UNITED STATES
NUCLEAR REGULATORY COMMISSION
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

STRUCTURAL INTEGRITY ASSESSMENT OF CRDM PENETRATIONS

AT THE OCONEE NUCLEAR STATION, UNIT 2

DOCKET NO. 50-270

1.0 INTRODUCTION

On November 30, 1993, Mr. James Taylor, the Executive Director for Operations for the Nuclear Regulatory Commission, provided the Commission with an updated, "Status Report on Primary Water Stress Corrosion Cracking of PWR Reactor Vessel Head Penetration Cracking" (Ref. 1). The updated report indicated that the industry, through the efforts of the Nuclear Management and Resources Council (NUMARC, now the Nuclear Energy Institute (NEI)), had committed to perform nondestructive examinations of the control rod drive mechanism (CRDM) penetration nozzles and other reactor pressure vessel head (RPVH) penetrations at three domestic pressurized water reactors (PWRs). Duke Power Company's (DPC's) Oconee Nuclear Station (ONS) Unit 2 was included among the group of lead plants for NEI's pilot study of primary water stress corrosion cracking (PWSCC) in PWR RPVH penetrations.

In 1994, DPC contracted with Babcock and Wilcox Nuclear Technologies (BWNT, now Framatome Technologies Inc. (FTI)) to perform eddy current testing (ET), ultrasonic testing (UT), and penetrant testing (PT) of the CRDM penetration nozzles at ONS Unit 2. BWNT performed both blade probe and motorized rotating pancake coil (MRPC) ET of the ONS Unit 2 CRDM penetration nozzles during the September 1994 refueling outage (RFO) for the plant. BWNT's ET results revealed indications of flaws in the No. 23, 28, 60, 62, 63, and 65 CRDM penetration nozzles to the RPVH. The flaw indications detected in the No. 28, 60, 62, and 65 CRDM penetration nozzles were determined to be bounded by the flaw indications detected in the No. 23 CRDM penetration nozzle.

Penetrant testing (PT) of the No. 23 CRDM penetration confirmed the flaw indications identified by the ET examinations of the penetration nozzle. The PT results indicated that the flaws were located on the inner diameter (ID) surface of the No. 23 CRDM penetration, with 18 of the flaws being oriented in the axial direction and 2 of the flaws being oriented in off-axis direction. The responses from ET examinations of the No. 63 CRDM penetration nozzle exhibited excessive noise levels, which precluded an accurate assessment of

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the test results. UT of the penetration nozzles in 1994 failed to provide indication of the flaws. DPC therefore concluded that all flaws in the penetration nozzles were less than 0.079 inch (2 mm) in depth since UT cannot provide indication of near side flaws less than 2 mm in depth. In its safety evaluation (SE) dated March 31, 1995 (Ref. 2), the staff stated that DPC's evaluation of the flaw indications in the ONS Unit 2 CRDM penetration nozzles was acceptable and justified operation of ONS Unit 2 for one additional cycle of operation.

On March 12–13, 1996, DPC met with the NRC at FTI's facilities in Lynchburg, Virginia. At the meetings DPC informed the NRC that it would be reexamining the No. 23 and No. 63 CRDM penetration nozzles at ONS Unit 2 during the Spring 1996 refueling outage (RFO) for the plant. As stated previously, the No. 23 CRDM penetration nozzle has the worst case, bounding flaw indications of all the CRDM penetration nozzles at ONS Unit 2. At the meetings FTI provided the NRC with its schedule and scope for the examinations, as well as its actions for qualifying the capabilities of the ET techniques that would be employed during the examinations. DPC opted to include the No. 63 CRDM penetration nozzle in the inspection scope due to the excessive noise levels in the previous ET results. The scope for the 1996 nondestructive examinations (NDE) was to include both ET and PT of the penetration nozzles.

The staff's SE of the 1996 CRDM penetration nozzle examinations for ONS Unit 2 is provided in Section 2.0. This SE is based in part on observations of staff members who were present for the CRDM penetration examinations at ONS Unit 2, and in part on the staff's review of DPC's most recent safety evaluation of the ONS Unit 2 CRDM penetration nozzles (Ref. 3).

2.0 SAFETY EVALUATION OF THE CRDM PENETRATION NOZZLES AT ONS UNIT 2 — APRIL 1996 EXAMINATION RESULTS

2.1 Inspection Methods

On April 9–11, 1996, during the April–May 1996 RFO for ONS Unit 2, DPC conducted ET and PT of the No. 23 and No. 63 CRDM penetrations to the ONS Unit 2 RPVH. FTI performed these examinations in accordance with approved NDE procedures and procedure qualifications under the directions of FTI's Level III ET and PT examiners. This is in accordance with Criterion IX ("Special Processes") of Appendix B to 10 CFR Part 50, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants."

2.1.1 Qualification of ET Techniques

The 1996 ET examinations were conducted using a ZETEC Corporation designed, motorized rotating pancake coil (MRPC) head containing the following ET coils: a differential pancake coil with a 45° offset, an axial coil, and a plus-point coil. The ET methods included ET Lissajous pattern (phase angle) analysis methods and ET response amplitude analysis methods from the ET strip chart profiles and terrain maps.

Prior to the 1996 CRDM penetration examinations, DPC contracted with the Electric Power Research Institute (EPRI) to evaluate the ability of the ET coils to detect and size flaws in RPVH penetrations. EPRI tested the coils on a series of CRDM penetration mockups that were designed at EPRI's NDE-Center in Charlotte, North Carolina. The differential pancake coil was evaluated in both the differential and absolute modes. The axial coil and the plus-point coil were tested in the absolute mode only. The coils were tested at the following frequencies: 600 Hz, 280 Hz, and 100 Hz. This provided a total of 12 inspection channels. All 12 channels of ET data were acquired at 1000 samples/sec, with a rotational scan speed of 2 rev./sec. EPRI tested each channel for its ability to size flaws in the mockups. The sizing techniques included peak-to-peak (P-P) phase angle, P-P amplitude, and V-max amplitude techniques.

The design of the two CRDM penetration mockups contain a number electro-discharge machined (EDM) notches that were subjected to a cold isostatic pressure (CIP) treatment following the machining process. CIP isostatically squeezes the host material around the notches and reduces the width of the notches without significantly changing the notch length or depth. The CIP treated notches in the mock-ups included axial, circumferential, clustered axial, and skewed axial (< 15° off axis) orientations. The eddy current responses of the coils to the CIP treated notches is similar to the coil responses to stress corrosion cracks. EPRI presented the results to the staff during the staff's meetings with DPC, FTI, and EPRI in Lynchburg, Virginia (March 12–13, 1996). The results of these evaluations are summarized in detail in EPRI Report "Eddy Current Depth Sizing Evaluation of PWSCC-Type Flaws in Alloy 600 Reactor Vessel Head Penetrations" (Ref. 4). EPRI's evaluation of these coils indicated that the plus-point coil had the best overall ability to detect and size the flaws in the CRDM penetration mockups. FTI, therefore, decided to use the plus-point coil for the 1996 MRPC ET examinations of the No. 23 and 63 CRDM penetrations.

2.1.2 Eddy Current (ET) Examinations

On April 9, FTI performed a second test of the MRPC probe (using the plus-point coil) on EPRI's CRDM penetration mockup. The ET strip chart and terrain map results of the CRDM penetration mockup indicated that the ET probe was capable of detecting all types of induced flaws (i.e., CIP treated EDM notches) in the CRDM penetration mock-up. A member of the staff from EPRI–Charlotte was on site to provide an independent third-party review of the ET technique. The EPRI staff member concluded that FTI's test of the Plus-Point Probe provided proper indication of the flaws in the CRDM penetration mock-up and that the plus-point probe was therefore acceptable for examination of the CRDM penetration nozzles.

FTI performed the ET examinations in accordance with approved ET procedures and procedure qualifications. This is in accordance with the quality assurance requirements of 10 CFR Part 50, Appendix B. Two sets of ET examinations were performed on the No. 23 and No. CRDM penetration nozzles, one after preparing the surface of each penetration with Scotch Brite,[1] and the other after preparing the surface of each penetrations with a honing head. The ET responses of the CRDM penetration nozzles taken after Scotch Brite surface preparation of the ID surfaces did not differ significantly from those obtained after honing of the ID surfaces. Following the ET examinations, FTI qualified the accuracy the ET probe/remote VT camera mechanical positioning equipment.

2.1.3 Penetrant Testing (PT) Examinations

During the 1996 RFO for ONS Unit 2, FTI repeated the PT examinations of the Nos. 23 and 63 CRDM penetrations. DPC's PT examinations were performed in accordance with an approved PT procedure and an approved PT procedure qualification. This is in accordance with the quality assurance requirements of 10 CFR Part 50, Appendix B. For the 1996 PT examinations, FTI changed the compounds for the examination from a water-based penetrant dye and developer to an organic-based penetrant dye and developer. Visual (VT–1) examinations of the No. 23 and No. 63 CRDM penetrations were performed following the application of the penetrant developer to the penetration nozzles.

2.2 Flaw Evaluation of the No. 23 and No. 63 CRDM Penetration Nozzles

2.2.1 Supporting Documents for the 1996 Flaw Evaluation of the No. 23 and No. 63 CRDM Penetration Nozzles

DPC's criteria for evaluating the flaws in the ONS Unit 2 CRDM penetrations are provided in DPC's Interim Flaw Evaluation of April 30, 1996 (Ref. 3), as supplemented with the information provided in DPC's submittal of October 9, 1996 (Ref. 5), and BWNT Proprietary Calculation Summary Sheet (CSS) No. 32-1240855-00 (Ref. 6). DPC's flaw evaluation of April 30, 1996, and submittal of October 9, 1996, provided a summary of the inspection results from both the 1994 and 1996 CRDM penetration examinations at ONS Unit 2. The staff reviewed these documents as the basis for its evaluation. CSS No. 32-1240855-00 provided BWNT's assessment of the flaw indications in the No. 23 CRDM penetration from the 1994 examinations.

2.2.2 ET Examination Results

The Lissajous pattern and strip chart and terrain map amplitude responses from the 1996 ET examinations of the No. 23 and No. 63 CRDM penetrations did not differ significantly from the corresponding responses from the 1994 ET examinations.

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1 Scotch Brite is a trademark of the Minnesota Manufacturing and Mining Company.

2.2.3 PT Examination Results

Indications of surface flaws from the 1996 PT results were clearer and more precise than the corresponding indications from the 1994 PT results. DPC attributed the improvement in the results of the 1996 PT examinations to the change in selection of the penetrant dye and developer compounds.

The 1996 PT examination results of the No. 23 CRDM penetration confirm the indications of cracking identified from the 1996 ET results and the 1994 ET and PT results. The results of 1996 PT examinations of the No. 63 CRDM penetration indicated the presence of multiple, shallow (< 0.079 inch (2mm) deep), axial surface indications in the penetration's inner wall surface at and below the penetration nozzle's weld profile. DPC attributed the indications to craze cracking that resulted during fabrication of the penetration. DPC stated that the presence of these multiple, shallow flaw indications in the No. 63 penetration explains the presence of high noise levels in the corresponding ET strip chart and terrain maps results.

2.2.4 Evaluation Acceptance Criteria

In 1993, the Nuclear Management and Resources Council (NUMARC, now the Nuclear Energy Institute (NEI)) submitted its generic acceptance criteria for flaw indications identified during inservice inspections (ISI) of RPVH penetration nozzles (Ref. 7). Table 2.2.4-1 summarizes the acceptance criteria proposed by NEI.

Table 2.2.4-1 NEI's Acceptance Criteria for Evaluation of Cracks At or Above the Full/Partial Penetration Weld of PWR RPVH Penetrations[1]

Crack Orientation	Allowable Crack Length	Allowable Crack Depth
Axial[1]	Any length	Up to 75% Throughwall
Circumferential	To 50% of Circumference	Up to 75% Throughwall

1. Axial cracks below the full/partial penetration weld would be acceptable for any length below the weld, and up to a throughwall depth.

In 1994, DPC submitted its proposed plant-specific acceptance criteria (summarized in Table 2.2.4-2) for any postulated axial or circumferential flaws in the Oconee RPVH penetration nozzles:

Table 2.2.4-2 DPC's Acceptance Criteria for Evaluation of Axial and Circumferential Cracks in the Oconee RPVH Penetrations[1]

Crack Orientation	Allowable Crack Length	Allowable Crack Depth
Axial[1]	Any Length	Up to 75% Throughwall
Circumferential	2 inches on the outside surface— ~16% of the outer circumference	Up to 75% Throughwall

1. Axial cracks below the full/partial penetration weld would be acceptable for any length below the weld, and up to a throughwall depth.

In its safety evaluation (SE) dated November 19, 1993 (Ref. 8), the staff informed NEI that axial flaws in the pressure boundary portion of CRDM penetration nozzles (i.e., at or above the partial penetration weld of the nozzle) may grow to any size if the flaw depths are less than 75 percent of the nozzles' throughwall thickness. In this SE, the staff only accepted the acceptance criteria proposed for axial flaws. DPC's acceptance criteria for axial flaw indications are equivalent to the acceptance criteria proposed by NEI for axial flaw indications (Ref. 7) and approved by the staff (Ref. 8), and are therefore acceptable.

In regard to acceptance criteria for circumferential flaw indications, in November 1993, the staff informed NEI that the "criteria for circumferential flaws would not be pre-approved," and that "any circumferential flaw found through ISI, which a licensee proposes to leave in-service without repair, ... [would] ... be reviewed on a case-by-case basis" (Ref. 8). In our SE to DPC dated March 31, 1995 (Ref. 2), the staff made the following conclusions with respect to DPC's proposed acceptance criteria for circumferential flaws in the ONS Unit 2 CRDM penetration nozzles:

1. Axial and circumferential cracks below the J-Groove weld (partial penetration weld) would not violate the reactor coolant pressure boundary, even if throughwall, and therefore are acceptable for further service.

2. Circumferential cracks at or above the J-Groove weld could result in ejection of a CRDM (a large break loss-of-coolant accident scenario); however, stress analysis conducted as part of the owners groups' safety assessments predict that it would be very unlikely that circumferential cracks would form due to the stress distributions in the RPVH.

Therefore, the staff requested in its SE of March 31, 1995 (Ref. 2), that licensees report the occurrence of any circumferential flaws at or above the J-Groove weld for disposition. To date, the staff has not deviated from this position regarding evaluation of circumferential flaw indications in RPVH penetrations. It should be noted that for evaluation purposes, the staff considers any flaw indications with planes oriented more than 45° off-axis from the center-line penetration nozzle axis to be circumferential flaws (Ref. 8). To date, DPC has not detected any circumferential flaw indications in the ONS Unit 2 CRDM penetration nozzles.

2.2.5 Evaluation of Flaw Indication Geometry

By phone conversation with DPC in August 1993, the staff inquired about the geometry orientation of flaw indications in the No. 23 and No. 63 CRDM penetration nozzles. In 1994, DPC had indicated that all indications in the No. 23 CRDM penetration nozzle were axial in orientation, with the exception of two, which were axial in orientation with some off-axis orientation near the flaw indication ends. During the phone conversation DPC informed the staff that none of the indications in the No. 23 and No. 63 CRDM penetration nozzles were oriented more that 45° off of the centerline axis of the nozzles. Therefore, DPC informed the staff that all of the flaws indications were being evaluated as being axial indications. DPC confirmed this in its submittal to the staff of October 9, 1996 (Ref. 5). This is consistent with the acceptance criteria previously approved by the staff (Ref. 8).

2.2.6 Evaluation of Flaw Depth

It should be noted that, in 1994, the results of the UT examinations of the No. 23 and No. 63 CRDM penetrations did not provide any indication of cracking in the penetrations. DPC, FTI, and EPRI have stated (Ref. 3) that UT cannot provide indication of cracking when cracks are less than 0.079 inch (2mm) deep. Therefore, since the 1994 UT examination did not provide any UT indication response, DPC dispositioned all indicated flaws in the No. 23 and No. 63 CRDM penetrations as being less than 0.079 inch (2 mm) in depth. The scope the 1996 CRDM penetration nozzle examinations did not include any UT examinations of the penetrations nozzles. In the SE of March 31, 1995 (Ref 2.), the staff concluded that UT could not accurately quantify the depth of indications that are less than 1 mil (0.025 mm) deep. DPC's current limit of detection for the UT examinations of the CRDM penetration nozzles is 0.079 inches (2 mm). This is consistent with, but more conservative (i.e., greater uncertainty) than the value used in the staff's SE of March 31, 1995. Therefore, since the phase angle and amplitude results of the 1996 ET examinations did not differ significantly from the results of the 1994 examinations, and since 1994 UT examinations did not provide any indication of cracking in the penetrations, the staff finds that 0.079 inch (i.e., 12.64 percent of the CRDM penetration nozzle throughwall thickness) places a conservative estimate on the depths of the crack indications identified from the 1996 PT examinations of the No. 23 and No. 63 CRDM penetration nozzles.

2.2.7 Evaluation of Flaw Length

The results from the 1996 PT examinations of the No. 23 CRDM penetration nozzle indicate that the flaw indications in the nozzle range from 0.06 inch – 0.34 inch in length. Evaluation of the maximum sized flaw (0.34 inch) in the No. 23 CRDM penetration nozzle is bounded by the results of flaw evaluation in CSS No. 32-1240855-00.

The PT results of the No. 63 CRDM penetration nozzle indicate that the flaws in the nozzle range from 0.03 inch — 0.44 inch in length. Upon initial review, the flaw indications that were in excess of than 0.37 inch in length did not appear to be bounded by the flaw evaluation in CSS No. 32-1240855-00. By conference call in August 1996, the staff discussed the appropriateness of using CSS No. 32-1240855-00 to evaluate flaw indications in excess of 0.37 inch in length. During the conference call, and in DPC's submittal of October 9, 1996 (Ref. 5), DPC informed the staff that the longest flaw indication at or above the partial penetration weld of the No. 63 CRDM penetration nozzle was 0.29 inch in length, and that the only indications in excess of 0.37 inch were located below the partial penetration weld.

Flaw indications located below the partial penetration weld are not part of the pressure boundary and may grow to any sized length without threatening the structural integrity of the pressure boundary. This is in accordance with the acceptance criteria previously approved by the staff (Ref. 8). Since the only indications in the No. 23 and No. 63 CRDM penetration nozzles located at or above the partial penetration weld are axial indications ≤ 0.37 inch in the length, the staff concludes that CSS No. 32-1240855-00 is bounding for evaluation of all the flaw indications that have been detected in the pressure boundary portions of the No. 23 and No. 63 CRDM penetration nozzles. It should be noted, however, that the approved acceptance criteria for axial flaw indications in the pressure boundary portions of CRDM penetration nozzles is that axial flaws may be any sized length so long as the axial flaw depths remain below 75 percent of the nozzle throughwall thickness. Since the staff has not placed a limit on the acceptance criteria for axial flaw lengths in CRDM penetration nozzles, axial flaws with flaw lengths in excess of 0.37 inch would be acceptable for further service, provided that the flaw depths would remain below 75 percent of the nozzle throughwall thickness over the duration of the operating cycle.

2.2.8 Flaw Evaluation — Conservatisms in B&W Nuclear Technologies Summary Calculation Sheet No. 32-1240855-00

By SE of March 31, 1995 (Ref. 2), the staff approved operation of the ONS Unit 2 reactor for an additional cycle of operation based on a maximum CRDM penetration nozzle flaw size of 0.37 inch in length and the limit load analysis and fatigue analysis results found in BWNT Proprietary Calculation Summary Sheet (CSS) No. 32-1240855-00. CSS No. 32-1240855-00 was based on a predicted total of 360 heatup and cooldown cycles over the design life of the ONS Unit 2 plant. This is equivalent to nine heatup/cooldown cycles per year or 27 heatup/cooldown cycles over 3 years. BWNT used the following conservative assumptions in performing its calculation:

- The flaw evaluation was based on an assumed flaw length of 0.37 inch. This corresponds to the flaw length of the maximum sized flaw indication identified from the PT examinations and blade probe ET examinations of the No. 23 CRDM penetration nozzle in 1994.

- The flaws in the No. 23 and No. 63 CRDM penetration nozzles were assumed to have depths of 0.079 inch. This depth represents the upper bound value based on the threshold of detectability from the 1994 UT examinations, since no indications were detected by the UT equipment during the examinations. The 1996 ET results did not differ significantly from the ET results from the 1994 examinations, and indicate little crack growth over the last operating cycle.

- Nozzle stresses used in CSS No. 32-1240855-00 were based on an Alloy 600 Material Heat with a yield strength of 64.4 ksi. Since this yield strength is the bounding maximum value for all CRDM penetration nozzles in the ONS Unit 2 reactor pressure vessel head (RPVH), the yield strength for the No. 23 CRDM penetration nozzle would actually be lower. This would result in lower steady state operating and residual stresses in the penetration than were used for input to the calculation. The reference yield strength for the No. 23 CRDM penetration nozzle is listed (in accordance with the Certified Material Test Report) as being 55.2 ksi.

- Nozzle stresses used in CSS No. 32-1240855-00 were obtained from a finite element analysis of the most peripheral nozzle in the ONS Unit 2 vessel head. Vessel head penetration nozzles at the periphery of the head tend to have higher operating stresses and residual stresses than more centrally located penetration nozzles.

- Crack growth in the CRDM penetration nozzles is based a maximum growth rate of 6 mm/year (based on the P. Scott model, Ref. 9), as opposed to a maximum growth rate of 3.3 mm/year as proposed at the EPRI Workshop in 1994 (Ref. 10)

CSS No. 32-1240855-00 is still bounding for evaluation of axial flaw indications located in the pressure boundary portions of the No. 23 and No. 63 penetration nozzles. The results of CSS No. 32-1240855-00 predict that an axial flaw indication in the CRDM penetration nozzles will grow to 75 percent of the nozzle throughwall thickness in 26 heat/cooldown cycles, which is equivalent to 2.89 years. The results of CSS No. 32-1240855-00 are bounding for the No. 63 CRDM penetration nozzle as well because the depths of flaw indications in both the No. 23 and No. 63 CRDM penetration nozzles are conservatively estimated to be 0.079 inches or less in depth (i.e., the flaw depths are $\leq$ 12.64 percent of the nozzle throughwall thickness). Assuming a plant operating capacity factor of 95.5 percent over the next 2 years, the next cycles at power (during operating cycles 16 and 17) are calculated to last only 2.75 years. Thus, CSS No. 32-1240855-00 indicates that the flaws in the No. 23 and No. 63 CRDM penetration nozzles will be acceptable over the next two cycles assuming a 95.5 percent capacity factor for the ONS Unit 2 facility.

3.0 CONCLUSIONS

Based on DPC's flaw evaluation of the No. 23 and No. 63 CRDM penetration nozzles, and the number of conservatisms inherent in the evaluation, the staff concludes that the flaw indications in the No. 23 and No. 63 CRDM penetration nozzles will be acceptable for service over the next two operating cycles for the plant, and justify operation of the ONS Unit 2 plant for operating cycles 16 and 17.

4.0 REFERENCES

1. Memorandum to the U.S. Nuclear Regulatory Commission Chairman and Commissioners from James M. Taylor, Executive Director for Operations, "Status Report on Primary Water Stress Corrosion Cracking of PWR Reactor Vessel Head Penetration Cracking," dated November 30, 1993.

2. Letter from L.A. Wiens, Senior Project Manager, Project Directorate II-3, Division of Reactor Projects I/II, Office of Nuclear Reactor Regulation, to J.W. Hampton, Vice President — Oconee Nuclear Station, Duke Power Company, enclosing the "Safety Evaluation of Control Rod Drive Mechanism Penetration Inspection Results — Oconee Unit 2 (TAC No. M90773)," dated March 31, 1995.

3. Letter from J.W. Hampton, Vice President — Oconee Nuclear Station, Duke Power Company, to the U.S. Nuclear Regulatory Commission Document Control Desk, submitting the "Interim Engineering Evaluation of Control Rod Drive Mechanism (CRDM) Penetration Inspections," for Oconee Unit 2 (Docket No. 50-270), dated April 30, 1996.

4. "Eddy Current Depth Sizing Evaluation of PWSCC-Type Flaws In Alloy 600 Reactor Vessel Head Penetrations," — Internal Document Prepared Mr. Larry Cagle of the EPRI NDE Center for Presentation to the Duke Power Company, the U.S. Nuclear Regulatory Commission, and Framatome Technologies Incorporated, dated March 13, 1996.

5. Letter from J.W. Hampton, Vice President — Oconee Nuclear Station, Duke Power Company, to the U.S. Nuclear Regulatory Commission Document Control Desk, submitting the "Interim Engineering Evaluation of Control Rod Drive Mechanism (CRDM) Penetration Inspections, Supplemental Information," for Oconee Unit 2, dated October 9, 1996.

6. B&W Nuclear Technologies (BWNT) Internal Proprietary Calculation Summary Sheet (CSS) No. 32-1240855-00, "Flaw Evaluation for Oconee-2 CRDM Nozzle No. 23," dated November 20, 1995. (Submitted by FTI letter dated May 22, 1996)

7. Letter from A. Marion, Manager — Technical Division, Nuclear Utilities Management and Resource Council (NUMARC), to W.T. Russell, Associate Director for Inspection and Technical Assessment, dated July 30, 1996.

8. Letter from W.T. Russell, Associate Director for Inspection and Technical Assessment, Office of Nuclear Reactor Regulation, to W. Rasin, Vice President and Director — Technical Division, Nuclear Management and Resources Council, submitting the "Safety Evaluation for Potential Reactor Vessel Head Adaptor Tube Cracking," dated November 19, 1993.

9. Scott, P.M., "An Analysis of Primary Water Stress Corrosion Cracking in PWR Steam Generators," Proceedings of the Specialists Meeting On Operating Experience with Steam Generators, Paper No. 5-6, Brussels, Belgium, September 16-20, 1991.

10. Salin, J., "Overview of CRDM Nozzle Inservice Inspections in France (1991-1994) -- In Plant Evaluation of Crack Propagation Kinetics," Paper E2, Proceedings: 1994 EPRI Workshop on PWSCC of Alloy 600 in PWRs, EPRI Report TR-105406, Tampa, Florida, November 15-17, 1994.

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