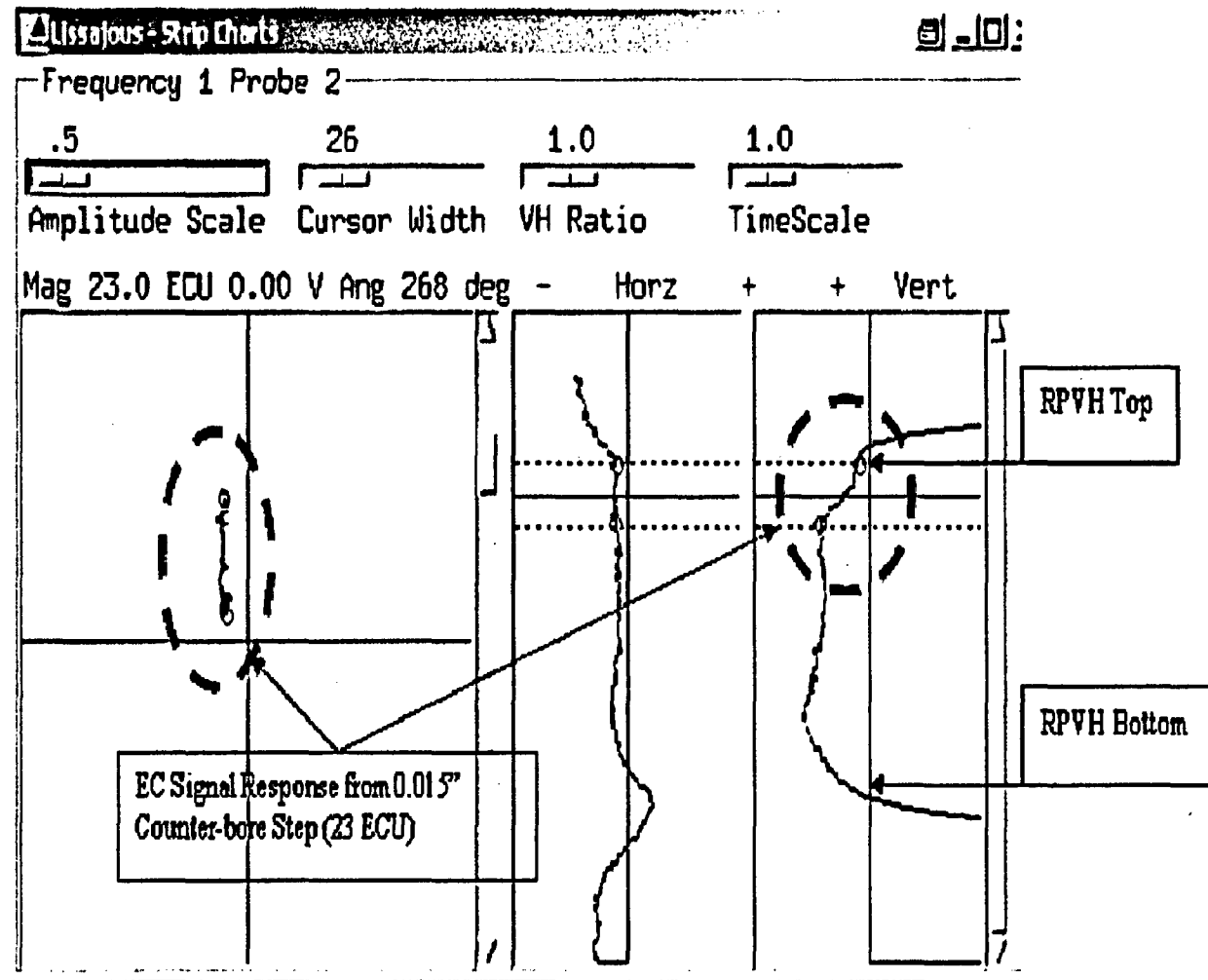


Development of Low Frequency Vessel Leakage/Integrity Inspection

- Inspections were performed on six penetrations on the Jamesport reactor head
- Results showed this tool's ability to map the counter bore region near the OD of the head (0.015" change)

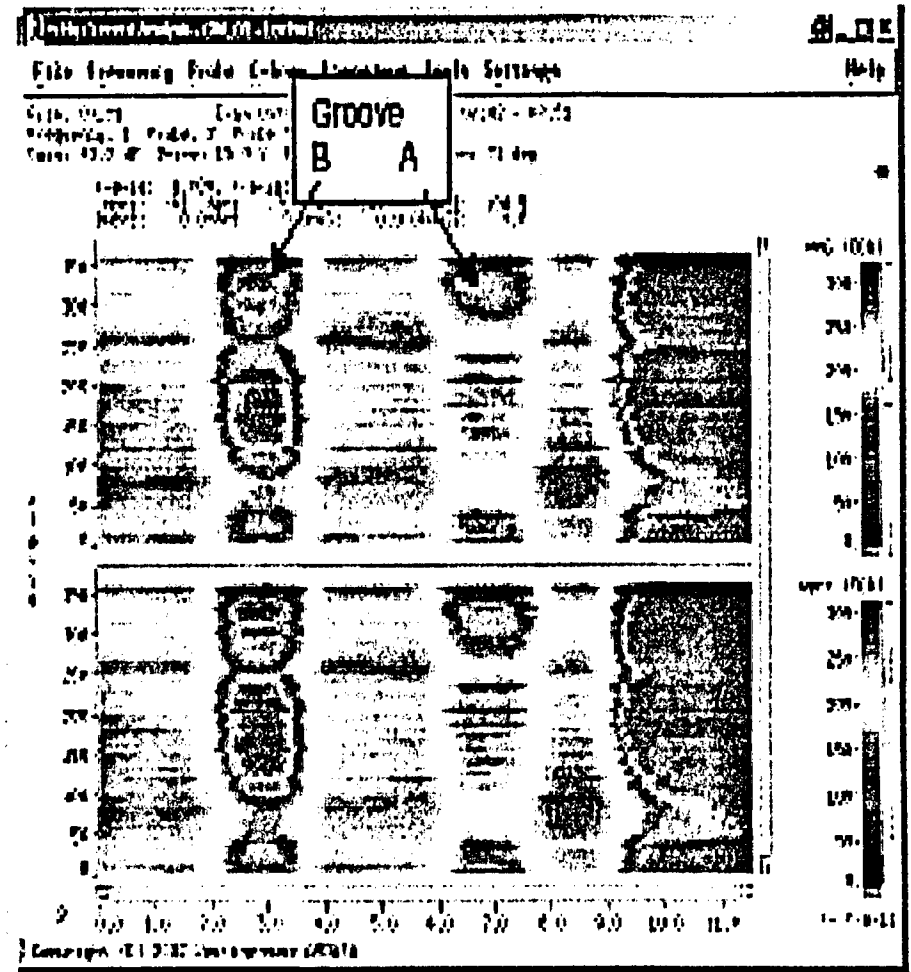


Development of Low Frequency ECT Vessel Leakage/Integrity Inspection



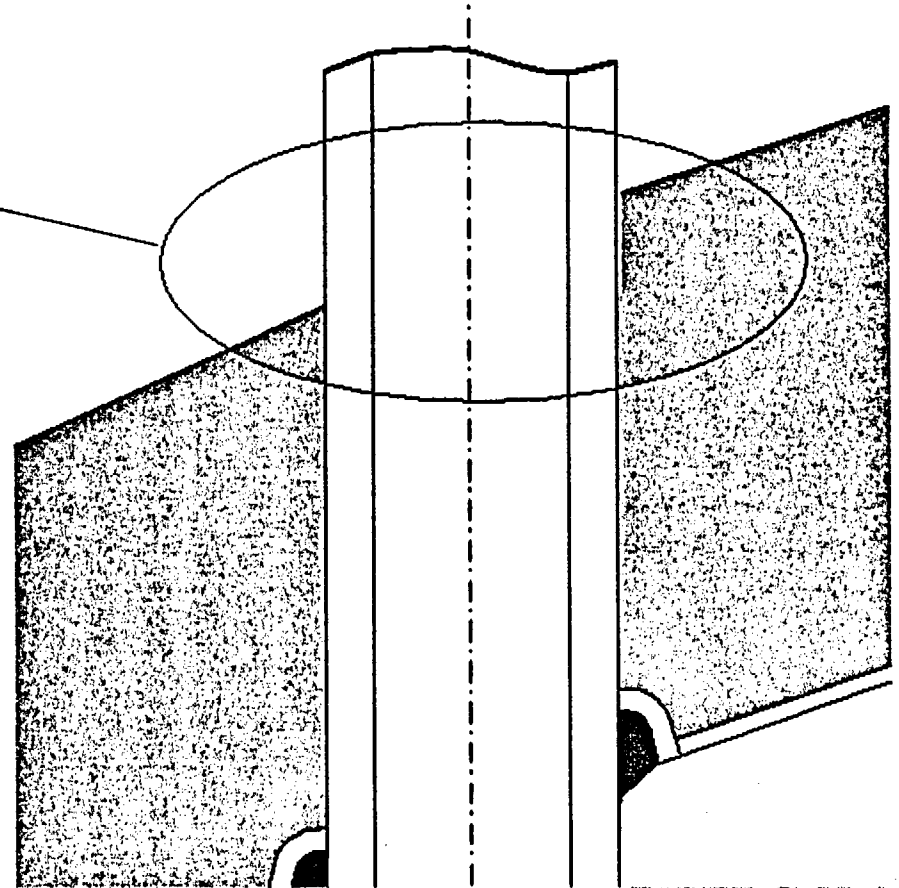
Development of Low Frequency Vessel Leakage/Integrity Inspection

- ▶ Picture shows machined grooves of 0.250" depth (A) and 0.500" depth (B).
- ▶ Both grooves are 2" in axial length and 360 degrees around the sample.



Low Frequency Vessel Inspection

- ▶ OD of Vessel and counter bore inspection area
- ▶ Measures degradation
- ▶ Diverse and complementary to UT (triple point and riverbed)
- ▶ Assures integrity of OD of Vessel



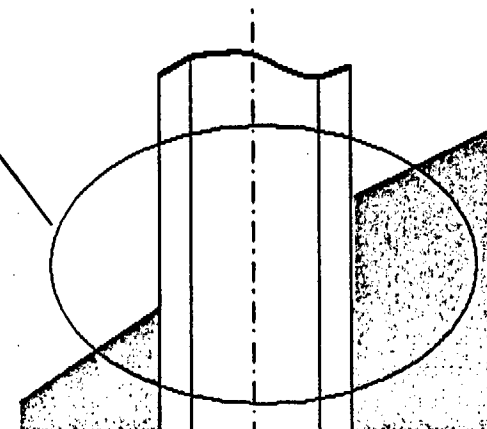
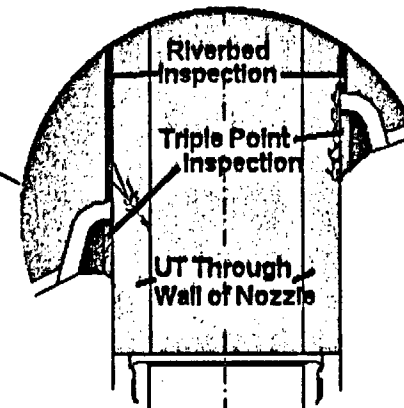
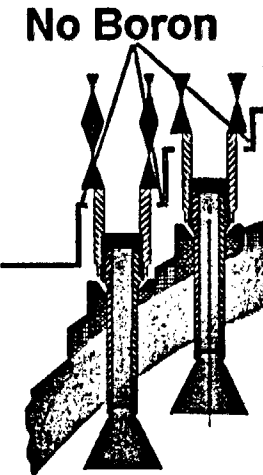
ICI BMV

- ▶ Open Cooling Shroud Doors
- ▶ Remove Insulation Collars
- ▶ Perform BMV around ICI Annulus

Conclusion

- ▶ Combination of Supplementary and BMV inspection
- ▶ Volumetric Insp. of nozzle/J-weld
 - UT through wall of nozzle
 - Weld fusion line and Triple Point
 - Riverbed
- ▶ CEDM/Vent Low Freq ECT Vessel Inspection
 - Leakage/degradation assessment on vessel OD and annulus region

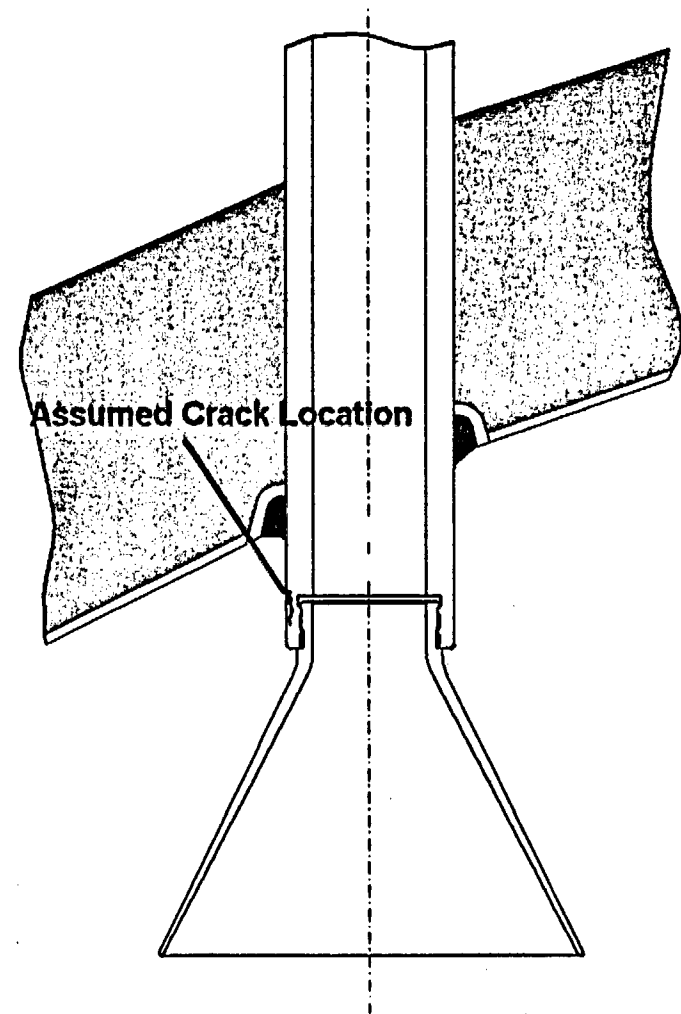
Diverse & Complementary inspections that ensure quality and safety



Other Relaxation Requests

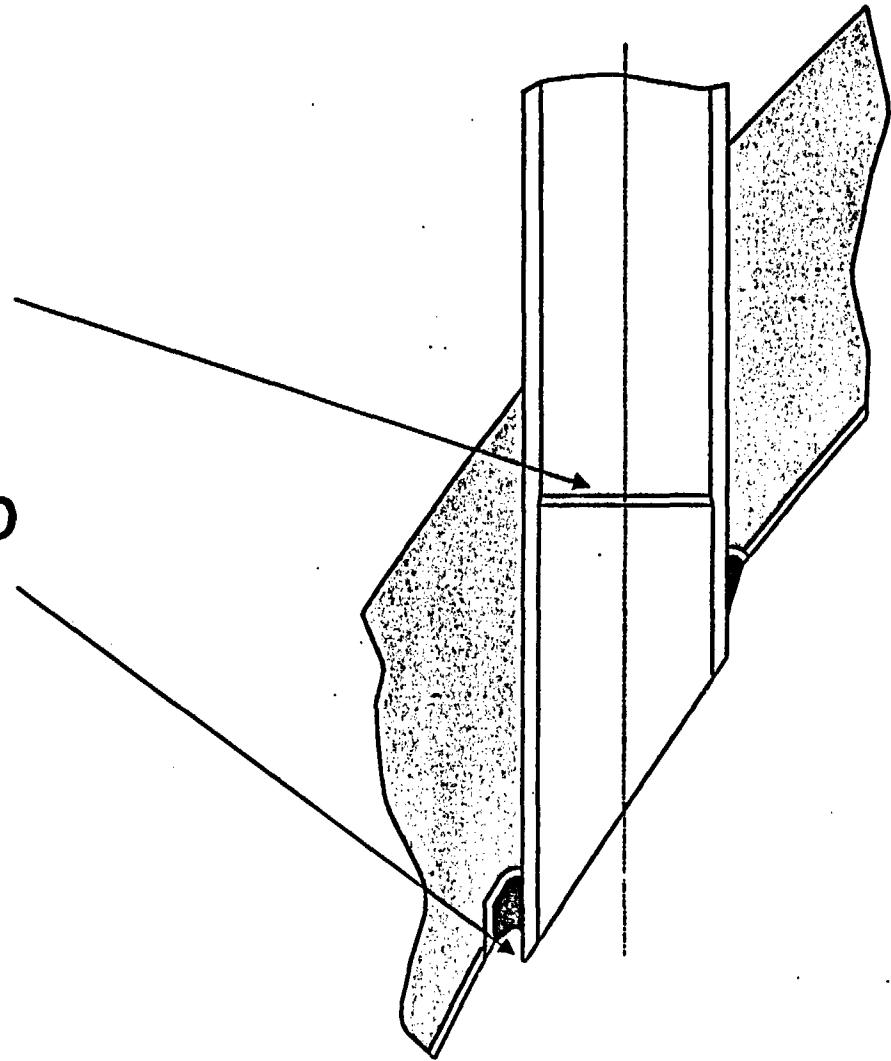
ORDER Relaxation - Inspection of Threaded Nozzle Cone Area

- ▶ Threaded length 1.34" not inspected
- ▶ Dead Zone ~0.2 inches
- ▶ Crack Growth Analysis from dead zone area to J-weld interface
 - Finite element analysis for residual operating and weld stresses
 - Elastic/plastic fracture mechanics analysis
- ▶ All nozzles acceptable for greater than one cycle



ORDER Relaxation - Inspection of ICI Nozzle Ends

- ▶ Counter Bore affects the 2" criteria above the weld
- ▶ Cannot see to the tip of nozzle



Order / Alternative

2R16 Inspections Complying with Order			
	CEDM (81)	ICI (8)	Vent (1)
BMV	See alternative	BMV around penetrations	See alternative
UT or Wetted Surface	UT/Riverbed	UT/Riverbed	Wetted Surface (eddy current)
Complementary Alternative			
	CEDM (81)	ICI (8)	Vent (1)
BMV	<ul style="list-style-type: none"> • Triple Point • Low Frequency Eddy Current Vessel Exam • Supplemental Visual 	N/A	<ul style="list-style-type: none"> • Low Frequency Eddy Current Vessel Exam • Supplemental Visual

Closing Remarks