PUBLIC MEETING WITH NUCLEAR ENERGY INSTITUTE (NEI) AND EPRI MATERIAL RELIABILITY PROGRAM (MRP) November 27, 2001				
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ATTACHMENT 1

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November 27, 2001

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November 27, 2001

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ATTACHMENT 1

MRP Alloy 600/82/182 Status Update

Larry Mathews, Southern Nuclear
Raj Pathania, EPRI

November 27, 2001
NRC Offices, Rockville, MD

EPRI

Agenda

- Alloy 600 MRP Overall Plan
  - Flowchart Overview
  - Alloy 82/182 Butt Welds
    - Activities to Date
    - Future Plans
  - Alloy 600 RPV Head Penetrations
    - Current Inspection Status
    - Future Inspection Plans
    - Risk Assessment
    - Crack Growth Rates
    - Inspection NDE Status
    - Repair Plans
- Communications
- TGSCC
  - MRP Introduction
  - Owner's Groups

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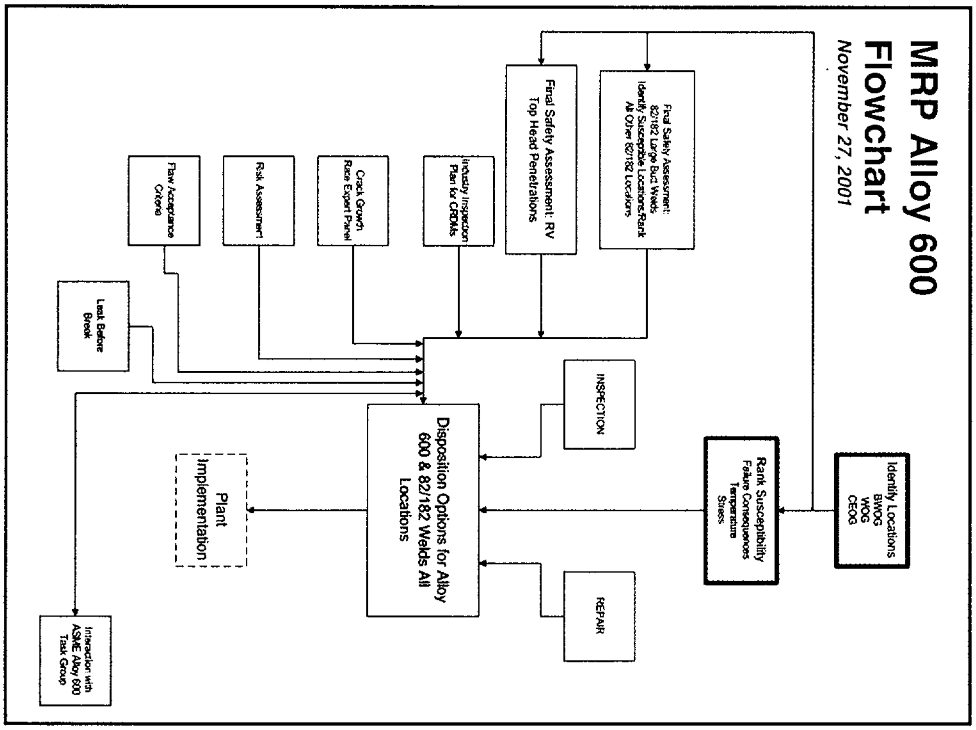
Attachment 3



ALLOY 82/182 BUTT WELDS:
Activities to Date and Future Plans

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Alloy 82/182 Butt Weld Activities

- MRP 44 Part –1, Interim Report
  - Submitted April, 2001
  - Primary Conclusions
    - Cracking predominately axial
    - Axial crack growth bounded
    - Significant margin to critical flaw size
    - Boric acid corrosion not a significant concern
  - Staff Response June, 2001
    - Low probability of near term failure
    - More work needed in areas of
      - Identification/ranking of susceptible areas
      - Crack growth
      - Leak Before Break
      - NDE methods
      - Multiple initiation sites in welds
      - Circumferential cracking

Alloy 82/182 Butt Weld Activities (cont)

- Major Alloy 82/182 Butt Weld locations identified in MRP-44, Part 1
  - Typical locations (see next slide)
  - Significant variation among manufacturers
  - Owners' Groups to prioritize, and identify other locations
    - Stresses, temperature, consequences of failure, etc.
    - Some work already completed
      - Previous operating history
      - License renewal activities
  - Results to be evaluated for further inspection recommendations

Example of Butt Weld Location Data

Location	Quantity	Nozzle Materials	Weld Material	Pipe Material	Est. Peak Temp. (°F)	Nominal Size
PZR surge nozzle weld	1	CS/SS/182	82/182	SS	650	10"
PZR pressure relief nozzle weld	3	CS/SS/182	82/182	SS	650	2.5" (ID)
RV CRDM motor tube welds (2)	69	LAS/82	82	SS	350	~3.5" (ID)
RV core flood nozzle weld	2	LAS/SS/82	82	SS	575	14"
RCS piping surge nozzle weld	1	CS/SS	182	SS	604	10"
RCS piping RCP inlet weld	4	CS/SS	182	SS	575	28"
RCS piping RCP outlet weld	4	CS/SS	182	SS	575	28"
RCS piping decay heat nozzle weld	1	CS/SS	182	SS	604	12"
RCS piping HPI nozzle weld	4	CS/SS/82	182	SS	575	2.5"
CFT outlet nozzle weld	1	CS/SS/82/182	182/82	SS	120	14"

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Alloy 82/182 Butt Weld Activities (cont)

- Crack Growth being addressed by Expert Panel
  - Discussed later
- LBB Applicability Evaluation Underway
  - Preliminary report due 12/01
  - Final results to be incorporated into the final safety assessment
- Improved NDE
  - EPRI Report issued on Automated UT of ID Butt Weld
  - PDI for other Butt Welds
    - NRC interaction with PDI
    - DM welds have to be qualified by Nov 2002
- Other areas to be addressed in 2002

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Alloy 82/182 Butt Weld Inspections

- Butt weld inspections continue to be made
  - Spring 2001
    - 61 Butt Welds Inspected
      - 49 VT and/or PT exams (*insulation removed for PT)*
      - 23 UT
    - No evidence of 182 cracking reported
  - Fall 2001
    - 31 Butt Welds Inspected
      - 31 VT and/or PT exams (*insulation removed for PT)*
      - 9 UT exams
    - No evidence of 182 cracking reported

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Alloy 82/182 Butt Weld Inspections

- Spring 2002 Inspection Plans
  - 88 Butt Welds Planned for Inspection
    - 68 VT and/or PT exams
    - 20 UT

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Alloy 82/182 Butt Weld Inspections

- Summary
  - Inspection results to date support interim safety significance conclusions
    - low probability of near term failure
  - Inspections continue as part of Section XI
    - Volumetric and surface exams
    - Insulation removed
  - GL88-05 walkdowns with enhanced awareness
  - 82/182 locations identified and being evaluated
    - Coordinated through OGs
    - Schedule for completion based on results of evaluations – target 3rd qtr, 2002

RPV HEAD PENETRATIONS:
Inspection Status and Plans

Current Inspection Status
Inspection Overview

- Two types of inspections have been performed: Visual for leakage and NDE for cracks
- Credit is only taken for effective visual inspections performed since December 2000
- Guidance provided for spring and fall 2001 inspections
- Non-Visual NDE (ECT, UT, PT) inspections include:
  - Inspections performed to assess condition without prior indication of cracks/leaks
  - Inspections performed in response to leaks
    - Determine source of leak
    - Assess extent of condition on non-leaking nozzles

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Current Inspection Status
Conclusions From Visual Inspections

- Based on the <5 EFPY category, there are significantly more leaks from nozzles in B&W design plants than in non-B&W design plants (6% vs 1%)
- Leaks in B&W design plants
  - Have been from cracks in the nozzle base metal and welds
  - Have included circumferential cracks above the J-groove weld
- Leaks to date in non-B&W design plants have been limited to the J-groove welds in one plant fabricated by Rotterdam Dockyard Company

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Current Inspection Status
Plants With Effective Visual Insp. Since 12/00

Bulletin 2001-01	B& W Plants					Non B&W Plants				
Category	Plant Name	Inspected	Leaks	% Leaks	Circ Above	Plant Name	Inspected	Leaks	% Leaks	Circ Above
Plants < 5 EFPY	Oconee 1	69	1	1.4%	0	North Anna 1	65	0	0.0%	0
Relative to Oconee	Oconee 2	69	4	5.8%	1	Robinson 2	69	0	0.0%	0
	Oconee 3	69	9	13.0%	3	Surry 1	65	2	3.1%	0
	ANO-1	69	1	1.4%	0					
	TMI-1	69	5	7.2%	0					
	Totals =>	345	20	5.8%	4	Totals =>	199	2	1.0%	0
Plants 5-30 EFPY	Crystal River 3	69	1	1.4%	1	Turkey Point 3	65	0	0.0%	0
Relative to Oconee	Totals =>	69	1	1.4%	1	Farley 1	69	0	0.0%	0
						Farley 2	69	0	0.0%	0
						Calvert Cliffs 2	8	0	0.0%	0
						St. Lucie 1	2	0	0.0%	0
						SONGS 3	34	0	0.0%	0
						Beaver Valley 1	65	0	0.0%	0
						Salem 1	78	0	0.0%	0
						Kewaunee	40	0	0.0%	0
						Prairie Island 1	40	0	0.0%	0
						Totals =>	470	0	0.0%	0
Plants >30 EFPY						McGuire 1	11	0	0.0%	0
Relative to Oconee						Totals =>	11	0	0.0%	0
	Totals =>	**414**	**21**	**5.1%**	**5**	**Totals =>**	**680**	**2**	**0.3%**	**0**

Leaks are from base and weld metal cracks — Leaks are from weld metal cracks

Note: Values above do not reflect results of current Oconee 3, Surry 2 and North Anna 2 inspections. Results of these inspections are still being evaluated.

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Current Inspection Status
Conclusions from Non-Visual NDE Inspections

- NDE inspections prior to December 2000
  - Were focused on the nozzle inside surface where cracks had been discovered in France and Sweden
  - Other than a single nozzle with a maximum 0.27" deep crack at Cook 2, only a few nozzles had shallow axially oriented craze type cracks
- NDE inspections performed in response to leaks after December 2000
  - Confirmed source of leaks through either nozzle wall or welds
  - Confirmed presence of five nozzles with circumferentially oriented cracks above the J-groove weld
- Formal results have not yet been reported for three plants (Oconee 3, North Anna 2, Surry 2) that performed NDE inspections this fall

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Current Inspection Status
Plants With Non-Visual NDE Inspections

Reason for Inspection	Plant Name	Category	Date	Leaks	Inspected	Method	Cracks	
							Nozzles	Circ Above
Planned Inspections Prior to Dec. 2000	Point Beach 1	5-30	Apr-94	0	49	49 ID ECT	0	N/A
	Oconee 2	<5	Oct-94	0	69	69 ID ECT, 2 UT	6-13 - craze	N/A
	Cook 2	5-30	Oct-94	0	71	71 ID ECT, 1 UT	cluster 0.27" deep	N/A
	Palisades	5-30	1995	0	8	8 ID ECT	0	N/A
	North Anna 1	<5	Feb-96	0	20	20 ID ECT	0	N/A
	Cook 2	5-30	Mar-96	0	5	5 ID ECT	confirmed '94	N/A
	Oconee 2	<5	Apr-96	0	2	2 ID ECT	confirmed '94	N/A
	Millstone 2	5-30	Aug-97	0	77	77 ID ECT, 1 UT	1 - craze	N/A
	Ginna	5-30	Oct-99	0	37	37 ID ECT, 1 UT	1 - craze	N/A
	Oconee 2	<5	Nov-99	0	8	8 ID ECT	confirmed '94, '96	N/A
			Totals =>	**0**	**331**		**1 noz w/ 0.27" deep**	
In Response to Leaks	Oconee 1	<5	Nov-00	1	18	8 ECT, 18UT	0 (8 - craze)	0
	Oconee 3	<5	Feb-01	9	18	18 ECT/UT, 9 PT	10 (18 - craze)	3
	ANO-1	<5	Mar-01	1	1	1 ECT/UT/PT	1	0
	Oconee 2	<5	Apr-01	4	4	4 ECT/UT/PT	4	1
	Crystal River 3	5-30	Oct-01	1	9	9 UT	1	1
	Surry 1	<5	Oct-01	2	16	16 UT, 14 PT	0	0
	TMI-1	<5	Oct-01	5	12	12 UT/PT	7	0
	North Anna 1	<5	Oct-01	0	30	30 ECT, 8 UT, 4 PT	6 (4 - craze)	0
			Totals =>	**23**	**108**		**29 (30 - craze)**	**5**
Ongoing Inspections Fall 2001 (results not yet available)	Oconee 3	<5	Nov-01					
	Surry 2	<5	Nov-01					
	North Anna 2	<5	Nov-01					

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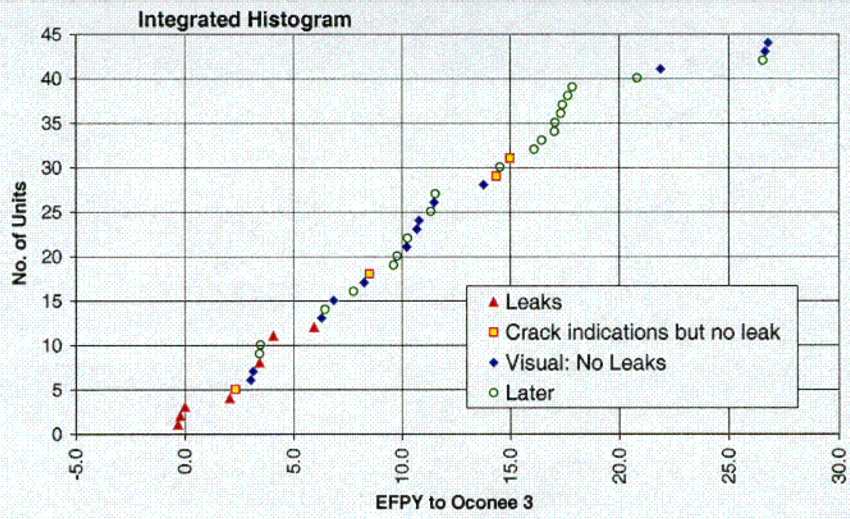
Ranking with Inspection Results



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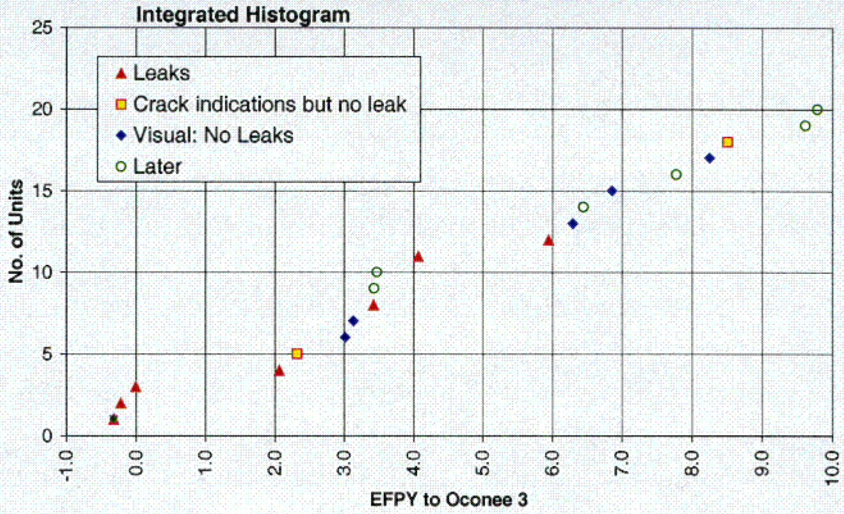
C01

Ranking with Inspection Results



Current Inspection Status
Overall Inspection Conclusions

- Significant nozzle cracking has been limited to B&W designed/fabricated plants with B&W Tubular Products nozzle material
  - Most of the leaks (26 of 28) have occurred in these plants
  - The only detected circ cracks above the J-groove weld have occurred in these plants
  - All of these plants will have been inspected by Spring 2002
- Leaks due to weld cracks have occurred in some B&W designed/fabricated heads and one head fabricated by Rotterdam Dockyard Company
- Top head visual inspections are a cost and radiation exposure effective means of identifying leaks prior to there being a risk of rupture

C02

Industry Inspection Plans
Overview

- There are three main elements to the inspection plan
  - Visual or non-visual NDE examinations of all nozzles in plants with < 30 EFPYs to Oconee 3 by the end of the Spring 2003 outage season

Time	Visual	non-visual NDE
Spring 01	12	4
Fall 01	12	8
Spring 02	13	6
Fall 02	7	4
Spring 03	1	2

  - Sufficient non-visual NDE examinations to assess condition and improve understanding of cracking
  - Risk assessment demonstrating that the increase in predicted core damage frequency resulting from RPV head nozzle PWSCC is within regulatory limits

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Potential Plant Groupings

- Inspection data to date suggest that there may be differences in material susceptibilities
- For tracking and evaluation of data, plants with less than 30 EFPYs to reach Oconee have been separated into five groups by material type and vessel fabricator
  - B&W design plants with B&WTP materials fabricated by B&W
  - Plants with B&WTP materials fabricated by others
  - Plants with Huntington materials
  - Plants with Standard Steel and possibly some Huntington materials
  - Plants with other materials (Sandvik, Westinghouse, Aubert et Duval and C.L. Imphy)
- Current inspection plans will provide information for all groups

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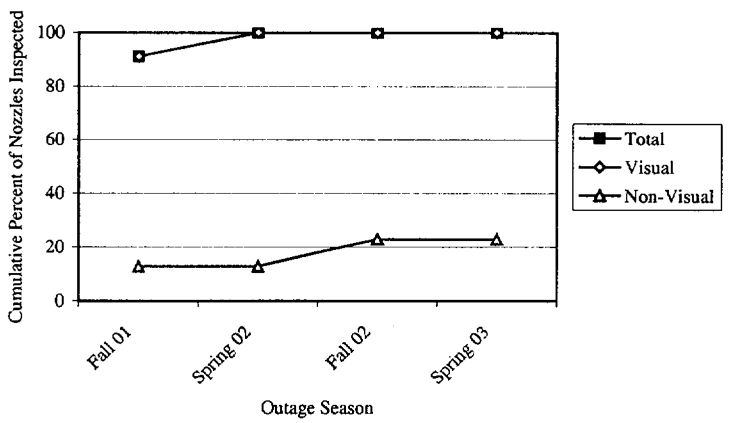
Plan for Future Inspections
All Plants with <5 EFPY Relative to Oconee



MRP- A600 ITG 23

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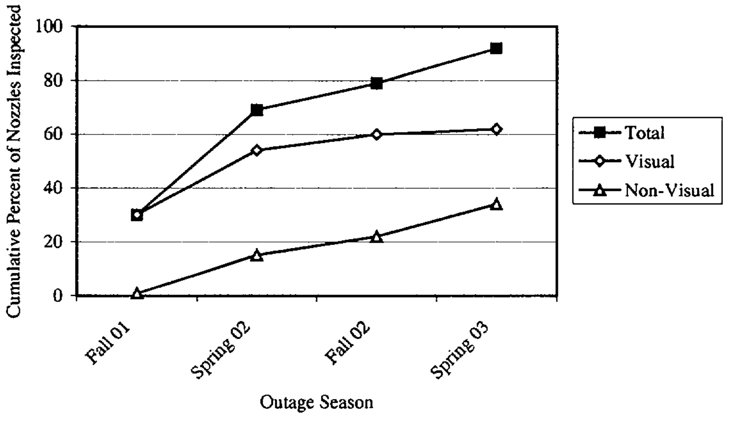
Plan for Future Inspections
All Plants with 5-30 EFPY Relative to Oconee



MRP- A600 ITG 24

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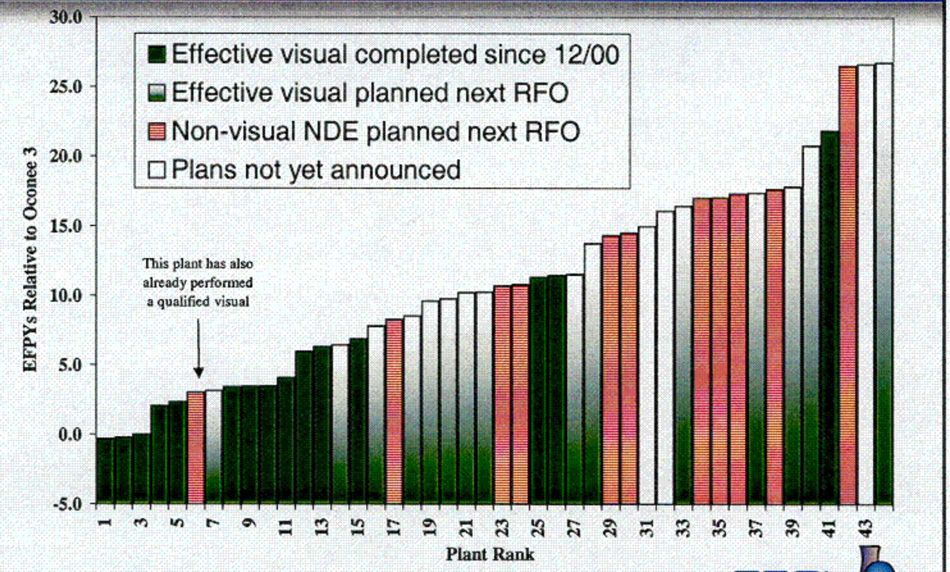
Plan for Future Inspections
All Plants with <30 EFPY Relative to Oconee



Summary Regarding Planned Inspections

- Significant top head visual inspections and non-visual NDE examinations have been completed and more will be performed over the next year
- The inspections have been focused on those plants with the greatest susceptibility
- Inspections are planned for all five categories of material to assess the material condition
- Currently planned inspections will challenge existing capacity

C03

Refinement of Inspection Plan

- As inspection data are compiled, the results will be assessed to determine the need for modifications to the plan
- Still need to address
  - Reinspection frequency and scope
  - Sampling versus 100%
  - Reinspection requirements while permanent repairs are implemented
  - Post-repair inspections
  - How the picture changes with time

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RPV HEAD PENETRATIONS:
Risk Assessment

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Risk Assessment for RPV Head Nozzles

- The industry inspections will be supported by an MRP prepared risk assessment
- The risk assessment expected to demonstrate that the planned inspections will maintain core damage frequency within applicable Reg Guide criteria
- The risk assessment schedule is as follows:
  - Basic risk assessment approach is outlined herein
  - Results will be discussed with the NRC during a proposed technical meeting in January 2002
  - Risk assessment report will be delivered to NRC (Target: February 2002)

Risk Assessment *Methodology*

- Prediction of time to leakage using temperature corrected Weibull statistics for each group
- Required remaining ligament based on limit load analysis
- Time for leak to result in rupture based on crack growth evaluation and deterministic/probabilistic fracture mechanics modeling
- Probability of crack detection prior to leak and leak detection prior to rupture based on inspection plan and analysis
- Core damage frequency assuming small/medium break LOCA
- Effect of collateral damage

Risk Assessment
Schedule and Interaction

- Schedule for Completion
  - CGR for Alloy 600 – Jan 2002
  - Beta Version of PFM Model (B&W Plants) – Dec 2001
  - CCDP from each utility – Dec 2001
  - Collateral Damage – Dec 2001
  - Draft of Risk Assessment
    - Preliminary review with NRC - Jan 2002
    - Final Report – Feb 2002
- Interactions with NRC
  - Crack growth expert panel
  - Review of PFM model
  - More interaction desired on key parameters

RPV HEAD PENETRATIONS:
Crack Growth Rates

Crack Growth Rates for Evaluating PWSCC of Alloy 600 Vessel Head Penetration Material (MRP-055): Overview

- Crack Growth Review Team ('Expert Panel') Meetings
- Environment in OD Crevice
- Crack Growth Database
- Crack Growth Screening Criteria
- MRP Crack Growth Rate Curves
- Application of Curves for Evaluation of Flaws
  - Deterministic Evaluation
  - Probabilistic Evaluation
- Conclusions
- ASME Interaction

Crack Growth Review Team

- MRP assembled a team of international experts on materials and chemistry issues related to PWSCC of Alloy 600
- A kick-off meeting was held on August 10, 2001 during the 10th International Symposium on Environmental Degradation of Materials in Lake Tahoe, NV
- A three day follow up meeting held on October 2-4, 2001 in Airlie, Va to:
  - Define the Annulus Environment of a Leaking Head Penetration
  - Review available CGR data on Alloy 600 & Alloy 182/82 Weld Materials in PWR Primary Water and in Annulus Environment
  - Define screening criteria for CGR data for flaw evaluation, focusing on data quality and consistency
  - Recommend a suitable approach for CGR curves for flaw evaluation

Define OD Annulus Environment

- Oxygenated crevice environment highly unlikely because:
  - Back diffusion of oxygen is too low compared to counter flow of escaping steam
  - Oxygen consumption by metal walls would further reduce concentration
  - Presence of hydrogen from leaking water and diffusion through upper head results in a reducing environment

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Define OD Annulus Environment

- Most likely environments
  - Hydrogenated superheated steam if pressure drop within SCC crack
  - Normal PWR water if boiling transition well above J weld
  - Concentrated PWR primary water if boiling at the exit of SCC crack
    - pH_T between 4 and 9.4 based on MULTEQ calculations
    - Actual pH_T range expected to be narrower due to precipitation of complex lithium-iron borates
    - A French experiment simulating a leak detected such borate compounds and estimated that pH_T of the liquid phase was between 7-8
    - Cleaning practices followed during assembly of penetrations should minimize contamination by sulfates and chlorides

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CGR in OD Annulus Environment

- A study on the effect of pH_T on crack growth rates in Alloy 600 shows that:
  - No significant effect between pH_T of 5 to 7.5
  - An increase of a factor of 1.75 between pH_T of 7.1 to 9.4
- The CGR in the OD crevice environment is expected to be similar (within a factor of 2) to that in the normal PWR environment with a pH_T of 6.9-7.4

MRP Crack Growth Rate Database for Alloy 600

- Domestic and Overseas material suppliers
  - B&WTP, Huntington, INCO, Standard Steel
  - Creusot-Ondaine, Creusot-Imphy, Tecphy, Arbed, VDM, Schneider-Creusot, Sandvik, Sumitomo Metal
- Multiple product forms
  - Thick walled tube
  - Forged bar
  - Rolled bar
  - Forged plate
  - Rolled plate

MRP Crack Growth Rate Database for Alloy 600

- Multiple Labs
  - Westinghouse, U. S.
  - EdF, France
  - CEA, France
  - Studsvik, Sweden
- Crack Growth Tests
  - Twenty three heats
  - 130 data points
  - Actively loaded compact tension specimens
  - Displacement loaded WOL specimens
  - K range of 14.8 to 46.5 MPa$\sqrt{m}$
  - Temperature range of 290 to 363° C (554 to 686 °F)
  - Average crack growth rates

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Crack Growth Screening Criteria

- Material within specifications including condition/heat treatment
- Composition within material specifications
- Mechanical strength properties
- ASTM specimen size criteria
- Straightness criteria and crack front mapping
- Standard procedure for welds
- Environment (Li, B, and H_2 concentrations; hydrogen control; temperature; ECP)
- Loop configuration (e.g., once-through, refreshed, static with H_2 control) and flow rate
- Water chemistry confirmation (e.g., Cl, SO_4)
- Crack length confirmed by destructive examination
- Transgranular fraction on fractograph
- Fraction SCC along crack front
- Changing conditions during a test?
- Constant load versus constant displacement (e.g., wedge loading) versus cyclic loading
- Load during "cool down"
- Crack length versus time data
- SCC crack increment
- Precision on measurement of crack length increase

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Development of CGR Curves

- Develop CGR vs. K power law relationship of the form da/dt = $A(K-9)^n$ for one heat with a large number of data points
    - Best fit exponent n = 1.11
- Develop Log-Normal Distribution Fit of Mean Power-Law Constants for all 23 Alloy 600 Heats Assuming Best-Fit Exponent of 1.11
- Develop appropriate CGR curves for
    - Deterministic evaluation of actual axial flaws (sized by NDE) to make run/repair decisions
    - Deterministic evaluation of hypothetical circumferential flaws on the OD above the weld
    - Probabilistic evaluation of hypothetical circumferential flaws on the OD above the weld

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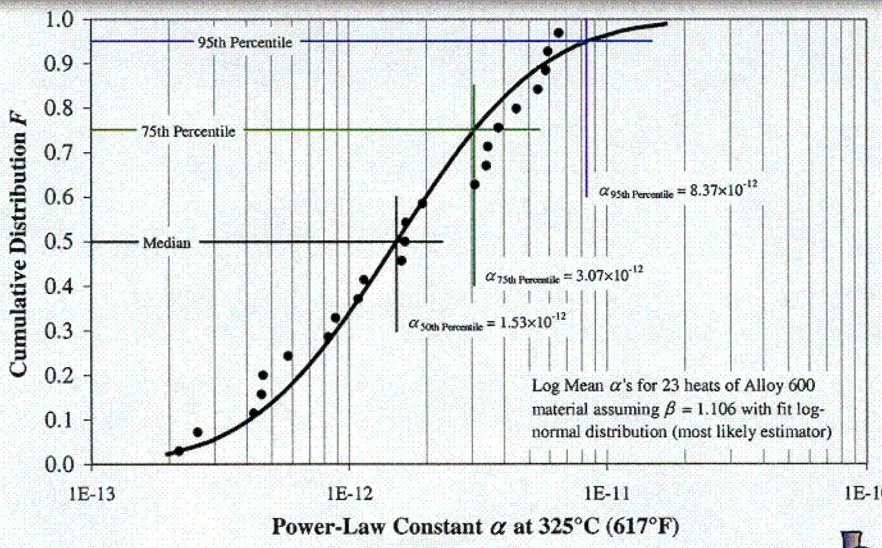
Log-Normal Distribution Fit of Log-Mean Power-Law Constants for 23 Alloy 600 Heats



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C04

Crack Growth Rates
Tentative Conclusions

- The CGR in the OD annulus environment is expected to be similar to (within a factor of two) to that in the normal PWR environment
- MRP recommends the following crack growth rates for Alloy 600 vessel head penetrations:
  - For deterministic evaluation of growth of actual axial flaws to make run/repair decisions use the MRP 75th percentile curve
  - For deterministic evaluation of circumferential flaw growth of hypothetical flaws in the OD annulus environment use the MRP 95th percentile curve
  - For probabilistic evaluation of circumferential flaw growth of hypothetical flaws in the OD annulus environment use the MRP mean curve based on all 130 data points from 23 heats with the CGR variability treated statistically
- It is expected that OD circumferential flaws above the weld will be repaired
- Report MRP-055 covering Alloy 600 CGRs to be completed Jan. 2002
- Subsequent MRP report will address CGRs in Alloy 182/82 weld metal

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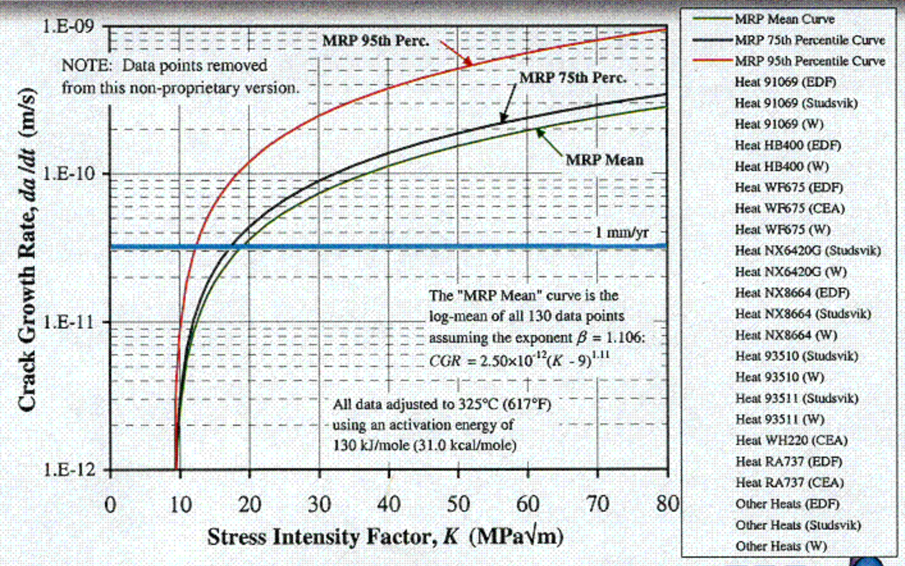
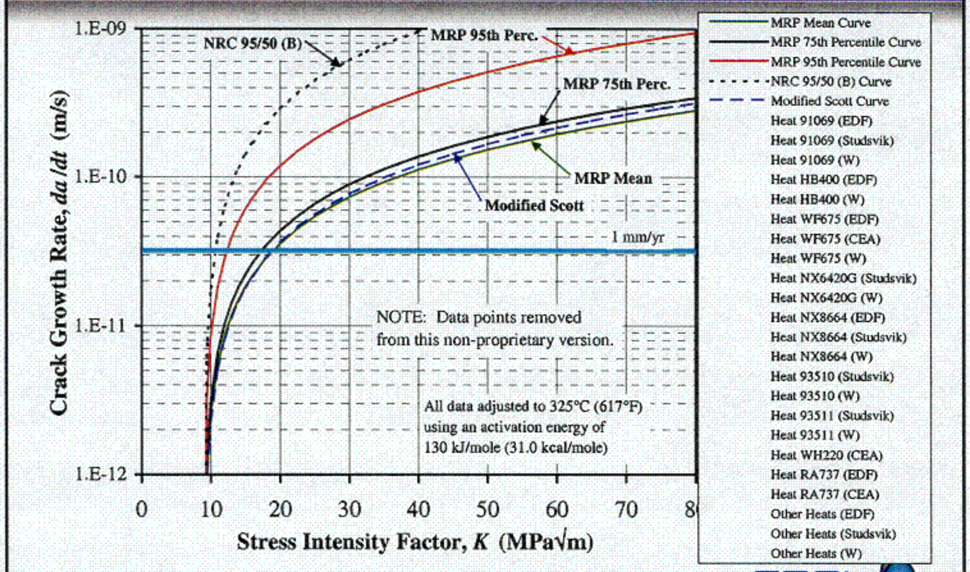
Westinghouse, Studsvik, EDF, and CEA Lab Data for Alloy 600 with MRP CGR Curves



EPRI

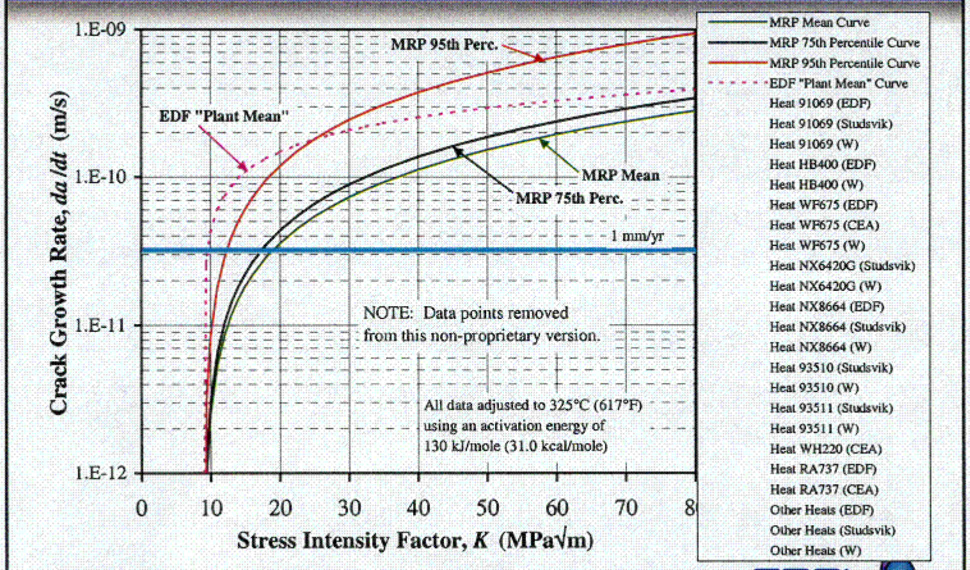
C05

Comparison of MRP Curves with the NRC 95/50 (B) Curve and the Modified Scott Curve



EPRI

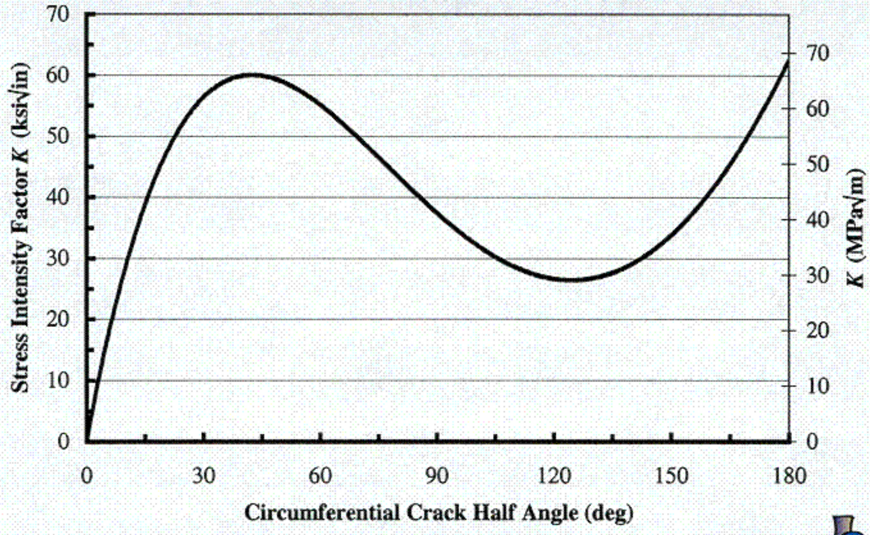
Comparison of MRP Curves with the EDF "Mean" Curve Based on EDF Plant CGR Data



EPRI

C06

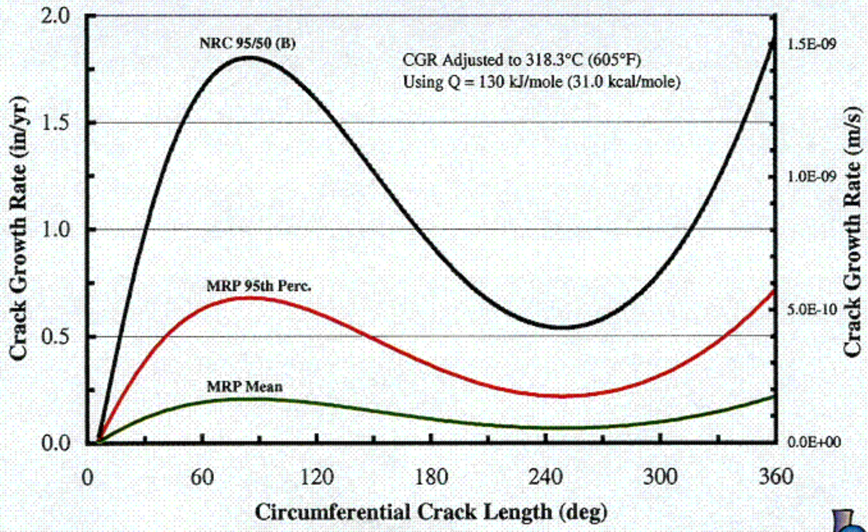
Crack Tip Stress Intensity Factor Estimated by NRC Assumed to Produce the Circumferential Crack Growth Results Shown in Following Figures



MRP- A600 ITG 47

EPRI

Circumferential Crack Growth Rates for the MRP Curves and the NRC 95/50 Curve at the Maximum U.S. Head Temperature of 605°F

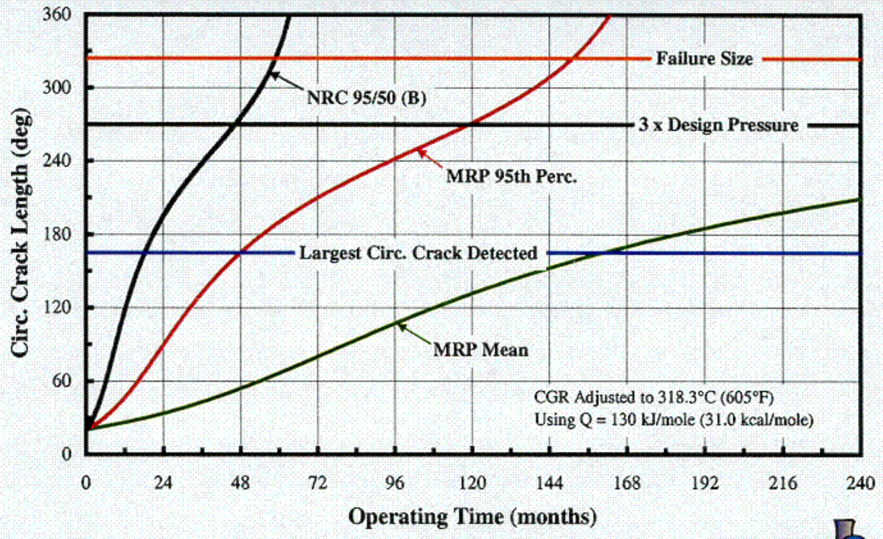


MRP- A600 ITG 48

EPRI

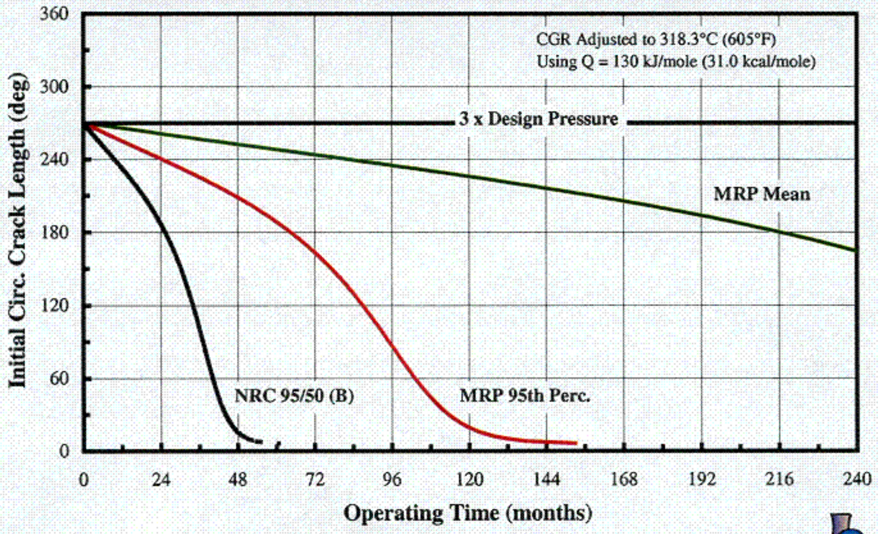
C07

Calculated Operating Time for an Initial 20° Circumferential Crack to Grow to a Larger Size at the Maximum U.S. Head Temperature of 605°F



MRP- A600 ITG 49

Calculated Remaining Operating Time for a Circumferential Crack to Grow to the 3x Limit Load Condition at the Maximum U.S. Head Temperature of 605°F



MRP- A600 ITG 50

C08

ASME Interaction

- ASME Section XI
  - Established task group to evaluate need for code changes as a result of V. C. Summer and reactor head penetration concerns
  - Kickoff at August 2001 Section XI meeting
  - Will meet again at December meeting (12/11)
  - Focus on head penetrations initially
- Liaison Between MRP and TG Established

RPV HEAD PENETRATIONS:
Inspection NDE Status

2001 MRP Inspection Tasks: RPV Head Nozzles

- Provide up-to-date lessons learned from industry events
- Identify and evaluate available NDE technologies using existing and new mockups
  - Faster, more economical inspection
- Continue evaluations to support inspections in 2002 and beyond
- Maintain database of inspection schedules/results/issues
- Develop demonstration process
  - Short-term to addressed Fall '01 inspections
  - Longer-term approach
    - More comprehensive tube mock-ups
    - Flaw sizing
    - Attachment weld inspection
- Provide guidance for top of the head visual inspections

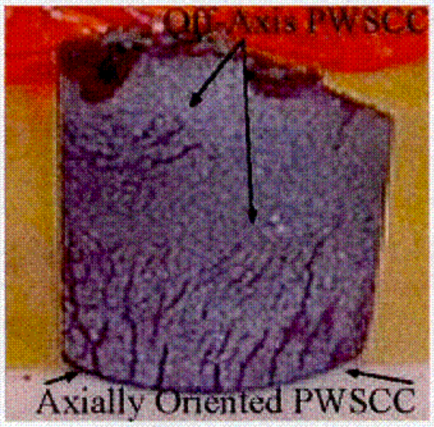
Demonstration Approach

- Objective
  - Demonstrate capability to detect and locate OD-initiated PWSCC in CRDM head penetration base material
  - Previous program implemented ~ 1994 addressed ID-initiated cracking only
- Scope of Current Demonstration Program
  - Base material PWSCC (weld not addressed at the present time)
  - OD-Initiated flaws
  - Axial and circumferential cracking addressed

MRP Demonstration Approach

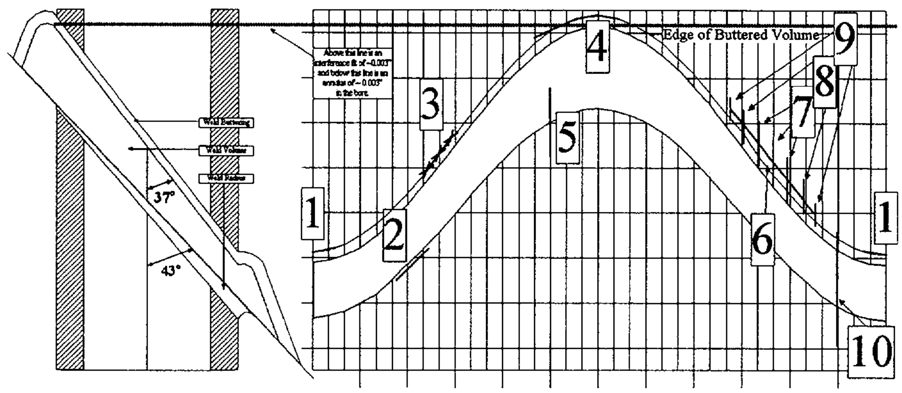
- Two parts to the demonstration
- Both parts must be completed according to published MRP protocol (given to all vendors)
- Part I — Detection of real PWSCC
  - Use remnants of Oconee penetrations containing PWSCC
    - Clusters, isolated cracks, various orientations & sizes (3mm deep and larger)
    - Small pieces, can be hard to scan with full automated systems
  - Establish basic procedure essential variables
- Part II — Full-scale, welded mockup
  - OD notches
  - Establishes capability to scan using essential variables identified in Part I
  - Evaluates flaw location capability with respect to weld

One of the Oconee Samples Used in the Demonstrations



C09

Notch Layout in the Notch Mockup



Current MRP Demonstrations

- Two demonstration activities conducted to date
  - Wesdyne
    - Blade-probe UT
  - Framatome
    - Blade-probe UT
    - "Top-down" tool for open penetrations
- Both vendors detected circumferential OD flaws in the tube above the weld
- One vendor has additionally demonstrated:
  - Detection of OD axial flaws in the tube
  - Detection of OD axial flaws in the tube over the weld (most challenging)

Demonstration Results

- Both vendors have performed their own demonstrations of technology for detecting flaws on the surface of the attachment weld
- Tecnatom demonstration scheduled for early December
  - ID flaw qualification (97-01)
  - Blade-probe UT

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Next Steps & Tasks Under Consideration

- Design additional mockups
  - Flaws
    - Size
    - Type
    - Location
    - Orientation
    - Number
  - J-Groove weld flaws
    - Remote PT
    - Other NDE
      - Surface methods
      - Volumetric
- Tiger Team
  - Meeting 11/28 to decide on these issues
  - Made up of committee members from Assessment and Inspection
- Update visual guidance based on recent experience
  - Available for Spring 2002 outage

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REPAIR PLANS

Repair & Mitigation Committee Status

- OBJECTIVE:
  Investigate, assess, and develop Repair and Mitigation options
  - Develop generic topical reports & relief requests for qualified Repair and Mitigation processes
  - Investigate, evaluate, stimulate, and coordinate industry research & development into effective Repair, Mitigation, and Prevention strategies
- STATUS :
  In Early Spring 2002, publish a report on Repair and Mitigation options

R&M Industry Options

- Change Head Temp.
- Mechanical Stress Improvement Process — Westinghouse / AEA
- Zinc Injection
- Underwater Welding
- MRP Report: Alloy 600 PWSCC Mitigation Techniques

Generic Relief Requests Under Consideration

- Use of Alloy 52/152 Weld Metal
- CRDM Embedded Flaw / Ambient Temperbead Repair Method
- CRDM Relocate Pressure Boundary Repair Method
- Mechanical Stress Improvement Process

Communications

- Communication Improvements
  - Periodic phone calls
- Topics
  - Crack Growth Rate
  - Flaw Acceptable Criteria
  - NRC Research on PFM Analysis
  - Inspection Capabilities
  - Joint Sponsorship with NRC Research
    - Mitigation/initiation testing
    - Harvesting a CRDM
    - Boron testing

TGSCC

TGSCC

- Most recent event was the CEDM housing leakage discovered at Palisades in summer 2001
  - Part through-wall cracks also found in numerous housings
  - Cracks predominantly axial, but some circumferential cracks present
- Root Cause Recently Received
- NDE Center NDE Review
  - Joint Effort of MRP, PDI, NDE Center & NMC
  - Reviewed methods/results/correlations
  - Some cracks detected, others not
  - UT Procedure neither optimized nor qualified for the particular application
  - Design-specific geometry issues affected UT
    - Limited number of units are expected to have this configuration
  - More experimental work is proposed at NDE Center to address detectability in weld
- TGSCC Currently Being Assessed by OGs
  - Designs in Upper CRDM/CEDM area different

Palisades TGSCC Leaks B&WOG Activities

NRC/MRP Alloy 600 Meeting
November 27, 2001
David Whitaker
Chairman, B&WOG Materials Committee

1

Palisades TGSCC Leaks B&WOG Activities

ξ **The B&W Owners Group Materials Committee initiated a project in October following the Brian Sheron September 14, 2001 letter to NEI, "Request for Meeting to Discuss Potential Industry Activities Related to CRDM TGSCC Leakage Found At Palisades"**

2

Current B&WOG Activities

The project involves the following:

-Review CRDM housing designs used at B&W plants and identify configurations of weld junctions

-Identify areas of stagnant flow within CRDM housing

-Identify plant venting procedures and practices

-Catalog CRDMs removed from service for possible NDE

-Prepare a plan for performing NDE on CRDMs removed from service

3

Project Status

- **The B&WOG Materials Committee Completed 2 reports in 1998 which provide the design details of the CRDM Motor Tubes (Housings)**
  - **BAW-2326, June 1998 and Addendum 1 to BAW-2326**
  - **These reports were prepared in response to the Prairie Island CRDM housing leak (fabrication induced weld defect)**
  - **The data and information contained in these reports provide the basis for reviewing the applicability of the "Palisades" findings**
- **The CRDM Motor Tube Venting Procedures, documented in 1994, are being updated**
- **CRDM Motor Tubes removed from service are being catalogued for possible NDE**
  - **Both Type "A" and "C" design motor tubes have been identified**
- **LERs and supplementary information are being reviewed: Palisades, Ft. Calhoun, other**

4

CRDM Motor Tubes Removed from Service

- Design Type "A"
  - ONS-2 — 33-35
  - CR-3 — 8-9
  - ANO-1 — one (1) Type "B"; Type "A" motor tube
- Design Type "C"
  - CR-3 — one (1) Type "C"

5

WESTINGHOUSE OWNERS GROUP
NRC INDUSTRY MEETING
NOVEMBER 27, 2001

II. WOG PRESENTATION

- Palisades TGSCC Issue
  - WOG Program Plan
    - Identify the joint configurations for all the Westinghouse domestic plants for the CRDM tubes above the head. This would include all the joints above the butt weld to the Alloy 600 head penetration tubes.
      - All Westinghouse Plants: No full penetration welds above the head except one dissimilar metal weld (A600 to SS)
      - Confirmed from design manufacturing center - EMD Cheswick
    - Identify WOG plant venting practices/history
    - Evaluate Palisades metallurgical examination/root cause. Consider supplemental examinations, as appropriate
    - Document CRDM housing flaw tolerance
    - Review industry information on TGSCC
    - Provide brief summary report / white paper

CEDM Stainless Steel (TGSCC) Update

- CEOG performing work to identify potential susceptible regions/conditions:
  - stainless steel applications in RCS pressure boundary
  - flow stagnation and venting practices, history
  - update CEDM housing inspection results
  - evaluate Palisades root cause report and compare findings to conditions in remaining plants
- Expectation is to be able to determine plants susceptibility to TGSCC and recommend next steps

CEDM Stainless Steel (TGSCC) Update

- If TGSCC susceptibility is found to be likely in other plants, planning for inspections is anticipated:
  - CEDM housing NDE from ID has been demonstrated
    - Requires disassembly
    - Detection only, depth sizing limited by metallurgy
  - Development of CEDM housing NDE from OD is proposed
    - prepare axial and circumferential-oriented crack samples
    - develop OD UT techniques for detection of ID TGSCC
    - Pending CEOG/Plant action

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