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UNITED STATES  
NUCLEAR REGULATORY COMMISSION

WASHINGTON, D.C. 20555-0001

December 20, 1994

LICENSEE: Nuclear Energy Institute (NEI)  
FACILITY: All Pressurized Water Reactors  
SUBJECT: SUMMARY OF DECEMBER 1, 1994, MEETING TO DISCUSS THE STATUS AND RESULTS OF ALLOY 600 CONTROL ROD DRIVE MECHANISM (CRDM) REACTOR VESSEL HEAD PENETRATION INSPECTIONS

A meeting was held on December 1, 1994, in the NRC One White Flint North Office in Rockville, Maryland, with NEI and NRC staff representatives. Enclosure 1 is a copy of the meeting agenda. Enclosure 2 is a list of meeting attendees.

The purpose of the meeting was for the NEI representatives to brief the NRC staff on the results of recent inspections of Alloy 600 CRDM reactor vessel penetrations at the Oconee-2, D.C. Cook-2, and Point Beach-1 facilities and to discuss licensee's plans for future inspections of the CRDM penetrations. Enclosures 3, 4, and 5 are copies of the material presented at the meeting by the NEI representatives.

Inspection of the Oconee-2 reactor vessel head penetrations disclosed that one CRDM penetration had 20 small crack-like indications. The maximum length of these indications was 0.37 inches (9.4 mm). The indications were apparently shallow and their depth could not be quantified by UT inspection techniques. An engineering evaluation of these indications assumed a maximum depth of 2 mm. The licensee concluded that the indications were acceptable as is for a minimum of one additional fuel cycle. The affected penetration will be reinspected during the next refueling outage.

Inspection of the D.C. Cook-2 reactor vessel head penetrations disclosed three axial flaws in a thermocouple instrument column penetration. The lengths of the three flaws were 45 mm, 16 mm, and 9 mm. The maximum depth of the flaws occurred in the 45 mm long flaw; its maximum depth was 6.8 mm. Evaluation of these flaws determined that the penetration is acceptable as is for the next fuel cycle. The affected penetration will be reinspected during the next refueling outage.

No crack indications were discovered during inspection of the Point Beach-2 reactor vessel head penetrations.

Based on the results of these three inspections, NEI concluded that no further generic activity regarding Alloy 600 penetrations was required.

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December 20, 1994

The NRC staff noted that:

1. Results of the 3 pilot inspections are consistent with prior evaluations submitted by the industry and confirm there is no immediate safety concern. However, two of the three plants did detect cracking; this indicates that there is an active cracking mechanism that needs to be addressed on an industry-wide basis.
2. The most susceptible plants may not have been inspected.
3. The NRC staff suggested that the industry should continue to be proactive on this issue and provide the NRC with a well thought out and technically sound plan for addressing the issue.
4. It will be most effective to continue to deal with this issue on a generic basis.

The NRC staff also has the following outstanding issues that should be addressed by the industry:

1. The industry should identify the point(s) of contact for the NRC staff to interface with on this issue.
2. The NRC considers primary water stress corrosion cracking in CRDM's a generic issue. The NRC staff requests industry to provide an integrated inspection plan. This should include schedules for pressurized-water reactors that have not completed the CRDM penetration inspections, criteria for reinspections, and scope and method of inspection. The voluntary ad hoc approach suggested by NEI is undesirable in that plant specific submittals and reviews of this generic problem would be resource intensive both for the NRC and industry.
3. The Zorita data has been sent to the owners groups. The industry should provide an assessment of the Zorita experience and its implications with regard to their previously submitted stress analyses and safety evaluations.
4. The industry should provide information regarding any primary system resin intrusions at US plants.
5. The staff has previously requested NEI to provide the NRC with susceptibility indexes for Alloy 600 material within the primary pressure boundary. The Combustion Engineering Owners Group and Babcock & Wilcox Owners Group have provided the indexes. The Westinghouse Owners Group stated at the meeting that they would provide their information by the end of January 1995.
6. The NRC staff understands that criteria presented by NEI for the evaluation of flaws found during CRDM penetration inspections are based on Section XI piping criteria found in IWB-3640 and using the flaw proximity rules in Figure IWA-3400-1. The NRC staff has requested the industry to provide the staff with the analysis of any flaws found

during a CRDM penetration inspection. This flaw analysis should be consistent with American Society of Mechanical Engineers, Section XI, practice (IWB-3134) for the disposition of any flaw evaluated and found acceptable for service without repair.

- 7. The industry should consider providing, in advance, information on the types of repair that would be used if penetrations are found with indications that exceed the acceptance criteria.

Original signed by

Donald S. Brinkman, Senior Project Manager  
 Project Directorate I-1  
 Division of Reactor Projects - I/II  
 Office of Nuclear Reactor Regulation

- Enclosures:
- 1. Agenda for December 1, 1994, Meeting
  - 2. List of Attendees
  - 3. Handout Material for Oconee-2 Inspection Results
  - 4. Handout Material for D.C. Cook-2 Inspection Results
  - 5. Handout Material for Point Beach-1 Inspection Results

cc w/encls: Mr. Alex Marion  
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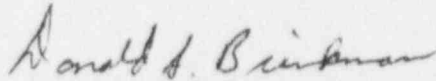
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DATE	12/19/94		12/19/94		12/14/94		12/10/94		12/	/94

December 20, 1994

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**Agenda**  
**NRC/NEI Meeting on CRDM Nozzles**  
**December 1, 1994**  
**9:00 am to 12:00 am**

<b>Item</b>	<b>Topic</b>	<b>Responsible Party</b>
1.	Introductions	--
2.	Review of significant NRC/industry interactions:	Alex Marion
3.	Pilot inspection results: <ul style="list-style-type: none"><li>• Oconee</li><li>• D. C. Cook</li><li>• Point Beach</li></ul>	Mel Arey John Jenson Tom Staskal/ Craig Pruthru
4.	Restart criteria & Subsequent inspections	NEI NRC Staff
5.	Discussion of future activities	NEI NRC staff

December 1, 1994, Meeting with NEI to  
Discuss Status and Results of CRDM  
Penetration Inspections

Attendance List

<u>Name</u>	<u>Position</u>	<u>Organization</u>
Donald S. Brinkman	Senior Project Manager	NRC
Michael Case	Project Director	NRC
Jim Davis	Materials Engineer	NRC
Chuck Hus	Mechanical Engineer	NRC
William Koo	Sr. Materials Engineer	NRC
Phillip Rush	Materials Engineer	NRC
Robert A. Hermann	Section Chief	NRC/NRR/DE/EMCB
Jack Strosnider	Branch Chief, EMCB	NRC/NRR/DE/EMCB
Brian W. Sheron	Director, DE, NRR	NRC/NRR/DE
P. Patnaik	Reactor Engineer	NRC/RGN-I
Douglas A. Brinkman	Sr. Mechanical Engineer	Self
Melvin Arey	Senior Engineer	Duke Power Co.
David E. Whitaker	Duke Power	Duke Power Co.
Craig Prothero	Senior Engineer - WEPCo	Wisconsin Electric
Tom Staskal	Sr. Project Engineer	Wisconsin Electric
Alex Marion	Manager - Engineering	NEI
Kurt Cozens	Project Manager - Eng.	NEI
John Jensen	Project Manager RV&SG	AEP
Steven J. Brewer	Division Manager	AEP
Tom Spry	Staff Engineer	Com ED
Roy Pathacia	Project Manager	EPRI
Frank Annirato	Insp. Div. Manager	EPRI NDE Center
E. Kim Kietzman	Supervisor, HSI NDE	EPRI NDE Center
Anand Gangadharan	Project Manager	Consumers Power Co.
Stephen Fyfitch	Sr. Supervisory Engr.	B&W Nuclear Technologies
Kevin Fleming	Project Manager	B&W Nuclear Technologies
Tony Robinson	Project Manager	B&W Nuclear Technologies
Bob Black	Customer Service Mgr SE	B&W Nuclear Technologies
Steven K. Williams	Senior Engineer (Materials)	Carolina Power & Light (Robinson Nuclear Plant)
John Galembush	Senior Engineer	Westinghouse Nuclear
David Boyle	Manager	Westinghouse Elec.
Warren Bamford	Fellow Engineer	Westinghouse
Ed Rusnica	Manager	Westinghouse
Sid Burns	Manager	W(SI) <sup>2</sup> /Welding SVCS&STR. Integrity
Charles Brinkman	Manager, Wash. Nuc. Opr.	ABB Combustion Eng.
Steven Maginnis	Project Manager	PSE&G
Steve Hunt	Principal Engineer	Dominion Engineering

**INCONEL 600 REACTOR VESSEL HEAD  
PENETRATION INSPECTION**

**OCONEE NUCLEAR STATION, UNIT 2**

**Melvin Arey**

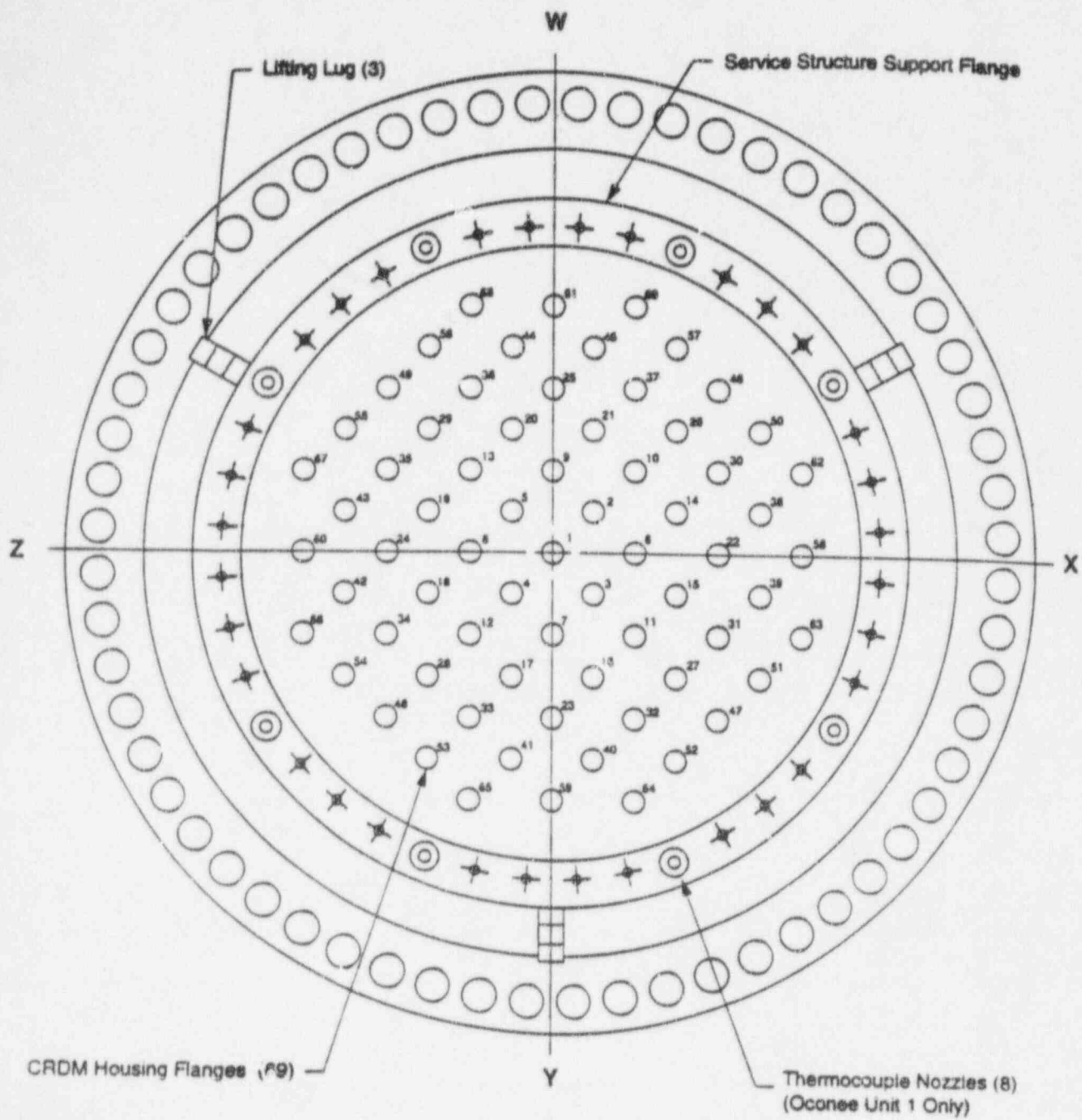
**Duke Power Company**

## ONS UNIT 2 HISTORY

- |                                |  |
|--------------------------------|--|
| - Hours of Operation -         | 140,000 hours                          |
| - Estimated Head Temperature - | 602 degrees F                          |
| - NSSS Supplier -              | Babcock and Wilcox<br>Model 177 Design |

## INSPECTION DATA

- B&W Nuclear Technologies.
- Demonstrated per EPRI Program.
- 69 Total Penetrations, no open penetrations.



Oconee 2 Reactor Vessel Head Plan

Figure A-6

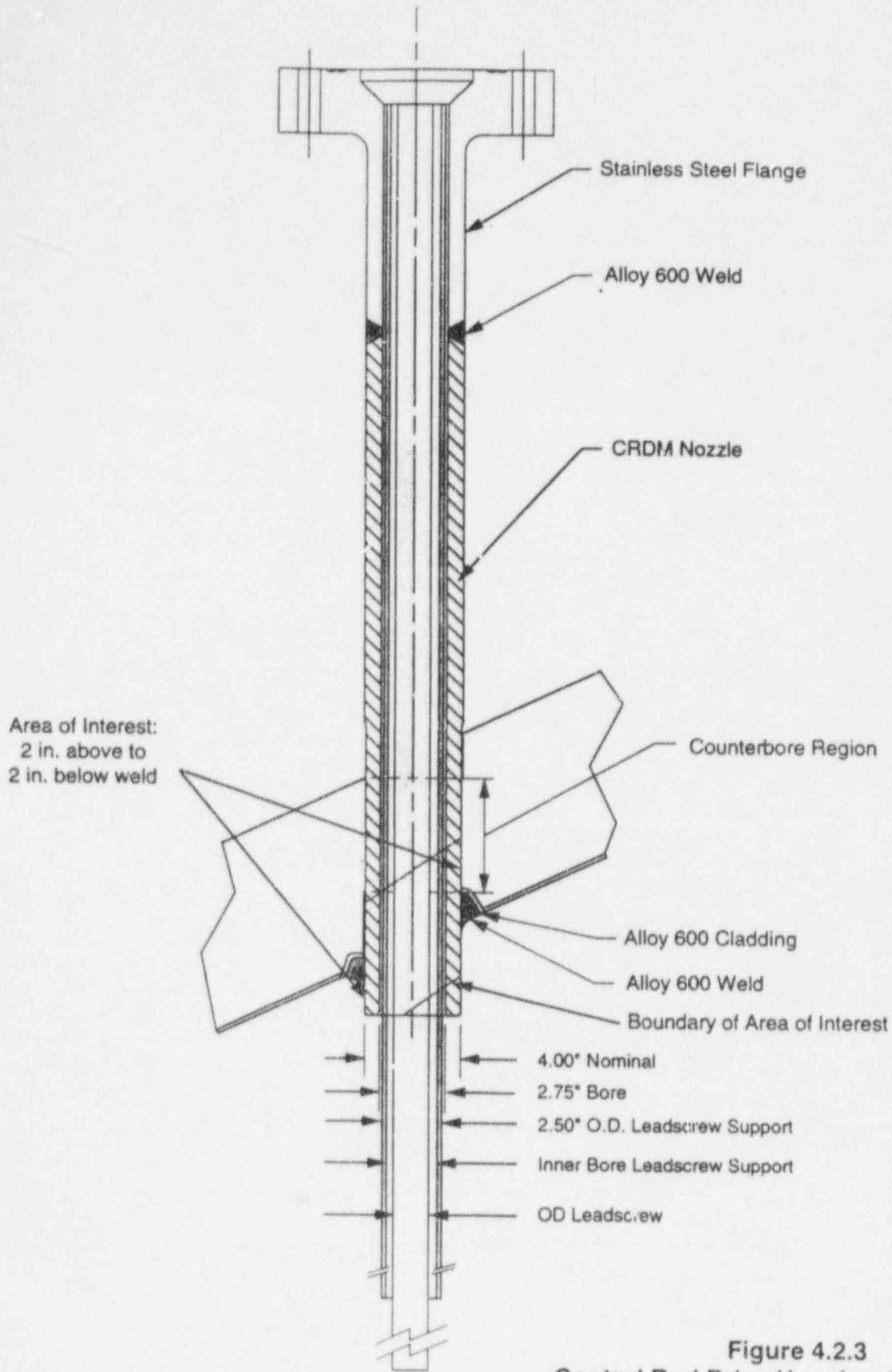


Figure 4.2.3  
Control Rod Drive Housing Arrangement  
Oconee Unit 2

## INSPECTION RESULTS

- 100% Coverage of all 69 Penetrations with ECT Blade Probe.
  - 63 Penetrations: NDD with ECT Blade Probe.
  - 1 Penetration: NDD with MRPC ECT.
  - 4 Penetrations: NDD with MRPC ECT, PT, UT.
  
- PT Exam of #23 identified 20 small indications.  
Maximum length at 0.37 inches (9.4 mm)
  
- UT Exam of #23 could not identify or size indications.

## ENGINEERING EVALUATION

- Assumed Indication Depth of 2 mm.
- Assumed Maximum Yield Strength and Angle of RV Head.
- Calculated 2.89 years to 75% TW per Acceptance Criteria.
- Concluded Indications Acceptable for Minimum of One Cycle.

## SCHEDULE

Set up -	4.0 Days
Cleaning -	1.5 Days
Blade Probe ECT -	10.5 Days
MRPC ECT -	0.5 Days
PT/VT -	3.0 Days
UT -	1.5 Days

## RADIATION DOSE RECEIVED

Set up -	0.024 Man Rem
Cleaning -	0.112
ECT Blade Probe -	1.815
MRPC ECT -	0.099
Dye Penetrant -	0.504
UT Exam -	<u>0.516</u>
Total -	3.070 Man Rem



**DONALD C. COOK NUCLEAR PLANT UNIT 2**

**RVH PENETRATION INSPECTION**

**PRESENTATION**

**JOHN R. JENSEN**

**DECEMBER 1, 1994**

**NEI NRC MEETING**

**NRC HEADQUARTERS**

**WHITE FLINT, MARYLAND**



## **DONALD C. COOK NUCLEAR PLANT UNIT 2**

### **RVH PENETRATION INSPECTION**

#### **BACKGROUND**

- ◆ 4 LOOP WESTINGHOUSE PWR
- ◆ CB & I VESSEL
- ◆ UNIT OPERATES AT 3425 MW<sub>T</sub>
- ◆ HEAD REGION TEMPERATURE, 604° F
- ◆ 78 ALLOY 600 PENETRATIONS
  - MATERIAL, SB-166 (BAR STOCK)
  - WALL THICKNESS, 0.625" (16 mm)
  - 53 FULL LENGTH DRIVE LOCATIONS WITH THERMAL SLEEVES
  - 8 PART LENGTH DRIVE LOCATIONS
  - 12 SPARE LOCATIONS
  - 5 THERMOCOUPLE LOCATIONS
- ◆ OPERATED 9.88 EFPY's TO INSPECTION



## **DONALD C. COOK NUCLEAR PLANT UNIT 2**

### **RVH PENETRATION INSPECTION**

#### **INSPECTION VENDOR**

**- WESTINGHOUSE**

#### **SCOPE OF WORK**

- ◆ **71 OF 78 PENETRATIONS EDDY CURRENT INSPECTED**
  - 53 FULL LENGTH DRIVE LOCATIONS**
  - 18 BARE HOLE LOCATIONS**
  
- ◆ **NOT INSPECTED, 7 PART LENGTH DRIVE LOCATIONS**
  
- ◆ **#75 PENETRATION ULTRASONICALLY INSPECTED TO CHARACTERIZE EDDY CURRENT RESULTS**



## DONALD C. COOK NUCLEAR PLANT UNIT 2

### RVH PENETRATION INSPECTION

#### EDDY CURRENT TESTING RESULTS

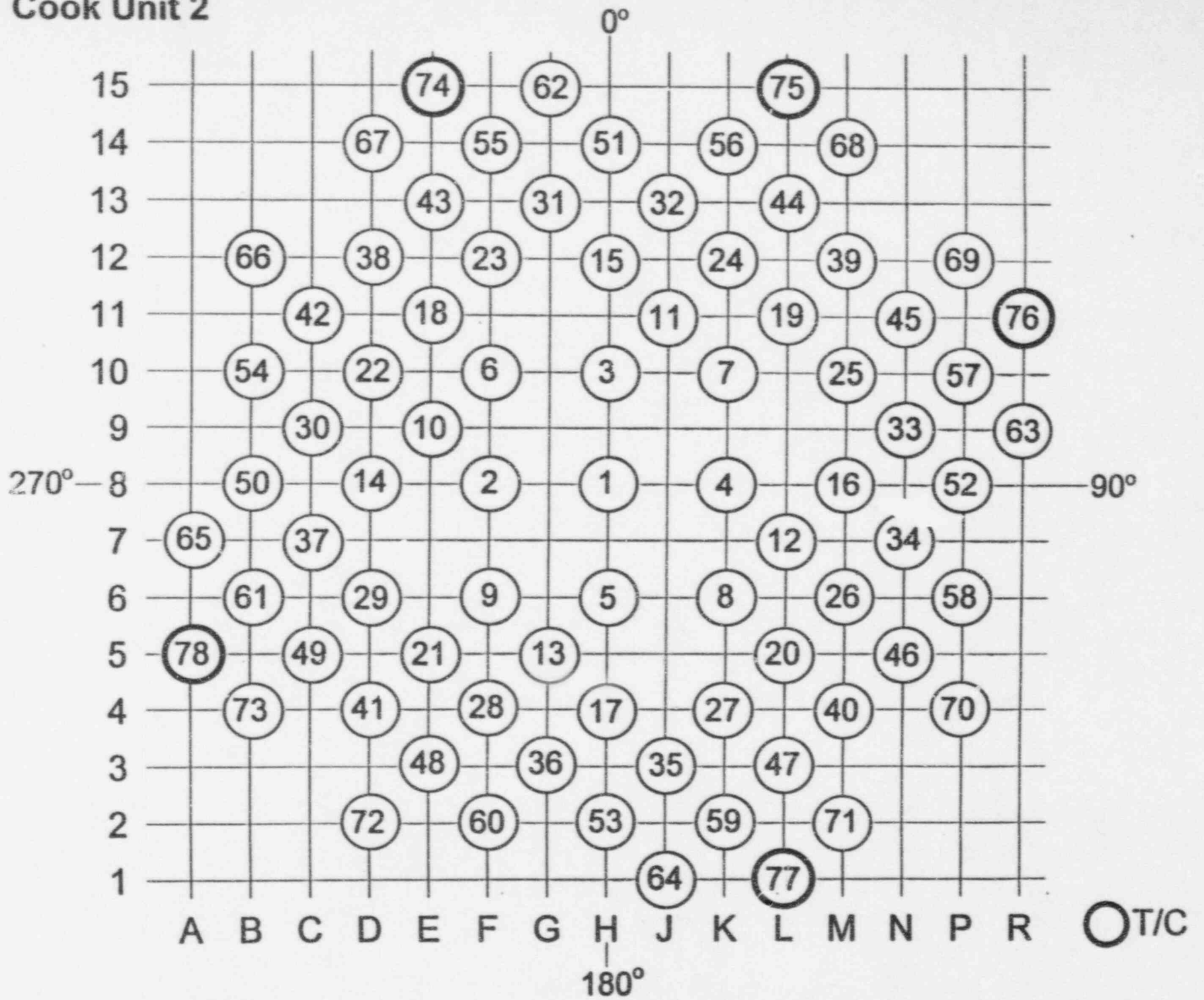
- ◆ 3 AXIAL FLAWS DETECTED IN #75 PENETRATION, A THERMAL COUPLE INSTRUMENT COLUMN LOCATED AT OUTERMOST ROW

- FLAW LENGTHS; 45mm, 16mm and 9mm
- FLAWS ARE ON THE ID SURFACE AT BETWEEN 140 TO 160 DEGREES

NOTE: 0° IS THE OUTER MOST SIDE OF A PENETRATION FROM THE CENTER OF THE RVH AND LOW SIDE OF THE WELD. THE 180° LOCATIONS REPRESENTS THE UPPER SIDE AND THE HIGH SIDE OF THE WELD. BOTH THE 0° AND 180° LOCATIONS ARE CONSIDERED THE REGIONS OF HIGHEST STRESS

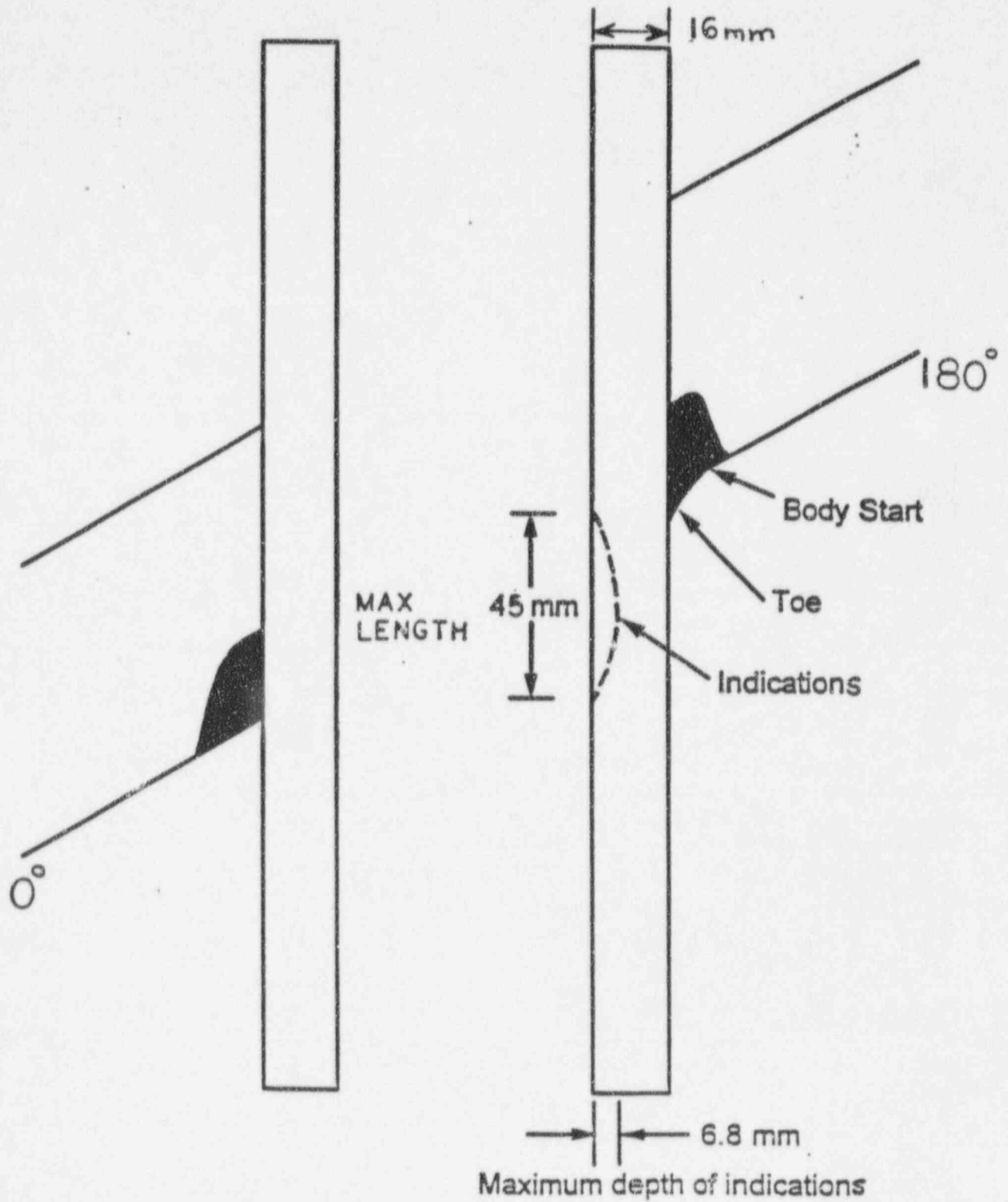
- THE UPPER EXTENT OF THE LARGEST INDICATION IS NEAR THE ATTACHMENT WELD, BUT THE FLAW IS MOSTLY BELOW THE WELD

# Cook Unit 2



# Inspection Results for Cook Unit 2

## Penetration #75





**DONALD C. COOK NUCLEAR PLANT UNIT 2**

**RVH PENETRATION INSPECTION**

**ULTRASONIC TEST RESULTS OF PENETRATION #75**

- ◆ **FLAWS ARE AXIAL**
- ◆ **MAXIMUM DEPTH RECORDED WAS 6.8mm**



## **DONALD C. COOK NUCLEAR PLANT UNIT 2**

### **RVH PENETRATION INSPECTION**

#### **CONCLUSION**

- ◆ **BASED ON INDUSTRY GROWTH RATE MODEL, FLAW GROWTH WILL NOT EXCEED 75% THROUGHWALL LIMIT DURING THE NEXT 18 EFFECTIVE FULL POWER MONTHS OF PLANT OPERATION**
- ◆ **THEREFORE, CONTINUED PLANT OPERATION IS ACCEPTABLE FOR THE NEXT FUEL CYCLE**

#### **FUTURE PLANS**

- ◆ **PENETRATION #75 WILL BE INSPECTED AT THE NEXT UNIT 2 REFUELING OUTAGE**

**INCONEL 600 REACTOR VESSEL HEAD  
PENETRATION INSPECTION**

**POINT BEACH UNIT 1**

**Craig Prothero**

**Wisconsin Electric Power Co.**

## Unit 1 Background

- Began commercial operation 12/21/70
- Hours of operation 139K (15.9 EFPY)
- Estimated Head Temperature 598.6°F
- Vessel Fabricated by Babcock & Wilcox
- 2 Loop PWR Westinghouse NSSS Supplier
- Head penetration
  - Inconel 600 (SB-167) Huntington

## Basis for Inspection

- Preventative Maintenance/Good Engineering Practice
- Prove Long term viability
  - Dry Cask Storage
  - SG Replacement (Unit 2)
  - Life Extension
- Support Industry Initiative

## Inspection Vendor

- Westinghouse
- Qualified per EPRI program

## **Inspection Results**

### **NDE**

- All 49 Penetrations Inspected by ECT
  - 12 unsleeved (rotating probe)
  - 33 sleeved (blade probe)
  - 4 Part-Length CRD (blade probe)
- Limitations on 8 sleeved penetrations
  - high stress regions inspected
- No Indications observed

### **Schedule**

- Setup 96 hrs
- Inspection Time 184 hrs
- Takedown 66 Hrs

### **Dose**

- Radiation Dose Received - 1.77 Man-Rem