



UNITED STATES  
NUCLEAR REGULATORY COMMISSION

WASHINGTON, D.C. 20555-0001

September 12, 1995

LICENSEE: NUCLEAR ENERGY INSTITUTE (NEI), WESTINGHOUSE OWNERS GROUP (WOG),  
COMBUSTION ENGINEERING OWNERS GROUP (CEOG), AND BABCOCK & WILCOX  
OWNERS GROUP (BWOG)

FACILITY: All Pressurized Water Reactors (PWRs)

SUBJECT: SUMMARY OF AUGUST 24, 1995, MEETING TO DISCUSS TOPICS OF INTEREST  
PERTAINING TO ALLOY 600 AND CONTROL ROD DRIVE MECHANISM (CRDM)  
PENETRATION INSPECTION SCHEDULE

A meeting was held at the U.S. Nuclear Regulatory Commission (NRC) One White Flint North office in Rockville, MD, on August 24, 1995, with NRC staff representatives and members of the NEI, and the PWR Owners Groups (PWRGs) - WOG, CEOG, and BWOG - to discuss the status of the industry's proposed long term program plan for the inspection and monitoring of PWR control rod drive mechanism CRDM penetrations and other Alloy 600 penetrations. Enclosure 1 is a list of attendees. Enclosures 2 through 11 are the various presentation slides.

The NRC staff opened the meeting with a brief summary of the December 1, 1994, meeting between the NRC staff, NEI and the PWRGs which discussed the status of Alloy 600 CRDM penetration inspections (Enclosure 3). At that meeting, the NRC staff was informed that three plants had performed pilot inspections, and that two of these had discovered flaw indications. However, none of the discovered flaws exceeded NRC criteria and none were expected to grow to a size that would exceed the criteria prior to their next refueling outage. Further, NEI stated at the December 1, 1994, meeting and in their May 24, 1995, letter that, based on these first three inspections, no additional generic activity is required. The NRC still considers primary water stress corrosion cracking of CRDM penetrations a safety concern. While the NRC staff agrees that it is not of an immediate safety concern, there is currently no evidence to conclude that it will not become a concern in the longer term. As such, the NRC staff believes that an integrated, long-term program, which includes periodic inspections and monitoring, is necessary.

The three PWRGs representatives presented overviews of the individual inspection programs that they are developing (Enclosures 4, 5 and 6). It was indicated that the three PWRGs were sharing the specifics of the development among themselves, but that they had not yet started individual plant inspections. The PWRGs stated that they have modeled the individual plants and have ranked each according to its modeled susceptibility to Alloy 600 cracking. However, the PWRGs are not planning to submit these rankings to the NRC staff, but will provide a listing of who has completed the inspection programs.

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IDR-12  
X-I+P-10  
X-IDR-5 - Facility Licenses  
X-OM-6 - Meetings  
X-RD-8-2 - Westinghouse

Representatives from Duke Power Company (Oconee Unit No. 2), American Electric Power (D. C. Cook Units 1 and 2), Consumers Power Company (Palisades), and Virginia Power (North Anna Units 1 and 2, Surry Units 1 and 2) presented the results of their plant-specific inspections (Enclosures 7, 8, 9 and 10). Each utility representative indicated that they are implementing a prioritized screening program to manage the economic risk associated with Alloy 600 cracking.

Virginia Power also indicated that they may inspect the CRDM penetrations at North Anna during the next refueling outage for each unit. Further, Virginia Power is considering CRDM cracking at the Surry units as well, and their planning will be based on economic considerations for the units.

A representative of the WOG presented information on Zorita, a foreign Westinghouse single loop PWR which experienced two cation resin ingress events in 1980 and 1981. These events contributed to significant cracking in several areas around the CRDM penetrations. Westinghouse formally notified the WOG plants of this issue by issuance of NSAL-94-028. The WOG stated that inspections of head penetrations are ongoing, but have not yet identified similar degradation elsewhere.

NEI suggested that the NRC staff meet again with NEI and the PWROGs in the January 1996 timeframe to discuss the results of the PWROGs inspections.

Original signed by:

C. E. Carpenter, Jr., Lead Project Manager  
Project Directorate I-1  
Division of Reactor Projects - I/II  
Office of Nuclear Reactor Regulation

Enclosures: As stated

cc w/encls: See next page

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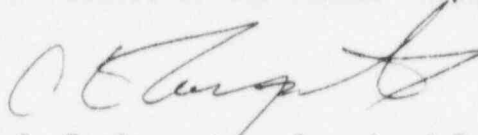
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Enclosures: As stated

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AUGUST 24, 1995, MEETING WITH NUCLEAR ENERGY INSTITUTE (NEI), WESTINGHOUSE OWNERS GROUP (WOG), COMBUSTION ENGINEERING OWNERS GROUP (CEOG), AND BABCOCK & WILCOX OWNERS GROUP (BWOX) TO DISCUSS TOPICS OF INTEREST PERTAINING TO CONTROL ROD DRIVE MECHANISM (CRDM) PENETRATION INSPECTION SCHEDULE.

NAME	ORGANIZATION	TITLE	PHONE NUMBER
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AGENDA

NRC/NEI MEETING ON HEAD NOZZLE CRACKING

AUGUST 24, 1995

ITEM	TOPIC	RESPONSIBLE PARTY
1.	Opening Remarks	NRC NEI
2.	Re-Inspection Activities	Duke Power AEP
3.	Palisades Head Inspection Results	Consumers Power
4.	Owners Group Activities	WOG CEOG BWO
5.	Future Inspections	Virginia Power
6.	Wrap-up	NRC NEI
7.	Adjournment	

## BACKGROUND

- December 1, 1994, Meeting with NRC staff, NEI and PWROGs' representatives to discuss the status of Alloy 600 control rod drive mechanism (CRDM) penetration inspections
  - Two of three pilot plants had CRDM penetration flaw indications
  - None of the flaws exceeded NRC criteria and none were expected to grow to a size that would exceed the criteria prior to next refueling outage
  - NEI stated at meeting and in May 24, 1995, letter that, based on the first three inspections, no additional generic activity is required.
- NRC believe's that longer term follow-up program of systematic inspections of CRDM penetrations by PWR licensees is needed to confirm expected crack growth rates and verify crack orientation (NRC letter to NEI dated June 16, 1995).
  - Integrated, Long-Term Inspection and Monitoring Program for CRDM Penetrations
  - Industry Assessment of the ZORITA Experience and Its Implications
  - Proposed Repair Methods



**U.S. NUCLEAR REGULATORY COMMISSION MEETING**  
**August 24, 1995**

**MANAGEMENT OF CRDM ALLOY 600 PWSCC ISSUE**



Westinghouse Owners Group

## TOPICS

- O Review Completed Items**
- O Inspection Program**
- O Managing The Issue**
- O Summary**
- O Conclusions**



## MAJOR ITEMS COMPLETED

### **O Penetration Stress Analysis - Conclusions**

- Hoop Stresses Are Larger Than Axial Stresses
- Tensile Stress Levels Are Highly Localized
- Stresses 90° To The Peak Hoop Stresses Are Compressive

### **O Safety Evaluation - Conclusions**

- Not an Immediate Safety Issue
- Crack Extension (I.D. Axial or O.D. Circumferential) Limited - Not Expected to Reach Critical Flaw Size
- Axial Critical Flaw Size Approximately 20 Inches (13 Inches Above the Vessel Head)
- Technical Specification Leak Rate of 1.0 gpm Reached Before Approaching Critical Flaw Size
- Postulated Leakage Would Be Less Than 1.0 gpm
- Vessel Head Structural Degradation Due To Boric Acid Corrosion Wastage Not An Issue For 6 Years After Leak Occurs
- Generic Letter 88-05 Walkdowns For Boric Acid Deposits Adequate For Managing Wastage Issue



## **MAJOR ITEMS COMPLETED**

### **O Inspection Capabilities**

- Remote Inspection Tooling (EC & UT) Developed
- Tooling/Techniques Evaluated During EPRI Inspection Performance Demonstration
- Tooling Successfully Utilized At Domestic Plants

### **O Crack Growth Testing**

- On-going - Expected To Continue Through 1996
- Confirms Assumptions In Safety Evaluation

### **O Flaw Acceptance Criteria**

- Developed As Part Of Industry Wide Program
- Provides Basis For Continued Plant Operation With Penetration Cracking

### **O Inspection Guidelines**

- Flaw Detection Criteria
- Screening Criteria For Examining A Population Of Head Penetrations Of A Given Vessel Closure Head
- Guidance On Inspection Intervals
- Approach For Flaw Evaluation Methodology



## MAJOR ITEMS COMPLETED

### O WELD OVERLAY REPAIR PROGRAM

- Objective - Provide A Weld Design Data Package For Repair Of Head Penetration Tube ID Initiated PWSCC
  
- Program Tasks
  - o Develop Weld Overlay Repair Process Specification
    - Local Weld Repair
    - 360° Weld Overlay
  - o Define Penetration Excavation Geometry
  - o Provide Evaluation Of Applying Weld Overlay Over Existing Cracks
  - o Penetration Mock-up Tests
  - o Perform A Generic 50.59 Safety Evaluation
  
- Provided Under Program
  - o WCAP Report Containing
    - Weld Process Specification
    - Weld Repair Drawing
  - o Generic 50.59 Safety Evaluation



## **Penetration Susceptibility Assessment**

### **O Cumulative Susceptibility Index Assessment Considering:**

- Material Condition Factor
- Peak Residual And Steady State Stress
- Grain Boundary Carbide Index
- Activation Energy For The Process
- Gas Constant
- Service Temperature
- Service Time At Temperature

### **O Relative Susceptibility Determined From Inspection Results From:**

- D.C. Cook 2
- Ringhals 4

### **O Updates/Revisions Based On Inspections, Testing (US & Worldwide)**



## **Economic Decision Analysis Tool**

- O Computerized Technique To Provide Utilities With:**
  - Probability And Depth Of Cracking At A Particular Time
  - Number Of Penetrations Affected
  - Ability To Evaluate Individual Penetrations
  
- O Bench Marked To Inspection Data**
  
- O Used By Utilities For Evaluation Of Economic Risk And Timing Of Inspections If Applicable**
  
- O Model And Software Complete**
  
- O Distribute For Use In August 1995**
  
- O Training Session Planned In September 1995**



## **Inspection Program**

### **O Inspections Performed At:**

- Point Beach Unit 1
- D. C. Cook Unit 2
- High Susceptibility Based On Ringhals 2 As Reference Plant

### **O Anticipate Additional Inspections**

### **O Inspection Results - Integrate Periodically Into Ranking And Economic Decision Analysis Tool**





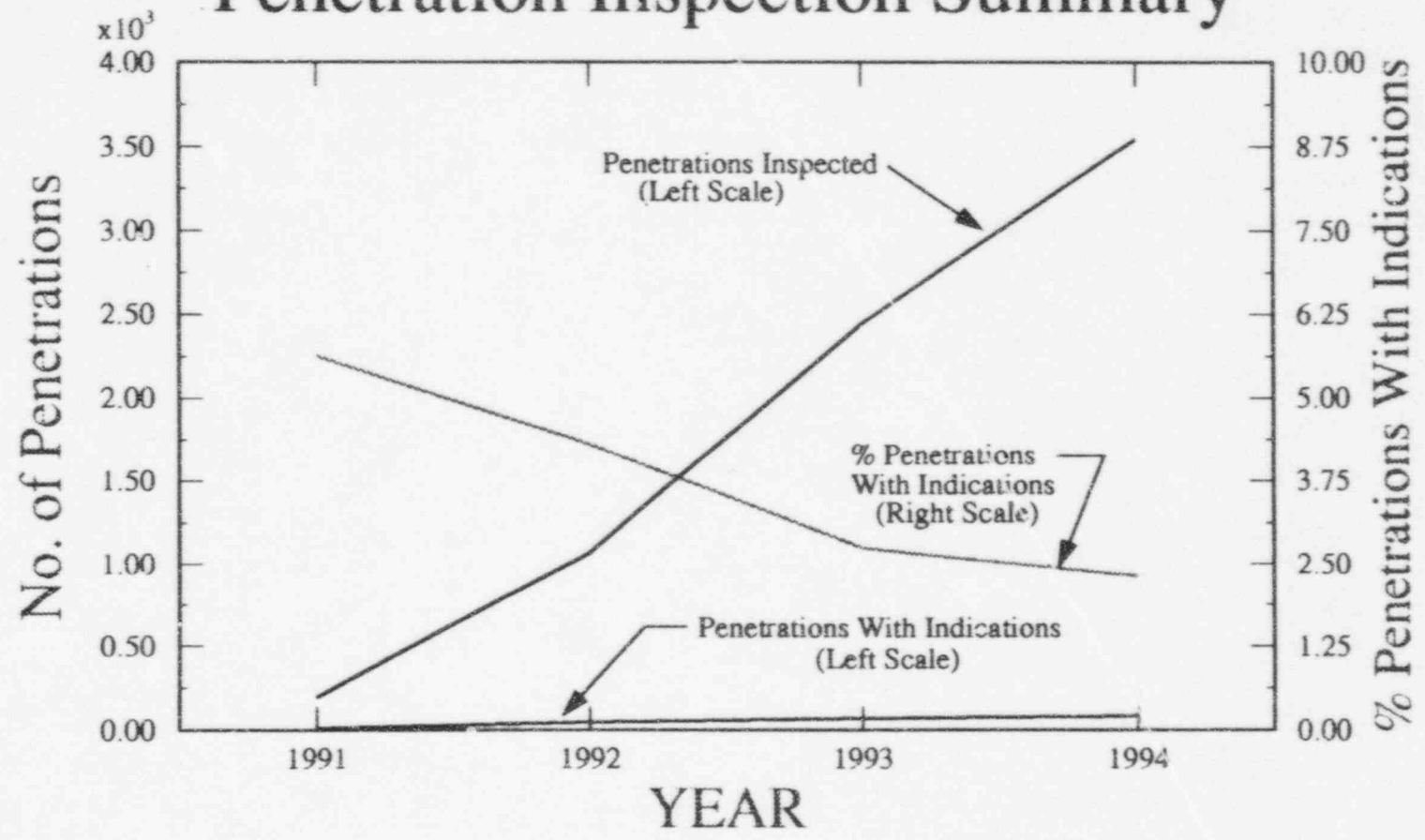
## **Managing The Issue**

- O Continue Inspections Based On Economic Risk**
- O Continuous Confirmation Of Assumptions In Safety Evaluation**
  - Mechanism Of Cracking
  - Crack Orientation And Growth Rates
- O Incorporate New Inspection Results Into Susceptibility Assessment And Economic Decision Analysis Tool**
- O Participate In Integration Of Inspection Results**
  - Incorporate Inspection Results Generated By Others
  - Continue Opportunities To Share Data Between Owners Groups & Others (EPRI, Non U.S. Utilities)
- O Economic Modeling To Determine Depth And Probability Of Cracking On Penetration By Penetration Basis**
- O Future Inspections Based On Economic Cost Benefit Analysis And Investment Protection**
  - Through Wall Leak Cannot Be Easily Tolerated From Economic Viewpoint
  - Deep Flaw Repair More Difficult Than Shallow Flaw Repair





# Penetration Inspection Summary



## SUMMARY

### **O Letter From B. Sheron (NRC) To R. Newton (W/OG) Requested Information**

- Plan For Managing Issue
- Resin Ingress At Zorita
- Repair For Indications That Exceed Acceptance Criteria

### **O Plan For Managing Issue**

- Confirmatory Testing
- Ranking
- Economic Decision Model
- Inspection Guidelines
- Inspections Based On Economics
- Incorporate Testing And Inspection Results Into Ranking And Economic Model

### **O Repair**

- Flaw Excavation Up To 60% Wall Thickness Acceptable (Plant Specific Evaluations Required)
- Flaw Excavation >60% Requires Weld Repair For Minimum Wall Restoration
- Supplemental Surface Treatment May Be Beneficial

### **O Resin**

- Inspection At Plants Have Not Identified Severe Cracking As Zorita
- Westinghouse NSA Letter Advising Utilities Of Issue
- Previous Safety Evaluation Remains Valid (LBB)



## CONCLUSIONS

- O PWSCC Of Alloy 600 Head Penetrations Is Not A Safety Issue**
  
- O WOG Has And Continues To Actively Address And Manage The Issue**
  
- O WOG Will Continue To Pursue Programs Which Assist Member Utilities With Managing The Issue**
  
- O WOG Will Continue To Participate In Industry Programs Concerning The Issue**
  
- O WOG Will Continue To Update Its Activities Based On Future Inspections And Information As They Become Available**



**COMBUSTION ENGINEERING  
OWNERS GROUP**

**STATUS OF  
ALLOY 600 PENETRATIONS ACTIVITIES**

**PRESENTED BY:**

**MIKE MELTON  
ARIZONA PUBLIC SERVICE**

**NEI/USNRC MEETING ON  
ALLOY 600 PENETRATIONS**

**AUGUST 24, 1995  
ROCKVILLE, MARYLAND**

## **OUTLINE OF PRESENTATION**

- **HISTORY OF CEOG ACTIVITIES  
TO ADDRESS ALLOY 609 CRACKING**
- **TASKS TO ADDRESS CEDM  
NOZZLE CRACKING**
- **CURRENT TASKS**
- **INDUSTRY ACTIONS**

## **CEOG ALLOY 600 PENETRATIONS ACTIVITIES**

- **WORKING GROUP FORMED 1989 TO  
ADDRESS SMALL DIAMETER PRESSURIZER  
PENETRATION CRACKING**
  
- **ALLOY 600 WG SPONSORED NUMEROUS  
ACTIVITIES 1989 - 1992**
  - **HEATER SLEEVE SUSCEPTIBILITY TO  
PWSCC**
  
  - **DESTRUCTIVE EXAMINATION OF  
CRACKED INSTRUMENT NOZZLES AND  
EVALUATION OF NOZZLES**
  
  - **INFORMATION PACKAGE ON ALL  
ALLOY 600 RCS PENETRATIONS**
  
  - **ECT DEVELOPMENT**
  
  - **RESIDUAL STRESS MEASUREMENTS**
  
  - **HEATER SLEEVE EXAMINATIONS**
  
  - **BORIC ACID CORROSION TESTING**

# **CEOG ALLOY 600 PENETRATIONS ACTIVITIES**

(continued)

- **HEATER SLEEVE THERMAL ANALYSIS**
- **PZR INSPECTION RECOMMENDATIONS**
- **ALLOY 690 BAR STOCK PROCUREMENT**
- **MEETINGS WITH USNRC**
- **PARTICIPATION IN INDUSTRY  
MEETINGS**



## **CEOG ALLOY 600 PENETRATIONS ACTIVITIES**

- **IN 1992, WG EMPHASIS SWITCHED TO CEDM AND ICI PENETRATIONS. SPONSORED ACTIVITIES COMPLETED INCLUDE:**
  - **CEDM NOZZLE EVALUATION**
  - **WORLD FOLLOW**
  - **INITIAL SUSCEPTIBILITY ASSESSMENT**
  - **SAFETY EVALUATION FOR ID AXIAL CRACKING**
  - **SAFETY EVALUATION FOR OD CIRCUMFERENTIAL CRACKING**
  - **STRESS ANALYSIS SENSITIVITY STUDY**
  - **BORIC ACID CORROSION EVALUATION FOR RV HEADS**
  - **INSPECTION TIMING MODEL**

# **CEOG ALLOY 600 PENETRATIONS ACTIVITIES**

(continued)

- **INSPECTION STRATEGY AND REPAIR**
- **PWSCC MITIGATION METHODS**
- **LEAK DETECTION METHODS EVALUATION**
- **FLAW ACCEPTANCE CRITERIA**
- **EPRI NDE DEMONSTRATION TEST ON CEDM  
MOCKUPS**

## **CURRENT CEOG ALLOY 600 PENETRATIONS ACTIVITIES**

- **PARTICIPATION BY FUNDING AND DATA REVIEW IN THE WOG/EPRI CRACK GROWTH TEST PROGRAM - ON GOING**
- **FABRICATION OF 10 SMALL DIAMETER ALLOY 690 NOZZLES WITH 316L SAFE ENDS ON GOING**
- **EVALUATION OF CARBIDE DISTRIBUTION AT GRAIN BOUNDARIES IN CEDM/ICI NOZZLES**
- **CEDM NOZZLE DEEP CRACK REPAIR**
  - **DEVELOPMENT OF REMOTE CAPABILITY (INCLUDING DESIGN, FABRICATION AND DEMONSTRATION OF EQUIPMENT)**
  - **DEMONSTRATION ON SEVERAL MOCK-UPS**
  - **XRD RESIDUAL STRESS MEASUREMENTS**
  - **ANALYTICAL STRESS ANALYSIS**

**CURRENT CEOG ALLOY 600  
PENETRATIONS ACTIVITIES**

(continued)

- **SYSTEM REVIEW FOR RESIN INGRESS**
- **NEI TASK FORCE SUPPORT**

## **INDUSTRY ACTIVITIES**

- **CEOG CONTINUES TO FOLLOW/  
PARTICIPATE IN INDUSTRY ACTIVITIES:**
  - **NEI CEDM TASK FORCE**
  - **NRC PRESENTATIONS**
  - **COFUNDING WORK WITH OTHER  
OWNERS GROUPS**
  - **INDUSTRY CONFERENCE  
PARTICIPATION**
  
- **MATERIALS AND CHEMISTRY  
SUBCOMMITTEE HAS ALLOY 600  
RESPONSIBILITY**
  - **MAINTAINS MOST OF ALLOY 600 WG  
MEMBERS**
  - **DESIGNATE LEAD ALLOY 600  
REPRESENTATIVE**

## **FUTURE ACTIVITIES UNDER CONSIDERATION**

- **EVALUATION/QUALIFICATION OF WELD REPAIR  
MITIGATION METHODS**
- **ECONOMIC MODEL FOR CEOG CEDM NOZZLES**
- **COMPLETE CRACK GROWTH TESTING**

## SUMMARY

- **CEOG HAS PROACTIVELY ADDRESSED CEDM NOZZLE CRACKING SAFETY ISSUES**
- **CEOG HAS DEVELOPED TOOLS FOR MEMBER PLANTS TO MAKE PLANT SPECIFIC DECISIONS REGARDING CEDM NOZZLE CRACKING INSPECTION**
- **CEOG EXTENSIVELY REVIEWS NEW EMERGING ISSUES AND AUTHORIZES TASKS AS REQUIRED TO ADDRESS GENERIC ISSUES AND PROVIDES SAFETY ASSESSMENTS OR COST BENEFITS TO MEMBERS**
- **ONE CEOG MEMBER (PALISADES) HAS PERFORMED SUCCESSFUL ICI/CEDM INSPECTION**

**U. S. NUCLEAR REGULATORY  
COMMISSION MEETING**

**B&W OWNERS GROUP  
MATERIALS COMMITTEE**

**CRDM NOZZLE PWSCC PROGRAM  
STATUS UPDATE**

**PRESENTED BY:**

**D. E. Whitaker - DUKE POWER COMPANY**

**AUGUST 24, 1995**



**B&WOG CRDM NOZZLE PWSCC PROGRAM**

**OUTLINE OF PRESENTATION**

- **INTRODUCTION**
- **PARTICIPATION IN INDUSTRY ACTIVITIES**
- **OWNERS GROUP SPECIFIC ACTIVITIES**
- **LONG RANGE PLANNING MODEL**
- **PROPOSED ACTIVITIES**
- **SUMMARY**

**AUGUST 24, 1995**

# **B&WOG CRDM NOZZLE PWSCC PROGRAM**

## **INTRODUCTION**

- **Work Toward Continual Improvement**
  
- **Continue Participation in Industry Activities**
  - **NRC Cooperation**
  - **NEI Support**
  - **Cofunded Programs with Other Owners Group**
  - **EPRI Support**
  - **Other Industry Forums (IAEA, NACE, etc.)**
  
- **Maintain Proactive Approach**

**AUGUST 24, 1995**

## **B&WOG CRDM NOZZLE PWSCC PROGRAM**

### **PARTICIPATION IN INDUSTRY ACTIVITIES**

- **Submittal of Combined Safety Analyses from All Three Owners Groups**
- **Submittal and NRC Acceptance of Generic Acceptance Criteria for Axial Indications**
- **Development of EPRI Blind Test Blocks and Demonstration of NDE Vendors**
- **Verification of Peter Scott Crack Growth Curves**
- **Inspection of Oconee Unit #2 as Part of Industry Program**
- **Sharing of Industry Inspection Data**

**AUGUST 24, 1995**

## **B&WOG CRDM NOZZLE PWSCC PROGRAM**

### **OWNERS GROUP SPECIFIC ACTIVITIES**

- **Evaluation of Leak Detection and Monitoring Systems (Complete)**
- **Development of Generic Crack Removal and Repair Strategy (Complete)**
- **Development of PWSCC Susceptibility Ranking Models (Complete)**
- **Assessment of Leakage Through RV Head Penetration (Complete)**
- **Evaluation of CRDM Flaw Acceptability and Inspection Guidelines (Complete)**
- **Evaluation of Industry CRDM Inspection Results (Ongoing)**
- **Replication of CRDM Nozzle Heats Located on the RV Head Periphery (Ongoing)**
- **Development of a Long Range Planning Model to Manage CRDM PWSCC (Ongoing with DEI)**
- **Development of Tooling for Inspection from Top of RV Head (Ongoing)**

**AUGUST 24, 1995**

## **B&WOG CRDM NOZZLE PWSCC PROGRAM**

### **LONG RANGE PLANNING MODEL**

- **Developed as a Planning Tool for Use by Each Utility**
- **Customized for Each B&WOG Plant**
- **Predicts Probability of CRDM Nozzle Cracking and Leakage**
- **Evaluates Life Cycle Cost for Alternative Approaches**
- **Anticipate Working Model Available by End of 1995**
- **Updated as Needed When Additional Information Becomes Available**

**AUGUST 24, 1995**

Strategy Scenario Summary Results  
 Scenario Identification: 710

Oco2i

8/10/95

Leak Detection Program

Open Nozzle Program

High Susceptibility Program

Under the Head Program

Head Replacement Option

Visual Only

No Program

Start at Outage No. 16

No Program

No Program

Leak Repair From Below

Re-inspect Every 1 Outages

Do Not Inspect All After Leak

Do Not Inspect All After Crack

6 Highest Suscep. of 6 Open

3 from 10 Highest Suscep.

Open Nozzle Insp. All Outages

**DRAFT**

Strategic Scenario Crack Predictions

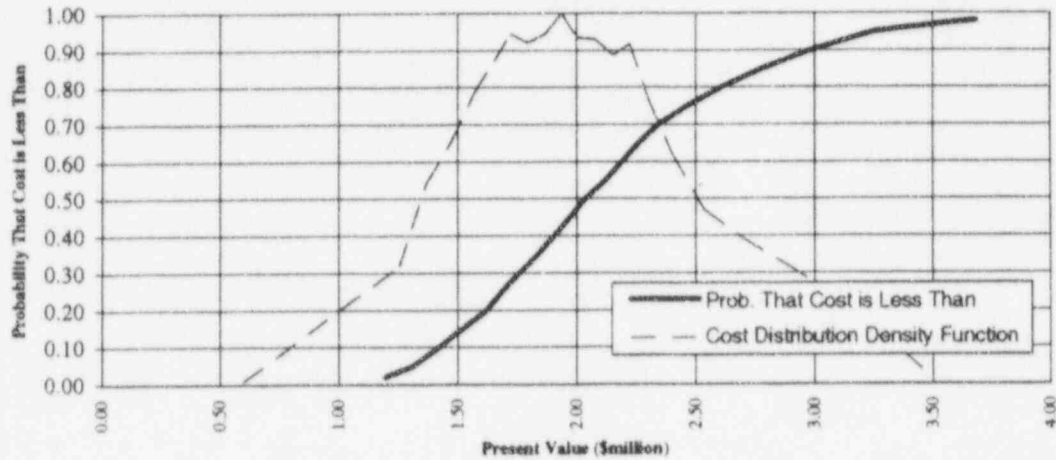
Cost Distribution Results

Probability NPV (\$mil)

0.02	1.190
0.05	1.310
0.10	1.422
0.15	1.518
0.20	1.619
0.25	1.686
0.30	1.756
0.35	1.832
0.40	1.904
0.45	1.969
0.50	2.033
0.55	2.124
0.60	2.190
0.65	2.263
0.70	2.344
0.75	2.463
0.80	2.607
0.85	2.781
0.90	2.983
0.95	3.253
0.98	3.682

Oco2e 2 - Distribution of Net Present Value Costs for Scenario Case 710

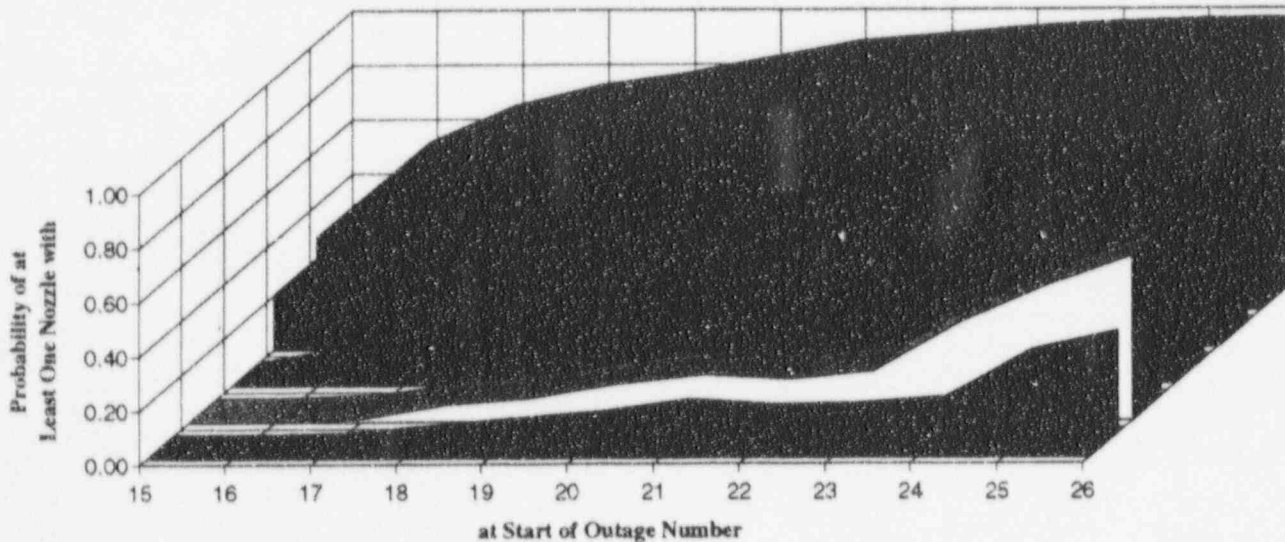
Oco2i



■ Leak □ Crack Above Weld > 12 mm ■ Crack Above Weld > 2 mm ■ Crack Above Weld ■ Crack

Oco2i

Oco2e 2 - Risk Assessment for Scenario Case 710



## **B&WOG CRDM NOZZLE PWSCC PROGRAM**

### **PROPOSED ACTIVITIES**

- **Continue Participation in Industry Activities**
- **Refine Long Range Planning Model and Use to Identify Developmental Needs**
- **Develop Tooling for Inspection from Top of RV Head**
- **Develop Mitigation and Permanent Repair Techniques**
- **Continue Replication Work**
- **Update Susceptibility Rankings**
- **Complete Crack Growth Testing**
- **Address Primary System Sulfur Intrusions**
- **Develop B&WOG Action Plan to be Completed after the scheduled Oconee Unit #2 Spring 1996 Reinspection**

**AUGUST 24, 1995**

## **B&WOG CRDM NOZZLE PWSCC PROGRAM**

### **SUMMARY**

- **B&WOG has Proactively Addressed CRDM Nozzle PWSCC**
- **Participation in Industry Consensus Approach and B&W Plant Specific Evaluations Will Continue**
- **B&WOG is Proactively Managing This Issue Via Long Range Planning and Evaluation**
- **B&WOG Will Continue to Increase Its Knowledge Base and Improve Its Prediction Capabilities**

**AUGUST 24, 1995**



**U. S. NUCLEAR REGULATORY  
COMMISSION MEETING**

**DUKE POWER COMPANY**

**OCONEE UNIT #2 REINSPECTION**

**PRESENTED BY:**

**D. E. Whitaker - DUKE POWER COMPANY**

**AUGUST 24, 1995**

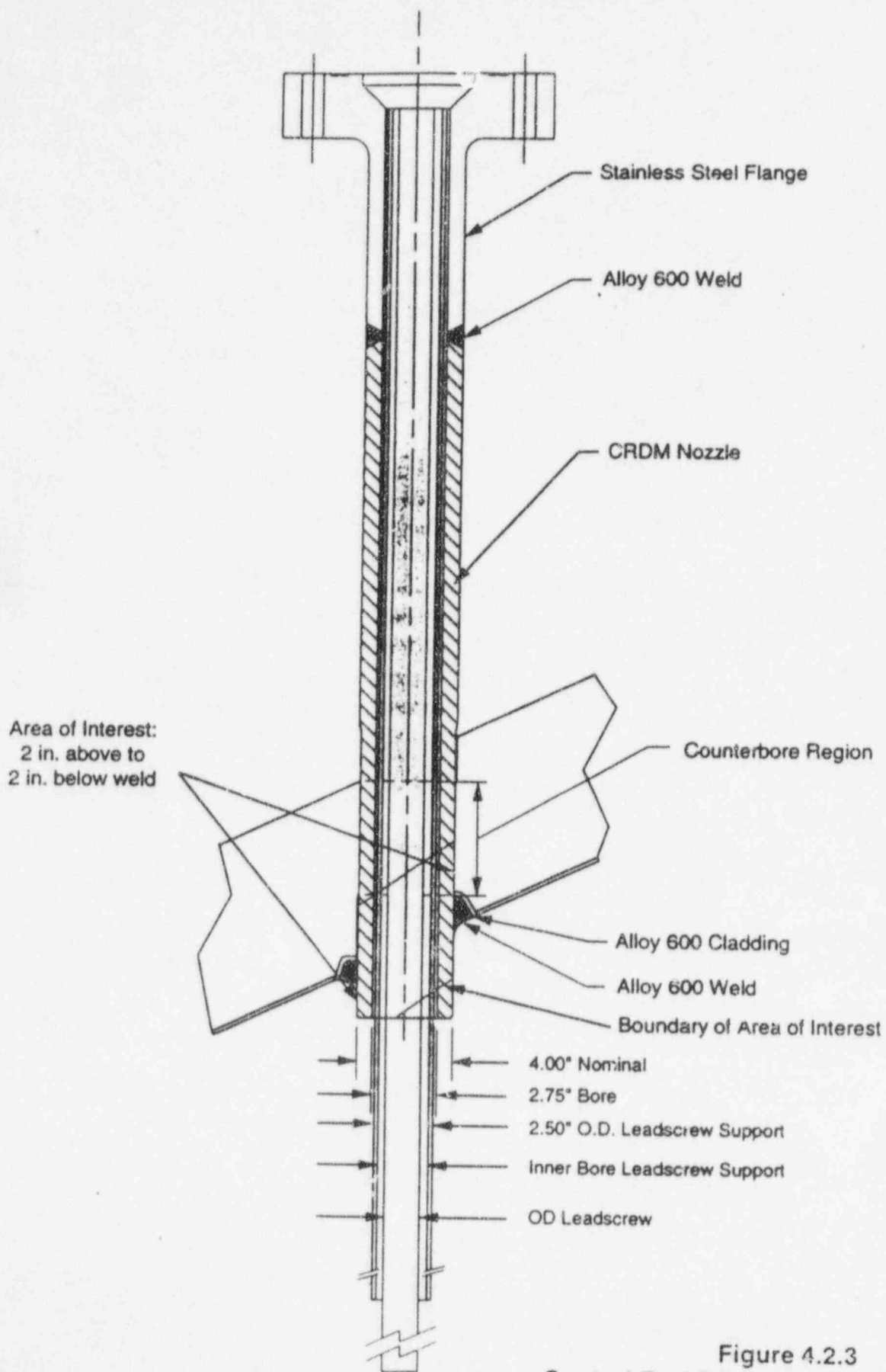


Figure 4.2.3  
Control Rod Drive Housing Arrangement  
Oconee Unit 2

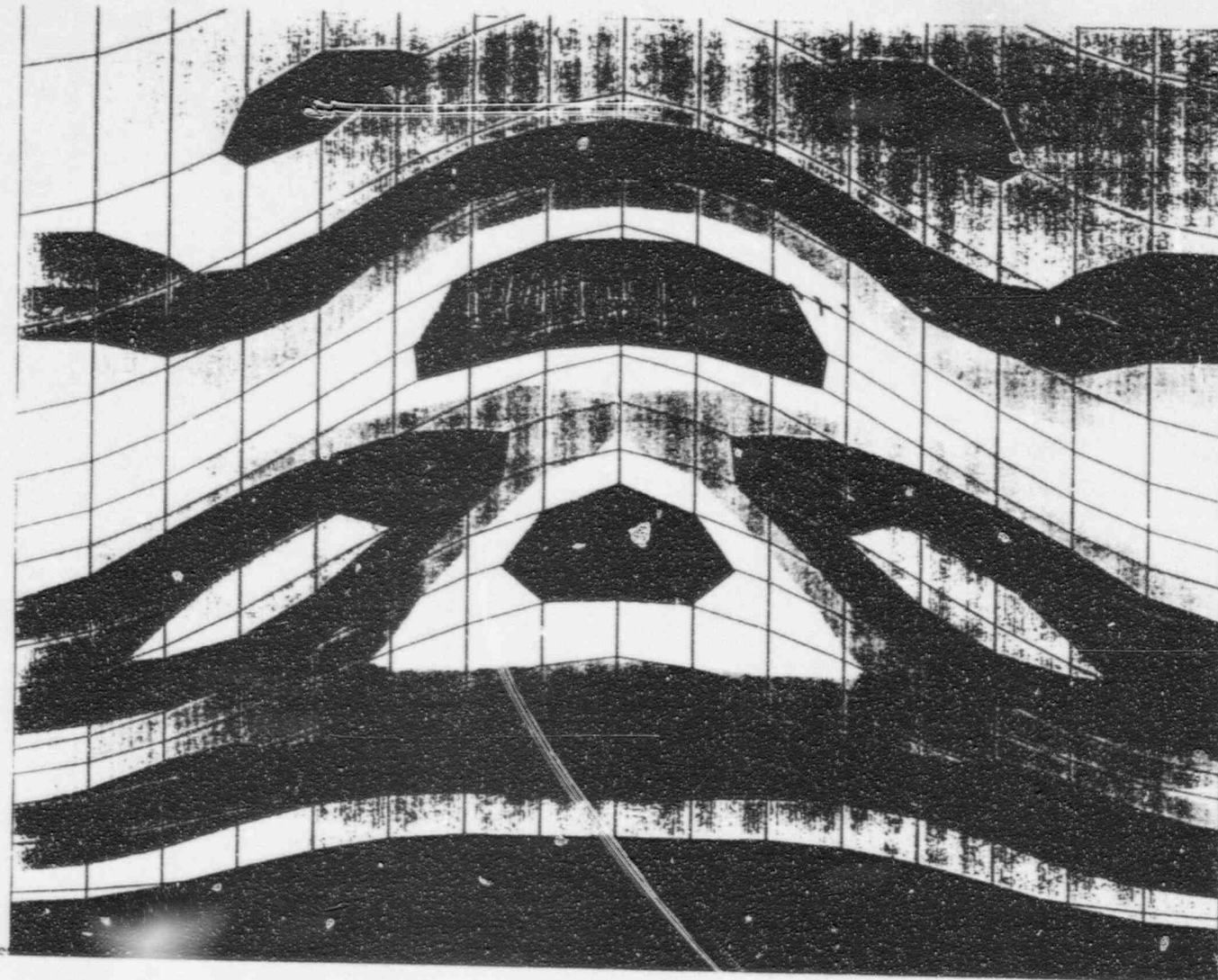
## INSPECTION RESULTS

- 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.

11/30/94



ANSYS 5.0 A  
OCT 27 1994  
17:29:38  
PLOT NO. 2  
NODAL SOLUTION  
TIME=4003  
SY (AVG)  
RSYS=11  
DMX =0.446909  
SMN =-30295  
SMX =61056  
DSYS=11  
-30295  
-10000  
0  
10000  
20000  
30000  
40000  
50000  
100000

Oco CRDM(23d, 55.2k, 4.000/2.7650, 0, B) - Operating

Correlation Between Computed Hoop Stress and  
Reported Cracks in Ocone 2 Nozzle #23

**B&WOG CRDM NOZZLE PWSCC PROGRAM**

**OCONEE UNIT #2 REINSPECTION**

- **Fabrication of Additional EPRI Test Blocks for Shallow Indications**
- **Demonstration of ECT for Depth Sizing of Shallow Indications**
- **Development of Tooling for Delivery from Top of RV Head**
- **Evaluation of Honing for Use as Cleaning Method for PT**
- **Reinspection is Planned from Top of RV Head During 1996 Spring Outage**

**AUGUST 24, 1995**

**AMERICAN ELECTRIC POWER**

**DONALD C. COOK NUCLEAR PLANT**

**R. V. HEAD PENETRATION INSPECTION STATUS**

**UNIT 1: 1995 REFUELING OUTAGE**

- **NO INSPECTION IS PLANNED**

**UNIT 2: 1996 REFUELING OUTAGE**

- **RE-INSPECT PENETRATION NO. 75**
- **REPAIR PENETRATION NO. 75 AS REQUIRED**
- **ADDITIONAL UNIT 2 PENETRATION INSPECTIONS  
HAVE NOT BEEN FINALIZED**



## REACTOR HEAD INSPECTIONS Palisades Nuclear Plant Consumers Power Company

### OUTLINE

- ☛ Introduction / Brief History
- ☛ 1995 REFOUT Scope - Reactor Head Inspection
- ☛ Outage Results
- ☛ Current Plans

### ALLOY 600 PROJECT

- ☛ History
  - ◆ 1989: Closely followed Calvert Cliffs Pressurizer Heater Sleeve cracking.
  - ◆ May '93: Alloy 600 Program established
  - ◆ Sept '93: Pressurizer Power Operated Relief Valve (PORV) line circumferential cracking.
  - ◆ Oct '93: Further inspection determined axial cracking on two pressurizer temperature element nozzles.
  - ◆ 1994: Initiated a major effort to assess Primary Water Stress Corrosion Cracking (PWSCC) of all primary Alloy 600 Components.
- ☛ Project Mission
  - ◆ Understand and control Alloy 600 issues at Palisades to ensure nuclear safety and reliable plant operations while minimizing economic consequences.

## REACTOR HEAD INSPECTIONS

- ☛ Reactor head inspection planned for economic reasons
  - ◆ Classic head nozzle PWSCC is axial & not a safety concern.
  - ◆ Palisades had no reason to inspect head penetrations for anything other than classic PWSCC.
  
- ☛ Reasons to inspect head penetrations
  - ◆ Plant strategic planning
    - Anticipate future maintenance expenses
    - Evaluate need for mitigation or head replacement
    - Will head nozzle life negate benefits of vessel annealing?
    - Does head condition support efforts toward life extension?
    - Will frequent repairs or major one-time repair expenses make continued Plant operation economically unjustifiable?
  - ◆ Future inspection scope
    - Is development of an expensive CRDM nozzle inspection program economically justifiable?
    - Is additional inspection necessary?

## REACTOR HEAD INSPECTIONS

- ☛ 1995 Outage Scope - RV Head
  - ◆ Bare metal visual inspections of all 54 Rx Head Penetrations.
  - ◆ ECT of all 8 incore instrumentation (ICI) penetrations
  - ◆ Insulation shroud modifications



## REACTOR HEAD INSPECTIONS

### Reasons to limit inspection scope

- ◆ Economic
  - 100% head nozzle inspection would cost additional millions of dollars due to unique CRD configuration.
  - High dose would require more staff (inspections & CRD removal/rebuild/reinstallation) due to dose limitations; hence greater expense.
  - CRD work would impact critical path
  - Potential questions of economic prudence by the Public Service Commission if nothing was found.
- ◆ ALARA
  - Considerable additional dose would be incurred.
- ◆ Safety
  - There is no identified safety need to internally inspect all nozzles immediately.

## OUTAGE STATUS

### Successes

- ◆ All 8 ECT examinations of RV head ICI penetrations successfully completed.
- ◆ 100% bare metal visual examinations performed.
- ◆ Zero PWSCC indications determined by NDE.
- ◆ Insulation modifications to support easy visual examinations were completed.
- ◆ Practiced excellent ALARA techniques.

☐ Concerns

- ◆ Higher than anticipated dose rates.

☐ Regulatory Interaction

- ◆ Generally cooperative
- ◆ Periodic reporting to the Resident Inspector, Region III and P.M. / NRR Personnel.
- ◆ Site visit by Region III inspector.

**CURRENT PLANS**

☐ Identify future inspection program

☐ Study PWSCC mitigation option

☐ Follow & support Alloy 600 activities.

**Potential RPVH Penetration Tube  
Cracking**

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**VIRGINIA POWER  
NORTH ANNA 1 & 2  
SURRY 1 & 2**

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# Background

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- Four VP units are in the high susceptibility category
- Low safety significance
- Current plan is to implement a prioritized screening inspection program to manage the economic risk

# Inspection Objectives

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- Integrated cost-effective approach to economic risk reduction for NAPS & SPS
  - Find relevant cracks before they reach an unacceptable size
  - Obtain data to refine WOG guidelines
- Scope and schedule to be consistent with WOG decision analysis prioritization

# Inspection Approach

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- Inspect most susceptible unit
- Inspect most susceptible penetrations
- Expand scope if flaws are detected
- Benchmark for other units

# North Anna: current thoughts

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- Some material heats common to Ringhals 2
- Material heat locations not established
- NAPS 1: Spring 1996
  - ECT ~ 3 outer rings
    - if indication, expand scope
    - UT to characterize flaw
    - repair if required
  - Replication to benchmark for NAPS 2
- NAPS 2: Winter 1996
  - Scope & schedule to be established based on NAPS 1 inspection results

# Surry: current thoughts

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- SPS 1: 9/95 Outage
  - Continue GL 88-05 visual inspection of reactor vessel head for evidence of leakage
    - material heat locations known
    - lowest susceptibility of VP units
    - only 2 penetrations with borderline high susceptibility
    - inadequate time to plan
- SPS 2: Summer 1996
  - Material heat locations not known
  - Inspection scope & schedule based on NAPS1



# Summary

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- Industry is sharing " lessons learned" from previous inspections
- Inspection of NAPS 1
  - Baseline data may refine WOG guidelines
  - Replication will benchmark NAPS 2
  - Establish scope & schedule of inspections with WOG decision analysis model
- Keep NRC Project Managers and Residents informed as inspection plans develop
  - July 25 meeting identified susceptibility & strategy

## Westinghouse Information On Zorita



Westinghouse Owners Group

Enclosure 11

## **RCS Resin Ingress**

### **O BACKGROUND - ZORITA**

- Two Cation Resin Ingress Events
  - o August, 1980 - 40 Liters Entered RCS
  - o September, 1981
    - CVCS Mixed Bed Demineralizer Screen Failed
    - Ingress ~ 5 to 8 Times Larger Than 1980
    - Coolant Conductivity High For At Least Four Months Following Ingress, Attributed To Acid Sulfate



## RCS Resin Ingress

### O BACKGROUND - ZORITA

- Results Of Inspections Of Head Penetrations (37)
  - o IGA & SCC Due To Reduced Sulfur Species
  - o Spare CRDM Head Penetrations (17)
    - Weld Area
      - 16 of 17 Penetrations With Cracking
      - Cracking Axial And Some Circumferential
    - Above Head Region
      - 11 Penetrations With Axial Cracks
  - o Active CRDM Head Penetrations (20)
    - Weld Area
      - 4 Penetrations With Significant Cracking (Isolated Axial Or Circumferential Cracks)
    - Above Head Region
      - No Indications Found
  - o Head Vent Nozzle - Circumferential Crack in HAZ Of Bi-metallic Weld

## **RCS Resin Ingress**

### **O Operating Experience**

- Worldwide Inspections Of Head Penetrations Have Not Indicated Severe Cracking Such As Found At Zorita
- U.S. Plant Inspection Results Similar

### **O Monitoring/Control**

- RCS Conductivity Routinely Monitored
  - o Increase In Conductivity - Indicator Of Resin Ingress
- EPRI Primary Water Chemistry Guidelines (Rev. 3) To Include:
  - o Control Parameter For Sulfate (Monitoring 3 Times/Week)
  - o Recommendation To Monitor For Reduced Sulfur Species

### **O WOG Plants Formally Notified Of Issue By Westinghouse (NSAL-94-028)**

- Not An Immediate Safety Issue
- Conclusions Of WCAP-13565, Rev.1 (Safety Evaluation) Remain Valid
- Review Of Chemistry And Other Operating Records Relative Sulfur Ingress Events Suggested



## **RCS Resin Ingress**

### **CONCLUSIONS**

- O Worldwide Inspections Of Head Penetrations Are Ongoing And Have Not Identified Degradation Similar Or Wide Spread As Found At Zorita**
- O Inspections Of Head Penetrations Will Continue To Confirm Any Prior Resin Intrusions Have Not Caused Significant Degradation To Them**
- O Monitoring That Exists Will Provide Timely Information That A Resin Intrusion Has Occurred**

