ELL

Duke Power®
A Duke Energy Company

Ken S. Canady
Vice President
Nuclear Engineering

Duke Energy Corporation
526 South Church St.
Charlotte, NC 28202
EC08H
P.O. Box 1006
(704) 382-4712 OFFICE
(704) 382-7852 FAX

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U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington D.C. 20555

Subject: Catawba Nuclear Station Units 1 & 2
Docket Nos. 50 -413, 414
McGuire Nuclear Station Units 1 & 2
Docket Nos. 50 -369, 370
Oconee Nuclear Stations Units 1,2 & 3
Docket Nos. 50-269, 270, 287
Response to NRC Bulletin 2002-01:
Reactor Pressure Vessel Head Degradation and
Reactor Coolant Pressure Boundary Integrity

Pursuant to 10 CFR 50.54(f), this letter and the associated attached Enclosures provide Duke Energy Corporation's (Duke's) response to NRC Bulletin 2002-01 for the Catawba, McGuire and Oconee Nuclear Stations. This bulletin requested plant-specific information as a result of NRC staff concerns regarding reactor pressure vessel head degradation and reactor coolant pressure boundary integrity.

Responses are provided for Bulletin items 1.A through 1.E in Enclosures I, II and III for Catawba, McGuire and Oconee respectively. These responses provide a basis for reasonable assurance that all applicable regulatory requirements are and will continue to be met and that the facilities will be operated in a safe manner. The responses describe methods and processes currently in place at each plant. This information was collected using reasonably available sources and means available to meet the requested 15 day response.

Additional information for this bulletin will be provided in accordance with the schedule established in the Bulletin. Items 2.A and 2.B will be provided within 30 days following the next inspection of the reactor pressure vessel head for each unit. Item 3.A will be provided within 60 days of the date of the bulletin. Duke Energy has not made any specific regulatory commitments in response to this bulletin.

If you have questions or need additional information, please contact Gregory S. Kent at (704)373-6032.

Very truly yours,

K.S. Canady
Vice President
Nuclear Engineering

ENCLOSURES

xc: L.A. Reyes
U.S. Nuclear Regulatory Commission Regional Administrator,
Region II Atlanta Federal Center
61 Forsyth St., SW, Suite 23T85

C.P. Patel
NRC Manager (CNS)
U.S. Nuclear Regulatory Commission
Mail Stop O-8 H12
Washington, DC 20555-0001

R.E. Martin
NRC Manager (MNS)
U.S. Nuclear Regulatory Commission
Mail Stop O-8 H12
Washington, DC 20555-0001

L.N. Olshan
NRC Manager (ONS)
U.S. Nuclear Regulatory Commission
Mail Stop O-8 H12
Washington, DC 20555-0001

S.M. Shaeffer
Senior Resident Inspector (MNS)

D.J. Roberts
Senior Resident Inspector (CNS)

M.C. Shannon
Senior Resident Inspector (ONS)

AFFIDAVIT

K.S. Canady, affirms that he is the person who subscribed his name to the foregoing statement, and that all the matters and facts set forth herein are true and correct to the best of his knowledge.

K.S. Canady, Vice President, Nuclear Engineering

Subscribed and sworn to me: April 1, 2002
Date

Mary P. Nelms, Notary Public

My Commission Expires : JAN 22, 2006
Date

ENCLOSURE I
Catawba Nuclear Station
Response to NRC Bulletin 2002-01

Requested Information

1. **Within 15 days of the date of this bulletin, all PWR addressees are required to provide the following:**

   A. **a summary of the reactor pressure vessel head inspection and maintenance programs that have been implemented at your plant,**

Response:

Catawba Unit 1

A complete bare metal inspection of the Catawba Unit 1 reactor pressure vessel (RPV) head has not been conducted since the unit began commercial operation in 1985. Catawba personnel removed sufficient insulation to perform an ISI of the Upper Head Injection (UHI) nozzle welds. This examination was conducted during the 1EOC10 refueling outage in 1997, as part of the 10 year ISI. Significant deposits of boron were not identified on the head or around the exposed CRDM penetrations during these inspections. These inspections did not include specific reviews for boron accumulations, however normal work practices would be expected to have identified such conditions had they existed. It is possible that some boric acid residue remains on the head in the areas that were not exposed for inspection. However, CNS Unit 1 has never experienced a large boric acid leakage event that would result in large corrosion or wastage.

Catawba Unit 2

A complete bare metal inspection of the Catawba Unit 2 RPV head has not been conducted since the unit began commercial operation in 1986. Catawba personnel removed sufficient insulation to perform an ISI of the UHI nozzle welds. This examination was conducted during the 2EOC8 refueling outage in 1997, as part of the 10 year ISI. Significant deposits of boron were not identified on the head or around the exposed CRDM penetrations during these inspections. These inspections did not include specific reviews for boron accumulations, however normal work practices would be expected to have identified such conditions had they existed. It is possible that some boric acid residue remains on the head in the areas that were not exposed for inspection. However, CNS Unit 2 has never experienced a large boric acid leakage event that would result in large corrosion or wastage.

Applicable to Both Catawba Units

The site has implemented certain programs designed to identify reactor coolant leakage[1] and document corrective actions necessary to prevent adverse affects on plant equipment. Some of these requirements were implemented in response to Generic Letter 88-05[2] (GL 88-05). Incidents of boric acid leakage are documented in the departmental corrective action program. The following is a description of the current practices.

There are three categories of RPV head inspections[3] which should be capable of detecting evidence of reactor coolant leakage in the vicinity of the RPV head support structure. These three inspections are part of an overall leak management program described in more detail in response to 1B. These three inspections are briefly described in the following:

(1) Post-shutdown "normal operating temperature / pressure" inspection - This inspection is controlled in accordance with station procedure by knowledgeable staff. Specific areas of the RPV head assembly that are inspected for indications of leakage include:

- RPV nozzles
- RPV head vent pipe
- RPV head CRDM nozzles
- RPV head UHI vent line
- RPV head UHI connections

Findings during this inspection should be documented in the procedure and entered into the station corrective action program.

(2) Inspection of RPV head while on the head stand - An inspection is conducted according to the RPV head removal procedure by knowledgeable staff. Indications of leakage should be documented and entered into the station corrective action program. In addition, a RPV head walk-down is performed each refueling outage by the responsible engineer.[4] This inspection covers accessible areas of the insulation which surrounds the RPV head.

(3) Startup "normal operating temperature / pressure" inspection – Multiple inspections occur prior to unit startup. A Mode 3 inspection is conducted in accordance with station procedures which conform to ASME XI, IWB-5000 (System Pressure Tests). This

[1] Reactor Coolant Leakage and boric acid leakage are used interchangeably to refer to primary water which contains some concentration of boric acid.
[2] Generic Letter 88-05 Boric Acid Corrosion of Carbon Steel
[3] Unless specifically noted the term inspection or examination is not given any specific regulatory definition, but is used generically to refer to some structured observation process.
[4] In accordance with the Engineering Directives Manual

examination covers the area above the insulation which surrounds the RPV head. All findings in these inspections and examinations are documented in the procedures and entered into the station corrective action program.

These inspections should identify the existence of borated water leakage onto the RPV head and associated structures. Visual inspection of the insulation above the vessel head ensures that leaks from conoseals, vent lines or other components are identified, and that appropriate corrective action is taken.

Primary Water Stress Corrosion Cracking (PWSCC) of RPV head penetrations

Catawba Nuclear Station has a low susceptibility ranking in accordance with the Material Reliability Program (MRP[5]) methodology for RPV head penetrations. This methodology ranks each reactors RPV head penetration nozzles susceptibility to PWSCC using Oconee Unit 3 as a measuring point. Duke participates in industry working groups and will adjust inspection plans as necessary in response to industry research and operating experience

<u>Requested Information</u>

1. **Within 15 days of the date of this bulletin, all PWR addressees are required to provide the following:**

    B. **an evaluation of the ability of your inspection and maintenance programs to identify degradation of the reactor pressure vessel head including, thinning, pitting or other forms of degradation such as the degradation of the reactor pressure vessel head observed at Davis-Besse,**

<u>Response:</u>

As noted above, Catawba's programs rely on several different inspections that identify leaks that can introduce boric acid onto the RPV head from above the insulation. Boric acid leakage through vessel head nozzles under the insulation is addressed in Catawba's Bulletin 2001-01 responses. Catawba has also considered potential leakage sources, from source above the insulation and from sources that may exist internal to the insulation. Catawba's RPV heads should be free of any substantial boric acid deposits. This is due to the programs designed to prevent boric acid from accumulating on the vessel head from sources outside of the RPV head insulation, ISI program, and also Catawba's low nozzle cracking susceptibility ranking.

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[5] Electric Power Research Institute Material Reliability Program

The site has implemented certain programs designed to identify reactor coolant leakage and document corrective actions necessary to prevent adverse affects on plant equipment. Some of these requirements were implemented in response to GL 88-05. Incidents of boric acid leakage are documented and evaluated in the departmental corrective action program. The following programmatic requirements were described in response 1A of this bulletin:

- Post-shutdown "normal operating temperature / pressure" inspection to identify leakage or evidence of leakage in the form of boric acid crystals on top or outside the support structure of the RPV head.
- Inspection of RPV head while on the head stand to look for evidence of borated water leakage inside the shroud.
- Startup "normal operating temperature / pressure" inspection to meet ASME XI system pressure test requirements and detect leakage that would be apparent with the insulation installed.

The inspection and maintenance programs at Catawba Nuclear Station are designed to prevent degradation of the RPV head by proactively detecting leakage or evidence of leakage before leakage can degrade the carbon steel pressure boundary. These programs are based on a hierarchy of administrative and technical procedures whose purpose is to detect boric acid leakage and implement appropriate corrective actions. Specific plant activities (walk downs and inspections) are periodically conducted to determine if boric acid deposits are present on the reactor coolant boundary equipment or borated water leakage is occurring. A knowledgeable individual is specifically assigned the task of examining the RPV head structures and adjacent areas prior to each unit start-up.

When boric acid deposits or evidence of boric acid leakage are detected, corrective actions are taken to resolve the specific problem. These corrective actions may include removal of boric acid, repair of components or engineering evaluations. The leak monitoring program requires investigation and appropriate corrective action for the area affected by the leak. This investigation should identify thinning, pitting or other forms of degradation. Taking action when boron deposits are identified rather than waiting for visible signs of degradation of the carbon steel protects the structural integrity of the pressure boundary.

Summary

In summary, Catawba's programs rely on several different inspections designed to identify leaks that can introduce boric acid onto the RPV head from above the insulation. It is reasonable to conclude that these programs could identify such degradation and that such degradation has not occurred on either Catawba RPV head.

Requested Information

1. **Within 15 days of the date of this bulletin, all PWR addressees are required to provide the following:**

    C. **a description of any conditions identified (chemical deposits, head degradation) through the inspection and maintenance programs described in 1.A that could have led to degradation and the corrective action taken to address such conditions,**

Response:

A review of the Catawba corrective action program and work management system documentation identified the following:

- There was a small conoseal leak on Unit 1 in 1992, prior to the partial head inspection in 1992. This leak was discovered during the start-up walk down while in Mode 5. Boron deposits were limited to the lower conoseal flange. Repairs to the conoseal eliminated the leakage.
- There was a conoseal leak on Unit 2 in 1990 prior to the partial bare metal head inspection conducted in 1994. The 1990 conoseal leak predominately sprayed away from the head. The shroud and insulation were not removed at the time of the leak. The area was cleaned with demineralized water.
- The Unit 2 1991 leak was from a CRDM vent line plug. All vent line plugs have been subsequently welded to prevent reoccurrence.
- There was a small conoseal leak on Unit 2 in 1995 discovered during unit startup. The amount of boric acid residue was minimal and was removed prior to restart. The conoseal was repaired and the leak is believed to have been caused by outage maintenance activities. The leak was not present long enough to produce significant boron deposits on the head.

Requested Information

1. **Within 15 days of the date of this bulletin, all PWR addressees are required to provide the following:**

    D. **your schedule, plans, and basis for future inspections of the reactor pressure vessel head and penetration nozzles. This should include the inspection method(s), scope, frequency, qualification requirements, and acceptance criteria, and**

Response:

Catawba Unit 1

Catawba Unit 1will conduct a complete bare metal visual inspection of the RPV head during the next RFO in April 2002. The EPRI MRP guidance for visual inspections will be used as a reference for this inspection. Any evidence of leakage will be evaluated according to the principles described in 1A and 1B above.

Catawba Unit 2

Catawba Unit 2 will conduct a complete bare metal visual inspection of the RPV head during the next RFO March 2003. The EPRI MRP guidance for visual inspections will be used as a reference for this inspection. Any evidence of leakage will be evaluated according to the principles described in 1A and 1B above.

Requested Information

1. **Within 15 days of the date of this bulletin, all PWR addressees are required to provide the following:**

   E. **your conclusion regarding whether there is reasonable assurance that regulatory requirements are currently being met (see Applicable Regulatory Requirements, above). This discussion should also explain your basis for concluding that the inspection discussed in response to Item 1.D will provide reasonable assurance that these regulatory requirement will continue to be met. Include the following specific information in this discussion**

   (1) If your evaluation does not support the conclusion that there is reasonable assurance that regulatory requirements are being met, discuss your plans for plant shutdown and inspection.

   (2) If your evaluation support the conclusion that there is reasonable assurance that regulatory requirements are being met, provide your basis for concluding that all regulatory requirements discussed in the Applicable Regulatory Requirements section will continue to be met until the inspections are performed

DESCRIPTION OF REGULATORY REQUIREMENTS

10 CFR 50, Appendix A
Criterion 14 - Reactor Coolant Pressure Boundary
The reactor coolant pressure boundary shall be designed, fabricated, erected, and tested so as to have an extremely low probability of abnormal leakage, of rapidly propagating failure, and of gross rupture.

Compliance

Existing leakage identification programs ensure the reactor coolant leakage is identified and corrected. These programs ensure early detection of small leakage prior to abnormal leakage, rapidly propagating failure or gross rupture. The inspection and maintenance programs described in 1.A and 1.B of this response describe a means of preventing thinning, pitting, or other forms of degradation of the RPV head. By preventing degradation of the RPV head there is a low probability of abnormal leakage, rapidly propagating failure or gross rupture. By maintaining these or other equivalent programs there is a reasonable assurance of continued compliance with this general design criteria.

Criterion 31 - Fracture Prevention of Reactor Coolant Pressure Boundary
The reactor coolant pressure boundary shall be designed with sufficient margin to assure that when stressed under operating, maintenance, testing, and postulated accident conditions (1) the boundary behaves in a nonbrittle manner and (2) the probability of rapidly propagating fracture is minimized. The design shall reflect consideration of service temperatures and other conditions of the boundary material under operating, maintenance, testing, and postulated accident conditions and the uncertainties in determining (1) material properties, (2) the effects of irradiation on material properties, (3) residual, steady state and transient stresses, and (4) size of flaws.

Compliance

The RPV head was designed and constructed of materials that will have sufficient margin to behave in a non-brittle manner under operating conditions. The programs described in 1A and 1B on this response describe a means a means of preventing thinning, pitting, or other forms of degradation of the RPV head. Maintaining the RPV head in this manner provides reasonable assurance that the head will continue to behave in a non-brittle manner. By maintaining these or other equivalent programs there is a reasonable assurance of continued compliance with this general design criteria.

Criterion 32 - Inspection of Reactor Coolant Pressure Boundary
Components which are part of the reactor coolant pressure boundary shall be designed to permit (1) periodic inspection and testing of important areas and features to assess their structural and leaktight integrity, and (2) an appropriate material surveillance program for the RPV.

<u>Compliance</u>

Catawba's Reactor Coolant Pressure Boundary met the requirements of GDC 32 through the incorporation of the following inspections:

- Post-shutdown "normal operating temperature / pressure" inspection to identify leakage or evidence of leakage in the form of boric acid crystals on top or outside the support structure of the RPV head.
- Inspection of RPV head while on the head stand to look for evidence of borated water leakage inside the shroud.
- Startup "normal operating temperature / pressure" inspection to meet ASME XI system pressure test requirements and detect leakage that would be apparent with the insulation installed.

These activities coupled with the ability to remove insulation and conduct bare metal inspections, if required, provide Catawba the ability to prevent boric acid corrosion from effecting the structural and leaktight integrity.

10 CFR 50.55a Codes and Standards - ASME Class 1 components (which include VHP nozzles) must meet the requirements of Section XI of the ASME Boiler and Pressure Vessel Code. Table IWA-2500-1 of Section XI of the ASME Code provides examination requirements for VHP nozzles and references IWB-3522 for acceptance standards

<u>Compliance</u>

Catawba is in compliance with 10 CFR 50.55a and code compliance criteria in IWB-3522. Table IWA-2500-1 of Section XI examination category B-P requires a VT-2 examination of the RPV during the system leakage test. This is accomplished in mode 3 during startup.

10 CFR 50 Appendix B Quality Assurance Criteria for Nuclear Power Plants and Fuel Processing Plants
Criterion IX- Control of Special Processes
Measures shall be established to assure that special processes including welding, heat treating, and nondestructive testing are controlled and accomplished by qualified

personnel using qualified procedures in accordance with applicable codes, standards, specifications, criteria, and other special requirements.

Compliance

Duke maintains full responsibility for assuring that its nuclear power plants are designed constructed, tested and operated in conformance with good engineering practices, regulatory requirements and specified design bases and in a manner to protect the public health and safety. To this end Duke has established and implemented a quality assurance program, described in the QA Topical Report, which conforms to the criteria established in Appendix B to 10 CFR, Part 50.

Repairs and inspections are conducted as per ASME Section XI Code. Where ASME Section XI Code is not applicable repairs and inspection are performed by personnel qualified in the process and knowledgeable of the equipment.

Criterion V - Instructions, Procedures, and Drawings
Activities affecting quality shall be prescribed by documented instructions, procedures, or drawings, of a type appropriate to the circumstances and shall be accomplished in accordance with these instructions, procedures, or drawings. Instructions, procedures, or drawings shall include appropriate quantitative or qualitative acceptance criteria for determining that important activities have been satisfactorily accomplished

Compliance

Activities associated with the RPV head are performed in accordance with the Duke QA program. Procedures which address activities associated with QA Condition 1 structures, systems and components are subjected to an established preparation, review, and approval process as defined in the Duke QA Program. This QA Program meets and will continue to meet Criterion V - Instructions, Procedures, and Drawings.

Criterion XVI - Corrective Action
Measures shall be established to assure that conditions adverse to quality, such as failures, malfunctions, deficiencies, deviations, defective material and equipment, and nonconformances are promptly identified and corrected. In the case of significant conditions adverse to quality, the measures shall assure that the cause of the condition is determined and corrective action taken to preclude repetition. The identification of the significant condition adverse to quality, the cause of the condition, and the corrective action taken shall be documented and reported to appropriate levels of management.

Compliance

Activities associated with the RPV head are performed in accordance with the Duke QA program. Pursuant to this program, station personnel are responsible for the implementation of the quality assurance program as it pertains to the performance of their activities. Specific to this responsibility is the requirement for informing the responsible supervisory personnel and/or for taking appropriate corrective action whenever any deficiency in the implementation of the requirements of the program is determined. Procedures require that conditions adverse to quality be corrected. In the case of significant conditions adverse to quality, the procedures assure that the cause of the condition is determined and action is taken to preclude re-occurrence.

Performance and verification personnel are to:

a) Identify conditions that are adverse to quality.

b) Suggest, recommend or provide solutions to the problems as appropriate.

c) Verify resolution of the issue.

Additionally, performance and verification personnel are to ensure that reworked, repaired and replacement items are inspected and tested in accordance with the original inspection and test requirements or specified alternatives.

In the event of a failure of QA Condition 1 components (such as degradation of the RPV head) the cause of the failure is evaluated and appropriate corrective action taken. Items of the same type are evaluated to determine whether or not they can be expected to continue to function in an appropriate manner. This evaluation is documented in accordance with applicable procedures.

This corrective action programs meets and will continue to meet the requirements of Criterion XVI - Corrective Action.

Technical Specifications
At Catawba 3.4.13 RCS Operational LEAKAGE is limited to:

a. No pressure boundary LEAKAGE;
b. 1 gpm unidentified LEAKAGE;
c. 10 gpm identified LEAKAGE;
d. 576 gallons per day total primary to secondary LEAKAGE through all steam generators (SGs); and
e. 150 gallons per day primary to secondary LEAKAGE through any one SG.

These limits are applicable in operational modes 1 through 4.

Compliance

The inspection and maintenance programs outlined in 1.A in combination with the corrective action program provides reasonable assurance of reactor pressure boundary integrity and compliance with Technical Specification 3.4.13 limits.

ENCLOSURE II
McGuire Nuclear Station
Response to NRC Bulletin 2002-01

Requested Information

1. **Within 15 days of the date of this bulletin, all PWR addressees are required to provide the following:**

    A. **a summary of the reactor pressure vessel head inspection and maintenance programs that have been implemented at your plant,**

Response:

McGuire Unit 1

A complete bare metal inspection of the McGuire Unit 1 reactor pressure vessel (RPV) head has not been conducted since the unit began commercial operation in 1981. McGuire personnel removed sufficient insulation to perform an ISI of the UHI[1] nozzle welds. This examination was conducted during the 1EOC11 refueling outage in 1997, as part of the 10 year ISI. No significant deposits of boron were identified on the head or around the exposed CRDM penetrations during these examinations. These examinations did not include specific reviews for boron accumulations; however normal work practices would be expected to have identified such conditions had they existed. It is possible that some boric acid residue exists on the RPV head in the areas that were not exposed for inspection. However, MNS Unit 1 has never experienced a large boric acid leakage event that alone would be expected to result in large head corrosion or wastage.

McGuire Unit 2

McGuire Unit 2 conducted a complete bare metal visual inspection in March 2002. The inspection was conducted in accordance with the EPRI MRP guidance. The inspection was performed utilizing an ASME Section XI qualified inspector and was consistent with VT-3 examinations methods. The results of this inspection indicated that the head is free of boron deposits and no corrosion or wastage was noted.

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[1] UHI – Upper Head Injection

Applicable to Both McGuire Units

The site has implemented certain programs designed to identify reactor coolant leakage[2] and document corrective actions necessary to prevent adverse affects on plant equipment. Some of these requirements were implemented in response to Generic Letter 88-05[3] (GL 88-05). Incidents of boric acid leakage are documented in the departmental corrective action program.

There are three categories of RPV head inspections[4] which should be capable of detecting evidence of reactor coolant leakage in the vicinity of the RPV head support structure. These three inspections are part of an overall leak management program described in more detail in response to 1B. These three inspections are briefly described in the following:

(1) Post-shutdown walkdown – A walkdown to assess plant materiel condition is performed and documented in the corrective action program.

(2) Partial inspection of RPV head structures while on the head stand - This inspection is conducted by knowledgeable and experienced personnel as required by the reactor vessel head removal procedure. Observed indications of leakage are required to be noted and entered into the station corrective action program. In addition, a RPV head walk-down is performed each outage as required by administrative procedures. This inspection includes the area of the RPV head above the insulation and components such as:

- CRDM housings
- Insulation at RPV head flange
- Five conoseal flanges and thermocouple fittings
- Part Length CRDM housings
- Head vent line flanges
- Reactor Vessel Level Instrumentation System (RVLIS) instrument tubing and isolation valve
- Beneath the shroud support ring

(3) Startup "normal operating temperature / pressure" inspection – Multiple inspections occur prior to unit startup. The Mode 3 inspection is controlled by station procedures and conforms to ASME Section XI, IWB-5000, (System Pressure Tests). This examination includes the area above the insulation. All findings in these inspections are documented in the procedures and entered into the station corrective action program.

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[2] Reactor Coolant Leakage and boric acid leakage are used interchangeably to refer to primary water which contains some concentration of boric acid.
[3] Generic Letter 88-05 Boric Acid Corrosion of Carbon Steel
[4] Unless specifically noted the term inspection or examination is not given any specific regulatory definition, but is used generically to refer to some structured observation process.

These inspections should identify the existence of borated water leakage onto the RPV head and associated structures. Visual inspection of the insulation above the vessel head ensures that significant leaks from conoseals, vent lines or other components are identified, and that appropriate corrective action is taken.

Primary Water Stress Corrosion Cracking (PWSCC) of RPV head penetrations

McGuire Nuclear Station has a low susceptibility ranking in accordance with the Material Reliability Program (MRP[5]) methodology for RPV head penetrations. This methodology ranks each reactor's RPV head penetration nozzles susceptibility to PWSCC using Oconee Unit 3 as a measuring point. Duke participates in industry working groups and will adjust inspection plans as necessary in response to industry research and operating experience.

Requested Information

1. **Within 15 days of the date of this bulletin, all PWR addressees are required to provide the following:**

   B. **an evaluation of the ability of your inspection and maintenance programs to identify degradation of the reactor pressure vessel head including, thinning, pitting or other forms of degradation such as the degradation of the reactor pressure vessel head observed at Davis-Besse,**

Response:

As noted above, Duke's programs rely on several different inspections that identify leaks that can introduce boric acid onto the RPV head from above the insulation. Boric acid leakage through vessel head nozzles under the insulation is addressed in Duke's Bulletin 2001-01 responses. McGuire has also considered potential leakage sources, from sources above the insulation and from sources that may exist internal to the insulation. McGuire's RPV heads should be free of any substantial boric acid deposits. This is due to the programs designed to prevent boric acid from accumulating on the vessel head from sources outside of the RPV head insulation, ISI program, and also McGuire's low nozzle cracking susceptibility ranking.

The site has implemented certain programs designed to identify reactor coolant leakage and document corrective actions necessary to prevent adverse affects on plant equipment. Some of these requirements were implemented in response to GL 88-05. Incidents of

[5] Electric Power Research Institute Material Reliability Program

boric acid leakage are required to be documented in the departmental corrective action program. The following programmatic requirements were described in response 1A of this bulletin:

- Post-shutdown walkdown to identify borated water leakage.
- Inspection of RPV head assembly while on the head stand to look for borated water leakage inside the shroud.
- Startup "normal operating temperature / pressure" examination to meet ASME requirements and detect leakage that would be apparent with the insulation installed.

The inspection and maintenance programs at McGuire Nuclear Station are designed to prevent degradation of the RPV head by proactively detecting leakage or evidence of leakage before leakage can degrade the carbon steel pressure boundary. These programs are based on a hierarchy of administrative and technical procedures whose purpose is to detect boric acid leakage and implement appropriate corrective actions. Specific plant activities (walk downs and inspections) are periodically conducted to determine if boric acid deposits are present on the reactor coolant boundary equipment or borated water leakage is occurring. A knowledgeable individual is specifically assigned the task of examining the RPV head structures and adjacent areas prior to each unit start-up.

When boric acid deposits or evidence of boric acid leakage are detected, corrective actions are taken to resolve the specific problem. These corrective actions may include removal of boric acid, repair of components or engineering evaluations. The leak monitoring program requires investigation and appropriate corrective action for the area affected by the leak. This investigation should identify thinning, pitting or other forms of degradation. Taking action when boron deposits are identified rather than waiting for visible signs of degradation of the carbon steel protects the structural integrity of the pressure boundary.

McGuire conducted a bare metal inspection of the Unit 2 RPV head during the EOC 14 refueling outage (March 2002). The inspection revealed no boron deposits or degradation as the result of boric acid corrosion. This inspection is further evidence of the effectiveness of the programs in place to protect the RPV heads from boric acid corrosion.

In summary, Duke's programs rely on several different inspections designed to identify leaks that can introduce boric acid onto the RPV head from above the insulation. The programs further require appropriate corrective actions if evidence of boric acid leakage is found. The recent bare metal inspection demonstrates the effectiveness of McGuire programs for detecting leakage and implementing appropriate corrective actions.

Requested Information

1. **Within 15 days of the date of this bulletin, all PWR addressees are required to provide the following:**

    C. **a description of any conditions identified (chemical deposits, head degradation) through the inspection and maintenance programs described in 1.A that could have led to degradation and the corrective action taken to address such conditions,**

Response:

A review of the McGuire corrective action program and work management system documentation identified the following:

- There was an incore thermocouple conoseal leak on Unit 1 during EOC-11 in 1997. The amount of boric acid residue was minimal. The leak was a result of maintenance error during assembly of one of five conoseal housings. The leak did not exist long enough to have sufficient time to produce significant boron deposits on the head. Corrective actions included cleanup of the boric acid residue and leak repair.

- Since 1988 approximately three Part Length CRDM mechanical joint leaks were identified and repaired during shutdown inspections. All leaks were minor and boric acid leakage was local to the housings. There was no indication of boric acid flow down to the head.

- A leak at the intermediate canopy seal weld of CRDM housing K-8 on Unit 2 was identified and repaired during refueling outage EOC14, March 2002. The leak was discovered during a routine walkdown prior to startup. Boric acid leakage onto the CRDM housing was minor. There was no indication that boric acid had flowed down to the RPV head.

Requested Information

1. **Within 15 days of the date of this bulletin, all PWR addressees are required to provide the following:**

    D. **your schedule, plans, and basis for future inspections of the reactor pressure vessel head and penetration nozzles. This should include the inspection method(s), scope, frequency, qualification requirements, and acceptance criteria, and**

Response:

McGuire Unit 1

McGuire Unit 1 will conduct a complete bare metal visual inspection of the RPV head during the September 2002 outage. The EPRI MRP guidance for visual inspection will be used as a reference for this inspection. Any evidence of leakage will be evaluated according to the principles described in 1A and 1B above.

McGuire Unit 2

McGuire Unit 2 completed a refueling outage in March 2002 during which a complete bare metal inspection of the RPV head was conducted.

Future inspections of the RPV head will be conducted as described in response to 1.A or by means found to be equivalent. Duke participates in industry working groups and will adjust inspection plans as necessary in response to industry research and operating experience.

Requested Information

1. **Within 15 days of the date of this bulletin, all PWR addressees are required to provide the following:**

   E. **your conclusion regarding whether there is reasonable assurance that regulatory requirements are currently being met (see Applicable Regulatory Requirements, above). This discussion should also explain your basis for concluding that the inspection discussed in response to Item 1.D will provide reasonable assurance that these regulatory requirement will continue to be met. Include the following specific information in this discussion**

   (1) If your evaluation does not support the conclusion that there is reasonable assurance that regulatory requirements are being met, discuss your plans for plant shutdown and inspection.

   (2) If your evaluation support the conclusion that there is reasonable assurance that regulatory requirements are being met, provide your basis for concluding that all regulatory requirements discussed in the Applicable Regulatory

Requirements section will continue to be met until the inspections are performed

DESCRIPTION OF REGULATORY REQUIREMENTS

10 CFR 50, Appendix A
Criterion 14 - Reactor Coolant Pressure Boundary
The reactor coolant pressure boundary shall be designed, fabricated, erected, and tested so as to have an extremely low probability of abnormal leakage, of rapidly propagating failure, and of gross rupture.

Compliance

Existing leakage identification programs ensure that reactor coolant leakage is identified and corrected. These programs ensure early detection of small leakage prior to abnormal leakage, rapidly propagating failure or gross rupture. The inspection and maintenance programs described in 1.A and 1.B of this response describe a means of preventing thinning, pitting, or other forms of degradation of the RPV head. By preventing degradation of the RPV head there is a low probability of abnormal leakage, rapidly propagating failure or gross rupture. By maintaining these or other equivalent programs there is a reasonable basis for continued compliance with this general design criteria.

Criterion 31 - Fracture Prevention of Reactor Coolant Pressure Boundary
The reactor coolant pressure boundary shall be designed with sufficient margin to assure that when stressed under operating, maintenance, testing, and postulated accident conditions (1) the boundary behaves in a nonbrittle manner and (2) the probability of rapidly propagating fracture is minimized. The design shall reflect consideration of service temperatures and other conditions of the boundary material under operating, maintenance, testing, and postulated accident conditions and the uncertainties in determining (1) material properties, (2) the effects of irradiation on material properties, (3) residual, steady state and transient stresses, and (4) size of flaws.

Compliance

The RPV head was designed and constructed of materials that will have sufficient margin to behave in a non-brittle manner under operating conditions. The programs described in 1A and 1B on this response describe a means of preventing thinning, pitting, or other forms of degradation of the RPV head. Maintaining the RPV head in this manner provides reasonable assurance that the head will continue to behave in a non-brittle manner. By maintaining these or other equivalent programs there is a reasonable basis for continued compliance with this general design criteria.

Criterion 32 - Inspection of Reactor Coolant Pressure Boundary
Components which are part of the reactor coolant pressure boundary shall be designed to permit (1) periodic inspection and testing of important areas and features to assess their structural and leaktight integrity, and (2) an appropriate material surveillance program for the RPV.

Compliance

McGuire's Reactor Coolant Pressure Boundary met the requirements of GDC 32 through the incorporation of the following inspections:

- Post-shutdown walkdown by engineering to identify borated water leakage.
- Inspection of RPV head while on the head stand to look for borated water leakage inside the shroud.
- Startup "normal operating temperature / pressure" inspection to meet ASME requirements and detect leakage that would be apparent with the insulation installed.

These activities coupled with the ability to remove insulation and conduct bare metal inspections, if required, provide McGuire the ability to prevent boric acid corrosion from affecting the structural and leaktight integrity.

10 CFR 50.55a Codes and Standards
ASME Class 1 components must meet the requirements of Section XI of the ASME Boiler and Pressure Vessel Code. Table IWA-2500-1 of Section XI of the ASME Code provides examination requirements for VHP nozzles and references IWB-3522 for acceptance standards

Compliance

McGuire is in compliance with 10 CFR 50.55a and code compliance criteria in IWB-3522. Table IWA-2500-1 of Section XI examination category B-P requires a VT-2 examination of the RPV during the system leakage test. This is accomplished in mode 3 during startup.

10 CFR 50 Appendix B Quality Assurance Criteria for Nuclear Power Plants and Fuel Processing Plants
Criterion IX- Control of Special Processes
Measures shall be established to assure that special processes including welding, heat treating, and nondestructive testing are controlled and accomplished by qualified personnel using qualified procedures in accordance with applicable codes, standards, specifications, criteria, and other special requirements.

Compliance

Duke maintains full responsibility for assuring that its nuclear power plants are designed constructed, tested and operated in conformance with good engineering practices, regulatory requirements and specified design bases and in a manner to protect the public health and safety. To this end, Duke has established and implemented a quality assurance program, described in the QA Topical Report, which conforms to the criteria established in Appendix B to 10 CFR, Part 50.

Repairs and inspections are conducted as per ASME Section XI Code. Where ASME Section XI Code is not applicable, repairs and inspection are performed by personnel qualified in the process and knowledgeable of the equipment.

Criterion V - Instructions, Procedures, and Drawings
Activities affecting quality shall be prescribed by documented instructions, procedures, or drawings, of a type appropriate to the circumstances and shall be accomplished in accordance with these instructions, procedures, or drawings. Instructions, procedures, or drawings shall include appropriate quantitative or qualitative acceptance criteria for determining that important activities have been satisfactorily accomplished

Compliance

Activities associated with the RPV head are performed in accordance with the Duke QA program. Procedures which address activities associated with QA Condition 1 structures, systems and components are subjected to a well-defined and established preparation, review, and approval process as defined in the Duke QA Program. This QA Program meets and will continue to meet Criterion V - Instructions, Procedures, and Drawings.

McGuire Unit 2 conducted a bare metal visual inspection in March 2002. The EPRI MRP guidance for visual inspection was used as a reference. The inspection was performed utilizing an ASME Section XI qualified inspector and was consistent with VT-3 examinations methods.

Criterion XVI - Corrective Action
Measures shall be established to assure that conditions adverse to quality, such as failures, malfunctions, deficiencies, deviations, defective material and equipment, and nonconformances are promptly identified and corrected. In the case of significant conditions adverse to quality, the measures shall assure that the cause of the condition is determined and corrective action taken to preclude repetition. The identification of the significant condition adverse to quality, the cause of the condition, and the corrective action taken shall be documented and reported to appropriate levels of management.

Compliance

Activities associated with the RPV head are performed in accordance with the Duke QA program. Pursuant to this program, station personnel are responsible for the implementation of the quality assurance program as it pertains to the performance of their activities. Specific to this responsibility is the requirement for informing the responsible supervisory personnel and/or for taking appropriate corrective action whenever any deficiency in the implementation of the requirements of the program is determined. Procedures require that conditions adverse to quality be corrected. In the case of significant conditions adverse to quality, the procedures assure that the cause of the condition is determined and action is taken to preclude re-occurrence.

Performance and verification personnel are to:

a) Identify conditions that are adverse to quality.

b) Suggest, recommend or provide solutions to the problems as appropriate.

c) Verify resolution of the issue.

Additionally, performance and verification personnel are to ensure that reworked, repaired, and replacement items be inspected and tested in accordance with the original inspection and test requirements or specified alternatives.

In the event of a failure or degradation of QA Condition 1 components (such as the RPV head) the cause of the failure is evaluated and appropriate corrective action taken. Items of the same type are evaluated to determine whether or not they can be expected to continue to function in an appropriate manner. This evaluation is documented in accordance with applicable procedures.

This corrective action program meets and will continue to meet the requirements of Criterion XVI - Corrective Action.

Technical Specifications

At McGuire 3.4.13 RCS Operational leakage is limited to:

a. No pressure boundary leakage;
b. 1 gpm unidentified leakage;
c. 10 gpm identified leakage;
d. 389 gallons per day total primary to secondary leakage through all steam generators (SGs); and
e. 135 gallons per day primary to secondary leakage through any one SG.

These limits are applicable in operational modes 1 through 4.

Compliance

The inspection and maintenance programs outlined in 1.A in combination with the corrective action program provides reasonable assurance of reactor pressure boundary integrity and compliance with Technical Specification 3.4.13 limits.

ENCLOSURE III
Oconee Nuclear Station
Response to NRC Bulletin 2002-01
(These responses apply to all three Oconee Units except where indicated)

Requested Information

1. **Within 15 days of the date of this bulletin, all PWR addresses are required to provide the following:**

   A. **a summary of the reactor pressure vessel head inspection and maintenance programs that have been implemented at your plant,**

Response:

Listed below are programmatic inspection and maintenance activities implemented at Oconee Nuclear Station to prevent degradation of the RPV head by boric acid corrosion.

1. A procedurally controlled walkdown of the Reactor Building looking for borated water leakage.
2. A qualified[1] bare metal visual examination of the top of the RPV head while still on the vessel. After the initial inspection, any boric acid crystals on the head surface are removed and portions of the RPV surface that may be masked are re-inspected.
3. Inspections for CRDM flange leakage while the vessel head is on the stand. All leaking flanges are repaired.
4. An ASME Section XI Examination Category B-P VT-2 visual examination during startup at Mode 3 conditions.
5. Nozzles identified as leaking will be examined by NDE methods capable of finding a leak path. Nozzles identified as unacceptable due to cracking will be repaired using an approved repair technique.

1. **Within 15 days of the date of this bulletin, all PWR addresses are required to provide the following:**

   B. **an evaluation of the ability of your inspection and maintenance programs to identify degradation of the reactor pressure vessel head including, thinning, pitting or other forms of degradation such as the degradation of the reactor pressure vessel head observed at Davis-Besse,**

[1] Qualified as described below in Section 1B

Response:

1. The Hot Shutdown Tour will identify boric acid crystals on top of or outside the support structure which is on top of the RPV head.

2. The bare metal visual inspection is performed in accordance with Duke Energy's response to NRC Bulletin 2001-01 as a "Qualified Visual" examination. The term "Qualified" means that the visual examination should be able to reliably detect and accurately characterize leakage from cracking in VHP nozzles considering two characteristics. The first characteristic is a plant-specific demonstration that any VHP nozzle exhibiting through-wall cracking will provide sufficient leakage to the RPV head surface (based on the as-built configuration of the VHP's). The second characteristic is that the effectiveness of the visual examination should not be compromised by the presence of insulation, existing deposits on the RPV head, or other factors that could interfere with the detection of leakage.

3. All CRDM flanges are inspected by video of the flange joint to identify any leakage. Any identified leaking flanges are repaired.

4. The ASME Section XI Examination Category B-P visual VT-2 examination performed during startup will detect leakage that would be apparent with the insulation installed.

5. Any nozzle identified as possibly leaking or masked will be examined by other NDE techniques capable of identifying a leak path. These examinations could include such inspections as ultrasonic examination of the nozzle from the ID surface, and/or liquid penetrant examination of the weld surface and OD of the nozzle, as appropriate. Any degradation inside the penetration annulus associated with boric acid corrosion of the RPV head would be identified during the repair process performed on leaking nozzles and by performing the bare metal top of the head visual inspection. The repairs at Oconee have either been performed manually or by using the ID temper bead. Both techniques would reveal wastage of the low alloy steel head material where the crack opened into the annulus. Because high corrosion rates of low alloy steel by boric acid require oxygen, it would be expected that the highest corrosion rates would be at the exit of the annulus on top of the head. This would be true until the wastage area is so large as to allow oxygen farther inside the annulus. A clean head provides reasonable assurance that degradation to the extent discovered at Davis-Besse would be easily observable.

   ONS has undertaken efforts to maintain the RPV heads in generally clean conditions, free of debris and other masking deposits. Also each ONS unit has large access openings in the head service structure that allows good visual access to all nozzle penetrations and to the top surface of the RPV. Any evidence of leakage, corrosion or wastage would be observed during the RPV head inspections.

1. **Within 15 days of the date of this bulletin, all PWR addresses are required to provide the following:**

   C. **a description of any conditions identified (chemical deposits, head degradation) through the inspection and maintenance programs described in 1.A that could have led to degradation and the corrective action taken to address such conditions,**

Response:

The last 100% bare metal inspection of the Oconee RPV heads took place in November 2000 for Unit 1, April 2001 for Unit 2, and November 2001 for Unit 3. The results of all inspections are given in the response to NRC Bulletin 2001-01 as given below:

Unit	Date	Page Number
Oconee Unit 1	Aug. 28, 2001	Page: 5, 6
Oconee Unit 2	Aug. 28, 2001	Page: 6, 7
Oconee Unit 3	Jan. 14, 2002	Page: 2 through 12

Attachments A, B, and C contain the respective correspondence described above.

1. **Within 15 days of the date of this bulletin, all PWR addresses are required to provide the following:**

   D. **your schedule, plans, and basis for future inspections of the reactor pressure vessel head and penetration nozzles. This should include the inspection method(s), scope, frequency, qualification requirements, and acceptance criteria, and**

Response:

Future inspection plan and schedules of the ONS RPV head and penetration nozzles remain consistent with the ONS response to NRC Bulletin 2001 01and as noted in this Bulletin's response.

Duke Energy currently has scheduled RPV head replacements to be complete at Oconee by the spring of year 2004. Oconee Unit 1 is planning to replace in fall 2003, Oconee Unit 2 in spring 2004, and Oconee Unit 3 (the next refueling outage) spring 2003. The plans for the next scheduled inspections of Oconee Unit 1 and 2 are given in Oconee's response to NRC Bulletin 2001-01 pages 16, 17 and 18. Future inspection of the new RPV heads for all units will include the bare metal visual inspections of the RPV head. Further Duke will continue to participate in industry activities (EPRI MRP, ASME and Owner's Group) and will consider these activities and will adjust inspection plans if industry activities indicate a change is required.

1. Within 15 days of the date of this bulletin, all PWR addresses are required to provide the following:

E. your conclusion regarding whether there is reasonable assurance that regulatory requirements are currently being met (see Applicable Regulatory Requirements, above). This discussion should also explain your basis for concluding that the inspection discussed in response to Item 1.D will provide reasonable assurance that these regulatory requirement will continue to be met. Include the following specific information in this discussion

(1) If your evaluation does not support the conclusion that there is reasonable assurance that regulatory requirements are being met, discuss your plans for plant shutdown and inspection.

(2) If your evaluation support the conclusion that there is reasonable assurance that regulatory requirements are being met, provide your basis for concluding that all regulatory requirements discussed in the Applicable Regulatory Requirements section will continue to be met until the inspections are performed

DESCRIPTION OF REGULATORY REQUIREMENTS

10 CFR 50, Appendix A
Criterion 14 - Reactor Coolant Pressure Boundary
The reactor coolant pressure boundary shall be designed, fabricated, erected, and tested so as to have an extremely low probability of abnormal leakage, of rapidly propagating failure, and of gross rupture.

Corresponding Oconee Criterion 9 - Reactor Coolant Pressure Boundary (Category A)
The reactor coolant pressure boundary shall be designed and constructed so as to have an exceedingly low probability of gross rupture or significant leakage throughout its design lifetime.

Compliance
As described in the Oconee UFSAR, the Reactor Coolant System pressure boundary at ONS meets the criterion through the following:

1. Material selection, design, fabrication, inspection, testing, and certification in accordance with ASME codes for all components excluding piping. Piping is maintained in accordance with the USAS B31.1 and B31.7 codes.

2. Manufacture and erection is in accordance with approved procedures.

3. Inspection is in accordance with code requirements plus additional requirements imposed by the manufacturer.

4. System analysis accounts for cyclic effects of thermal transients, mechanical shock, seismic loadings, and vibratory loadings.

5. Selection of RV material properties gives due consideration to neutron flux effects and the resultant increase of the nil ductility transition temperature. The materials, codes, cyclic loadings, and non-destructive testing are discussed further in Chapter 5 of the Oconee UFSAR.

The original materials and methods of construction have not been materially changed or altered. Compliance with GDC with regard to circumferential cracking of RPV head penetration nozzles was documented in response to NRC Bulletin 2001 01. The inspections and maintenance programs outlined in 1.A serve to provide reasonable assurance of continued compliance with this GDC through thorough inspection, boron removal and appropriate examination therefore, Duke concludes that the GDC is presently met and shall continue to be met in the future.

Criterion 31 - Fracture Prevention of Reactor Coolant Pressure Boundary

The reactor coolant pressure boundary shall be designed with sufficient margin to assure that when stressed under operating, maintenance, testing, and postulated accident conditions (1) the boundary behaves in a nonbrittle manner and (2) the probability of rapidly propagating fracture is minimized. The design shall reflect consideration of service temperatures and other conditions of the boundary material under operating, maintenance, testing, and postulated accident conditions and the uncertainties in determining (1) material properties, (2) the effects of irradiation on material properties, (3) residual, steady state and transient stresses, and (4) size of flaws.

Corresponding ONS Criterion 34 - Reactor Coolant Pressure Boundary Rapid Propagation Failure Prevention (Category A)

The reactor coolant pressure boundary shall be designed to minimize the probability of rapidly propagating type failures. Consideration shall be given a) to the notch-toughness properties of materials extending to the upper shelf of the Charpy transition curve, b) to the state of stress of materials under static and transient loadings, c) to the quality control specified for materials and component fabrication to limit flaw sizes, and d) to the provisions for control over service temperature and irradiation effects which may require operation restrictions.

Compliance

Any potential reactor coolant pressure boundary leakage is detectable by visual inspections during planned refueling outages. As a result of this detection any degradation is successfully identified and subsequently repaired in accordance with ASME Section XI.

As described in the Oconee UFSAR, the reactor coolant pressure boundary design at ONS meets this criterion by the following:

1. Development of RV plate material properties opposite the core to a specified Charpy-V- notch test result of 30 ft-lb or greater at a nominal low NDTT.

2. Determination of the fatigue usage factor resulting from expected static and transient loading during detailed design and stress analysis.

3. Quality control procedures including permanent identification of materials and non-destructive testing.

4. Operating restrictions to prevent failure towards the end of design vessel life resulting from increase in the nil-ductility transition temperature (NDTT) due to neutron irradiation, as predicted by a material irradiation surveillance program.

Further, all leakage that is discovered will be repaired in accordance with ASME Section XI, NRC approved ASME Code Cases or alternatives. In all cases, ASME safety margins are maintained during the specified period of operation; thereby giving reasonable assurance of present and continued compliance with the intent of the GDC.

Criterion 32 - Inspection of Reactor Coolant Pressure Boundary

Components which are part of the reactor coolant pressure boundary shall be designed to permit (1) periodic inspection and testing of important areas and features to assess their structural and leaktight integrity, and (2) an appropriate material surveillance program for the reactor pressure vessel.

Corresponding Oconee Criterion 36 - Reactor Coolant Pressure Boundary Surveillance (Category A)

Reactor coolant pressure boundary components shall have provisions for inspection, testing, and surveillance by appropriate means to assess the structural and leak-tight integrity of the boundary components during their service lifetime. For the RV, a material surveillance program conforming with ASTM-E-185-66 shall be provided.

Compliance

The reactor coolant pressure boundary components at Oconee meet this criterion. Oconee has facilitated RV head inspection by cleaning the heads, implementing service structure modifications that improve access under the RV head insulation, and the elevated design of the existing head insulation. A RPV material surveillance program conforming to ASTM-E-185-66 has been established.

Additionally, Oconee has been involved with supplemental proactive inspection and testing of the RPV penetrations since the early 1990's, modifying the program as appropriate.

10 CFR 50.55a Codes and Standards - ASME Class 1 components (which include VHP nozzles) must meet the requirements of Section XI of the ASME Boiler and Pressure Vessel Code. Table IWA-2500-1 of Section XI of the ASME Code provides examination requirements for VHP nozzles and references IWB-3522 for acceptance standards.

Compliance

Oconee is in compliance with 10 CFR 50.55a and code compliance criteria in IWB-3522. Oconee has detected leakage from insulated components, with detection being a result of identifiable boron deposits that had accumulated on the top of the head. As required, Oconee performed appropriate NDE of each of these leakage events to determine the source of the leakage/deposit and then performed repairs in accordance with rules stipulated by ASME Code and NRC approved Code alternatives.

For through-wall leakage identified by visual examinations in accordance with ASME Code, acceptance standards for the identified degradation are provided in IWB-3142. In accordance with these requirements, methods are in place to determine the acceptability of degraded components including supplemental exams, corrective measures, or repairs, analytical evaluation and replacement.

As required by IWB-3142, all identified degraded and leaking components were repaired prior to returning the unit to service. Specifically, all crack-like indications were removed from the leaking nozzles, and other non-leaking nozzles inspected for extent of condition. Minor shallow indications were evaluated by ASME Section XI analytical flaw evaluation rules and determined to be acceptable for continued service.

Additionally, Oconee performs visual examinations of accessible and exposed surfaces during system pressure testing as part of their In-Service Inspection Program required by 10 CFR 50.55a. The visual examination may be conducted by looking for evidence of potential leakage. The acceptance standard for the examination is found in IWA-5250, "Corrective Measures." This subsection requires repair or replacement if a leak is identified as well as assessment of damage, if any, from corrosion of steel components by boric acid deposits.

The effectiveness of the supplemental bare-metal visual inspection, the NDE performed to date and engineering analysis provide reasonable assurance that compliance with code margins and acceptance criteria will continue to be maintained for the operating period between inspections.

10 CFR 50 Appendix B Quality Assurance Criteria for Nuclear Power Plants and Fuel Processing Plants
Criterion IX- Control of Special Processes
Measures shall be established to assure that special processes including welding, heat treating, and nondestructive testing are controlled and accomplished by qualified personnel using qualified procedures in accordance with applicable codes, standards, specifications, criteria, and other special requirements.

Compliance
Activities for characterizing and repairing pressure vessel head CRDM nozzle defects are performed in accordance with the Duke Quality Assurance (QA) program which has been reviewed and approved by the NRC. The Duke QA Program, in general, maintains procedures for the control of a number of special processes including welding, heat treating, NDE, and cleaning. The program requires that approved, written procedures, qualified in accordance with applicable codes and standards, be utilized when it affects the performance of the station's QA Condition 1 structures, systems and components. These procedures provide for documented evidence of acceptable accomplishment of these special processes using qualified procedures, equipment and personnel as may be required by ASME Section XI for reactor coolant pressure boundary components.

Personnel performing such activities must be qualified in accordance with applicable codes and standards. Adequate documentation of personnel qualifications is required. NDE examination personnel are certified to required codes and standards.

Also, nozzle specific evaluations have been completed using original as built head bore and nozzle dimensions to demonstrate that at normal plant operations, a positive gap will exist such that through-wall leakage evidence would be visible on the RV head. Further, any UT or other NDE examinations performed in support of leaking nozzles will have been subjected to sufficient demonstration testing to substantiate the capability of the examination method.

Criterion V - Instructions, Procedures, and Drawings
Activities affecting quality shall be prescribed by documented instructions, procedures, or drawings, of a type appropriate to the circumstances and shall be accomplished in accordance with these instructions, procedures, or drawings. Instructions, procedures, or drawings shall include appropriate quantitative or qualitative acceptance criteria for determining that important activities have been satisfactorily accomplished.

Compliance
Activities associated with the RPV head are performed in accordance with the Duke QA program. Procedures which address activities associated with QA Condition 1 structures, systems and components are subjected to a well-defined and established preparation, review, and approval process as defined in the Duke QA Program. This QA Program meets Criterion V - Instructions, Procedures, and Drawings.

Criterion XVI - Corrective Action
Measures shall be established to assure that conditions adverse to quality, such as failures, malfunctions, deficiencies, deviations, defective material and equipment, and nonconformances are promptly identified and corrected. In the case of significant conditions adverse to quality, the measures shall assure that the cause of the condition is determined and that corrective actions are taken to preclude repetition. The identification of the significant condition adverse to quality, the cause of the condition, and the corrective action taken shall be documented and reported to appropriate levels of management.

Compliance
Activities associated with the RPV head are performed in accordance with the Duke QA program. Pursuant to this program, station personnel are responsible for the implementation of the quality assurance program as it pertains to the performance of their activities. Specific to this responsibility is the requirement for informing responsible supervisory personnel and/or for taking appropriate corrective action whenever any deficiency in the implementation of the requirements of the program is determined. Procedures require that conditions adverse to quality be corrected. In the case of significant conditions adverse to quality, the procedures assure that the cause of the condition is determined and action be taken to preclude repetition.

Performance and verification personnel are to:

a) Identify conditions that are adverse to quality.

b) Suggest, recommend, or provide solutions to the problems as appropriate.

c) Verify resolution of the issue.

Additionally, performance and verification personnel are to ensure that reworked, repaired, and replacement items be inspected and tested in accordance with the original inspection and test requirements or specified alternatives.

In the event of the failure of QA Condition 1 components (such as degradation of the RPV head) the cause of the failure is evaluated and appropriate corrective action taken. Items of the same type are evaluated to determine whether or not they can be expected to continue to function in an appropriate manner. This evaluation is documented in accordance with applicable procedures.

This corrective action program meets the requirements of Criterion XVI - Corrective Action.

Technical Specifications - The current limiting condition of operation (LCO) for ONS, TS 3.4.13, requires that RCS operational LEAKAGE be limited to no pressure boundary LEAKAGE;

- 1 gpm unidentified LEAKAGE;
- 10 gpm identified LEAKAGE;
- 300 gallon per day total primary to secondary LEAKAGE through all steam generators (SGs)
- and 150 gallon per day primary to secondary leakage through any one SG. These limits are applicable in operational modes 1 through 4.

Compliance

The technical specifications (TS) leakage limits are complied with through various means of monitoring and leak detection systems (e.g., the radiation monitoring systems, periodic system inventory balances and scheduled operator system walk-downs). Indicators and alarms for each leakage detection system are provided in the control room along with procedures for converting various indications to leakage rate equivalents. The leakage detection systems are also equipped with provisions for testing and calibration during operation. Leakage from the reactor coolant pressure boundary into connected systems is indicated by various radiation monitors, tank levels and other methods. A control room alarm is actuated in all cases. Because of the diverse detection methods, location of sensors, and alarms, when reactor coolant pressure boundary leakage occurs, the operator is provided with sufficient information to take corrective action in compliance with TS.

If a rapidly propagating crack resulted in reactor coolant pressure boundary leakage, the various leakage detection methods would provide indication of the leakage. However, the VHP nozzle cracking does not manifest into a rapidly propagating crack, and because of the small amount of leakage from the cracked nozzles (estimated less than 1 gallon per year), the existing leakage detection system is unable to detect leakage at that threshold. The most reliable evidence of VHP nozzle cracking leakage is the small amount of boric acid deposits that will be detected during visual inspections.

Therefore, a qualified 100 % visual inspection of the top of the RV head will be completed during each refueling outage until RV head replacement. Based on the previous Oconee inspection and repair data, boric acid crystal deposits will be visible on the top of the RV head. The cleaning of the top of the RV head and the installation of service structure modifications to improve access, have contributed to the effectiveness of these visual inspections as demonstrated in previous outages. As in previous outages, CRDM nozzles identified with potential leaks will receive additional inspections and any necessary repairs. All suspect leaking nozzles are fully investigated and repaired to meet all applicable code and regulatory requirements. All repairs are completed before the unit is returned to service. Any decision to expand and perform other NDE inspections of non-leaking nozzles will be based on the nature of the observed cracked conditions, the extent and severity of the cracking, the occupational exposures involved in performing additional inspections and examinations, the availability of qualified NDE techniques, equipment, procedures, personnel, and the impact to the refueling outage.

Compliance with Oconee TS 3.4.13 will be maintained through continued performance of the above described leakage detection surveillance and qualified visual inspection of the CRDM nozzles. The previously performed effective visual inspections identified evidence of leaking CRDM nozzles and provided for qualified repair of those nozzles. This provided assurance that all CRDM nozzles were leak-tight upon return of each unit to service. The qualified visual inspections to be performed during each Oconee unit's upcoming refueling outage will provide reasonable assurance of the discovery of conditions that could contribute to future CRDM nozzle leakage. Discovery of these conditions will ensure required repairs are completed prior to returning a unit to service. A corrective action to replace RV heads in all three units by spring of 2004 limits the period of time that the units will operate with the existing heads. The combination of the characterization of the existing RV heads (by the previously performed visual inspection and supplemental NDE) and this limited time period provides a basis for assuring conformance with the Oconee current licensing basis.

Attachment A

REQUESTED ACTION:

2. If your plant has previously experienced either leakage from or cracking in VHP nozzles addressees are requested to provide the following information:

a) a description of the extent of VHP nozzle leakage and cracking detected at your plant including the number, location, size, and nature of each crack detected;

Response:

A summary of the results of the inspections performed as a result of PWSCC of the RV head penetrations for the three Oconee units between November 2000 and June 2001 is given below for each unit.

Oconee Unit 1

On November 25, 2000,the beginning of the refueling outage, evidence of RCS leakage was found around CRDM nozzle 21 and five of eight thermocouple nozzles during visual inspection of the top of the RV head.[3]

The leak on CRDM nozzle 21 was through a single crack that originated in the J-groove weld and grew up through the weld and nozzle base material penetrating into the annulus region to create a leak path. The crack extended axially from the face of the filet weld cap to the root of the J-groove weld. The crack extended radially from about 0.40 inch deep in the outside diameter (OD) of the nozzle through the Alloy 600 weld butter to the alloy steel base metal where it was blunted. As the crack progressed to the weld butter, the crack branched and turned circumferential for a short distance (approximately 3/8 inch).

The thermocouple nozzles were each found to contain large axial crack-like indications originating on the inside of the nozzles. This was determined to be the leakage pathway for the thermocouples. EC and UT examination of the inside surfaces of the thermocouple nozzles showed that all eight nozzles contained deep crack-like indications that were predominantly axial in orientation and located adjacent to (extending both above and below) the J-groove weld elevation. The indications were

[3] LER 269/2000-006, Revision 1, "Reactor Coolant System Pressure Boundary Leakage Due to Cracks Found In Several Small Bore Reactor Vessel Head Penetration," dated March 1, 2001.

Attachment A

located primarily at the high stress areas that are the uphill and downhill locations. The thermocouple axial indications ranged in length from about 0.25 inches to about 2.5 inches in length.

Oconee Unit 2

On April 28, 2001, the beginning of the refueling outage, a visual inspection of the top surface of the Oconee Unit 2 RV head performed as part of normal shutdown surveillance activity showed evidence of boric acid crystals on the vessel head surface. Boric acid crystals were identified around four CRDM nozzles (4, 6, 18 and 30).[4]

Results from a PT examination using a visible dye, solvent removable technique, of the suspected leaking nozzles 4,6,18,30 revealed multiple rejectable indications on each of the four nozzles.

As part of the pre-repair nondestructive examinations, an EC inspection of CRDM Nozzles 4, 6, 18 and 30 was performed. The results of the EC inspections did not identify any indications that suggested a through-wall leak path.

The results of the EC inspections on these four nozzles did identify clusters of multiple axial indications on the nozzle ID surfaces that were located both above and below the J-groove weld. The axial extent of the clusters ranged from about 0.90 inch in length to about 3.1 inches in length. The range of depths of the cluster indications was from about 0.0138 inch to about 0.0315 inch. No ID initiated circumferential indications were found.

Automated UT examinations were performed on the suspect leaking CRDM nozzles 4, 6, 18, and 30. The examinations detected 36 axial OD indications and 1 circumferential OD crack that was located above the weld on nozzle 18 (see Table 1 for details of UT crack indications). The circumferential crack on nozzle 18 was reported to be about 1.25 inches in length with a depth of about 0.07 inches. The leakage pathway for the Unit 2 nozzle

[4] LER 270/2001-002, Revision 0, "Reactor Pressure Vessel Head Leakage Due To Stress Corrosion Cracks Found in Several Control Rod Drive Nozzle Penetrations," dated June 25, 2001.

Attachment B

located primarily at the high stress areas that are the uphill and downhill locations. The thermocouple axial indications ranged in length from about 0.25 inches to about 2.5 inches in length.

Oconee Unit 2

On April 28, 2001, the beginning of the refueling outage, a visual inspection of the top surface of the Oconee Unit 2 RV head performed as part of normal shutdown surveillance activity showed evidence of boric acid crystals on the vessel head surface. Boric acid crystals were identified around four CRDM nozzles (4, 6, 18 and 30).[4]

Results from a PT examination using a visible dye, solvent removable technique, of the suspected leaking nozzles 4,6,18,30 revealed multiple rejectable indications on each of the four nozzles.

As part of the pre-repair nondestructive examinations, an EC inspection of CRDM Nozzles 4, 6, 18 and 30 was performed. The results of the EC inspections did not identify any indications that suggested a through-wall leak path.

The results of the EC inspections on these four nozzles did identify clusters of multiple axial indications on the nozzle ID surfaces that were located both above and below the J-groove weld. The axial extent of the clusters ranged from about 0.90 inch in length to about 3.1 inches in length. The range of depths of the cluster indications was from about 0.0138 inch to about 0.0315 inch. No ID initiated circumferential indications were found.

Automated UT examinations were performed on the suspect leaking CRDM nozzles 4, 6, 18, and 30. The examinations detected 36 axial OD indications and 1 circumferential OD crack that was located above the weld on nozzle 18 (see Table 1 for details of UT crack indications). The circumferential crack on nozzle 18 was reported to be about 1.25 inches in length with a depth of about 0.07 inches. The leakage pathway for the Unit 2 nozzle

[4] LER 270/2001-002, Revision 0, "Reactor Pressure Vessel Head Leakage Due To Stress Corrosion Cracks Found in Several Control Rod Drive Nozzle Penetrations," dated June 25, 2001.

leaks was determined to be through the cracks on the OD of the nozzle and weld interface.

Oconee Unit 3

On February 18, 2001, during EOC 18, a visual inspection of the top surface of the Oconee Unit 3 RV head showed evidence of fresh boric acid deposits on the vessel head surface. This inspection was performed as part of a special surveillance activity performed following plant shutdown to repair a leaking pressurizer safety relief valve. Boric acid deposits were identified around nine CRDM nozzles (Numbers 3, 7, 11, 23, 28, 34, 50, 56 and 63).[5]

PT examinations results, using a visible dye, solvent removable PT technique on the nine suspected leaking nozzles revealed multiple rejectable indications on all nine nozzles. The PT covered an area 3 inches in diameter from the nozzle that included the J-groove weld surface, filet weld cap and part of the vessel head cladding. It also extended 1 inch down the OD of the nozzle from the weld to nozzle interface.

EC inspections results of the nine leaking CRDM nozzles (3, 7, 11, 23, 28, 34, 50, 56, and 63) and nine non-leaking CRDM nozzles (4, 8, 10, 14, 19, 22, 47, 64, and 65) had signals indicating clusters of shallow axial type cracks located above the weld and below the weld or both. Results for nozzles 50 and 56 identified non-typical clusters above the weld. These clusters were later determined to be associated with the approximately 165 degree circumferential cracks that were found by post repair PT. Six of the leaking nozzles (11, 23, 28, 50, 56 and 63) had deep axial (slightly off axis) indications. Nozzles 50 and 56 had circumferential indications below the weld.

UT inspections of the nine leaking CRDM Nozzles (3, 7, 11, 23, 28, 34, 50, 56, and 63) and nine non-leaking CRDM nozzles (4, 8, 10, 14, 19, 22, 47, 64, and 65) were performed. The nine non-leaking nozzles inspected for extent of condition did not have any crack like axial or circumferential indications. All leaking nozzles had at least 1 axial indication connected to the

[5] LER 287/2001-001, Revision 0, "Reactor Pressure Vessel Head Leakage Due To Stress Corrosion Cracks Found in Nine Control Rod Drive Nozzle Penetrations," dated April 18, 2001.

Report

Note: The following bold text provides the two specific NRC "Action Requests" followed by the Duke response.

5.a A description of the extent of VHP nozzle leakage and cracking detected at your plant, including the number, location, size, and nature of each crack detected.

Methods Used to Inspect VHP Nozzle and Nozzles Inspected During ONS-3, EOC-19 Refueling Outage:

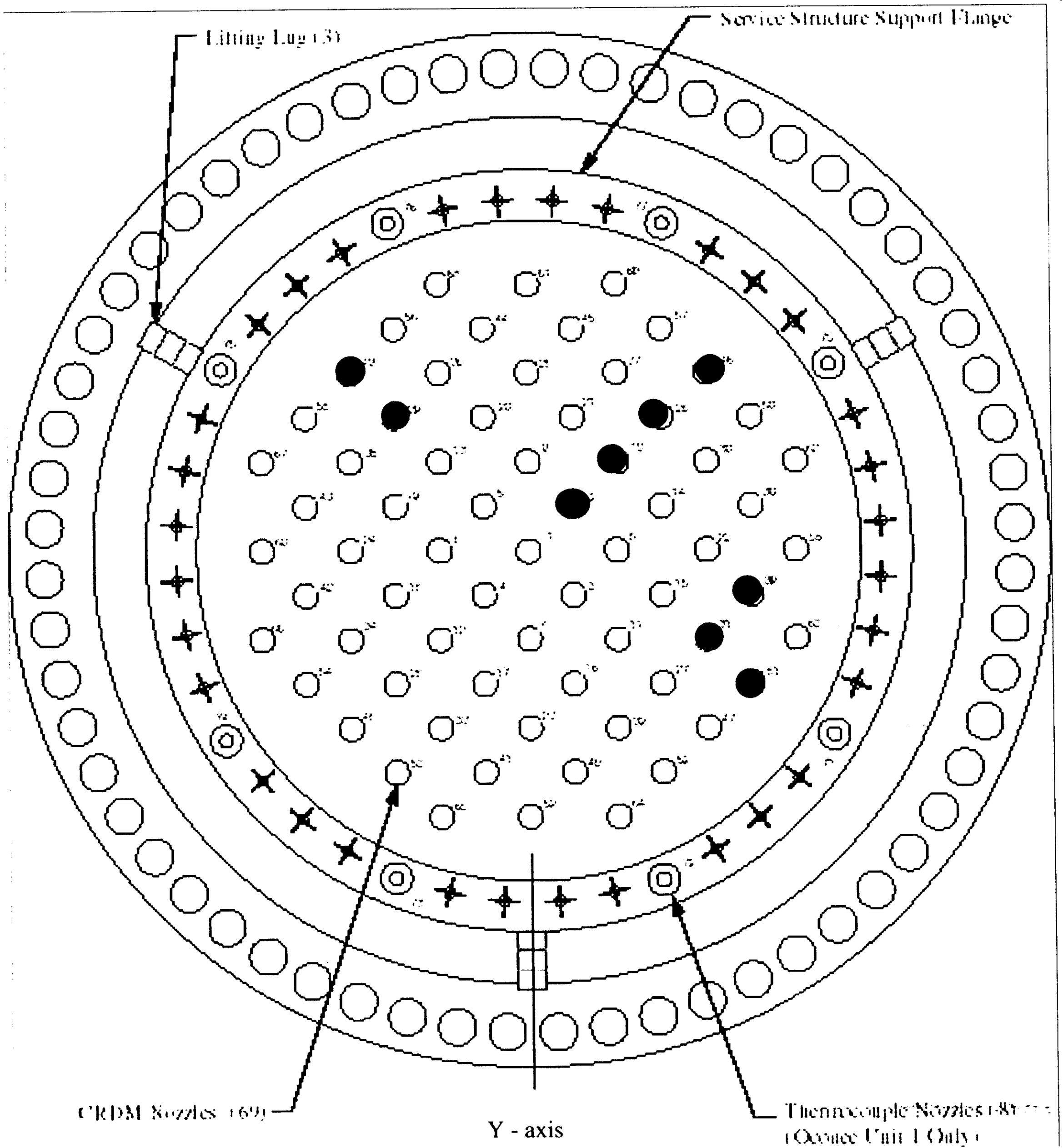
The methods used to inspect the reactor vessel closure head penetrations and the nozzles inspected by each method are given below:

Inspection Method	Nozzles Inspected
Qualified Bare Metal Visual Inspection of the Top of the RV Closure Head	CRDM Nozzles #1 through #69 (100% of the RV Closure Head Penetrations)
Ultrasonic Inspections using the Framatome-ANP "Top Down Tool"	CRDM Nozzles #2, #10, #26, #29, #31, #39, #46, #49, and #51
Liquid Penetrant Inspection of the surface of the J-groove weld and OD surface of the CRDM Nozzle	CRDM Nozzles #10, #31, and #46
Ultrasonic Inspection using the ARAMIS delivery tool and circumferential blade probe.	CRDM Nozzle #1, #5, #6, #9, #12, #13, #15, #16, #17, #18, #20, #21, #24, #25, #27, #30, #32, #33, #35, #36, #37, #38, #40, #41, #42, #43, #44, #45, #48, #52, #53, #54, #55, #57, #58, #59, #60, #61, #62, #66, #67, #68, #69 (43 nozzles)

Results of Qualified Bare Metal Visual Inspection of the Top of the RV Closure Head:

On November 12, 2001, during the EOC 19 refueling outage, a visual inspection of the top surface of the Oconee Unit 3 reactor vessel closure head showed evidence of primary water leakage on the vessel head surface. This inspection was performed in accordance with Duke Energy's response to NRC Bulletin 2001-01 as a "Qualified Visual" inspection. Boric acid deposits with a wet appearance were identified around four CRDM Nozzles (Numbers 26, 39, 49, and 51) and determined to be probable leak locations. Three additional CRDM Nozzles (Number 2, 10, and 46) were identified as being masked by boric acid crystals from an indeterminate leakage flow path and are therefore classified as possible leaking nozzles. Nozzles 2, 10, 26, and 46 all lie in a straight line running radially down the slope of the head such that if a nozzle were leaking the flow path could include the other three nozzles. This is the same visual inspection performed during the previous outages except that a VT-2 qualified inspector participated. The visual inspection was witnessed by a NRC resident inspector. Figure 1 shows the location of nozzles on RV head and the result of the visual inspection.

Figures 2 through 4 provide digital photographs of the boric acid deposits associated with Nozzles 2, 10, 26, 39, 46 and 51.



- Four nozzles identified as possible leakers by top of head visual inspection (26, 39, 49, 51)
- Three nozzles masked by flow (2, 10 and 46)

- Additional CRDMs being removed for access to perform repairs (29, 31)

Figure 1 Oconee Unit 3 CRDM Nozzles Identified as Possible Leakers during RV Head Visual Inspection, During EOC 19 Refueling Outage, November 12, 2001

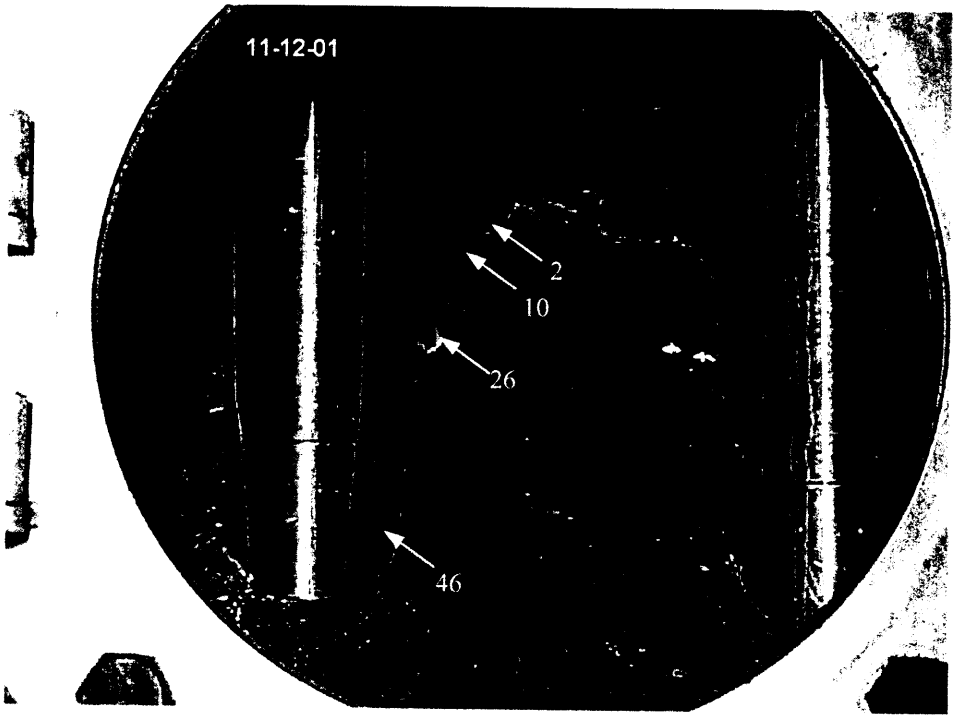


Figure 2 Oconee Unit 3 CRDM nozzles 2, 10, 26, and 46, Top of RV head inspection for boric acid crystals, November 12, 2001

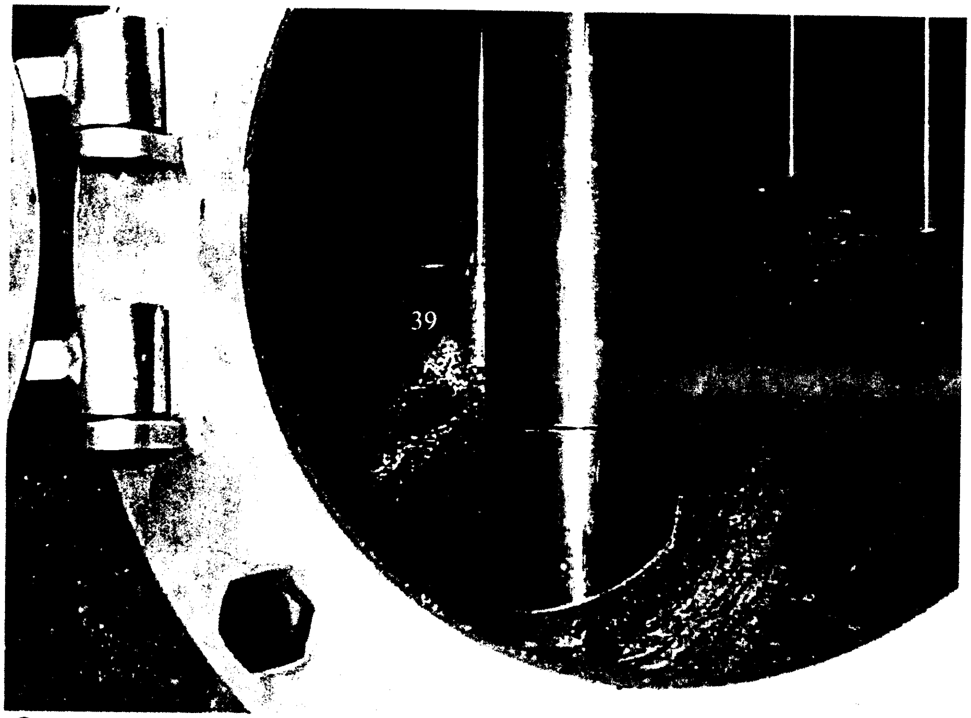


Figure 3 Oconee Unit 3 CRDM nozzle 39, Top of RV head inspection for boric acid crystals, November 12, 2001

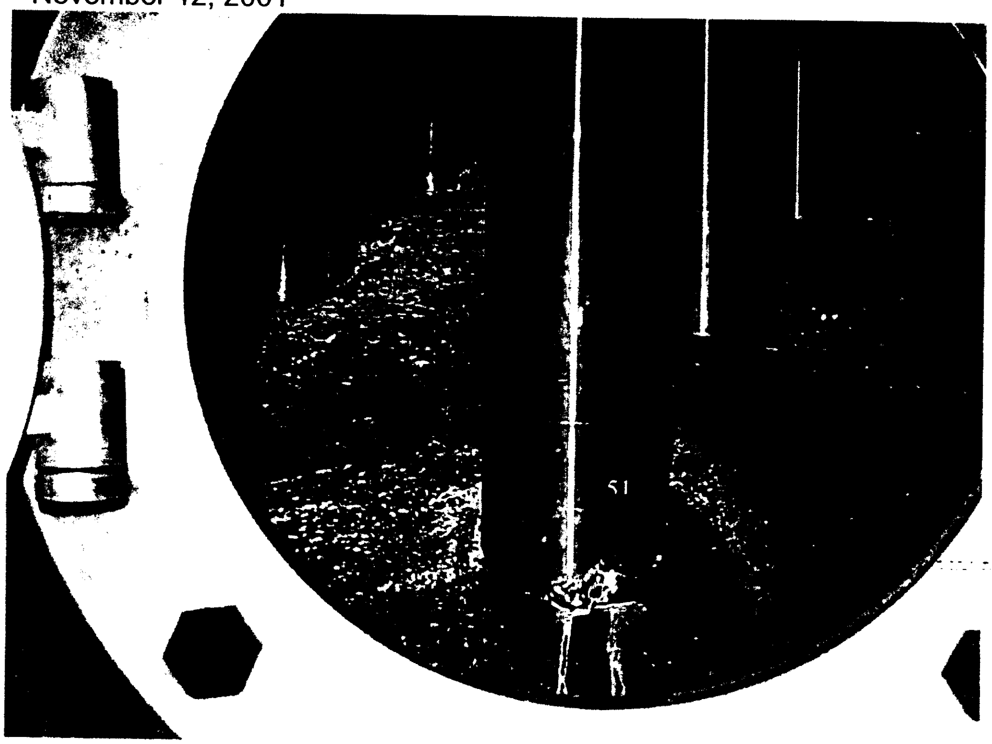


Figure 4 Oconee Unit 3 CRDM nozzle 51, Top of RV head inspection for boric acid crystals, November 12, 2001

Results of ONS-3, EOC-19 Refueling Outage Ultrasonic Inspections of CRDM Nozzles Using the Framatome-ANP "Top Down Tool":

Ultrasonic inspections (UT) from the inside diameter (ID) of nine CRDM housings were performed using the Framatome-ANP "Top Down Tool". Nozzles 26, 39, 49 and 51 were UT inspected due to being identified as having a high probability of leakage by the visual inspection; Nozzles 2, 10 and 46 due to masking by boric acid crystals; and Nozzles 29 and 31 for extent of condition (CRDMs at these locations were removed to allow access for repair equipment). The UT scans were performed using a battery of 10 transducers. Five of the transducer's beams were directed in the circumferential direction, four were directed in the axial direction, and one was a straight beam 0 degrees transducer.

Nozzles 29 and 46 had no UT indications. Nozzles 2, 26, 39, 49, and 51 all had indications in the nozzles that extended from below the weld to above the weld indicating a leak path in addition to various other ID and OD indications. Nozzle 2, in addition, had a circumferential indication in the nozzle above the weld. Nozzles 10 and 31 each contained several OD nozzle indications located below the weld and extending slightly into the weld area, but they show no leak path. Table 1 provides a summary of the UT results giving the indications location within the nozzle with respect to the J-groove weld and its circumferential location with respect to downhill, along with estimated through nozzle wall dimension and indication length within the nozzle. An adjustment was made to the circumferential location such that the downhill location is at 0° and the positive direction is clockwise looking down from the flange. A reactor vessel head map showing the UT results is given in Figure 5.

Table 1 Oconee Unit 3 CRDM Nozzle UT[1] Results, November 2001

Noz #	Ind #	Type	Circumferential Extent[2] (0° = downhill side) Min.	Max.	Flaw Through Nozzle Wall Thickness (in.)	Surface (ID/OD)	Location (B/W/A)[3]	Axial Length (in.)	Circum. Length (in.)
2	1	Axial	223.85°		TW	OD	B/W	2.82"	
2	2	Axial	277.3°	287.0°	0.438"	OD	B/W	2.54"	0.34"
2	3	Axial	313.2°	324.0°	TW	OD	B/W/A	3.35"	0.38"
2	4	Axial	38.4°	41.8°	TW	OD	B/W/A	3.22"	0.12"
2	5	Axial	110.74°	113.0°	0.528"	OD	B/W/A	2.69"	0.08"
2	6	Axial	145.3°	154.5°	0.588"	OD	B/W/A	3.13"	0.32"
2	7	Axial	194.6.6°		0.368"	OD	B/W	1.83"	
2	8	Axial	9.2°		0.088"	OD	W	0.10"	
2	9	Circ.	24.95°	73.09°	0.18"	OD	A	0.21"	1.68"

Noz #	Ind #	Type	Circumferential Extent[2] (0° = downhill side) Min.	Max.	Flaw Through Nozzle Wall Thickness (in.)	Surface (ID/OD)	Location (B/W/A)[3]	Axial Length (in.)	Circum. Length (in.)
10	1[4]	Axial	0°	360°	0.07" - 0.14"	ID	A	1.09"	8.64"
10	2[5]	Axial	156°	214°	0.06" – 0.13"	ID	B	1.15"	1.39"
10	3	Axial	12°		0.098"	OD	B	0.37"	
10	4	Axial	246°		0.118"	OD	B/W	0.26"	
26	1	Axial	267.9°	292.8	0.498"	OD	B/W/A	2.6"	0.86"
26	2	Axial	296.1°	303.1°	0.308"	OD	B/W/A	2.0"	0.24"
26	3	Axial	319.3°	331.8°	0.498"	OD	B/W/A	2.9"	0.44"
26	4	Axial	352.0°	10.0°	0.538"	OD	B/W/A	3.0"	0.63"
26	5	Axial	165.9°		0.348"	OD	B/W	0.9"	
26	6[8]	Circ.	351.6°	35.7°	0.068"	OD	W	0.2"	1.54"
29	No Recordable Indications								
31	1	Axial	292°		0.21"	OD	B/W	1.35"	
31	2	Axial	358°		0.34"	OD	B/W	0.9"	
31	3	Axial	96°		Shallow[6]	OD	B	0.3"	
39	1	Axial	178.0°		0.12"	ID	B	0.5"	
39	2	Axial	192.0°		0.13"	ID	B	0.6"	
39	3	Axial	240.2°	251.9°	0.25"	OD	B/W	1.0"	0.41"
39	4	Axial	273.0°	296.2°	0.48"	OD	B/W/A	2.4"	0.81"
39	5	Axial	73.0°		0.088"	OD	W	0.5"	
46	No Recordable Indications								
49	1	Axial	246.7°	286.4°	0.35"	OD	B/W/A	2.3"	1.39"
49	2	Axial	236.4°	260.7°	0.25"	OD	B/W/A	1.7"	0.85"
49	3	Axial	226.4°	261.4°	0.18"	OD	B/W	1.4"	1.22"
49	4	N/A	35.2°	128.9°	N/A	Weld[7]	J-Weld	2.9"	N/A
51	1	Axial	202.0°		0.12"	ID	B	0.6"	
51	2	Axial	278.7°	295.7°	TW	OD	B/W	1.8"	0.59"
51	3	Axial	321.0°	332.4°	0.188"	OD	B/W/A	2.1"	0.40"
51	4	Axial	14.0°		0.048"	OD	B	0.4"	
51	5[9]	N/A	349.5°	5.1°	N/A	Weld	W		N/A
51	6[10]	N/A	207.9°	257.0°	N/A	Weld	W	1.3"	N/A

1 The UT was performed as a best effort inspection. A finalized UT report has not been completed (numbers may change slightly).
2 0° = downhill side, 180° = uphill side. The positive direction is clock-wise looking down.
3 B = area of nozzle below the weld. W = area of nozzle opposite weld. A = area of nozzle above the weld. Only the Nozzle was volumetrically inspected.
4 This flaw is an elongated group of small axial orientated flaws located at the weld profile extending intermittently around the nozzle.

5 This flaw is a circular grouping of small ID axially orientated flaws located at the bottom of the weld profile.

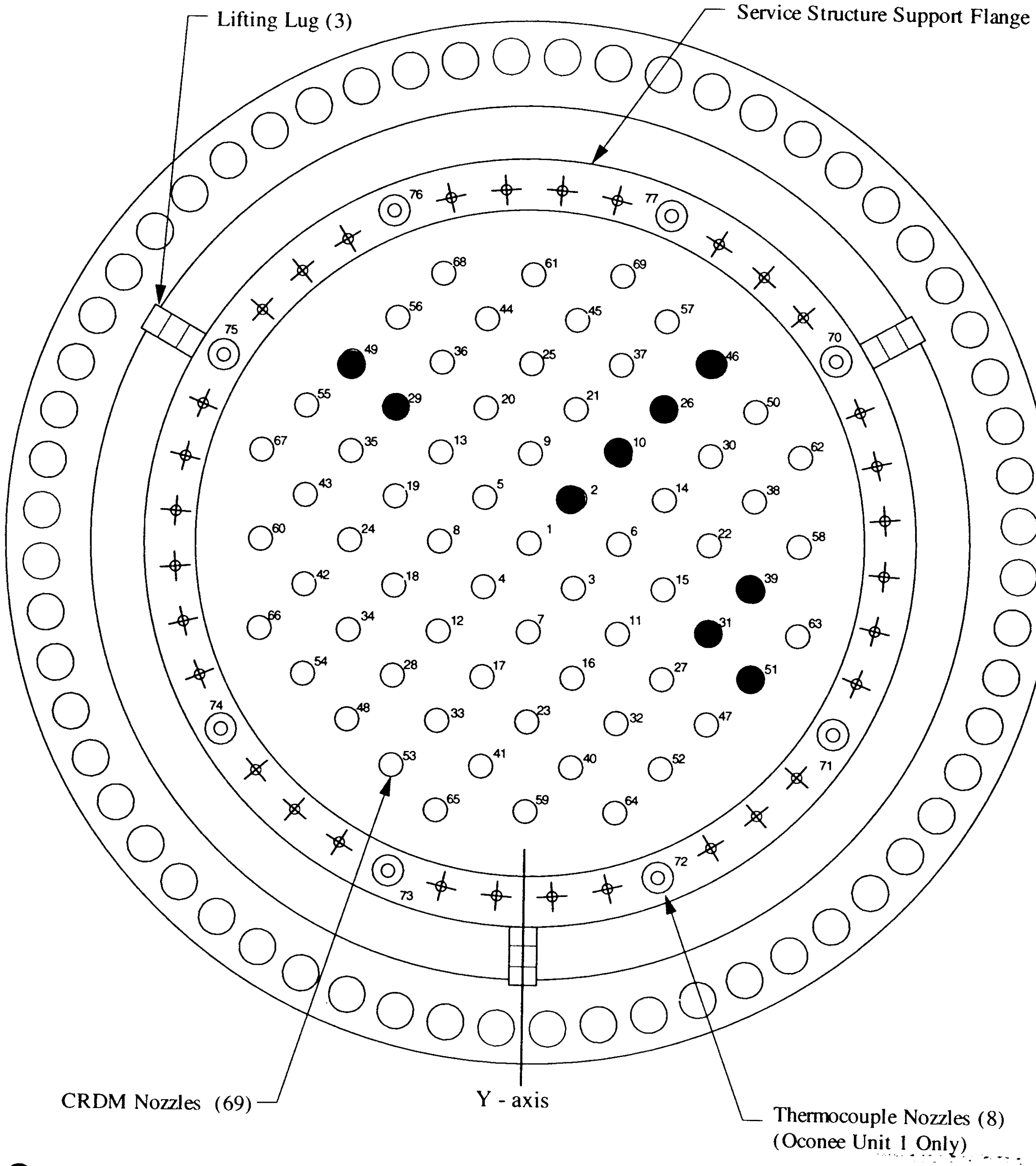
6 No measurable through wall dimension.

7 Flaw #4 nozzle 49 is located in the J-groove weld and is not within the scope of the procedure qualification. This indication is noted for supplemental information only and it has not penetrated the nozzle wall.

8 The majority of flaw # 6 is in the J-groove weld. However mapping of the extent into the weld is beyond the scope of the UT procedure.

9 Flaw # 5 is a weld inclusion

10 Flaw # 6 is in the weld and is not in the nozzle wall. Mapping of this indication is outside the scope of the UT procedure.



- Five nozzles with UT results showing a leak path (2, 26, 39, 49, 51)
- Two nozzles with UT results showing short shallow axial indications on the nozzle OD (10, 31)
- No UT indications (29, 46)

Figure 5 Oconee Unit 3 CRDM Nozzles "Top-Down" Ultrasonic Inspection Results, November 12, 2001

Results of Liquid Penetrant Inspection of the surface of the J-groove weld and OD surface of the CRDM Nozzle:

From the underside of the head, a manual liquid penetrant (PT) examination of nozzles 10, 31, and 46 was performed on November 18, 2001. Nozzle 10 was reported as having one linear indication 0.75 inches long running axial on the nozzle base material beginning at the toe of the weld and was located at the 12:00 o'clock position. The 12:00 o'clock position is located on the downhill side of the nozzle weld with subsequent locations clockwise looking up. Nozzle 31 was reported as having two linear indications, one 0.625 inches long at 1:00 o'clock and the second was 0.375 inches long at 2:00 o'clock. Both ran axially down on the nozzle base material beginning at the toe of the weld. No indications were found on Nozzle 46.

The PT covered an area 3 inches in diameter from the nozzle that included the J-groove weld surface, filet weld cap, and part of the vessel head cladding. It also extended down the OD of the nozzle from the weld to nozzle interface to the end of the nozzle. A visible dye, solvent removable PT technique was performed using Duke's PT Procedure, NDE 35. This is the same PT procedure as used during the previous Winter and Spring outages.

Results of Ultrasonic Inspection using the ARAMIS delivery tool and circumferential blade probe:

As a result of the circumferential flaw found above the weld on Nozzle 2, an extended scope inspection of 43 nozzles was performed using a Framatome-ANP ARAMIS inspection tool equipped to deliver a circumferential blade probe between the ID of the nozzle and the lead screw support tube (thermal shield). The 43 nozzles within the scope of the inspection had not been previously repaired or volumetrically inspected. The nozzle area inspected was a minimum of one inch below the J-groove weld to one inch above the J-groove weld. Thirty-six nozzles were inspected with 100 percent of the coverage area being examined. Due to limiting gap clearance between certain nozzles and their lead screw support tube, there were seven nozzles that 100 percent inspection coverage could not be obtained. The approximate percentage of the coverage area inspected for these nozzles were:

Nozzle 42	94%
Nozzle 45	94%
Nozzle 48	99%
Nozzle 60	76%
Nozzle 62	82%
Nozzle 66	89%
Nozzle 69	75%

Overall results revealed no recordable indications within the nozzle material for the 43 nozzles inspected. In Nozzle 43, an indication in the weld was detected from approximately 84° to 105°

at the nozzle to weld interface and was located about 0.4 inches above the fillet intersection with the nozzle OD. This indication follows the weld contour but is not surface connected. The signal characteristics of the indication suggest a weld fabrication flaw volumetric in nature, possibly slag trapped at the interface. This nondestructive examination was performed as an added assurance that there were no existing circumferential flaws that could potentially pose a safety risk during the upcoming operating cycle.

5.b If cracking is identified, a description of the inspection (type, scope qualification requirements, and acceptance criteria) repairs, and other corrective actions you have taken to satisfy applicable requirements. This information is requested only if there are changes from prior information submitted in accordance with the bulletin.

Inspections Performed During the ONS-3, EOC-19 Refueling Outage for Detection of RV Closure Head PWSCC:

Four inspection methods were used during the Oconee Unit 3 end-of-cycle 19 refueling outage:

- A qualified bare metal visual inspection of the of the top of the RV closure head,
- Ultrasonic inspections using the Framatome-ANP "Top Down Tool",
- Liquid penetrant inspection of the surface of the J-groove weld and the OD surface of the nozzle, and
- Ultrasonic inspection using the Framatome-ANP ARAMIS delivery tool and circumferential blade probe.

The qualified top of RV head visual inspection and the liquid penetrant inspection of the weld surface were performed in accordance with Duke Energy's response to the NRC Bulletin 2001-01. The ultrasonic inspection using the "Top Down Tool" was essentially the same inspection described in the Duke Energy Bulletin response with the exception of some enhancements to the delivery system and the transducers. The ultrasonic inspection method using ARAMIS and the circumferential blade probe was used for the first time by Duke during this outage and is described in a following section. Both ultrasonic methods were demonstrated to the NRC, EPRI, and industry in September 2001 at Lynchburg, VA.

Improved Ultrasonic Inspections Using the Framatome-ANP "Top Down Tool":

An automated Ultrasonic examination of nine CRDM nozzles (numbers 2, 10, 26, 29, 31, 39, 46, 49, and 51) was performed using the "Top Down Tool" and a qualified Framatome-ANP examination procedure. This Framatome-ANP procedure governs the remote automated contact ultrasonic examination of CRDM nozzles using the ACCUSONEX™ automated data acquisition and analysis system. The techniques utilized for the examination are intended for the detection and through-wall (depth) sizing of axial and circumferential ID and OD initiating flaws in the nozzle base metal only. Forward scatter, longitudinal-wave, and backward scatter shear wave techniques are used. The examinations were conducted from the bore of the CRDM nozzles in the J-groove weld region of the nozzle.

The inspections consisted of scanning for axial and circumferential reflectors within the nozzle. The tooling consisted of a transducer head that holds 10 individual search units. These search units were divided into two sets, one for the axial beam direction and one for the circumferential beam direction. The axial beam direction set of search units consisted of 5.0 MHz, longitudinal wave forward scatter time of flight search units with angles of 30° and 45°; backward scatter pulse echo, 2.25 MHz 60° shear wave search units; and a 5.0 MHz 0° search unit (see Appendix A for calibrations files and scan parameters). The circumferential beam direction set of search units consisted of 5.0 MHz, longitudinal wave forward scatter time of flight search units with angles of 45°, 55°, and 65°; backward scatter pulse echo, 2.25 MHz 60° shear wave search units; and a 5.0 MHz 0° search unit.

The detection of flaw indications is based upon the expected responses for each search unit and technique. The 0° transducer provides weld position information and reflector positional information due to lack of backwall response in the region of the reflector. The forward scatter time of flight techniques provides reflector detection and sizing information. For the forward scatter transducers, reflector detection is identified by loss of signal response either from the lateral wave or backwall responses as well as from crack tip diffracted responses. The 60° shear wave transducer provides detection by means of corner trap responses between the flaw and nozzle surface and sizing with tip diffracted signals.

The top-down tool was positioned with the "Y" axis (axial) zeroed at the top of the nozzle flange with the positive direction extending down the nozzle. The "Theta" axis was zeroed at the dowel pinhole in the flange with the positive direction in the clockwise direction while looking down from the top of the nozzle. The ultrasonic data is adjusted for individual transducer offsets in the transducer head to provide actual reflector location in the nozzle. The acceptance criterion was that any indication not considered geometrical was considered a flaw.

The changes made to the rotating probe used by the "Top Down Tool" are the result of technique optimization in preparation for detection and sizing of OD initiated flaws.

<u>Ultrasonic Inspection Using the ARAMIS Delivery Tool and Circumferential Blade Probe:</u>

Automated ultrasonic examinations of forty-three CRDM nozzles were performed using the ARAMIS inspection tool and a qualified Framatome-ANP examination procedure. This procedure governs the remote automated contact ultrasonic examination of CRDM nozzles using the ACCUSONEX™ automated data acquisition and analysis system. The techniques utilized for this examination are for the detection and through-wall (depth) sizing of circumferential ID and OD initiating flaws in the nozzle base metal only. Forward scatter, longitudinal-wave techniques are used. The examinations were conducted from the bore of the CRDM nozzles in the J-groove weld region of the nozzle.