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DATE OF MEETING

06/17/2003

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Docket Number(s)	<u>50-368</u>
Plant/Facility Name	<u>Arkansas Nuclear One, Unit 2 (ANO-2)</u>
TAC Number(s) (if available)	<u>MB8927</u>
Reference Meeting Notice	<u>06/04/03 (ML031560682)</u>
Purpose of Meeting (copy from meeting notice)	<u>To discuss the licensee's May 8, 2003, request for</u> <u>relaxation from NRC's vessel head inspection Order.</u>

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

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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

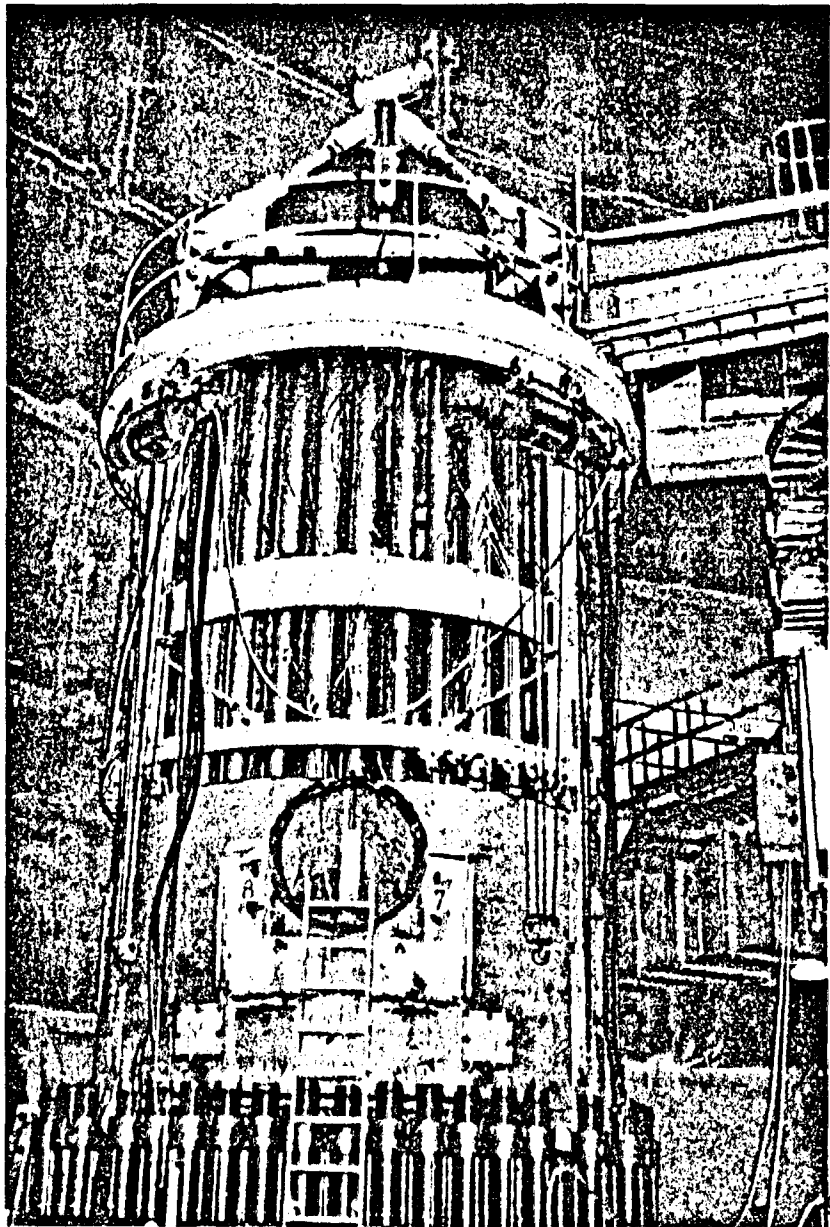
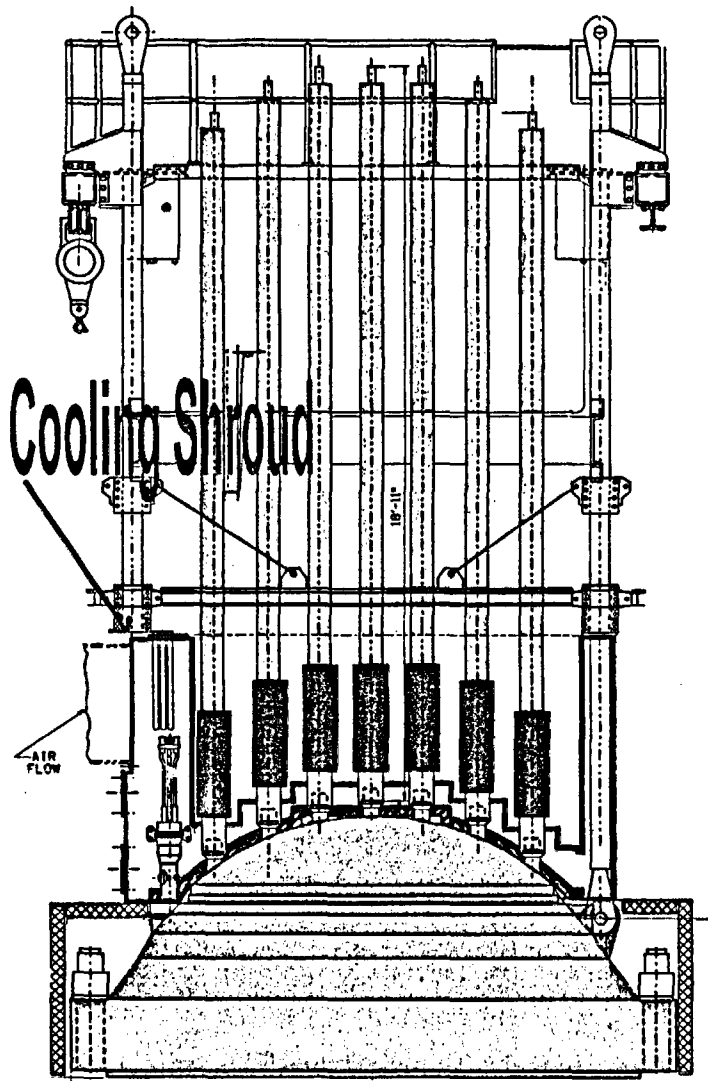
## APPROACH: Two-fold

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



# ANO-2 Relaxation Request

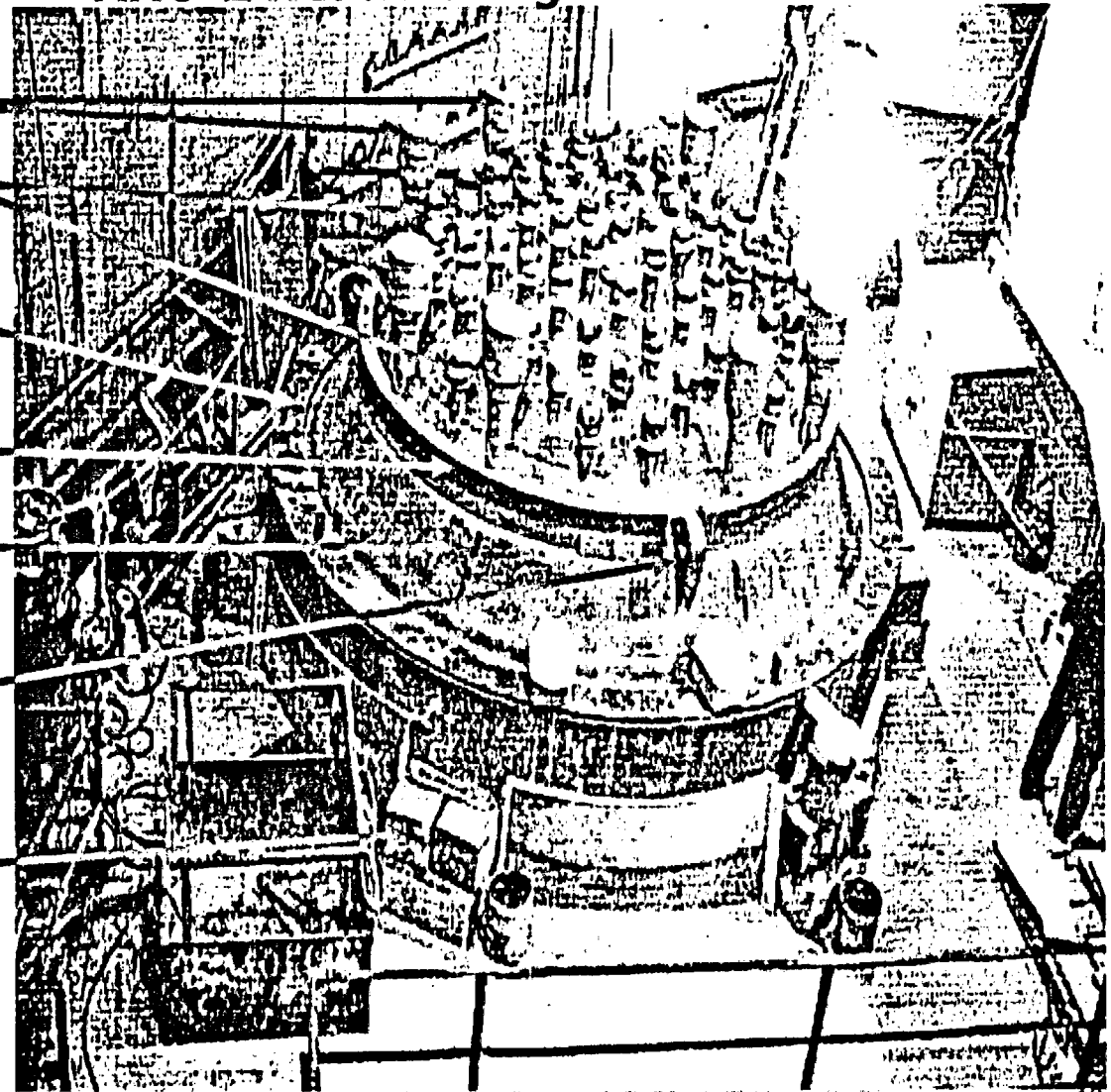
- ▶ May 8<sup>th</sup> Submittal: Believed to provide for both BMV hardship as well as a diverse and complementary approach to BMV
- ▶ Retrospect: Additional technology can provide supplemental level of diversity



# 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



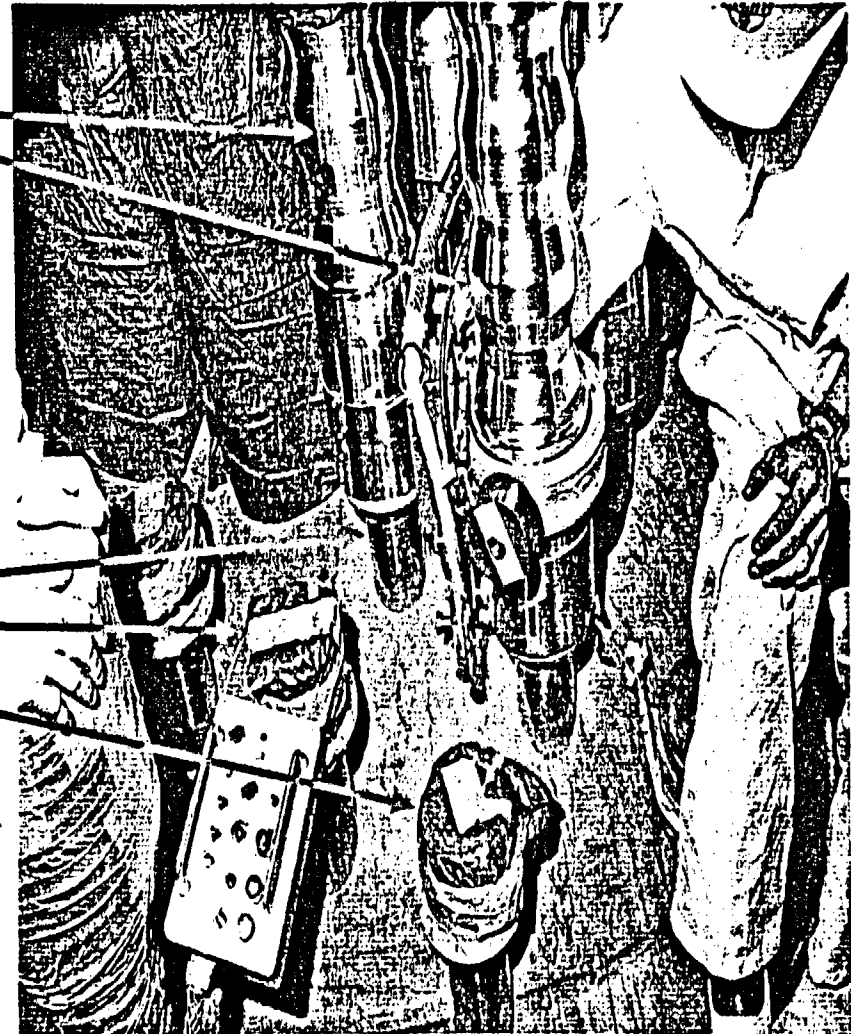
# Reactor Vessel Head Fabrication

## 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

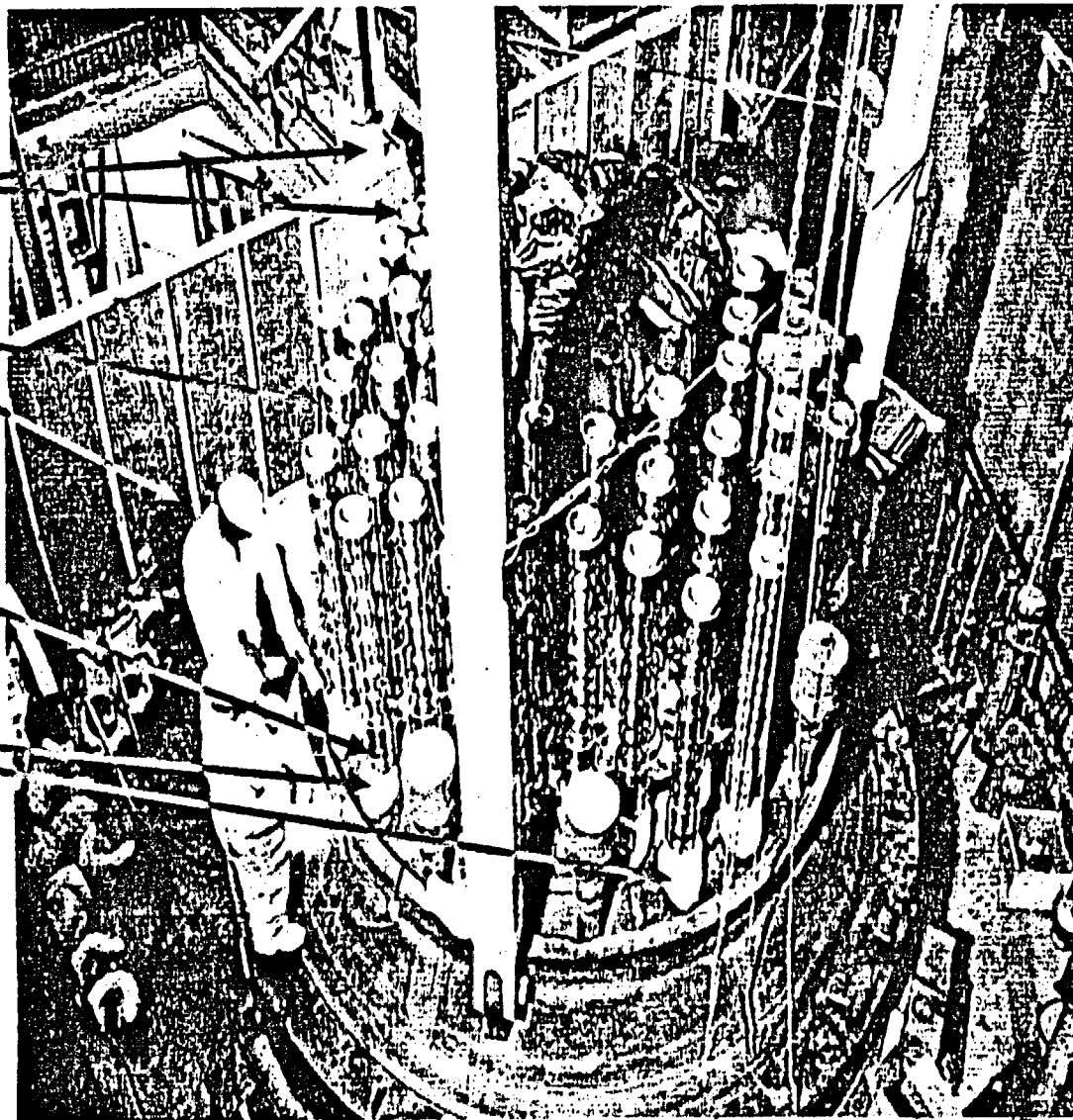
- ▶ CEDM Nozzles
- ▶ ICI Nozzles

**Note: Nozzle to CEDM connection follow head contour**



# Reactor Vessel Head Fabrication

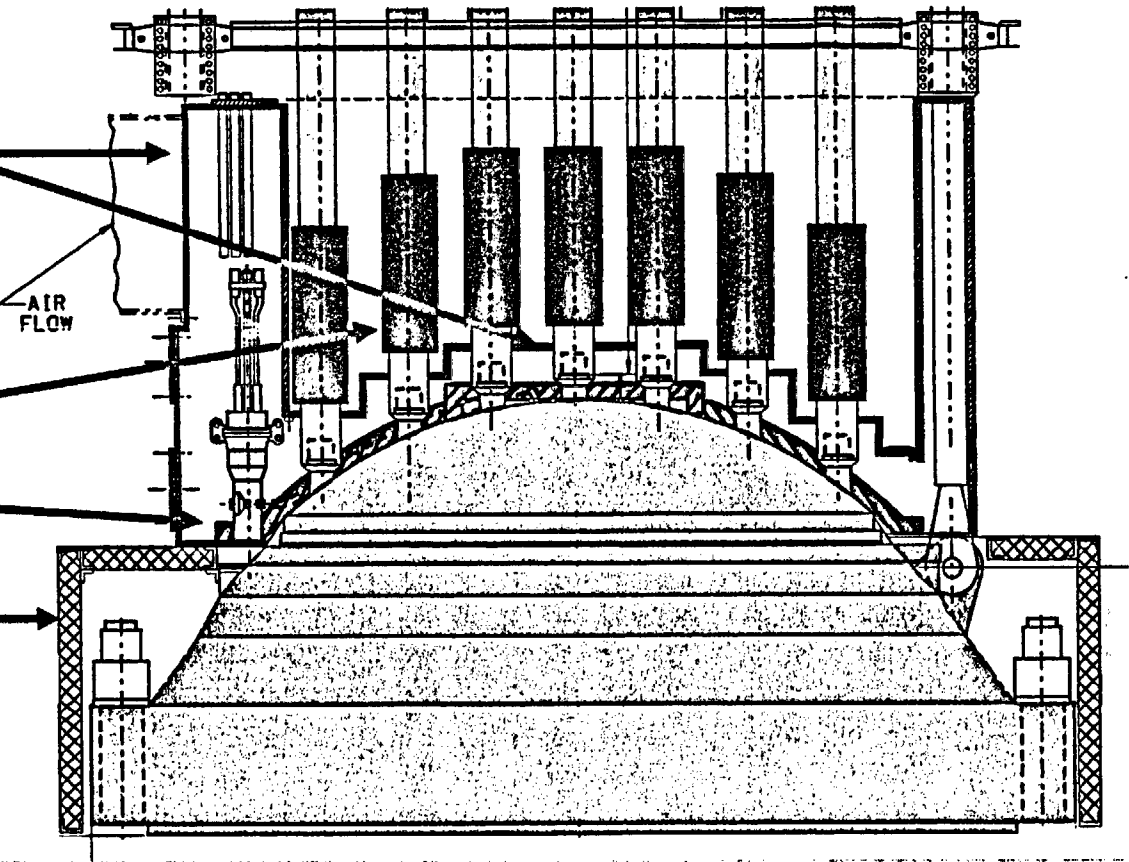
- ▶ **Lift Rig Columns**
- ▶ **CEDM Motor Housings**
- ▶ **ICI Nozzles**
- ▶ **CEDM Insulation Collars**



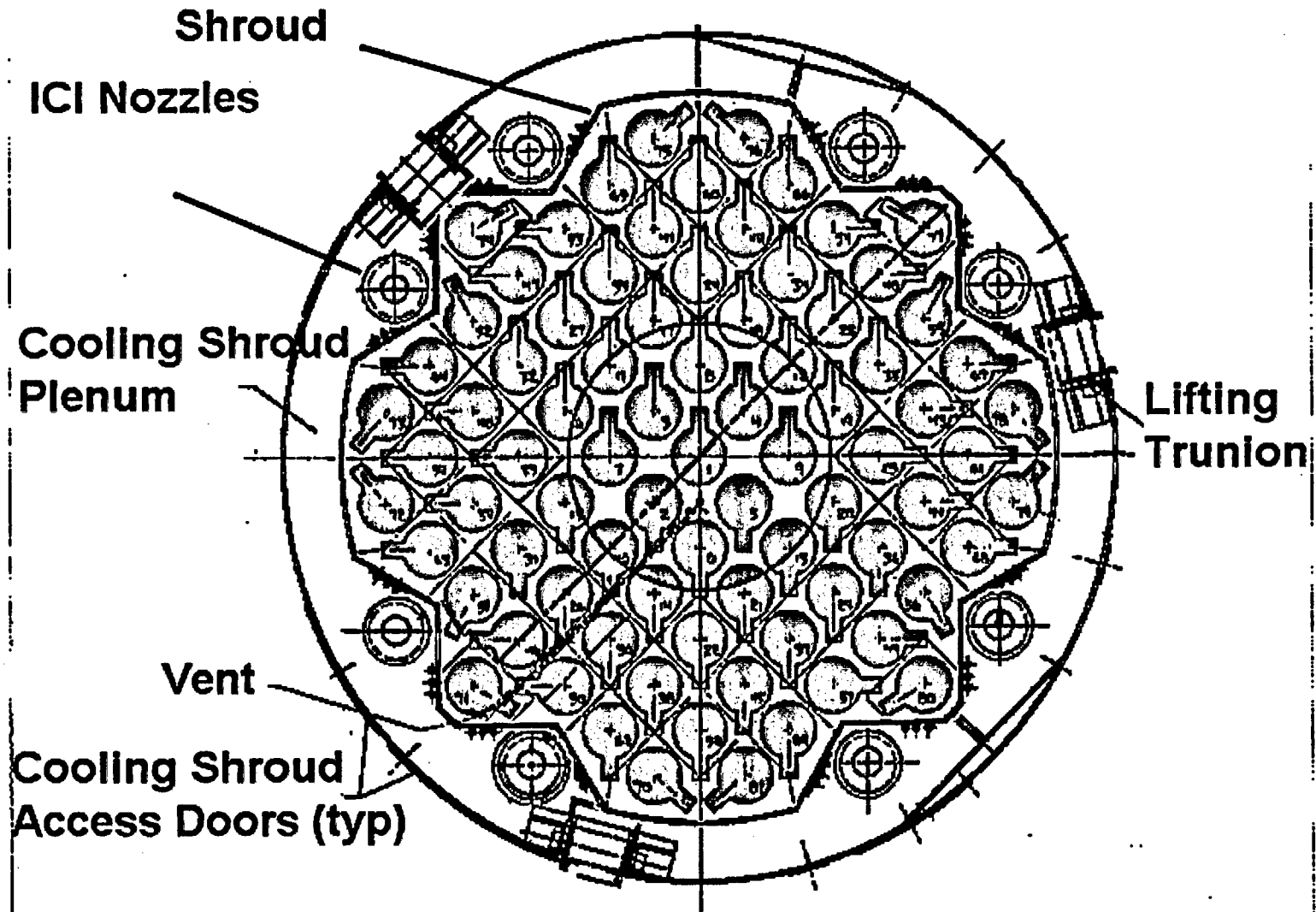
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# RVH Cooling Shroud and Insulation

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



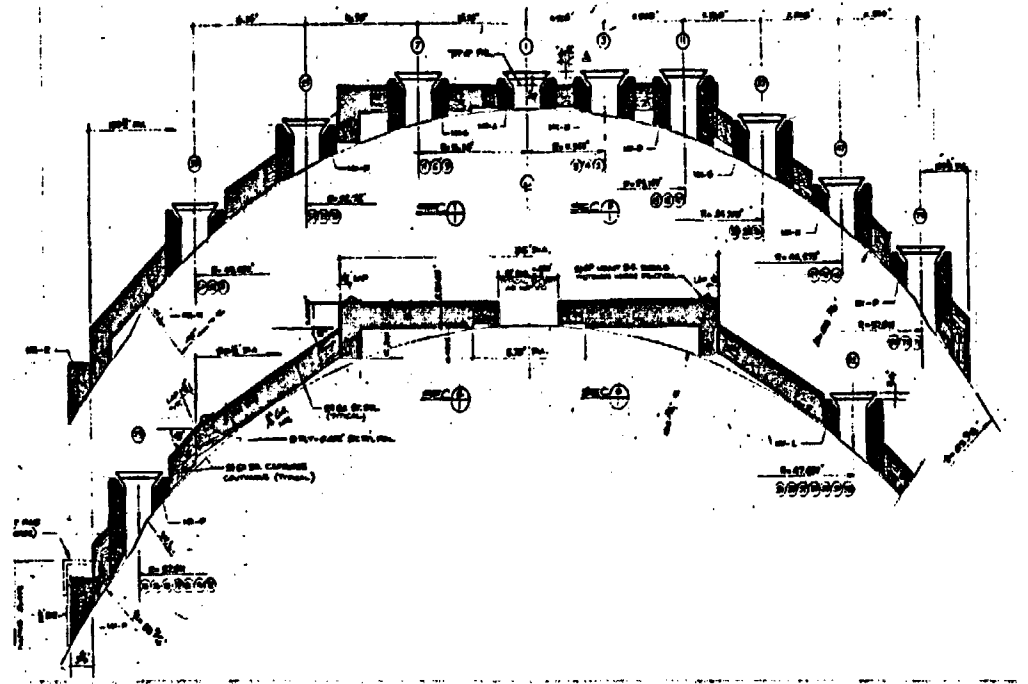
# RVH Cooling Shroud and ICI BMV



6/17/2003

# Panel Insulation

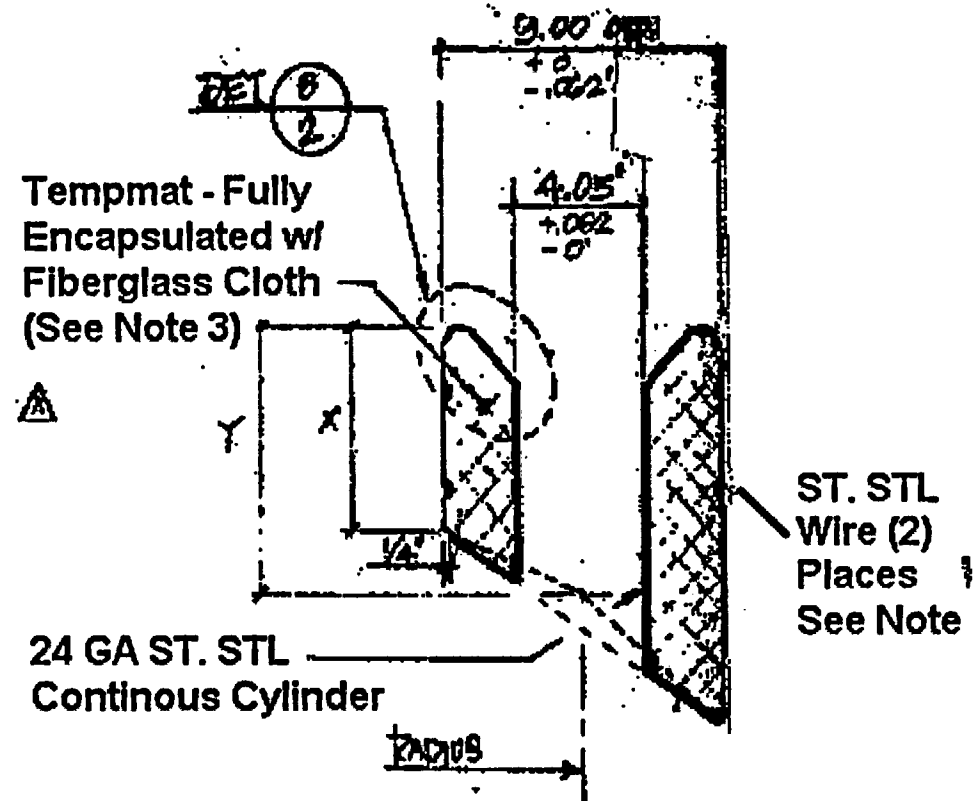
- ▶ Collars are enclosed by prefabricated Stainless Steel reflective insulation panels
- ▶ Panels are sized to closely fit around the collars
- ▶ 56" diameter dome panel and 16 panels around the radius





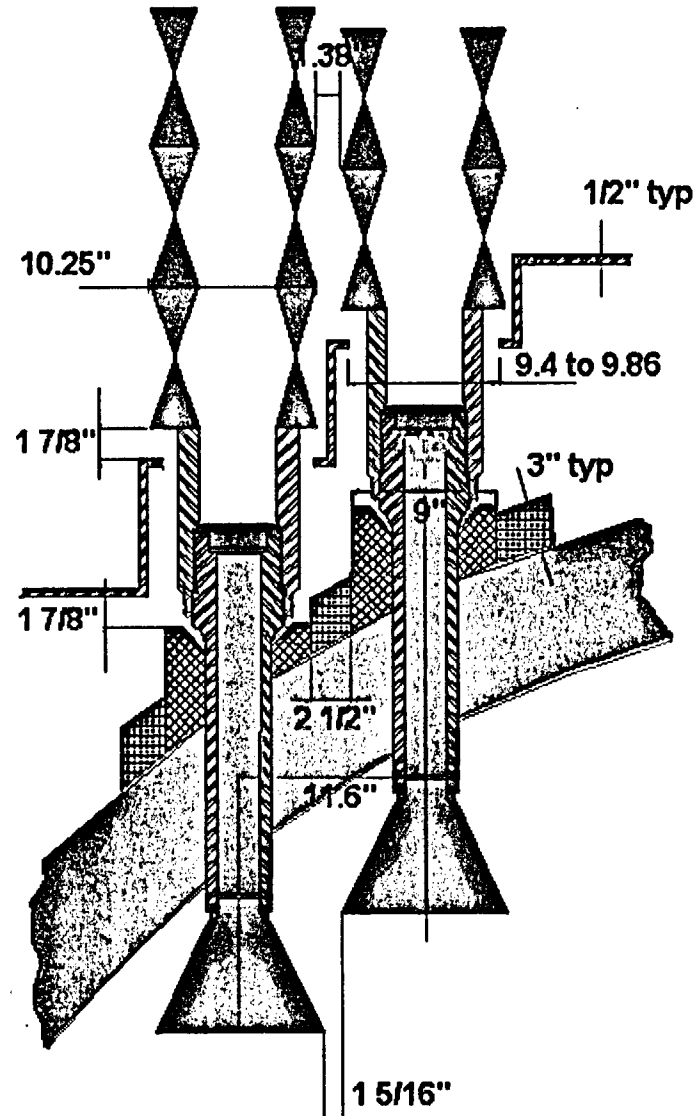
# Nozzle Insulation Collars

- ▶ 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



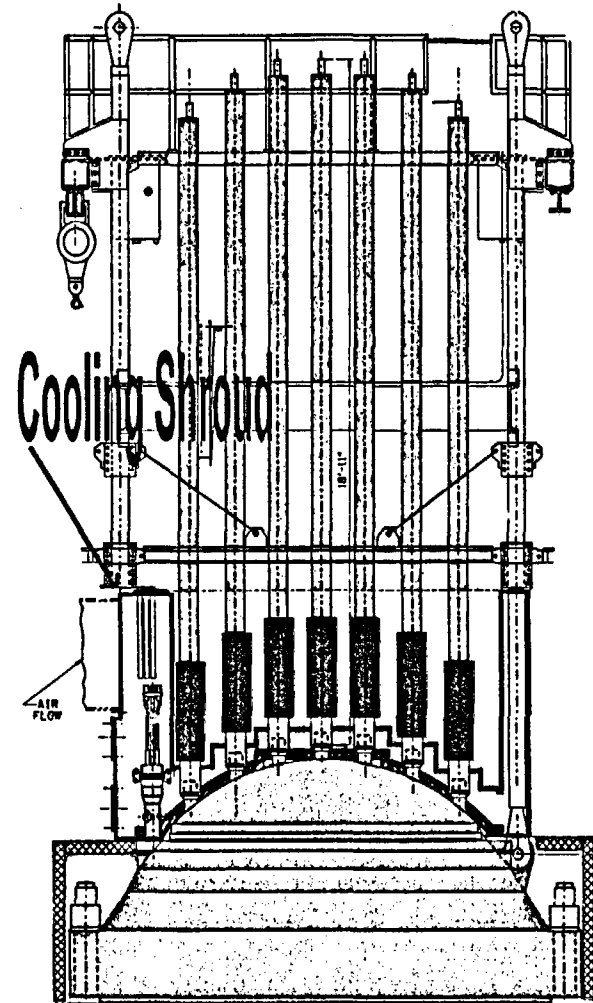
# What's Unique About ANO-2

- ▶ **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**



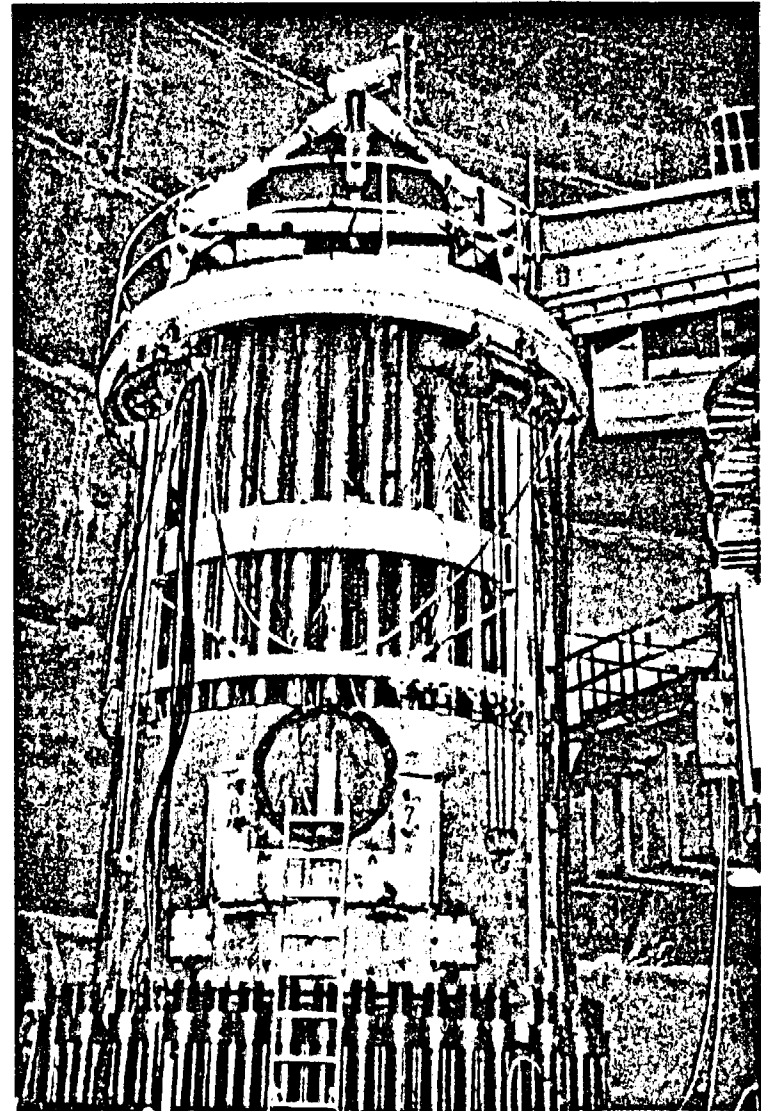
# Disassembly Sequence

- ▶ **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



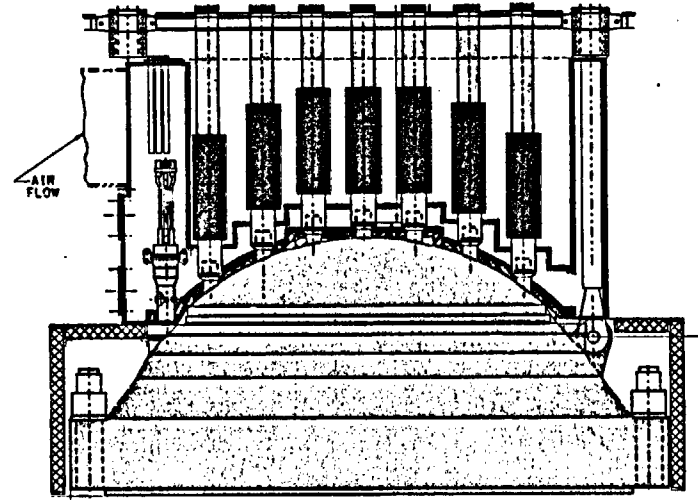
# Last Outage - 2R15

## 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



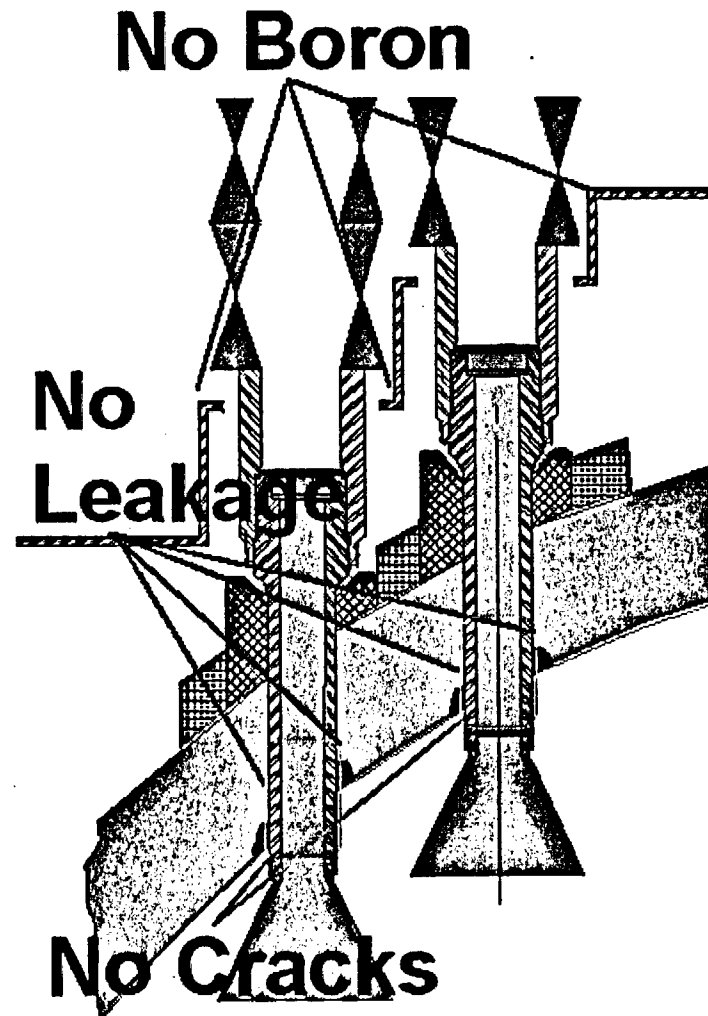
# 2R15 Inspection Results

- ▶ **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



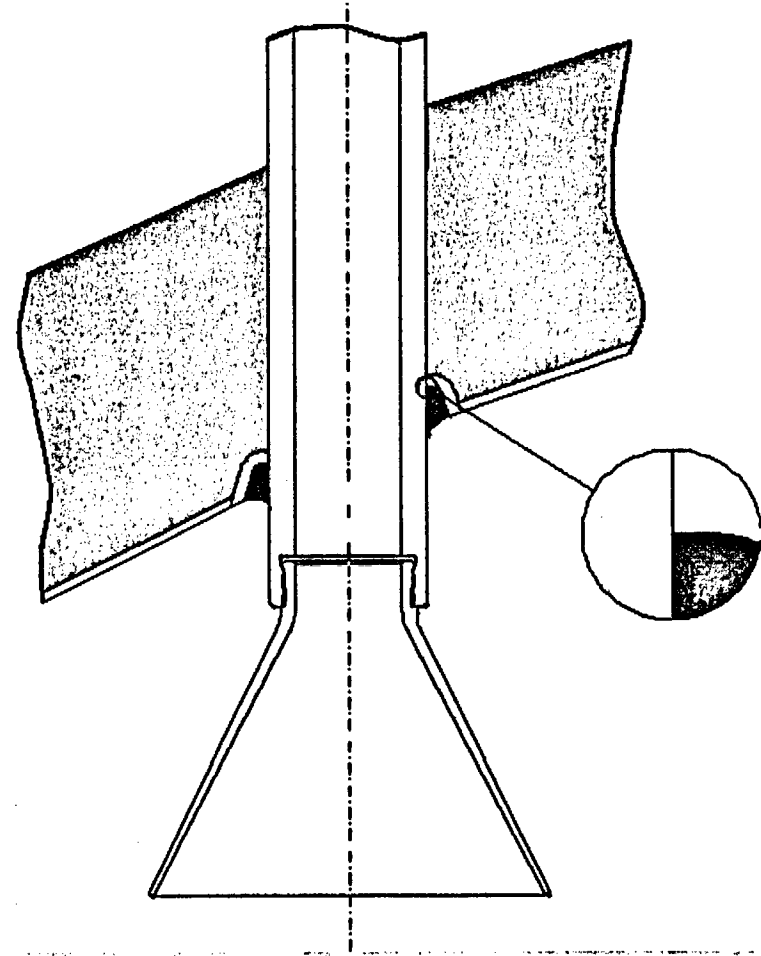
# Demonstration of Triple Point

## Energy Demonstration

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

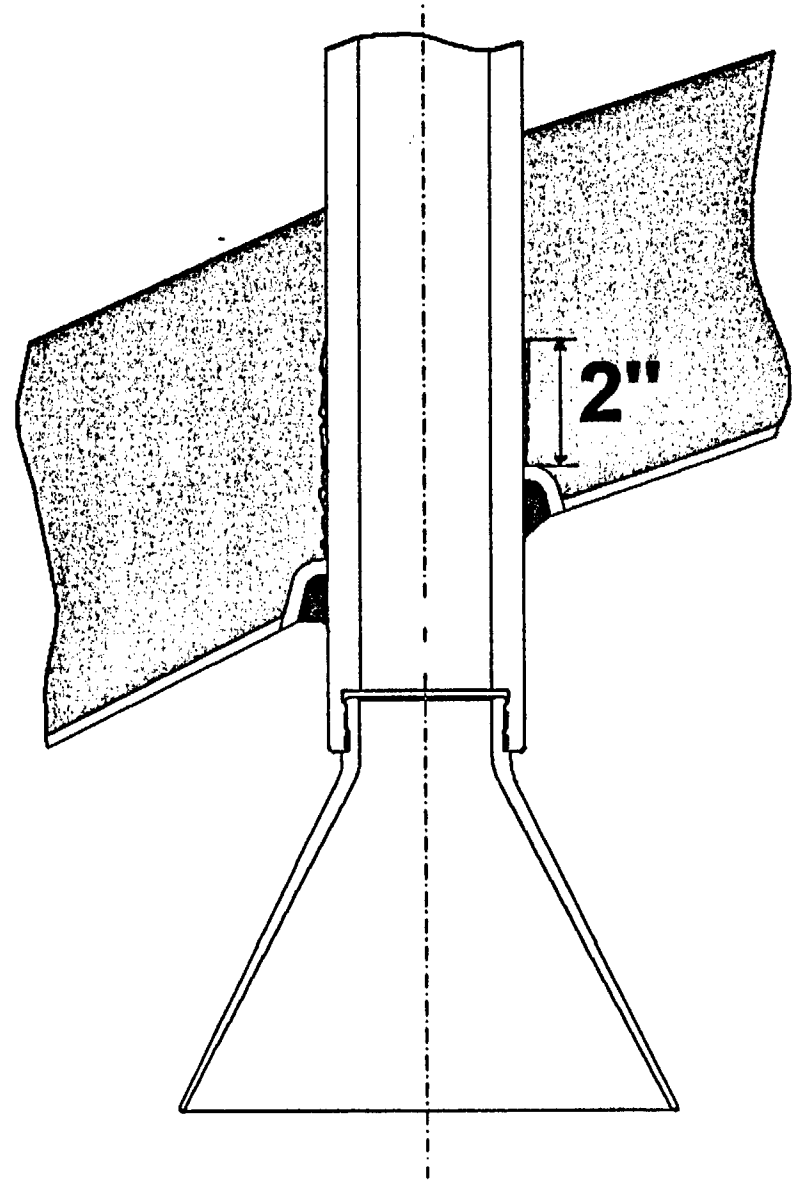
## Phase 2 MRP Demonstration

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

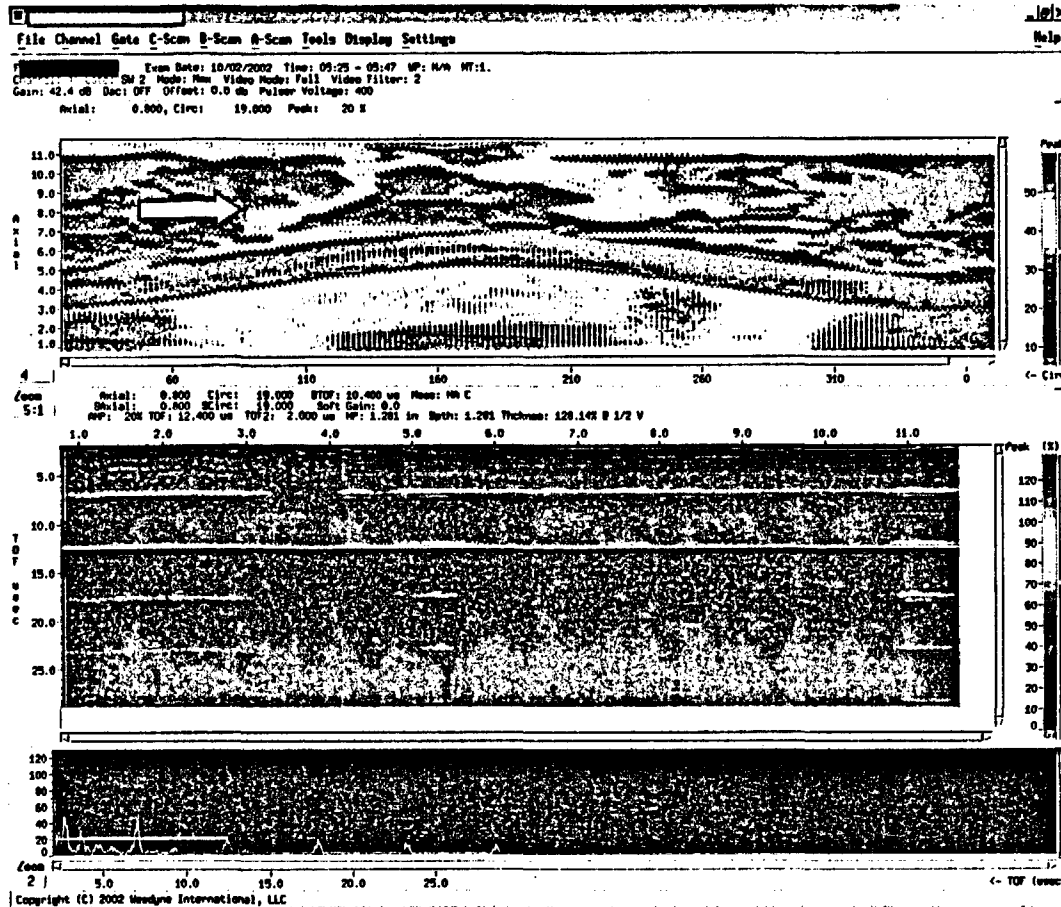


# Riverbed Exam

- ▶ 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



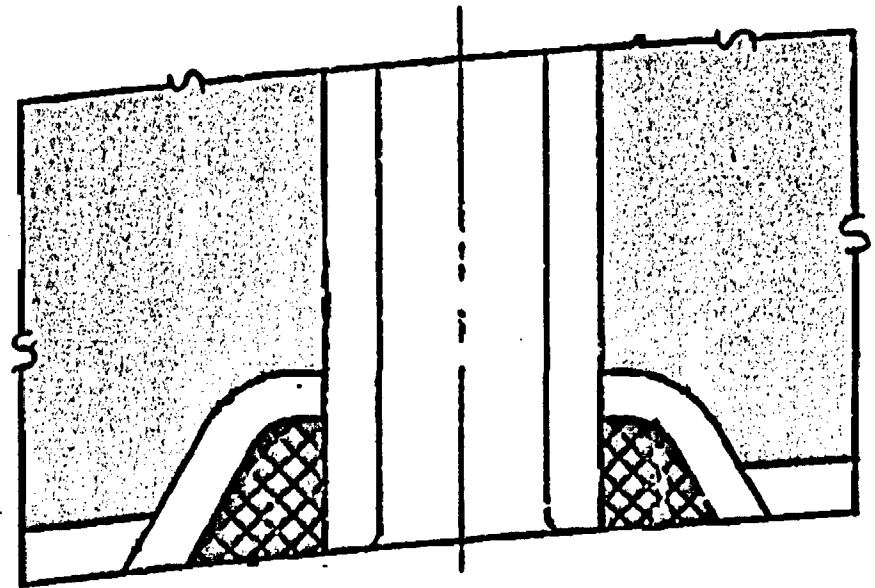
# Riverbed Identification



- ▶ 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

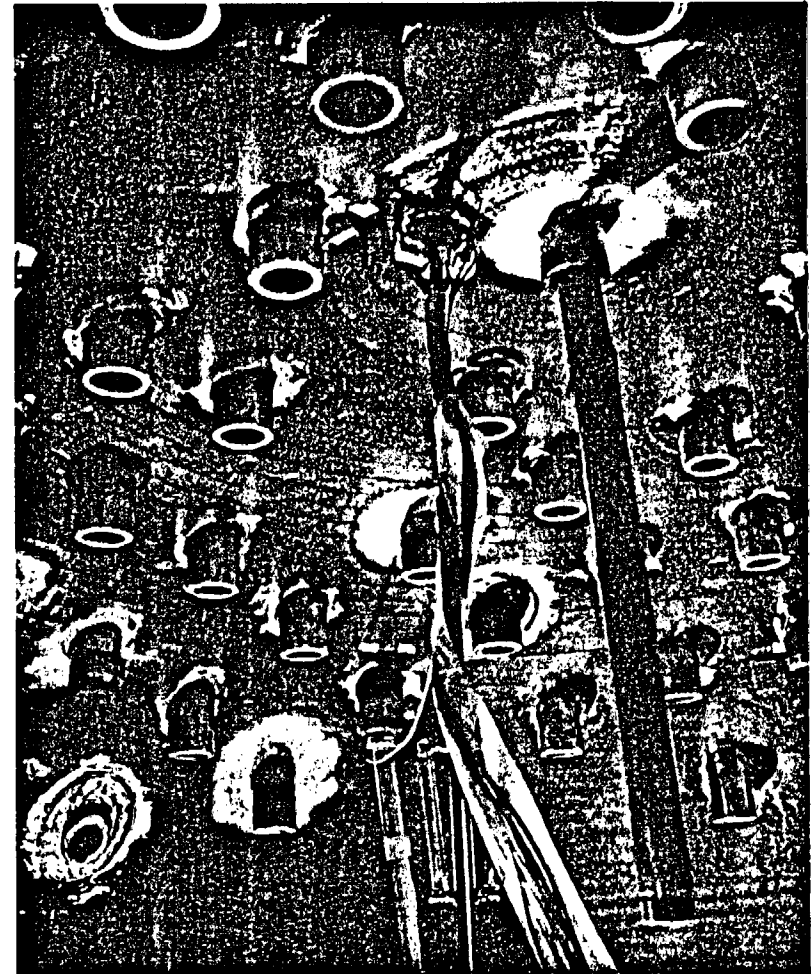
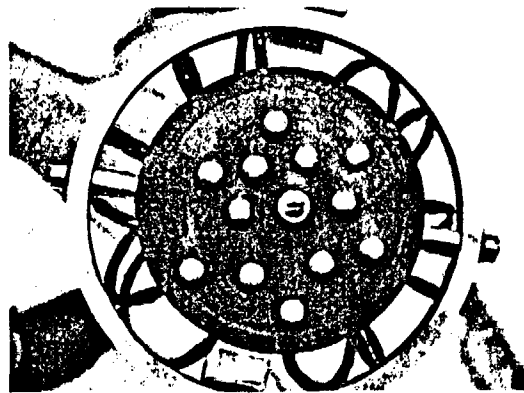
- ▶ Complete wetted surfaces examination
  - ECT examination at tube ID surface
  - ECT array examination of J-weld surface





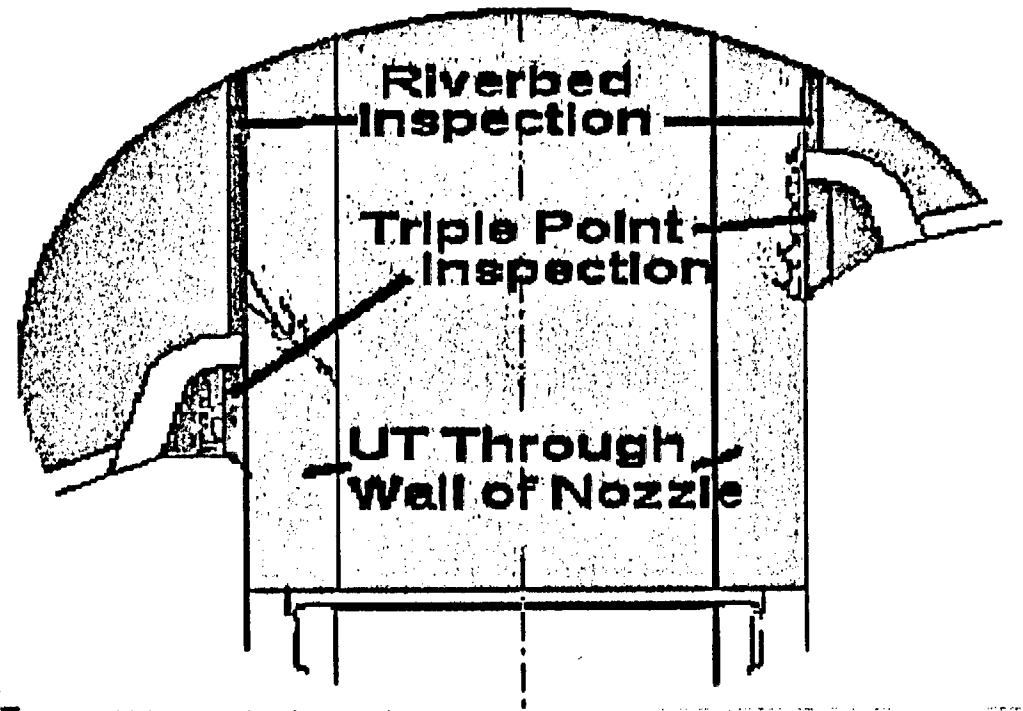
# Reactor Vessel Vent Line J-Groove Weld ECT Examination

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



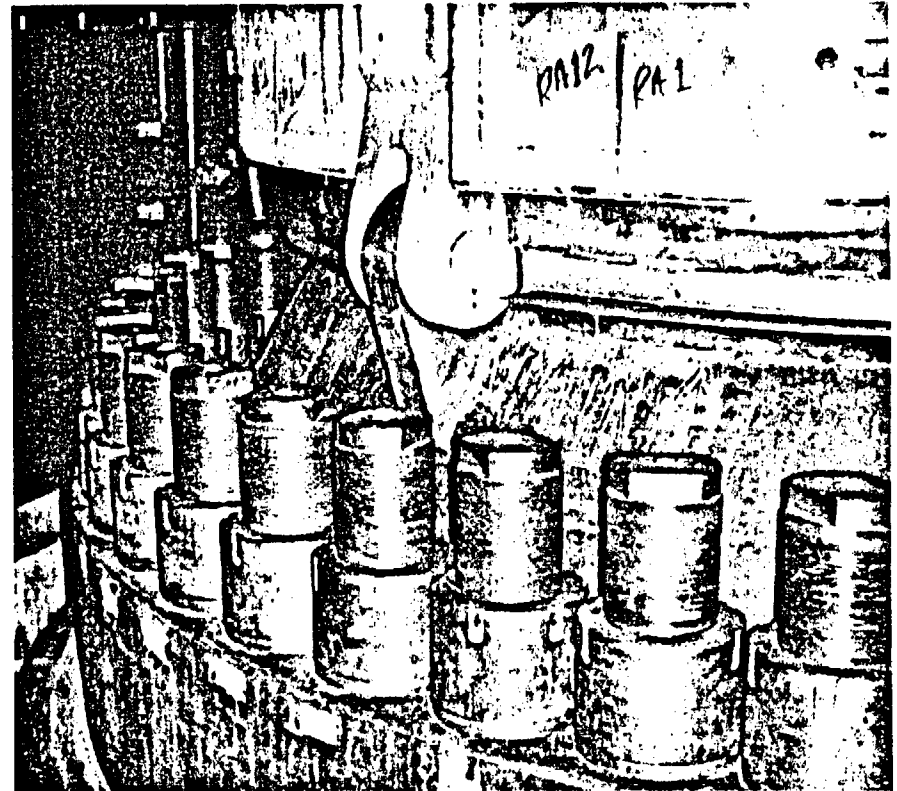
# CEDM/ICI Volumetric Summary

- ▶ 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

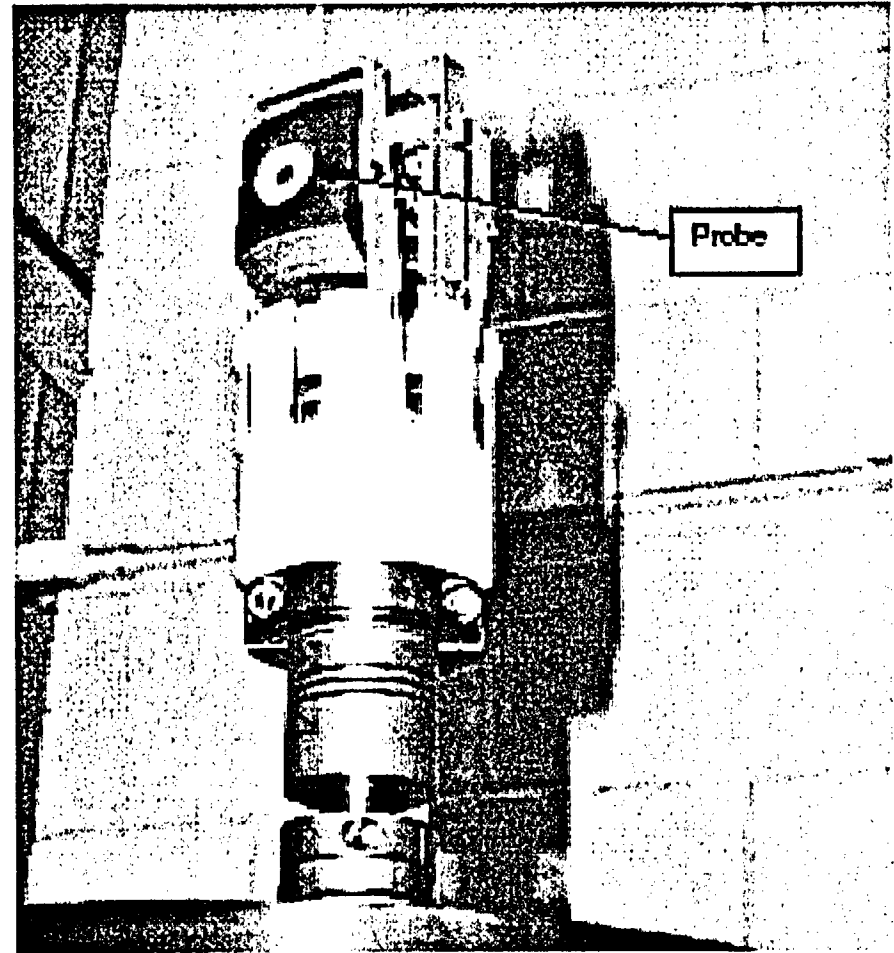
- ▶ CEDM/ICI nozzles
  - UT Through wall
  - Triple point
  - Riverbed
  - Supplemental Visual
  - BMV ICI
  - Low Frequency Eddy Current Vessel Exam (CEDMs)
- ▶ Vent Line
  - Wetted Surfaces Inspection
  - Supplemental Visual
  - Low Frequency Eddy Current Vessel Exam



# Low Frequency Eddy Current Exam for CEDM and Vent Locations

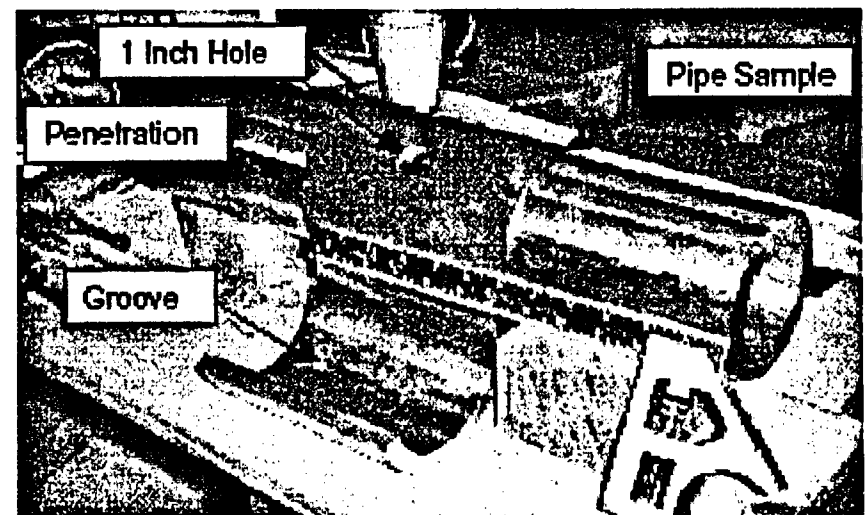
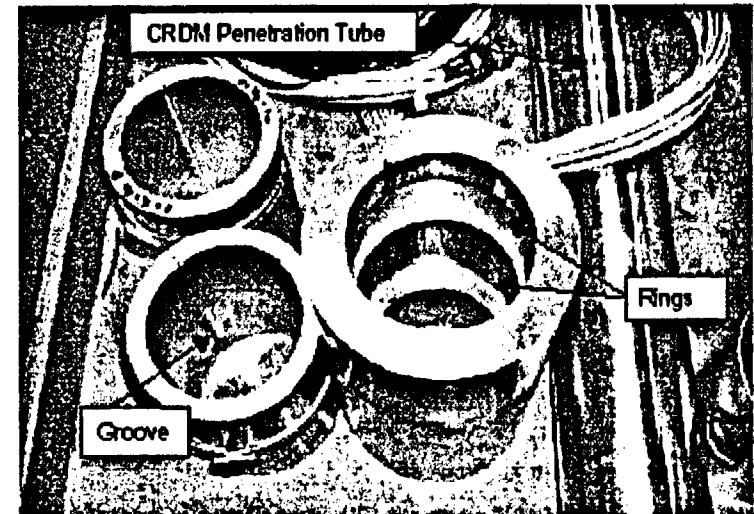
# Development of Low Frequency EC Vessel Leakage/Integrity Inspection

- ▶ 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



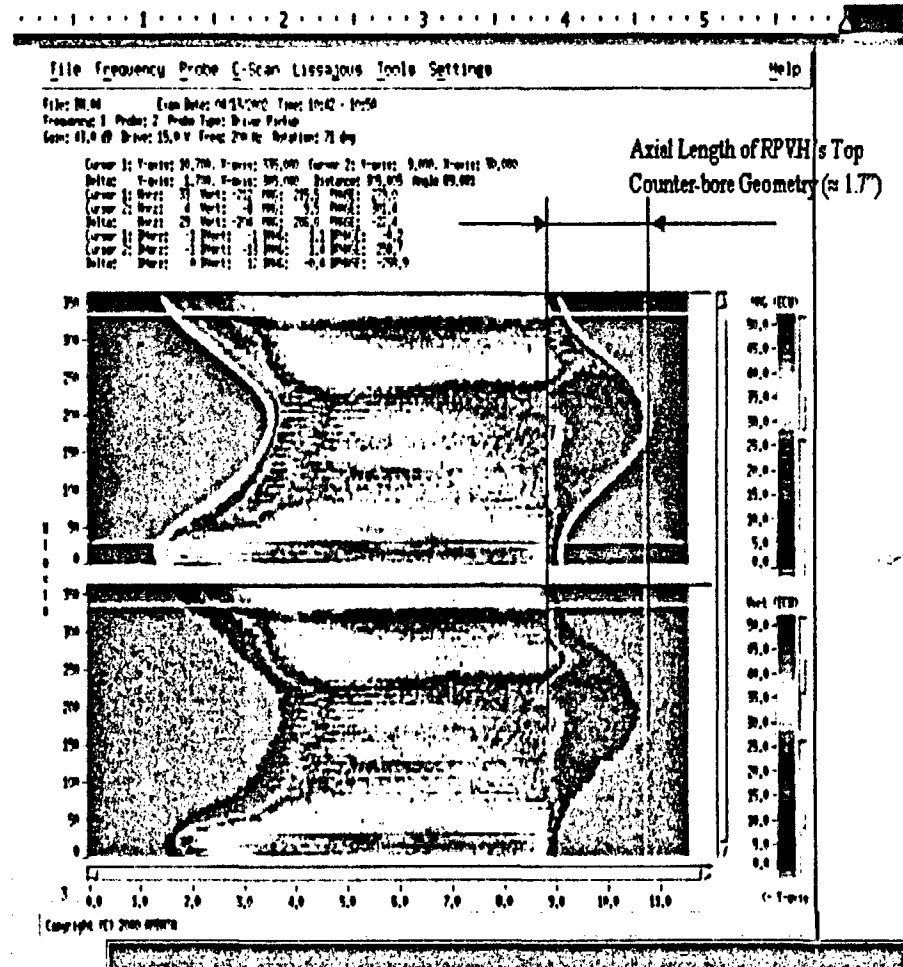
# Development of Low Frequency Vessel Leakage/Integrity Inspection

- ▶ 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



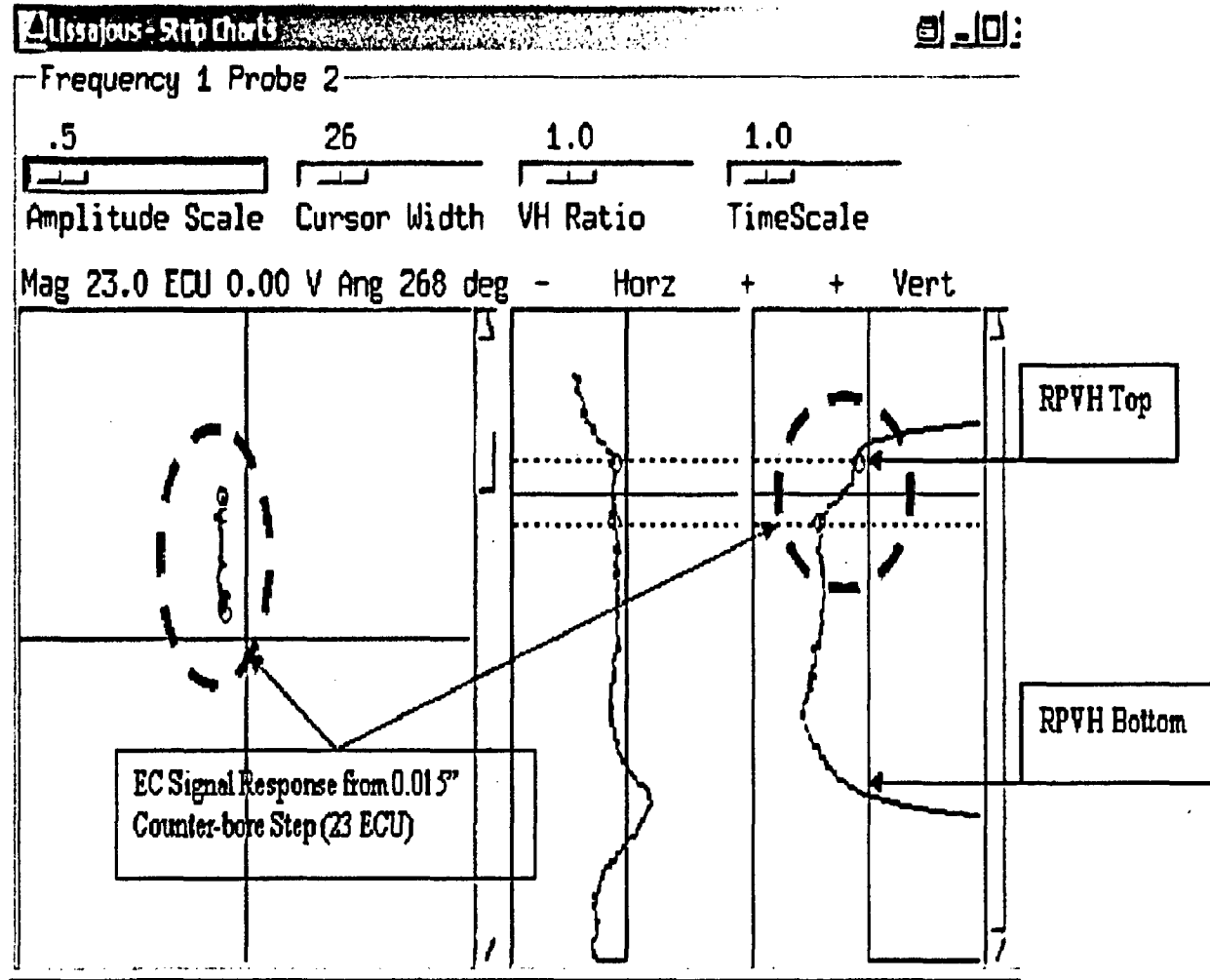
# Development of Low Frequency Vessel Leakage/Integrity Inspection

- ▶ 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)



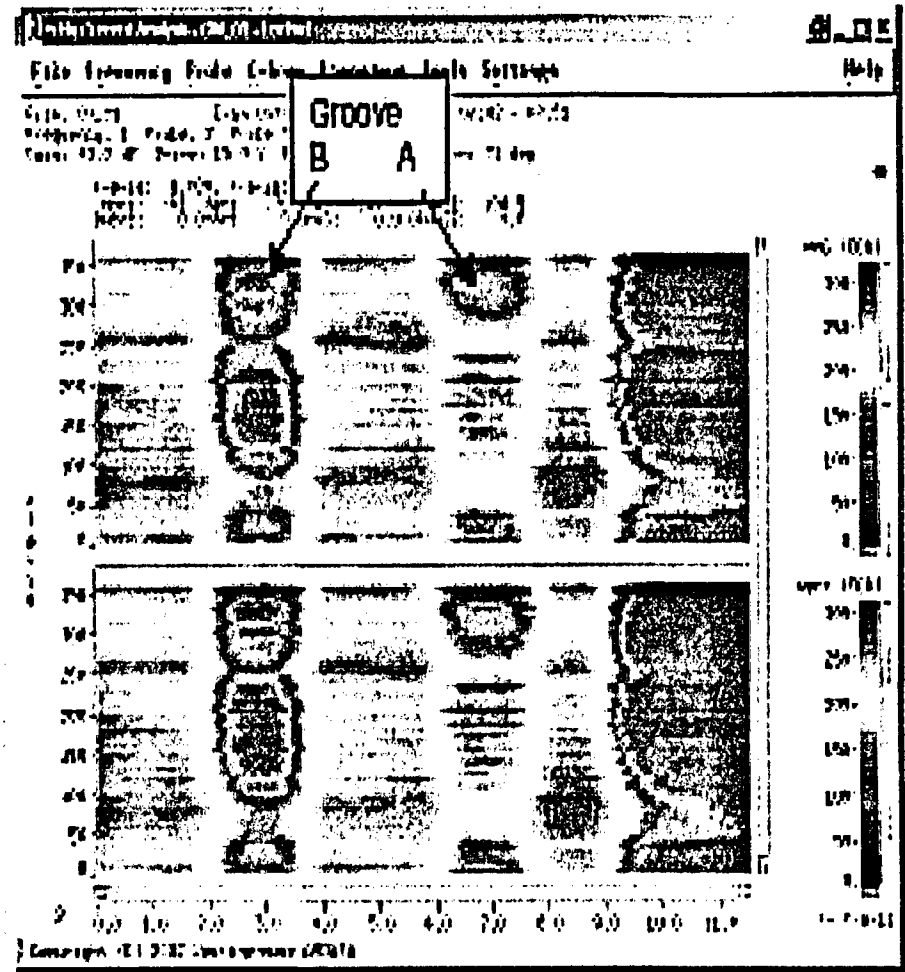


# Development of Low Frequency ECT Vessel Leakage/Integrity Inspection



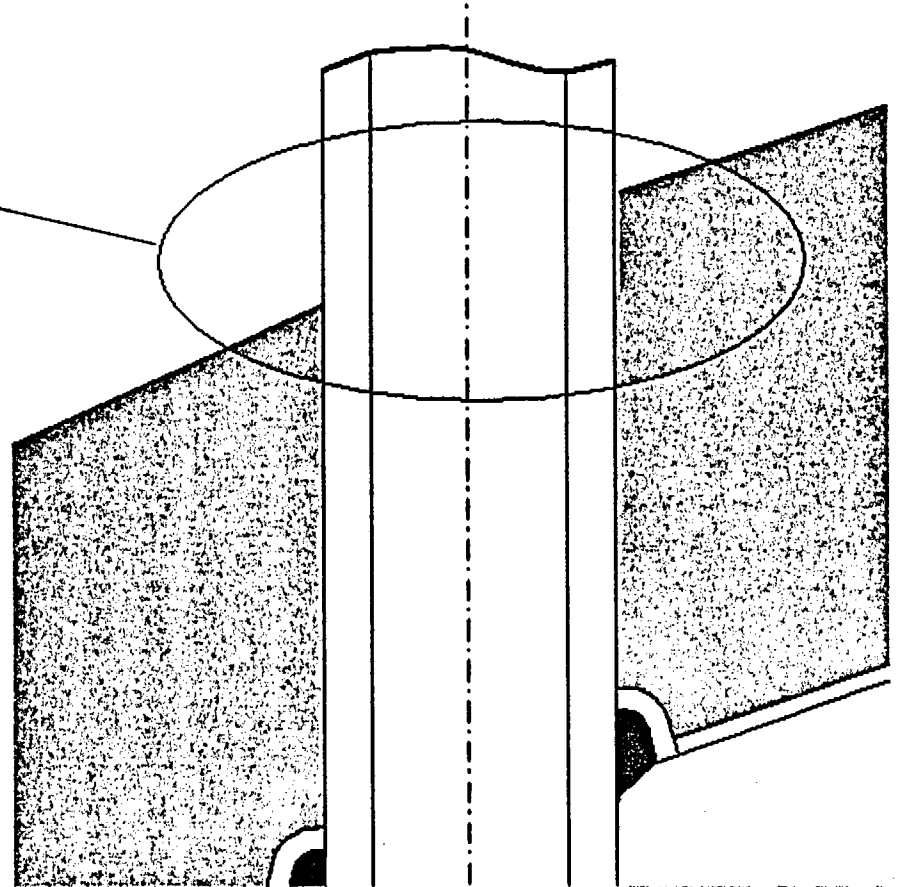
# Development of Low Frequency Vessel Leakage/Integrity Inspection

- ▶ 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



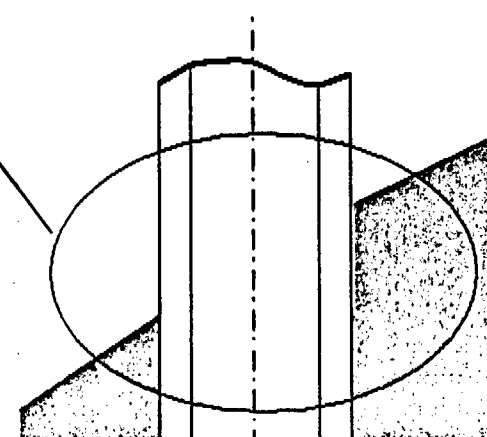
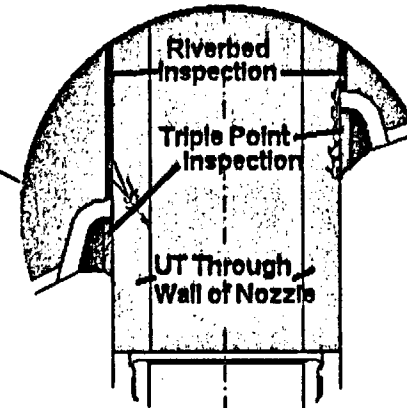
# ICI BMV

- ▶ 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

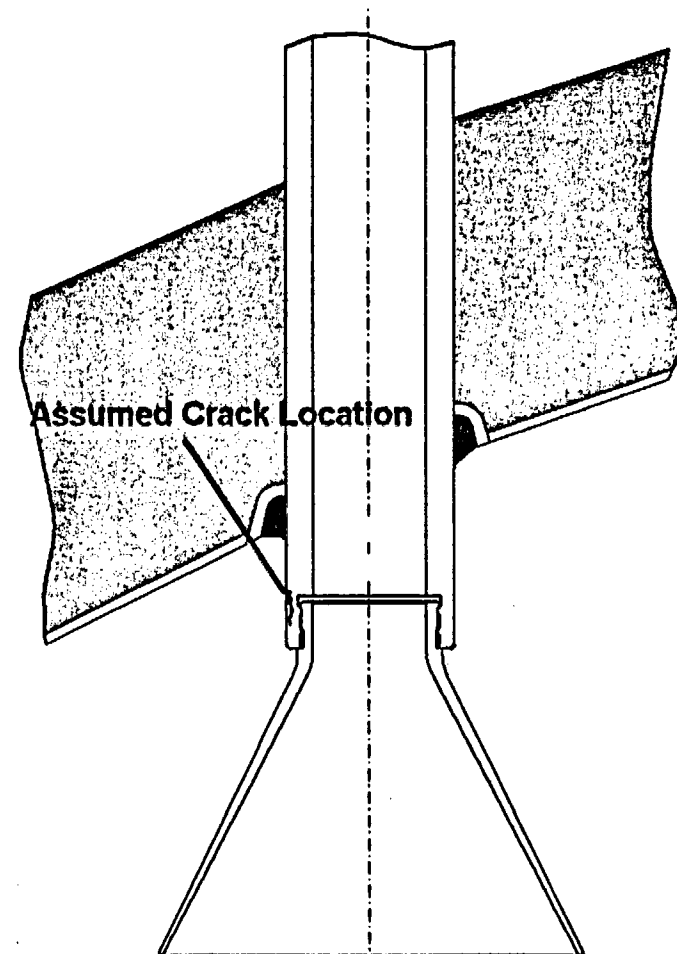
Diverse & Complementary inspections that ensure quality and safety



# Other Relaxation Requests

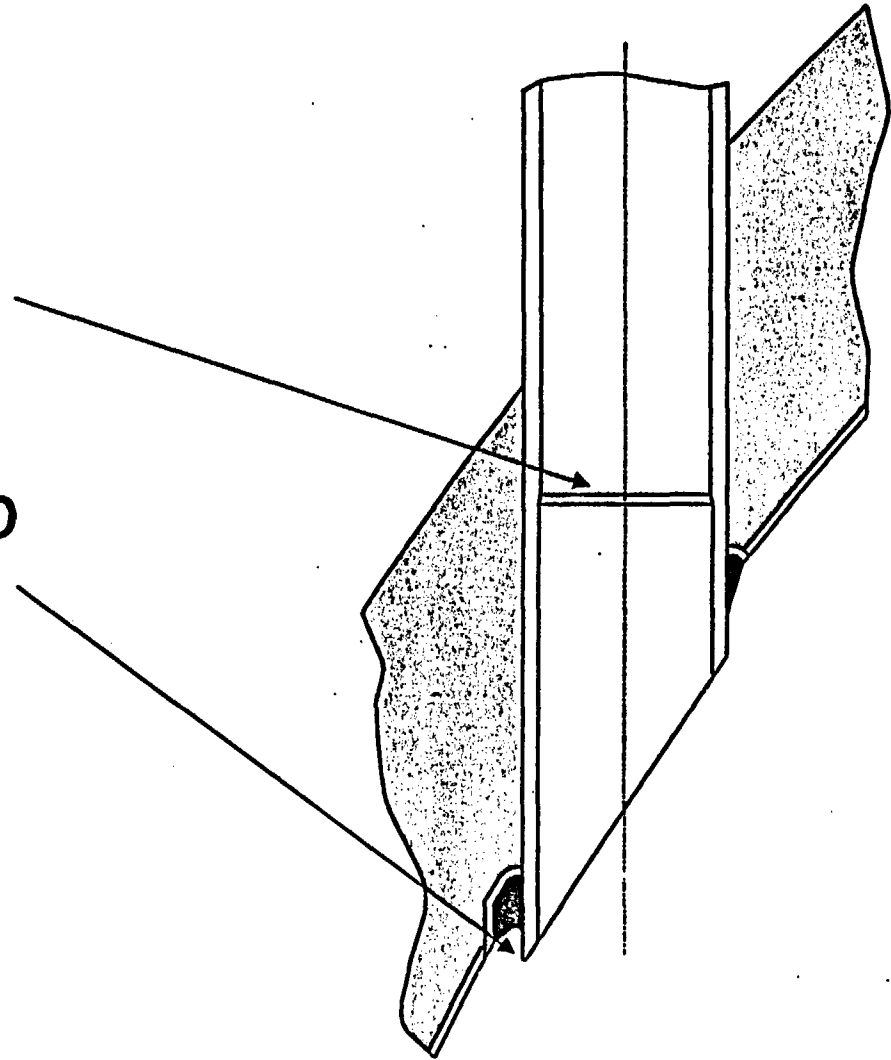
# ORDER Relaxation - Inspection of Threaded Nozzle Cone Area

- ▶ 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

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

# Closing Remarks