NRC FORM 658
(9-1999)

U.S. NUCLEAR REGULATORY COMMISSION

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Do not include proprietary materials.

DATE OF MEETING: 10/16/02

The attached document(s), which was/were handed out in this meeting, is/are to be placed in the public domain as soon as possible. The minutes of the meeting will be issued in the near future. Following are administrative details regarding this meeting:

Docket Number(s): 50-313

Plant/Facility Name: ANO-1

TAC Number(s) (if available): MB5870

Reference Meeting Notice: 10/15/02 (ML022880233)

Purpose of Meeting (copy from meeting notice): TO DISCUSS THE ARKANSAS NUCLEAR ONE, UNIT 1, REACTOR PRESSURE VESSEL HEAD WELD REPAIRS

NAME OF PERSON WHO ISSUED MEETING NOTICE	TITLE
TOM ALEXION	PROJECT MANAGER

OFFICE: NRR

DIVISION: DLPM

BRANCH: PD IV

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ANO-1 Reactor Vessel Nozzle Repair

Entergy Operations Inc.

October 16, 2002

Agenda

❖ Introduction/Purpose	Craig Anderson
❖ 1R16 (Spring 2001) Findings/Repair	William Sims
❖ 1R17 NDE Findings	Steve Lewis
❖ 1R17 Weld Repair Details	William Sims
❖ Evaluation of Weld Repair	Steve Lewis
❖ Assurance for Not Having Leakage Path to Annulus	Steve Lewis
❖ Safety Perspective	Mike Krupa
❖ Concluding Remarks	Craig Anderson

Introductory Remarks

Craig Anderson

Status of ANO-1 CRDM Nozzle Examinations

- 100% Bare Metal Visual Exam Completed
  - Periphery Nozzle 56 was identified to be leaking
- Volumetric Examinations in Progress
- Liquid Penetrant and Eddy Current Exams Performed on Nozzle 56

1R16 (Spring 2001) Findings/Repair

William Sims

Entergy A600 Technical Lead

Repairs Performed During 1R16 on Nozzle 56

- Visual Inspection Performed Identified Nozzle 56 was the Only Leaking Nozzle
- UT and PT Performed
  - Flaw was determined to be axial in the weld to nozzle interface at ~30 degrees from low hill side
  - Extended above J-weld in the nozzle
  - Circumferential flaw in nozzle below J-weld

Repairs Performed During 1R16 on Nozzle 56 (cont.)

- Severed Nozzle above the OD Circ Crack
- Excavated the Flaw in nozzle/J-Weld to Butter Region At Triple Point
- Excavated Area Filled with 152 Weld Material to Surface of Existing 082/182 weld
- New Weld was PT Cleared with Progressive Exams

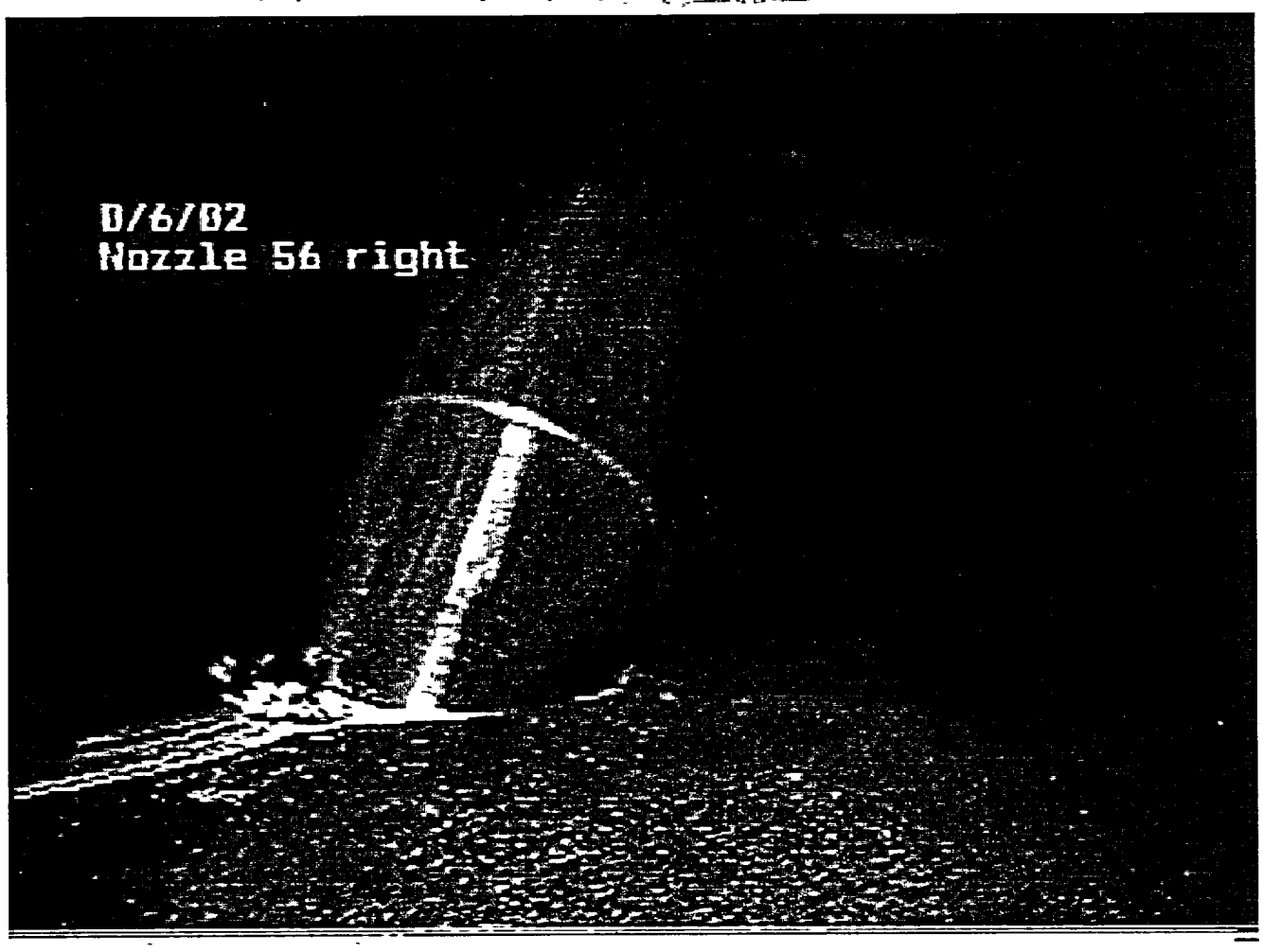
1R17 NDE Findings

Steve Lewis
Supervisor, Engineering

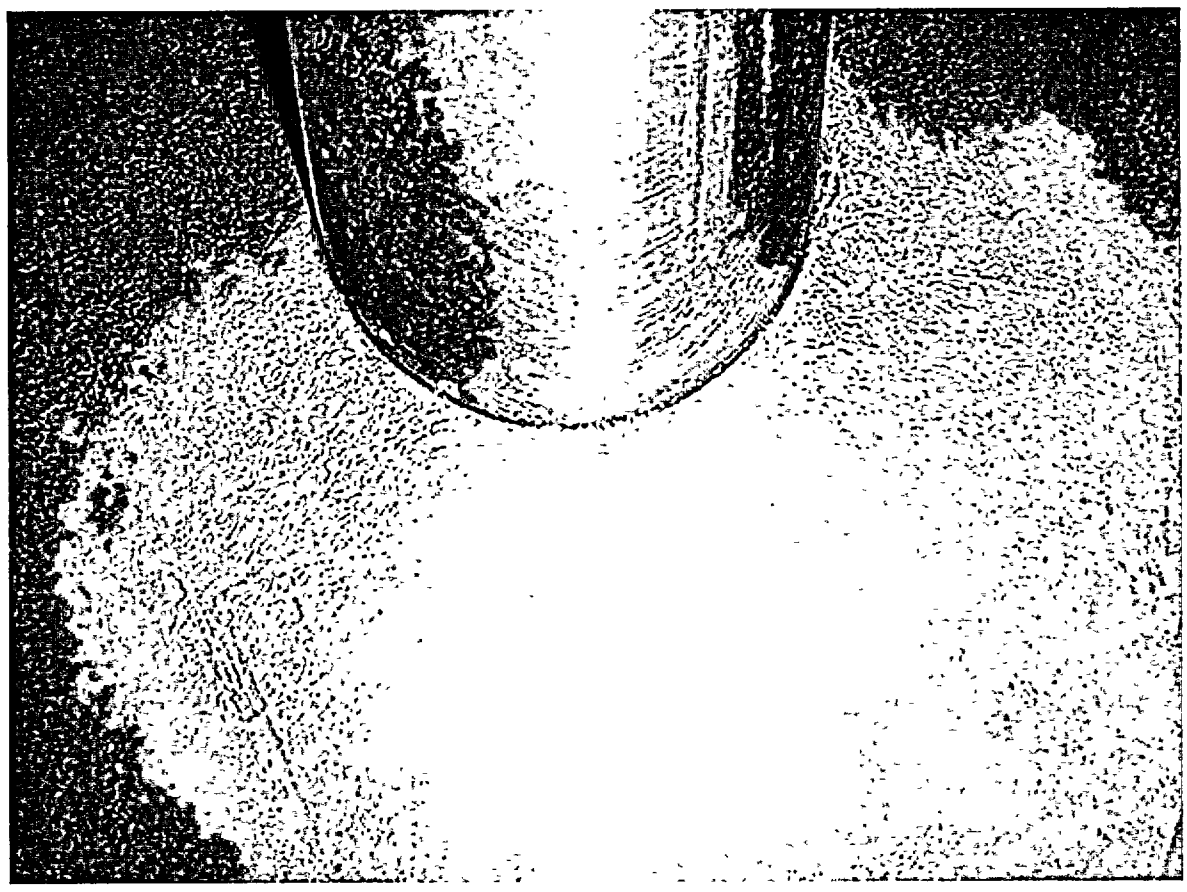
Status of Current Findings of Examinations of CRDM Nozzles

- Top Head Bare Metal Visual Inspections
  - Nozzle 56 Determined to be the only leaking nozzle
  - No evidence of wastage

1R17 Nozzle 56 Boric Acid



1R17 Post Cleaning of Nozzle 56



Status of Current Findings of Examinations of CRDM Nozzles (cont.)

Nozzle 56 Ultrasonic Data

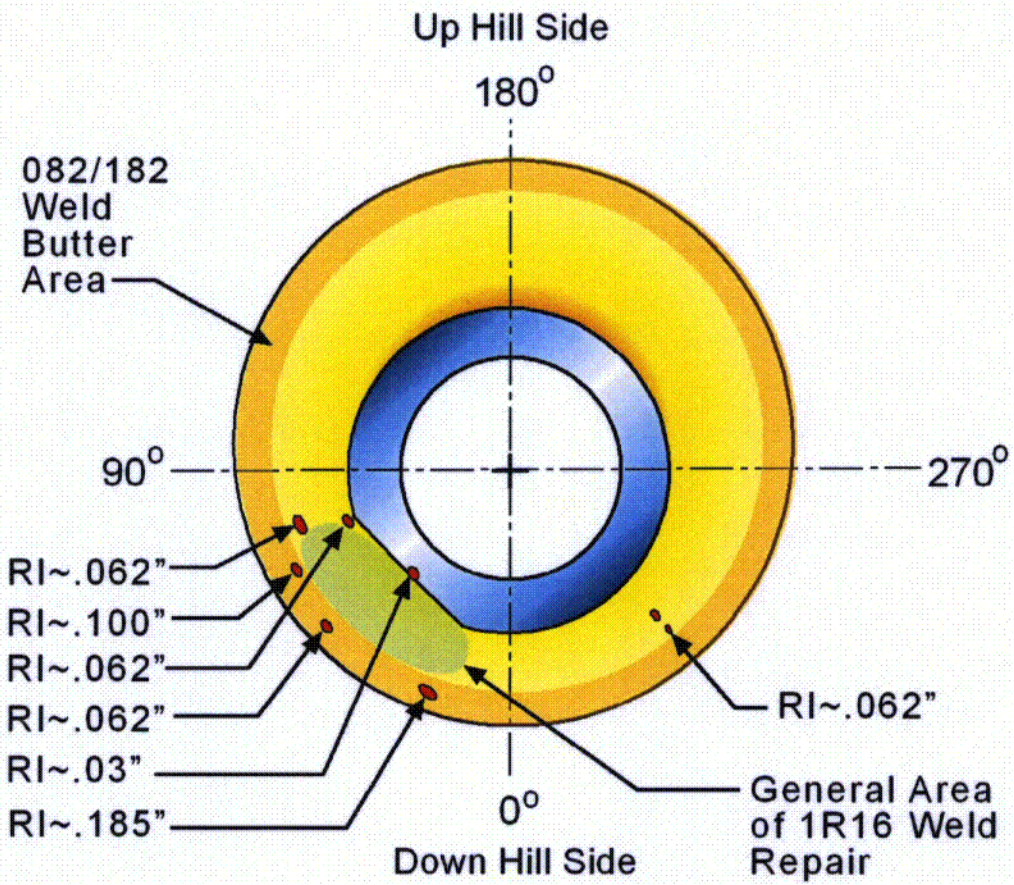
- Four Indications Adjacent to 1R16 Weld Repair
- Two Indications on Hill Side of Nozzle

Flaw #	Depth	Length	Az.	Above	Below
1A	0.177	0.56	20°	.16	---
2A	0.145	0.44	37 °	.12	---
4A	0.177	0.28	175 °	.16	---
5A	0.125	0.6	164 °	0	.12
1C	0.266	0.4	24 °	--	*
2C	0.180	0.68	39 °	.32	--

*With uncertainty below weld only

- No Indications Identified to Have Circumferential Extent

PT Layout of Nozzle 56
(General Representation)



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Preliminary Results of Nozzle 56 Findings

- No Evidence of Alloy 052 cracking
- No Wastage Identified at Nozzle Bore Annulus Area from Bare Metal Visual Inspection (Boric Acid Showed No Discoloration)

1R17 CRDM Nozzle Weld Repair

William Sims

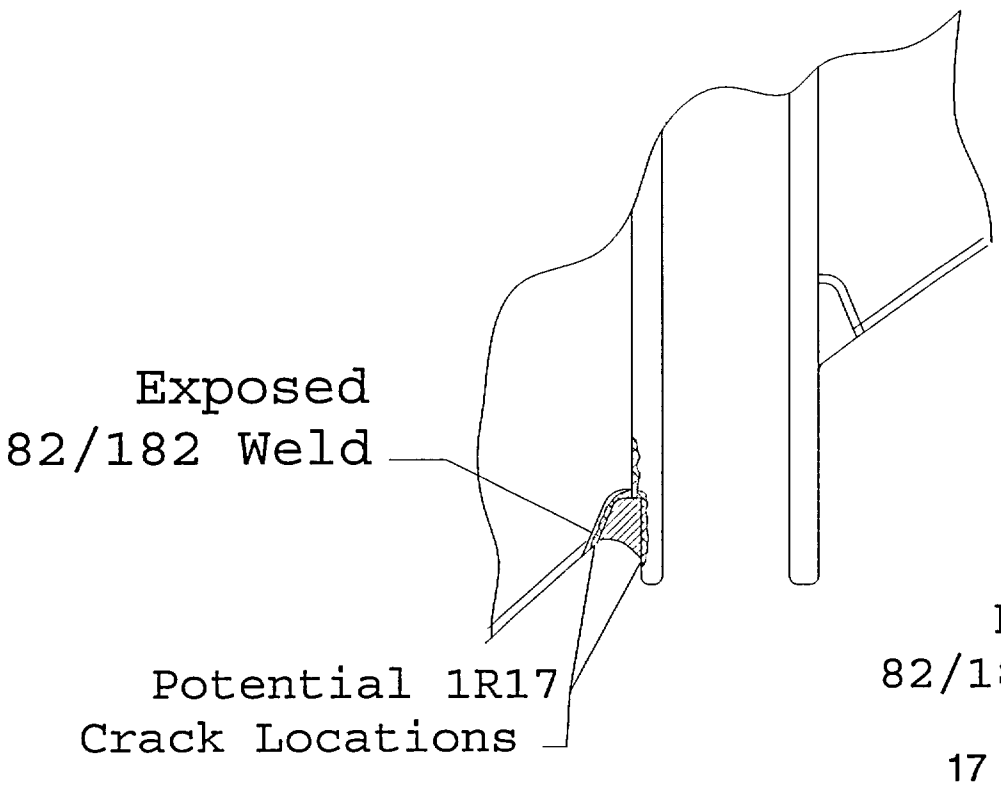
Entergy A600 Technical Lead

Design Repair Objectives

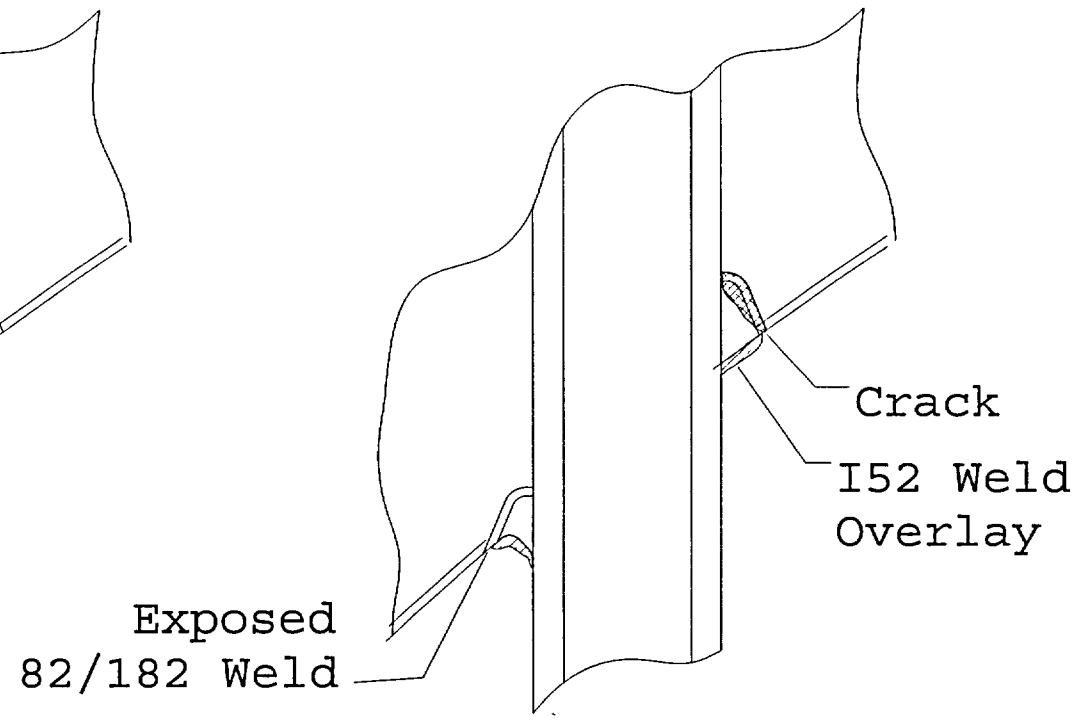
- Maintain Safe Operation of the Unit
  - Provide ASME Code Compliance for Two Cycles of Operation
    - Maintain Code margins
  - Isolate the Flaw from the PWSCC Environment
    - Use of PWSCC resistant material
    - Control of repair processes
  - No leaks
- Incorporate Lessons Learned

Incorporate Lessons Learned

ANO

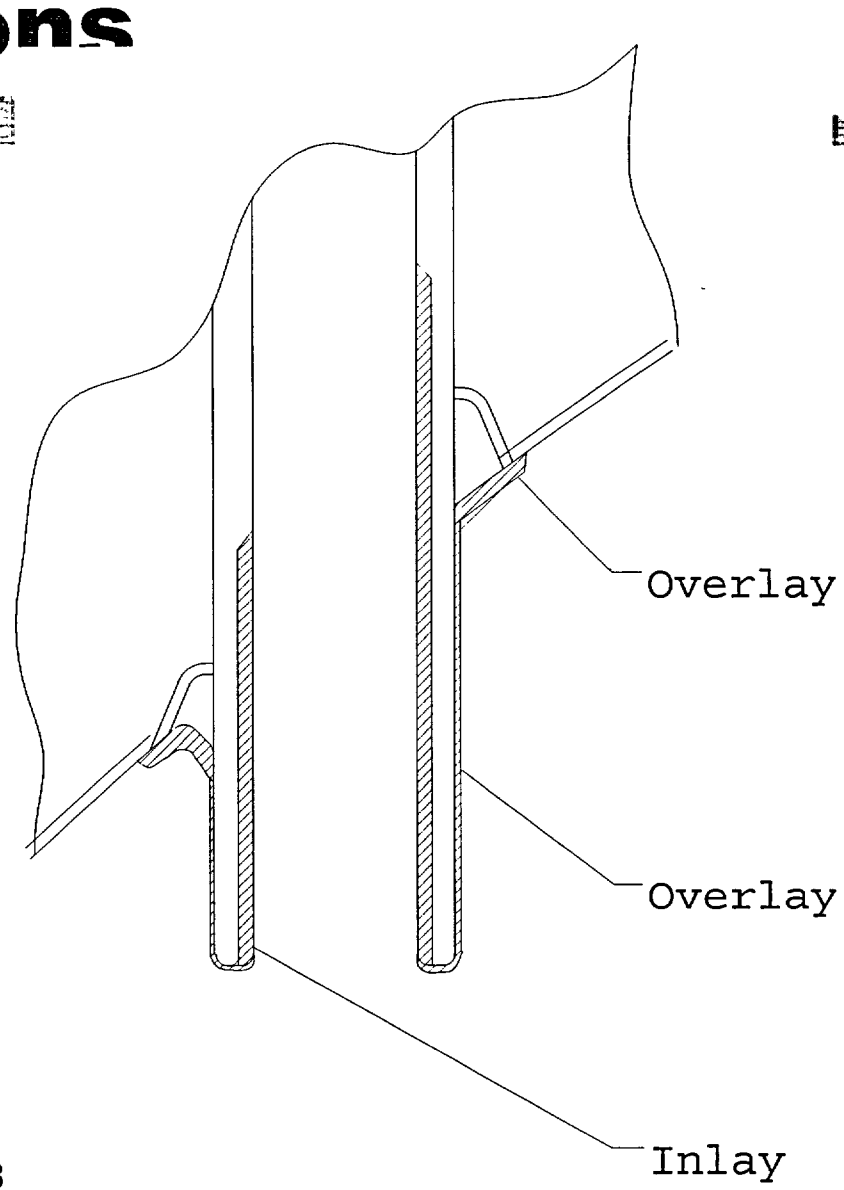


North Anna



Description of Weld Repair Options

- Embedded Flaw Repair Features (used in combination or individually)
  - 360° J-Groove weld and butter overlay
  - 360° Nozzle inlay or overlay
  - 90° Nozzle inlay
  - Weld overlay on nozzle OD surface to mitigate crack initiation
- Or Just Remove The Flaw



Weld Repair Process

- Identification of 082/182 Material Boundary
  - Entergy will identify boundary between existing 082 material and SS clad using "ferrite" tool
  - Marks will be applied to location of 082/182 SS clad interface to identify boundary
  - Personnel will be trained and qualified by blind mockup
  - Independent verification will be performed
  - Welds will overlap SS Clad by a minimum of 1/2"
  - Written instructions will control this process

Weld Repair Process

- Weld Process Applied at ANO-1
  - J-weld overlay will be at least 3/8" thick (minimum of 3 layers)
- Post Weld NDE
  - Surface exam of J-weld overlay and nozzle inlay
  - Volumetric exam of nozzle inlay
  - Visual of weld surfaces

Weld Repair Design

Steve Lewis
Supervisor, Engineering

Weld Repair Design

- Repairs were Designed by Detailed State of the Art Analysis
  - Repairs are Designed by Detailed 3D FE Analysis
  - Stress determination performed by Dominion Engineering
  - All other analysis performed by Structural Integrity Associates

Weld Repair Design (cont.)

- Testing and history to date has shown that 052 integrity is established for greater than two cycles
  - EPRI NP-3061, *SSC of A600 and A690*, May 1983
    - Tests @ 680°F for 6300 hrs
    - Could not get 052 to crack due to PWSCC
  - McDermott Tech Report, Evaluation of 82, 152 and 052 SSC, Constant Extension Rate Tests performed
    - 152(052) Materials tested at 650°F
  - Westinghouse Bettis Pub. PWSCC Crack Growth (1999)

Weld Repair Design

- Westinghouse Bettis Publication on PWSCC Crack Growth Results for Alloy 82H and Alloy 052
  - Fracture mechanics crack growth test a 360°C (680°F)
  - Results compared to industry data
  - Alloy 82H crack growth rates consistent with industry data for Alloy 600
  - No crack extension in Alloy 52 at high stress intensity and extended times

Recent Industry Experience with Alloy 052/152

- DC Cook Inlay Repair
- VC Summer Butt Weld Repair
- Canopy Seal Weld Overlay Repairs
- BWR Nozzle to Safe End Weld Overlay Repairs
- North Anna Overlay Repairs
- ANO-1 Repair in 1R16

To Date, No Problems Have Been Reported

Weld Repair Design (cont.)

- Summary
  - Material Demonstrated to be Resistant to PWSCC Initiation and Growth
  - Repair Qualified to Meet All Pertinent ASME Code Section III & XI Criteria

Repair Assurance for Not Having Leak Paths to Annulus

Repair Assurance for Not Having Leak Paths to Annulus

- Evaluation of Leak Paths to Annulus
  - Boron from above RV nozzle annulus
  - Flowpath through ID of nozzle to annulus
  - Flowpath through 052 weld material
  - Flowpath around 052 weld repair

Boron from Above RV Nozzle Annulus

- Geometry and Temperature Result in Low Probability of Maintaining a Wetted Surface
- Not Considered to be a Credible Condition

Flowpath Through ID of Nozzle to Annulus

- Volumetric Exam of Nozzles Performed
- No Indications will be Left in Service
- Adequate Assurance is Being Provided to Prevent Leakage through ID of Nozzle

Flowpath Through 052 Weld Material

- Previously Discussed the Integrity of the 052 Weld Material
- Not considered to be a Credible Leak Path

Flowpath Around 052 Weld Repair

- Existing 082/182 Weld Boundary Will Be Clearly Identified
- Lessons Learned on Ensuring Adequate Coverage of 082/182 Material with Repair Weld Included in Repair Procedures
- Repair Process Will Ensure Integrity of Weld Repair

Safety Perspective

Mike Krupa
Director, Nuclear Safety Assurance

Safety Perspective

- Repair Plans will Remove All Mechanistic Failures that Can Create Leak Paths
- Repair meets ASME Section XI Code Requirements
- Repair Process Has Incorporated Industry Lessons Learned
- Boundary of 082/182 and SS Clad will be Defined
- Appendix B Program will Ensure Proper Weld Application and Quality Control

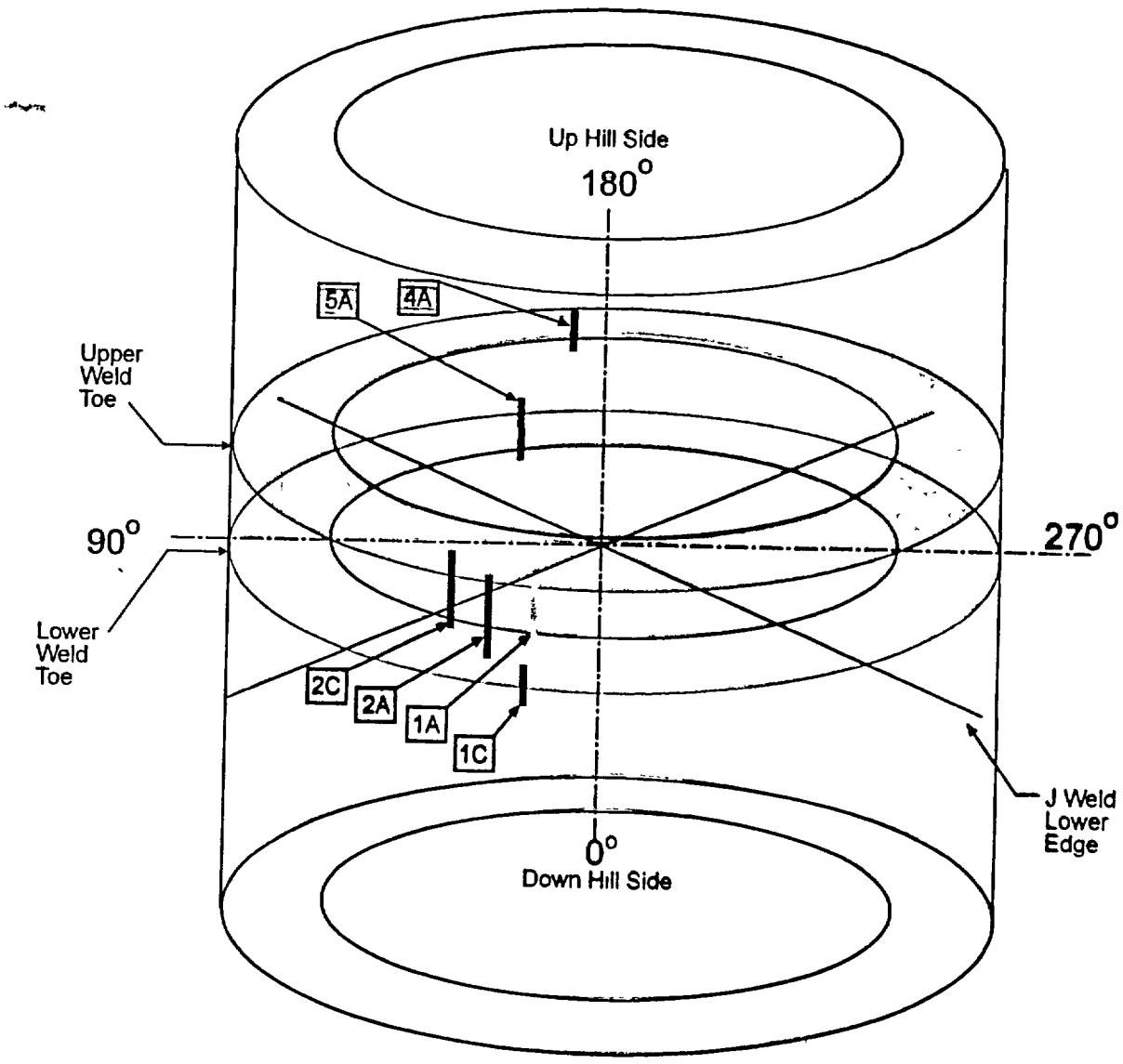
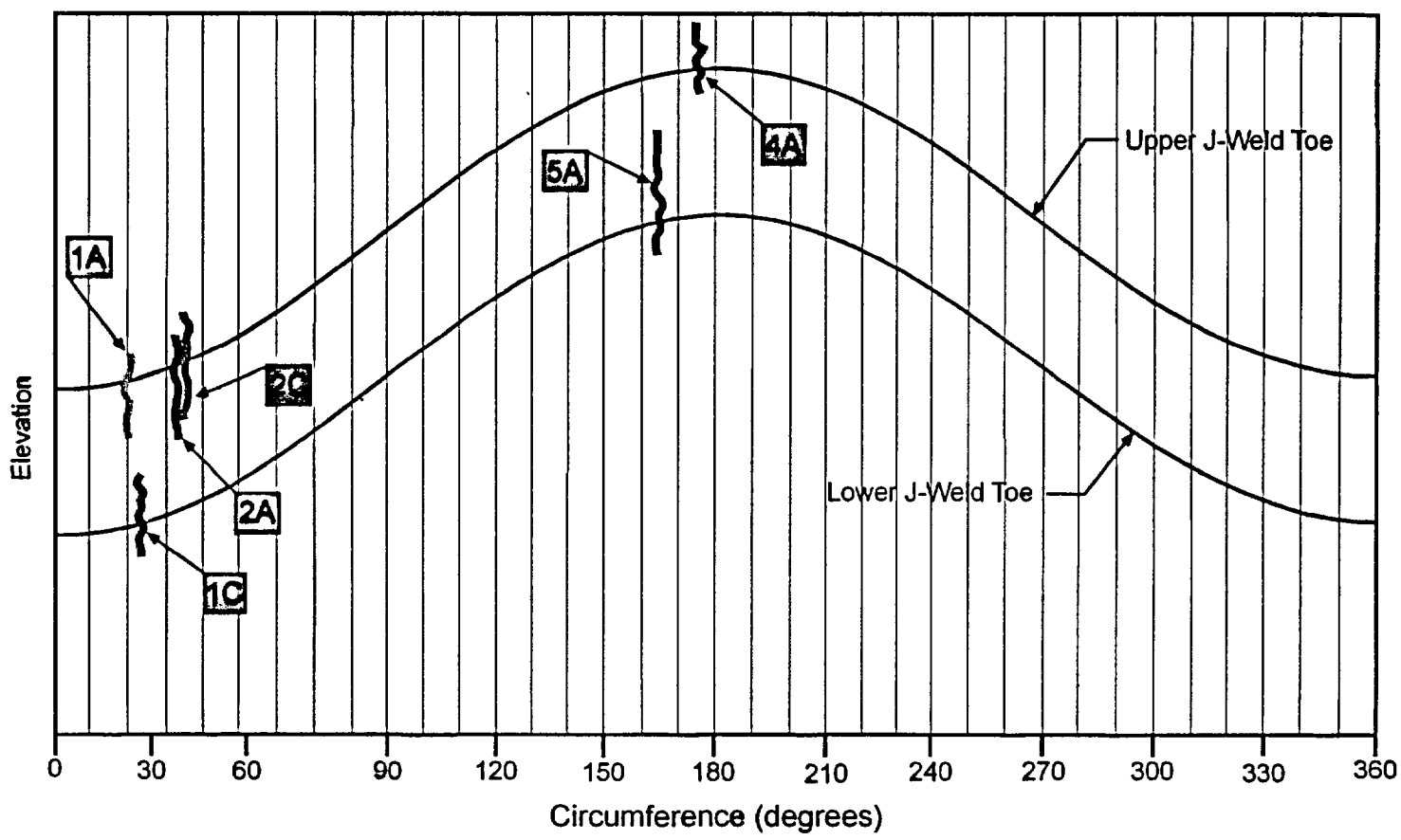
Safety Perspective

- Annulus Will Be Isolated from PWSCC Environment
- Industry/MRP Analyses Have Demonstrated that Alloy 600 Will Not Become a Safety Concern when Properly Managed

Concluding Remarks

Backup CRDM Nozzle Slides

Nozzle 56 UT Scans



UT Graphic of 1R17 Nozzle 56