



UNITED STATES
NUCLEAR REGULATORY COMMISSION

WASHINGTON, D.C. 20555-0001

May 6, 1998

MEMORANDUM TO: Thomas H. Essig, Acting Chief
Generic Issues and Environmental
Projects Branch
Division of Reactor Program Management
Office of Nuclear Reactor Regulation

FROM: Joseph L. Birmingham, Project Manager *J L Birmingham*
Generic Issues and Environmental
Projects Branch
Division of Reactor Program Management
Office of Nuclear Reactor Regulation

SUBJECT: SUMMARY OF APRIL 23, 1998, MEETING WITH THE BABCOCK &
WILCOX OWNERS GROUP

On April 23, 1998, representatives of the Babcock and Wilcox Owners Group (B&WOG) met with U.S. Nuclear Regulatory Commission (NRC) staff to present information on the B&WOG Reactor Vessel Internals Program (RVIP) and also the B&WOG Control Rod Drive Mechanism (CRDM) Motor Tube Program. A discussion of the two plans follows.

The RVIP consists of four task areas (1) irradiation-assisted stress corrosion cracking issues, (2) stress corrosion cracking issues, (3) stress relaxation issues, and (4) irradiation embrittlement. Under the plan, B&WOG will review data such as fabrication and manufacturing history, laboratory testing, analysis of withdrawn capsule and bolt material, and industry data to assess the susceptibility of the components to degradation. Based on a comprehensive evaluation of the reactor vessel internal components, B&WOG will rank the component items for safety concerns and identify critical locations. A specific action of the RVIP is participation in a joint owners group evaluation of reactor vessel baffle former bolts. The B&WOG discussed this participation in some detail presenting actions performed to date and plans for future analyses.

Regarding the baffle former bolts, the NRC staff noted that NRC Information Notice 98-11, "Cracking of Reactor Vessel Internal Baffle Former Bolts in Foreign Plants," dated March 25, 1998, had been issued on this subject. The staff commented that licensee processes should lead them to consider the need for an operability determination of the affect of potentially degraded baffle former bolts on their plants. The staff asked when B&WOG expected to complete the safety assessment of the baffle former bolt issue. The B&WOG indicated that it expected to complete a safety assessment about June 30, 1998 and provide a report to NRC. The staff commented that an assessment of the need for bolt inspections may be appropriate when more information was available. *1/1*
DF 3

For the CRDM Motor Tube Program, B&WOG described the three basic designs of the motor tubes, the type and qualification of the welds used for the motor tubes, and the manufacturing sources of the motor tubes. B&WOG plans to review fabrication and inspection records and to

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RD-8-2 B/W
x O&M-6 MEETS.

inspect the welds of a number of irradiated and unirradiated tubes of each type. To date, over 75 CRDM tubes have been inspected and no reportable indications have been found. B&WOG plans to continue examining fabrication records such as design drawings and procedures and to review fabrication process changes, certified material test reports of base materials and weld wire, welder identification records, heat treatment records, NDE records, and weld repair records. B&WOG will share information on this issue with other owners groups and participate in a joint owners group paper on the CRDM motor tubes. A preliminary safety assessment by B&WOG found that (1) defects in other motor tubes is improbable, (2) if a crack developed in a motor tube it would most likely be detected by existing leak detection measures, and (3) the effect of a control rod ejection is within the B&WOG design basis. B&WOG expects to complete its current activities and submit a final report to the NRC about June 19, 1998.

Those who attended the meeting are listed in Attachment 1 and the viewgraphs presented at the meeting are in Attachment 2.

Attachments: As stated

cc w/atts:

Mr. W. W. Foster, Chairman
B&WOG Materials Committee
Director of Safety Assurance
Duke Power Company
Oconee Nuclear Station
PO Box 1439
Seneca, SC 29679

Mr. W. R. Gray, Manager
B&WOG Materials Committee
Framatome Technologies, Inc.
PO Box 10935
Lynchburg, VA 24506
Mail Code OF 57

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T. Sullivan

G. Hornseth

W. Liu

C. Carpenter

C. Smith

T. Colburn

**Attendees for B&WOG Meeting with NRC
April 23, 1998**

NAME	ORGANIZATION
Bill Foster	B&WOG Materials Committee (Chairman)
Dan Spond	Entergy Operations
David Masiero	GPU Nuclear
Richard Miller	GPU Nuclear
Bob Reynolds	Florida Power Corp.
Roger Newton	WEPCO
David Whitaker	Duke Power
Jody Shuping	Duke Power
Karl Jacobs	New York Power Authority
David Forsyth	Westinghouse
William Gray	Framatome Technologies, Inc. (Framatome)
Frank Gregory	Framatome
Robert Borsum	Framatome
Patrick F. Williams	Framatome
Martin Parece	Framatome
Steve Fyfitch	Framatome
Joseph Birmingham	NRC\NRR\DRPM
Dick Wessman	NRC\NRR\EMEB
Ted Sullivan	NRC\NRR\EMCB
Geof Hornseth	NRC\NRR\EMCB
Bob Hermann	NRC\NRR\EMCB
Frank Grubelich	NRC\NRR\EMEB
Wan C. Liu	NRC\NRR\DRPM
C. E. Carpenter	NRC\NRR\PDLR
Craig Smith	NRC\NRR\DRPE
Timothy G. Colburn	NRC\NRR\DRPE

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

**B&W OWNERS GROUP MATERIALS COMMITTEE
RV INTERNALS PROGRAM
AND
CRDM MOTOR TUBE PROGRAM**

**ONE WHITE FLINT NORTH
ROCKVILLE, MARYLAND**

APRIL 23, 1998

**INTRODUCTION
AND
PURPOSE OF MEETING**

D. F. (Dan) Spond

B&WOG Materials Committee

Energy Operations, Inc.

PURPOSE OF MEETING

I. B&WOG Reactor Vessel Internals Program

- **Present program details (Multi-year program, funded on annual basis)**
- **Discuss plans for continued NRC interaction**

II. B&WOG Control Rod Drive Mechanism (CRDM) Motor Tube Program

- **Inform the NRC of the program status**

AGENDA

<u>Time</u>	<u>Item</u>	<u>Presenter</u>
8:30	Introduction and Purpose	D.F. Spond Energy Operations, Inc.
8:45	RV Internals Program	S. Fyfitch FTI
	<ul style="list-style-type: none">• Six Year Program Overview• 1998 Program Tasks• Baffle Bolt Design and Fabrication Activities• Joint Baffle Bolt (JcBB) Program	F.M. Gregory FTI
	<ul style="list-style-type: none">• Safety Assessment	All
9:45	Open Discussion/NRC Comments	All
9:55	Break	

Agenda (Cont.)

<u>Time</u>	<u>Item</u>	<u>Presenter</u>
10:00	CRDM Motor Tube Program	
	<ul style="list-style-type: none">• B&WOG CRDM Motor Tube Designs• Current Actions• Motor Tube Inspection Status• Fabrication Records Search Status• Industry Information Sharing	S. Fyitch FTI
11:15	Preliminary Safety Assessment	M.V. Parece FTI
11:15	Open Discussion/NRC Comments	All
11:25	B&WOG Materials Committee Topical Report Status	W.R. Gray FTI
11:30	Adjourn	

RV INTERNALS PROGRAM

S. (Steve) Fyfitch

Framatome Technologies, Inc.

SIX YEAR (1998 - 2003) PLAN REVIEW

- **The 1998 RV Internals Program initiates a proposed six-year effort**
 - **Goal is to ready the B&WOG for a potential inspection in 2003-2004**
 - **Six year plan based on preliminary evaluation (presented August 1997) and plant design features**
- **The RV Internals Program is divided into four major tasks**
 - **Task 1 – Irradiation-Assisted Stress Corrosion Cracking (IASCC) Issues**
 - **Task 2 – Stress Corrosion Cracking (SCC) Issues**
 - **Task 3 – Stress Relaxation (SR) Issues**
 - **Task 4 – Irradiation Embrittlement (IE) Issues**

SIX YEAR (1998 - 2003) PLAN REVIEW (Cont.)

- **IASCC and SCC identified as current day issues**
- **SR and IE currently considered license renewal issues**

SIX YEAR (1998 - 2003) PLAN REVIEW (Cont.)

- **Task 1 – IASCC Issues**
 - **Evaluation of baffle bolt fabrication and manufacturing history, including material test report information (1998-1999)**
 - **Evaluation of fabrication and manufacturing history of other internals component items, e.g. CB welds, baffle plates, etc. (2000)**
 - **RV internals component item ranking and identification of critical locations (1997, 2001)**

(Note: Dates indicate span times for tasks)

SIX YEAR (1998 - 2003) PLAN REVIEW (Cont.)

Task 1 – IASCC Issues (Cont.)

- **Completion of internals baffle bolting safety assessment, including stress analysis (1998-2000)**
- **Safety assessments for other critical locations, including stress analysis where needed (2000 - 2003)**
- **Evaluation of inspection, repair, and replacement concepts for baffle bolt locations (1997)**
- **Support of JOBB activities concerning replacement material development and testing (1997 - 2003)**
- **Preparation of a bid specification for baffle bolt inspection (1999)**

SIX YEAR (1998 - 2003) PLAN REVIEW (Cont.)

- **Task 2 – SCC Issues**
- **In-reactor IBSP capsule withdrawal and bolt examination (1999 - 2000)**
 - **Design and development of capsule inspection tooling**
 - **Capsule withdrawal and examination of in-reactor test bolts**
- **Laboratory (ex-reactor) tests completed in 1995**
- **In-reactor and laboratory data analysis (2001)**
- **Long-term recommendation developments (2001)**
- **Implementation of long-term recommendations (2002)**

SIX YEAR (1998 - 2003) PLAN REVIEW (Cont.)

- **Task 3 – SR Issues**
 - **Determine the susceptibility of RV internals bolting to stress relaxation (2001)**
 - **Review available industry and literature data**
 - **Evaluate IBSP data**
 - **Prepare white paper on potential for stress relaxation concerns**
 - **Identify the critical locations for stress relaxation (2001)**
 - **Safety assessments of critical locations, including stress analysis where needed (2001 - 2003)**

SIX YEAR (1998 - 2003) PLAN REVIEW (Cont.)

- **Task 4 – IE Issues**
 - **Determine the susceptibility of RV internals component items to irradiation embrittlement (2001)**
 - **Review available industry and literature data**
 - **Prepare white paper on potential for irradiation embrittlement concerns**
 - **Identify the critical locations for irradiation embrittlement (2001)**
 - **Safety assessments of critical locations, including stress analysis where needed (2001 - 2003)**

SIX YEAR (1998 - 2003) PLAN REVIEW (Cont.)

- **Task 5 – Industry Activities**
- **Engineering support of industry activities (EPRI, NACE, ASME, NRC, etc.) (1998 - 2003)**
- **JOBB program support (1998-2003)**

SIX YEAR (1998 - 2003) PLAN REVIEW (Cont.)

1998 PROGRAM TASKS

- **Task 1 – Evaluation of Baffle Bolt Fabrication and Manufacturing History**
- **Task 2 – Continuation of Baffle/Former Bolt Safety Assessment**
- **Task 3 – Support of JoBB Activities**
- **Task 4 – Industry Support**

**BAFFLE BOLT FABRICATION,
AND MANUFACTURING HISTORY
(TASK 1)**

- **Review of fabrication and manufacturing records available in Lynchburg**
- **Evaluation of information and draft report scheduled for 1998**
- **Completion of review and final report scheduled for 1999**
- **Task is underway, nothing significant currently to report**

JOINT BAFFLE BOLT (JOB) PROGRAM (TASK 3)

- **A cooperative industry group has been formed to evaluate IASCC**
- **Members include B&WOG, FTI, EdF, EPRI, W, and WOG**
- **Other members also being pursued**
- **Major goals and objectives:**
 - **Obtain and evaluate all available inspection data (world wide)**
 - **Develop an understanding and predictive capability for degradation of existing RV internals materials**
 - **Develop and qualify replacement bolting material**
 - **Provide a vehicle for interaction of international and domestic working groups addressing IASCC issues**

JOINT BAFFLE BOLT (JOB B) PROGRAM (TASK 3) (Cont.)

- **Funding provided to EPRI for B&WOG participation in the EdF program**
- **Procurement of B&WOG-specific materials for inclusion in EdF program (irradiation in Bor-60 reactor)**
- **Review of information received from EdF pertaining to ISACC, SR, and IE**
- **Attendance at meetings in support of JOB B program**

**JOINT BAFFLE BOLT (JOB) PROGRAM
(TASK 3)
(Cont.)**

- **US materials supplied for Bor-60 irradiation**
 - **Type 347 and 316 supplied by W**
 - **Type 304 and 308 supplied by FTI**
 - **Type 348 supplied by EPRI**
 - **Type 316 supplied by ABB-CE**
- **Type 304 SA material (27 original baffle bolts) and a block of RV internal weld material supplied by FTI to EdF**

**BAFFLE BOLT SAFETY ASSESSMENT
(TASK 2)**

F. M. (Frank) Gregory, Jr.

Framatome Technologies, Inc.

BAFFLE BOLT SAFETY ASSESSMENT

(TASK 2)

(Cont.)

Goal

- **Determine an acceptable baffle bolting configuration such that grid deformation does not occur or is limited to minor grid deformation on peripheral fuel assemblies (PCT limit criteria)**

Proposed Schedule

- **1998 - 2000**

BAFFLE BOLT SAFETY ASSESSMENT

(TASK 2)

(Cont.)

Approach

- **Determine effects of a reduced bolting configuration for following conditions:**
 - **Thermal**
 - **Seismic**
 - **LOCA**

BAFFLE BOLT SAFETY ASSESSMENT

(TASK 2)

(Cont.)

Outline

- . Determine hydraulic pressure loadings due to LOCA on RV internals component items (i.e., baffle plates)**
- . Perform detailed stress analysis of core barrel/baffle/former area to determine baffle bolt stresses due to normal loading conditions (including gamma heating)**
- . Perform a Monte Carlo simulation, using above results and other sources, to define and limit the number of reduced bolting configurations**

BAFFLE BOLT SAFETY ASSESSMENT

(TASK 2)

(Cont.)

Outline (Cont.)

- **Perform a structural analysis of RV internals using the hydraulic pressure loadings to determine fuel assembly/baffle plate response**
- **Perform a detailed analysis of baffle plate/fuel assembly region to determine impact loadings and grid deformation**

BAFFLE BOLT SAFETY ASSESSMENT

(TASK 2)

(Cont.)

B&W PLANT DESIGN FEATURES

- Upflow design
- Baffle plate pressure relief holes/slots
- Fourth former plate from bottom offset from baffle allows cooling of baffle bolts at this elevation

SUMMARY AND CONCLUSIONS

- **Aging effects could result in degradation of baffle bolts in B&W-design plants before the end of their current license**
- **The B&WOG has developed an RV Internals Program to manage RV Internals degradation issues**
- **Design features (flow holes, upflow design, etc.) minimize impact of bolt degradation for B&W-design plants**
- **B&WOG supporting analyses are not expected to require any changes in design basis**
- **Baffle bolt cracking is not a safety concern for the plants in the B&WOG**
- **B&WOG will meet with NRC on an annual basis to update NRC on status of RV Internals Program**

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Agenda

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10:00	CRDM Motor Tube Program	
	• B&WOG CRDM Motor Tube Designs	S. Fyfitch
	• Current Actions	FTI
	• Motor Tube Inspection Status	
	• Fabrication Records Search Status	
	• Industry Information Sharing	
	• Preliminary Safety Assessment	M.V. Parece
		FTI
11:15	Open Discussion/NRC Comments	All
11:25	B&WOG Materials Committee Topical Report Status	W.R. Gray
		FTI
11:30	Adjourn	

**B&WOG CRDM
MOTOR TUBE PROGRAM**

S. (Steve) Fyfitch

B&WOG Materials Committee

Framatome Technologies, Inc.

B&WOG CRDM MOTOR TUBE DESIGNS

- **Three basic designs of CRDMs in use—designated Types A, B, and C**
 - **Type A originally designed by Royal Industries, Inc.**
 - **Type C developed by Diamond Power Specialty Corporation (DPSC)**
 - **Type B is a hybrid with Type C internal mechanisms fitted within Type A motor tube assemblies**
- **All originally supplied CRDM motor tubes were designed, fabricated, tested, and inspected as Class A vessels in accordance with ASME B&PV Code, Section III, 1965 Edition with Addenda through Summer, 1967**
- **CRDM motor tubes supplied later as spares were also constructed in accordance with the Code, but probably to a later issue (determination underway)**

B&WOG CRDM MOTOR TUBE DESIGNS

(Cont.)

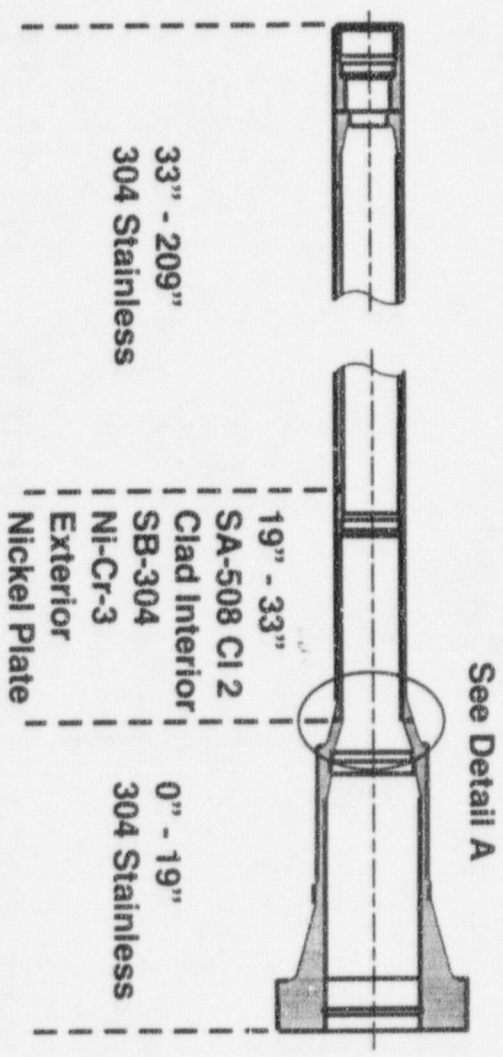
- **Type A motor tubes (used in Type A and Type B CRDMs) built by Royal:**
 - **ASME SA-508 Class 2 forgings for the center sections**
 - **Clad on the ID with Alloy 82 material, nickel-plated on the OD**
 - **Ends are buttered with Alloy 82 material**
 - **Full penetration welded to the upper extension and lower flange section with Alloy 82 material**
- **Type A and C motor tubes (used in Type A, Type B, and Type C CRDMs) built by DPSC:**
 - **ASME SA-182 Grade F6 (and Code Case 1337) forgings (Type 403 stainless steel) for the center sections**
 - **Ends are buttered with Type 309 material with 0.03 maximum carbon**
 - **Full penetration welded to the upper extension and lower flange section with Type 308L material**

B&WOG CRDM MOTOR TUBE DESIGNS

(Cont.)

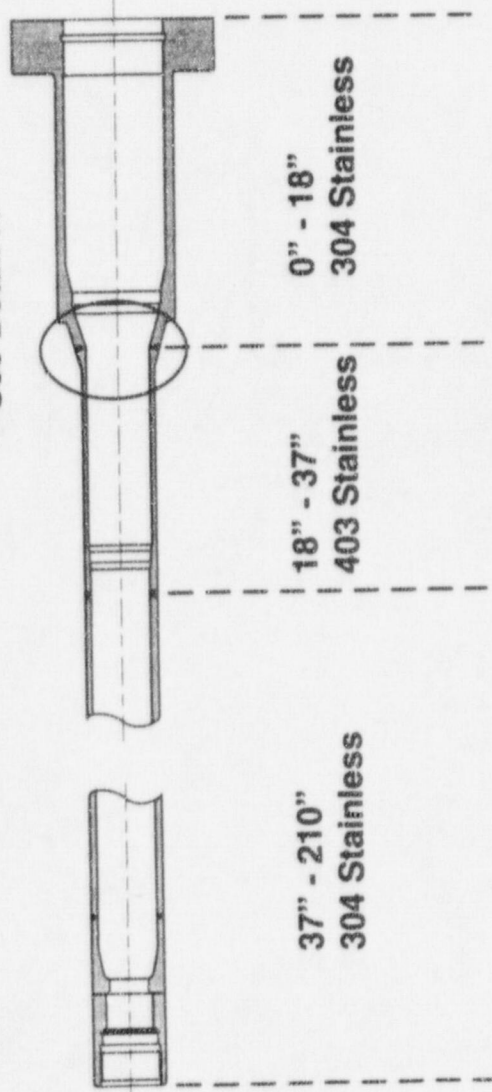
- **All motor tubes were inspected and hydrostatically tested in accordance with ASME B&PV Code Section III requirements**
- **Type A/B and Type C motor tube configurations are shown schematically in the following figures**

Type A/B CRDM Motor Tube

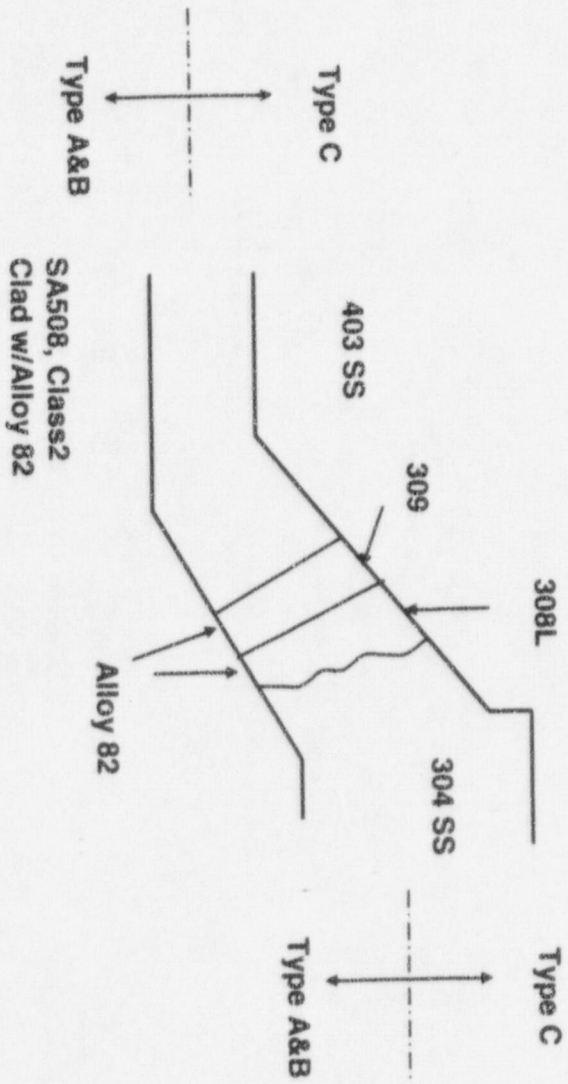


Type C CRDM Motor Tube

See Detail A



Detail A



CRDMs LOCATED ON EACH UNIT IN THE B&WOG

- **Oconee Unit 1 - 69**
- **Oconee Unit 2 - 69**
- **Three Mile Island Unit 1 - 69**
- **Crystal River Unit 3 - 68**
(Remaining CRDM nozzle used for a standpipe)
- **Arkansas Nuclear One Unit 1 - 68**
(Remaining CRDM nozzle used for RADCAL)
- **Oconee Unit 3 - 69**
- **Davis-Besse - 61**
(Remaining CRDM nozzles used as follows: one standpipe, four capped with vented blind flanges, and three capped with blind flanges)

CRDMS PROCURED BY EACH UNIT IN THE B&WOG

Plant	CRDM Type	Manufacturer	Number of CRDMS	Motor Tube/Weld
Oconee Unit 1	A	Royal Industries	70	SA-508 CI 2/Alloy 82
	A	DPSC	2	Type 403/309/308L
Oconee Unit 2	A	Royal Industries	70	SA-508 CI 2/Alloy 82
	A	DPSC	2	Type 403/309/308L
Three Mile Island Unit 1	A	Royal Industries	69	SA-508 CI 2/Alloy 82
	A	DPSC	2	Type 403/309/308L
	B	DPSC	2	Type 403/309/308L
	C	DPSC	10	Type 403/309/308L
Crystal River Unit 3	A	Royal Industries	70	SA-508 CI 2/Alloy 82
	A	DPSC	1	Type 403/309/308L
	C	DPSC	3	Type 403/309/308L
Arkansas Nuclear One Unit 1	B	Royal Industries	70	SA-508 CI 2/Alloy 82
	C	DPSC	5	Type 403/309/308L
Oconee Unit 3	C	DPSC	69	Type 403/309/308L
	C	DPSC	12	Type 403/309/308L
Davis-Besse	C	DPSC	63	Type 403/309/308L

CURRENT PROGRAM ACTIVITIES

- **Inspection of sixty available unirradiated Type C CRDMs at FTI**
- **Inspection of one unirradiated Type A CRDM performed at FTI**
- **Inspection on-site of thirteen Type A CRDMs removed from Oconee Unit 2 RV head for refurbishment during the spring 1998 outage (by Duke Energy)**
- **Inspection of three Type B CRDMs removed from Arkansas Nuclear One Unit 1 RV head for refurbishment at FTI**
- **Summarize pre-service and in-service inspections performed by B&WOG utilities**
- **Review fabrication records and reexamine RT film on select CRDMs**

CURRENT PROGRAM ACTIVITIES

(Cont.)

- **Development of a written status report of B&WOG activities for submittal to NRC (Submitted April 13, 1998)**
- **Preliminary review of CRDM fabrication records**
- **Preliminary safety assessment**
- **Industry information sharing**
- **Preparation of Joint Owners Group Paper on this topic**

MOTOR TUBE INSPECTION STATUS

- **Dye-penetrant testing (PT) examinations were performed using solvent removable dye**
- **Initially PT examined the ID and OD of the lower weld of unirradiated CRDMs**
- **Examination of the OD of the upper weld included later for both unirradiated and irradiated CRDMs**
- **Reexamination of radiographic testing (RT) film**

MOTOR TUBE INSPECTION STATUS (Cont.)

- **PT results of unirradiated Type C CRDMs**
 - **ID/OD of lower weld—60 motor tubes**
 - **OD of upper weld—37 motor tubes**
 - **No indications observed**
- **PT results of unirradiated Type A CRDM**
 - **ID/OD of lower weld—1 motor tube**
 - **OD of upper weld—1 motor tube**
 - **One rounded indication ($\leq 1/64$ inch) observed on ID of lower weld, acceptable by ASME Code criteria**
 - **No other indications observed**
- **RT film reexamination results of unirradiated Type C CRDMs**
 - **All 3 motor tube welds - 60 motor tubes**
 - **One 3/64" diameter pore noted on one motor tube, acceptable by ASME Code criteria**
 - **No reportable indications observed in RT film**

MOTOR TUBE INSPECTION STATUS (Cont.)

- **PT examination results of Type A CRDMs at Oconee-2**
 - **ID/OD of lower weld, and OD of upper weld—13 motor tubes**
 - **No indications observed**
- **PT examination results of ANO-1 Type B CRDMs at FTI**
 - **ID/OD of lower weld, and OD of upper weld—3 motor tubes**
 - **One PT indication detected at OD of upper weld location on CRDM S/N 319**
 - **Circumferential in orientation, 3 1/4-inch long**
 - **Incremental buffing/PT reexamination performed to base metal**
 - **Indication no longer evident after removal of 7 mils of material (plating and base metal)**
 - **Indication apparently caused by motor tube surface scratch or machining mark**
 - **No other indications observed**

PRE-SERVICE AND IN-SERVICE INSPECTIONS

- **ASME B&PV Code Section XI ISI programs and Technical Specification leakage limits are used to manage cracking of welded joints**
- **Each of the B&WOG utilities has ISI programs in place and leakage monitoring limits**
- **Leakage monitoring, in accordance with utility responses to Generic Letter 88-05, is performed during each refueling outage (if not more often)**

PRE-SERVICE AND IN-SERVICE INSPECTIONS (Cont.)

- **Visual inspection of the OD of every CRDM has been performed at least once during its service lifetime during gasket installation or replacement activities**
- **Visual inspection of the ID and OD of one CRDM from every plant in the B&WOG has been performed during the CRDM Life Extension Program**
- **No reportable indications or leaks have been identified as a result of all these inspections**

PRE-SERVICE AND IN-SERVICE INSPECTIONS (Cont.)

Oconee 1,2,3	Davis Besse	CR-3	ANO-1	TM1-1
<u>No Pre-service insp.</u>	<u>Pre-service insp.:</u>	<u>No Pre-service insp.</u>	<u>Pre-service insp.:</u>	<u>No Pre-service insp.</u>
<u>1" 10 yr ISI:</u>	UT all 3 MT welds on all 61 C drives	UT all 3 MT welds	UT all 3 MT welds on all 71 drives - '72	<u>1st 10 yr ISI:</u>
All 3 Motor Tube (MT) welds:	<u>ISI:</u>	<u>ISI:</u>	<u>ISI:</u>	UT + VT all 3 MT welds, one drive - '76
UT, 3 A drives, OC-1	PT OD of upper/lower center tube welds:	UT all 3 MT welds	UT all 3 MT welds on one drive - '83	<u>2nd 10 yr ISI:</u>
UT, 3 A drives, OC-2	3 drives - '84	4 drives - '80		UT (all 3 MT welds) + PT (cntr tube welds only) on 1 drive - '86
UT, 3 C drives, OC-3	4 drives - '90	PT OD of all 3 MT welds		
<u>2nd 10 yr ISI:</u>	1 drive - '94	3 drives - '94		UT (upper cntr tube weld), UT + PT (lwr cntr tube weld)
PT OD of 3 MT welds -	2 drives - '96	3 drives - '96		1 drive - '90
1 drive at each unit:				PT all 3 MT welds,
'86,'90,'91 - OC-1				1 drive - '93
'86,'89,'91 - OC-2				2 drives - '95
'85,'88,'91 - OC-3				
<u>3rd 10 yr ISI:</u>				
PT OD of 3 MT welds -				
1 A drive ea. OC-1, 2				
1 C drive OC-3				

FABRICATION RECORDS SEARCH

- **Review of available fabrication records underway for CRDM motor tubes supplied from Diamond Power Specialty Corporation (DPSC) to Babcock & Wilcox (B&W)**
- **Included in this review are motor tubes supplied to DPSC from Royal Industries**

FABRICATION RECORDS SEARCH (Cont.)

Records of interest include

- **DPSC's design drawings and procedures**
- **Fabrication processes and the chronology of changes**
- **Manufacturer identification (Royal Industries or DPSC)**
- **Weld wire and base material certified material test reports (CMTRs) for the motor tube sections**
- **Welder identification**
- **Heat treatment records (time, temperature, and cooling rates)**
- **Delta ferrite determinations**
- **NDE performed (particularly the RT films)**
- **Repair records**

Records located to date

- **Full set of DPSC manufacturing records**
- **QA data packages from Royal**

FABRICATION PROCESS

Royal Industries Original Type A/B Motor Tube Assembly

<u>Motor tube base</u>	<u>Motor tube center section</u>	<u>Lower motor tube assembly</u>	<u>Motor tube weld assembly</u>
SA-182 Grade F304 forging PT and UT examined Final machined PT examined	SA-508 Class 2 forging MT and UT examined Clad with SB-304 Type ERNiCr-3 (Alloy 82) PT examination of cladding (ID and end faces) RT end faces PWHT MT examination of finished part	Motor tube base welded to center section using SB-304 Type ER NiCr-3 (Alloy 82) RT examination Weld repair (if necessary) Finish machining Center section OD nickel plated Machined surfaces PT examined Surface indications repaired	Lower motor tube assembly welded to extension assembly (SA-182 Grade F304) using SB-304 Type ERNiCr-3 (Alloy 82) Finish machining RT examine weld joint PT examination of machined surfaces Surface indications or unacceptable welds repaired Finished assembly hydrostatically tested

FABRICATION PROCESS

Diamond Power Specialty Corporation Original and Replacement Type C Motor Tube Assembly

<u>Motor tube base</u>	<u>Motor tube center section</u>	<u>Lower motor tube assembly</u>	<u>Motor tube weld assembly</u>
SA-182 Grade F304 forging PT and UT examined Final machined PT examined	SA-182 Grade F6 (Type 403 stainless steel) forging MT examined Weld end preps machined and PT examined Both ends buttered with Type 309 weld wire Modified chemical composition. (< 0.03 carbon) Interim machined and delta ferrite check Both ends buttered with Type 308L weld wire Interim machining and delta ferrite check	Motor tube base welded to center section using SFA 5.9 Class ER 308L weld wire RT examination and delta ferrite check Weld repair (if necessary) Interim machining and PT examination of weld joint Additional machining and RT of weld joint Final machining PT of upper weld end prep and ID of lower weld	Lower motor tube assembly welded to extension assembly (SA-182 Grade F304) using SFA 5.9 Class ER 308L weld wire RT examination and delta ferrite check Finish machining RT examine weld joint PT examination Surface indications or unacceptable welds repaired Finished assembly hydrostatically tested PT examination

FABRICATION PROCESS (Cont.)

Diamond Power Specialty Corporation Original and Replacement Type C Motor Tube Assembly

	<p>Motor tube center section (Cont.)</p> <p>RT examination of buttered ends</p> <p>PWHT and delta ferrite check</p> <p>Hardness testing and additional machining and inspections</p> <p>PT examination of lower weld joint end</p> <p>UT examination center section</p>		
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FABRICATION PROCESS (Cont.)

Diamond Power Specialty Corporation Replacement Type A/B Motor Tube Assembly

- **Fabrication sequence for replacement Type A/B motor tube assemblies generally follows that of the Type C design**
- **Material requirements are the same**

INDUSTRY INFORMATION SHARING

- **Each Owners Group plans to share information on this issue**
- **Currently identified areas include:**
 - **Evaluation of the metallurgical failure analysis report**
 - **Summaries of UT/PT inspection data**
 - **Examination of the 60° wedge remaining from the Prairie Island Unit 2 failure (for a calibration block)**
 - **Fabrication histories of the various motor tubes**
 - **Qualification work being performed at the EPRI NDE Center**
 - **Preparation of a Joint Owners Group Paper**

PRELIMINARY SAFETY ASSESSMENT

M. V. (Marty) Parece

Framatome Technologies, Inc.

PRELIMINARY SAFETY ASSESSMENT

- **CRDM motor tube weld failure could result in SBLOCA or control rod ejection accident (CREA)**
- **SBLOCA and CREA have been analyzed extensively for B&W-designed plants**
 - **Responses to these accidents meet all acceptance criteria**
- **Inspections performed to date support the conclusion that there is no increase in the probability of failure of a CRDM motor tube on B&W-designed plants**
- **Consequently, there is no increase in the probability of a SBLOCA or a CREA**

SUMMARY AND CONCLUSIONS

- **Inspection activities by the B&WOG and others have resulted in zero additional instances of CRDM motor tube cracking**
- **Review of fabrication records indicates that similar flaws would not be anticipated and it is expected that the fabrication inspection procedures would have identified them**
- **Experience at Prairie Island Unit 2 indicates that a similar event would be detectable as part of the normal leakage monitoring performed by the B&WOG utilities**

SUMMARY AND CONCLUSIONS

(Cont.)

- **Preliminary safety assessment concludes that the unlikely event of a control rod ejection is within the design basis**
- **Conclusions to date, resulting from the aforementioned activities, validate the premise that the leakage at Prairie Island Unit 2 was a unique event**
- **The B&WOG will complete its current activities and submit a final report to the NRC (currently scheduled for June 19, 1998)**

SUMMARY AND CONCLUSIONS (Cont.)

Summary of B&WOG CRDM Motor Tube Weld Inspections

TYPE OF EXAM	CRDM TYPE	WELD EXAMINED	TOTAL
PT	TYPE A/B	ID/OD LOWER	17
		OD LOWER	20
		OD UPPER	34
UT	TYPE C	ID/OD LOWER	60
		OD LOWER	51
		OD UPPER	51
VT	TYPE A/B	LOWER	84
		UPPER	84
		TOTAL	168
VT	TYPE C	LOWER	65
		UPPER	65
		TOTAL	130
VT	TYPE A/B	OD LOWER	339
		OD UPPER	339
		TOTAL	678
VT	TYPE C	OD LOWER	134
		OD UPPER	134
		TOTAL	268