



Carolina Power & Light Company

JUL 15 1986

SERIAL: NLS-86-264

Director of Nuclear Reactor Regulation
Attention: Mr. Dan Muller, Director
BWR Project Directorate #2
Division of BWR Licensing
United States Nuclear Regulatory Commission
Washington, DC 20555

BRUNSWICK STEAM ELECTRIC PLANT, UNIT NO. 2
DOCKET NO. 50-324/LICENSE NO. DPR-62
INTERGRANULAR STRESS CORROSION CRACKING
PROGRAM FOR CYCLE 7 OPERATION

Dear Mr. Muller:

SUMMARY

On June 12, 1986, the NRC staff requested Carolina Power & Light Company (CP&L) to provide a commitment and schedule for performance of a mid-cycle inspection, or justification for not performing an inspection, of the two unrepaired nozzle to safe-end welds on Brunswick Unit 2. The Company has reviewed the questions regarding flaw-size determination and evaluation described in Section 3.2 of the June 12, 1986 Safety Evaluation Report and believes that continued operation of Brunswick Unit 2 for a complete 18-month fuel cycle is justified. CP&L's position is based upon the following additional information related to crack sizing, growth rate, and the insignificance of the cracks on Brunswick Unit 2.

Crack Growth Rate

Item 1 of Section 3.2 of the Safety Evaluation Report addresses the crack growth rate used for inconel 182. Attachment 1, "Evaluation of the Brunswick Unit 2 Recirculation Outlet Nozzles A1 and B1 Axial Indications," supplied by General Electric, provides a detailed justification showing that the inconel crack growth rate used in the flawed pipe analysis is conservative. Crack growth data provided by General Electric for inconel 182 demonstrates that the crack growth rate quickly reaches a maximum value of 4.5×10^{-5} in/hr. The extrapolation to a stress intensity factor of 52 ksi in^{1/2} is justified based on the test data trend and the known characteristics of similar materials. The report also reviews crack growth data obtained by other investigators which further demonstrates that the crack growth rate used in the analysis is conservative.

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Crack Sizing

Item 2 of Section 3.2 of the Safety Evaluation Report questions the accuracy and reliability of the crack sizing of the two unrepaired axial cracks based on past experience with UT inspections. There are two reasons why it is inappropriate to use past experience to evaluate the accuracy of the sizing techniques used during the recent inspection.

Typically, axial indications have been difficult to size due to the outside diameter surface conditions associated with the weld crown, which is the point of inspection (e.g., banding effect, fusion line grind-out, or weld crown configuration). These conditions interfere with acoustic coupling and prevent the examiners from obtaining accurate sizing information. These conditions do not exist on the Brunswick Unit 2 NIA and NIB nozzle to safe-end welds. The Brunswick welds were machined flush with a better than 125 rms finish. This allowed full acoustic coupling and acquisition of accurate sizing information.

The inspection techniques used in the nozzle examination during the 1986 Brunswick Unit 2 refueling outage were developed under a General Electric/EPRI contract. The indications were detected by SMART UT using GE Procedure UT-51, Revision 0. The initial detection was accomplished using a 70-degree RL RTD 1 MHz transducer with a 40 mm focal distance. In order to confirm and characterize the indications, manual reevaluation of the indications was performed using the following search units:

Manufacturer	Angle/Mode	Frequency	Focal Distance	Element Size
RTD	45° RL	1 MHz	40 mm	2 (20x34)
RTD	60° RL	1 MHz	45 mm	2 (20x34)
RTD	70° RL	1 MHz	50 mm	2 (20x34)
RTD	31° RL	2 MHz	55 mm	2 (15x25)
RTD	36° RL	2 MHz	60 mm	2 (15x25)
RTD	36° RL	2 MHz	60 mm	2 (15x25)
RTD	45° RL	2 MHz	55 mm	2 (15x25)
RTD	60° RL	2 MHz	30 mm	2 (10x18)
AEROTECH	45° Shear	2.25 MHz	N/A	1/2" Dual
AEROTECH	0° L	4 MHz	N/A	1/2" Dual

These techniques represent the state of the art in examination of inconel butter configurations. The more accurate techniques used larger and more innovative search units which were found to provide much improved penetration capability allowing improved sizing.

The 1 MHz 45-degree, 60-degree, and 70-degree RL transducer confirmed both nozzle butter indications with the 60-degree RL providing superior signal-to-noise ratio and dynamic pattern. The 45-degree RL had a lower signal-to-noise ratio, but was successful in providing the crack base and tip reflectors necessary to determine through-wall depth using the tip diffraction technique. The indications were sized as follows:

<u>Weld Number</u>	<u>Depth</u>	<u>Length</u>
2B32-RECIRC-28"-A-1	.250"	.300"
2B32-RECIRC-28"-B-1	.250"	.250"

The accuracy of the 45-degree RL examination was confirmed by examination of a "mock-up" 10 percent EDM notch inconel butter calibration block. The "mock-up" calibration block was a 2.1-inch thick trimetallic block with an inconel weld. An axial notch with a depth equal to the cladding thickness plus 10 percent of the base metal thickness was placed in the weld. An additional axial notch with a depth of 10 percent was placed in the cladding adjacent to the weld. Both notches were sized accurately with a 1 MHz 45-degree RL search unit. The depths of the indications are within the envelop covered by the calibration block, which gives further assurance that the depth sizing is accurate. The sizing technique was also successful in sizing cracks in EPRI samples with known lengths.

Radiographs and weld documentation from construction were reviewed for geometry effects. They did not indicate geometry or repair areas that would create ultrasonic reflectors which could affect the accuracy of the sizing.

A 45-degree shear wave examination was conducted to scan the nozzle forging looking for possible indication extension into the nozzle forging. No reflectors were found, confirming the indications are contained within the inconel butter. Confirmation, characterization, and sizing activities utilized a Panametrics 2002 Epoch instrument with video printer for obtaining CRT printouts.

The accuracy and reliability of the crack sizing is assured by the variety of examinations performed using the latest techniques developed by GE and EPRI, the involvement of three Level III personnel and a metallurgist, and by the verification of the calibration and sizing techniques on an actual weld mock-up.

Crack Extension Into Nozzle

Item 3 of Section 3.2 of the Safety Evaluation Report questions whether cracks in the inconel 182 butter may extend into the reactor vessel nozzle during continued plant operation. The reactor vessel nozzle is made of low alloy steel which is not susceptible to IGSCC. Therefore, any crack propagation into the nozzle would be predominately due

to fatigue cycling. Cyclic stresses are very small for the recirculation outlet nozzles and, therefore, crack growth into the nozzle would be insignificant. The other side of the weld is the low carbon stainless steel safe-end which is also not susceptible to IGSCC. As a result, the indication in the inconel butter is bounded by the low alloy nozzle and the low carbon stainless steel safe-end.

As an additional precaution, an analysis was performed assuming crack extension into the low alloy material to determine the limiting crack length. It was determined that a through-wall axial crack with a length of 30 inches is needed to exceed the arrest fracture toughness. This evaluation demonstrates a large leak-before-break margin against unstable crack propagation. This subject is discussed in detail in Attachment I to this letter.

Surveillance Measures

The following special surveillance measures, coupled with the large leak-before-break margin, provide additional assurance that the health and safety of the public is not compromised:

1. As required by the Technical Specifications, plant shutdown will be initiated for inspection and corrective action taken when any leakage detection system indicates, within any 24-hour period, an increase in the rate of unidentified leakage in excess of 2 gpm. The leakage rate is determined every four hours.
2. At least one of the leakage measurement instruments associated with each sump is required to be operable with the outage time limited to 24 hours. Otherwise, an orderly shutdown is required to be immediately initiated.
3. A visual inspection for leakage of the reactor coolant piping is required to be performed during each plant outage in which the containment is deinerted when such an inspection has not been made in the previous 92 days. The examination is performed in accordance with the requirements of IWA5241 and IWA5245 of the 1980 Edition of Section XI of the ASME Boiler and Pressure Vessel Code. The system boundary for this examination contains susceptible welds inside the primary containment.

Safety Significance

From a practical viewpoint, it is important to recognize that the observed indications are relatively benign since they are short, shallow, uncreviced, and axially oriented. Unlike circumferential indications which could propagate around the entire circumference, the axial flaw is expected to arrest once it extends beyond the weld metal. Furthermore, even if the observed cracks were assumed to be through-wall cracks, substantial structural margins are still maintained since there is negligible reduction in the section

modulus of the pipe with an axial crack. Thus, operation with the observed indications is fully justified.

CONCLUSION

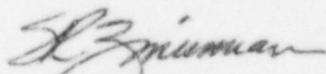
CP&L has evaluated the NRC's questions described in Section 3.2 of the June 12, 1986 Safety Evaluation Report and has provided responses which justify safe operation of Brunswick Unit 2 for a full 18-month cycle without performing a mid-cycle inspection. The accuracy and reliability of the crack sizing is assured by the variety of examinations performed using the latest techniques developed by GE and EPRI, the involvement of three Level III NDE personnel and a metallurgist, and by the verification of the calibration and sizing techniques on an actual weld mock-up. General Electric has provided a detailed justification for the inconel 182 crack growth rate used and has also provided a detailed discussion as to why crack extension into the reactor vessel nozzle is highly unlikely. Crack propagation into the safe-end is also unlikely. A substantial leak-before-break margin has been demonstrated should crack propagation into the reactor vessel nozzle occur. Leak-before-break coupled with CP&L's stringent drywell leakage surveillance requirements provide in-depth assurance that the health and safety of the public is not compromised.

As stated above, the observed indications are oriented axially and are very short and shallow. Axial indications pose no threat of catastrophic failure since they arrest once they extend past the weld metal and present negligible reduction in the section modulus of the pipe.

Based on the information provided in this letter and the attached report, the Company has determined that operation of Brunswick Unit 2 for a full 18-month cycle without performing a mid-cycle inspection is justified and does not compromise the public's health and safety.

Please refer any questions regarding this matter to Mr. Stephen D. Floyd at (919) 836-6901.

Yours very truly,



S. R. Zimmerman
Manager

Nuclear Licensing Section

SRZ/MAT/pgp (4013MAT)

Attachment

cc: Mr. W. H. Ruland (NRC-BNP)
Dr. J. Nelson Grace (NRC-R11)
Mr. E. Sylvester (NRC)

ATTACHMENT 1
TO SERIAL: NLS-86-264

Attachment 1 consists of an evaluation of the Brunswick 2 recirculation outlet nozzles A1 and B1 axial indications (dated June 19, 1986). General Electric considers portions of this report to contain proprietary information and, therefore, not for public disclosure. An affidavit to this effect is also included.

GENERAL ELECTRIC COMPANY

AFFIDAVIT

I, Rudolph Villa, being duly sworn, depose and state as follows:

1. I am Manager, Safety & Licensing, General Electric Company, and have been delegated the function of reviewing the information described in paragraph 2 which is sought to be withheld and have been authorized to apply for its withholding.
2. The information sought to be withheld pertains to the proprietary information submitted in "Evaluation of the Brunswick 2 Recirculation Outlet Nozzles A1 and B1 Axial Indications", June 1986 (DRF 137-C010, SASR#86-39 Rev 1).
3. In designating material as proprietary, General Electric utilizes the definition of proprietary information and trade secrets set forth in the American Law Institute's Restatement of Torts, Section 757. This definition provides:

"A trade secret may consist of any formula, pattern, device or compilation of information which is used in one's business and which gives him an opportunity to obtain an advantage over competitors who do not know or use it.... A substantial element of secrecy must exist, so that, except by the use of improper means, there would be difficulty in acquiring information.... Some factors to be considered in determining whether given information is one's trade secret are: (1) the extent to which the information is known outside of his business; (2) the extent to which it is known by employees and others involved in his business; (3) the extent of measures taken by him to guard the secrecy of the information; (4) the value of the information to him and to his competitors; (5) the amount of effort or money expended by him in developing the information; (6) the ease or difficulty with which the information could be properly acquired or duplicated by others."

4. Some examples of categories of information which fit into the definition of proprietary information are:
 - a. Information that disclosed a process, method or apparatus where prevention of its use by General Electric's competitors without license from General Electric constitutes a competitive economic advantage over other companies;

- b. Information consisting of supporting data and analyses, including test data, relative to a process, method or apparatus, the application of which provide a competitive economic advantage, e.g., by optimization or improved marketability;
 - c. Information which if used by a competitor, would reduce his expenditure of resources or improve his competitive position in the design, manufacture, shipment, installation, assurance of quality or licensing of a similar product;
 - d. Information which reveals cost or price information, production capacities, budget levels or commercial strategies of General Electric, its customers or suppliers;
 - e. Information which reveals aspects of past, present or future General Electric customer-funded development plans and programs of potential commercial value to General Electric;
 - f. Information which discloses patentable subject matter for which it may be desirable to obtain patent protection;
 - g. Information which General Electric must treat as proprietary according to agreements with other parties.
5. In addition to proprietary treatment given to material meeting the standards enumerated above, General Electric customarily maintains in confidence preliminary and draft material which has not been subject to complete proprietary, technical and editorial review. This practice is based on the fact that draft documents often do not appropriately reflect all aspects of a problem, may contain tentative conclusions and may contain errors that can be corrected during normal review and approval procedures. Also, until the final document is complete it may not be possible to make any definitive determination as to its proprietary nature. General Electric is not generally willing to release such a document in such a preliminary form. Such documents are, however, on occasion furnished to the NRC staff on a confidential basis because it is General Electric's belief that it is in the public interest for the staff to be promptly furnished with significant or potentially significant information. Furnishing the document on a confidential basis pending completion of General Electric's internal review permits early acquaintance of the staff with the information while protecting General Electric's potential proprietary position and permitting General Electric to insure the public documents are technically accurate and correct.
6. Initial approval of proprietary treatment of a document is typically made by the Subsection Manager of the originating component, who is most likely to be acquainted with the value and sensitivity of the information in relation to industry knowledge. Access to such documents within the Company is limited on a "need to know" basis and such documents are clearly identified as proprietary.

7. The procedure for approval of external release of such a document typically requires review by the Subsection Manager, Project Manager, Principal Scientist or other equivalent authority, by the Subsection Manager of the cognizant Marketing function (or delegate) and by the Legal Operation for technical content, competitive effect and determination of the accuracy of the proprietary designation in accordance with the standards enumerated above. Disclosures outside General Electric are generally limited to regulatory bodies, customers and potential customers and their agents, suppliers and licensees and then only with appropriate protection by applicable regulatory provisions or proprietary agreements.
8. The document mentioned in paragraph 2 above have been evaluated in accordance with the above criteria and procedures and have been found to contain information which is proprietary and which is customarily held in confidence by General Electric.
9. The information mentioned in paragraph 2 includes significant proprietary test data and crack growth rate information and excerpts from GE proprietary documents.
10. The information to the best of my knowledge and belief has consistently been held in confidence by the General Electric Company, no public disclosure has been made, and it is not available in public sources. All disclosures to third parties have been made pursuant to regulatory provisions of proprietary agreements which provide for maintenance of the information in confidence.
11. Public disclosure of the information sought to be withheld is likely to cause substantial harm to the competitive position of the General Electric Company and deprive or reduce the availability of profit making opportunities because over 200 manhours in document research and \$1 million in test facilities were required to obtain the information:
 - a. Public availability of this information would deprive General Electric of the ability to seek reimbursement and would permit competitors to utilize this information to General Electric's detriment, to the substantial financial and competitive disadvantage of General Electric.

STATE OF CALIFORNIA)
COUNTY OF SANTA CLARA) ss:

Rudolph Villa, being duly sworn, deposes and says:

That he has read the foregoing affidavit and the matters stated therein are true and correct to the best of his knowledge, information, and belief.

Executed at San Jose, California, this 25th day of July 1986.

Rudolph Villa.
Rudolph Villa, Manager
General Electric Company

Subscribed and sworn before me this 25th day of July 1986.



Paula F. Hussey
NOTARY PUBLIC, STATE OF CALIFORNIA