

Commonwealth Edison Company
Byron Generating Station
4450 North German Church Road
Byron, IL 61010-9794
Tel 815-234-5441



DATE: May 24, 1996

LTR: BYRON 96-0157
FILE: 3.03.0800 (1.10.0101)

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

Dear Sir:

The Enclosed Licensee Event Report from Byron Generating Station is being transmitted to you in accordance with the requirements of 10CFR50.73(a)(2)(ii).

This report is number 95-011 Supplement 1; Docket No. 50-454.

Sincerely,

A handwritten signature in dark ink, appearing to read "K. L. Kofron", is written over the printed name.

K. L. Kofron
Station Manager
Byron Nuclear Power Station

KLK/PW/js

Enclosure: Licensee Event Report No. 95-011 Supplement 1

cc: H. J. Miller, Regional Administrator-RIII
H. Peterson, Senior Resident Inspector-Byron
Office of Nuclear Safety-IDNS

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| NRC FORM 366 (4-95) | | U.S. NUCLEAR REGULATORY COMMISSION | | | APPROVED BY OMB NO. 3150-0104 EXPIRES 04/30/98 | | | | | |
| LICENSEE EVENT REPORT (LER) (See reverse for required number of digits/characters for each block) | | | | | ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS MANDATORY INFORMATION COLLECTION REQUEST: 50.0 HRS. REPORTED LESSONS LEARNED ARE INCORPORATED INTO THE LICENSING PROCESS AND FED BACK TO INDUSTRY. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE INFORMATION AND RECORDS MANAGEMENT BRANCH (T-6 F33), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555-0001, AND TO THE PAPERWORK REDUCTION PROJECT (3150-0104), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503. | | | | | |
| FACILITY NAME (1) BYRON NUCLEAR POWER STATION | | | | | DOCKET NUMBER (2) 05000454 | | PAGE (3) 1 OF 5 | | | |
| TITLE (4) INCREASED TUBE DEGRADATION IN THE BYRON UNIT 1 STEAM GENERATORS | | | | | | | | | | |
| EVENT DATE (5) | | | LER NUMBER (6) | | REPORT DATE (7) | | OTHER FACILITIES INVOLVED (8) | | | |
| MONTH | DAY | YEAR | YEAR | SEQUENTIAL NUMBER | REVISION NUMBER | MONTH | DAY | YEAR | FACILITY NAME | DOCKET NUMBER |
| 11 | 07 | 95 | 95 | -- 011 | -- 01 | 05 | 24 | 96 | Braidwood | 05000456 |
| OPERATING MODE (9) 5 | | | THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more) (11) | | | | | | | |
| POWER LEVEL (10) 0 | | | 20.2201(b) | | 20.2203(a)(2)(v) | | 50.73(a)(2)(i) | | 50.73(a)(2)(viii) | |
| | | | 20.2203(a)(1) | | 20.2203(a)(3)(i) | | X 50.73(a)(2)(ii) | | 50.73(a)(2)(x) | |
| | | | 20.2203(a)(2)(i) | | 20.2203(a)(3)(ii) | | 50.73(a)(2)(iii) | | 73.71 | |
| | | | 20.2203(a)(2)(ii) | | 20.2203(a)(4) | | 50.73(a)(2)(iv) | | OTHER | |
| | | | 20.2203(a)(2)(iii) | | 50.36(c)(1) | | 50.73(a)(2)(v) | | Specify in Abstract below or in NRC Form 366A | |
| | | | 20.2203(a)(2)(iv) | | 50.36(c)(2) | | 50.73(a)(2)(vii) | | | |
| LICENSEE CONTACT FOR THIS LER (12) | | | | | | | | | | |
| NAME JOSEPH K. LONIGRO, SITE ENGINEERING, EXT. 2166 | | | | | | | | TELEPHONE NUMBER (include Area Code) 815-234-5441 | | |
| COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13) | | | | | | | | | | |
| CAUSE | SYSTEM | COMPONENT | MANUFACTURER | REPORTABLE TO NPRDS | | CAUSE | SYSTEM | COMPONENT | MANUFACTURER | REPORTABLE TO NPRDS |
| X | AB | | W120 | N | | | | | | |
| | | | | | | | | | | |
| SUPPLEMENTAL REPORT EXPECTED (14) | | | | | | | | | | |
| YES (If yes, complete EXPECTED SUBMISSION DATE). | | | | | X | NO | | EXPECTED SUBMISSION DATE (15) | | |
| | | | | | | | | MONTH | DAY | YEAR |
| | | | | | | | | | | |

ABSTRACT (Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines) (16)

A steam generator (SG) eddy current inspection was performed in accordance with Technical Specification Surveillance Requirement (TSSR) 4.4.5.0 during the Byron Unit 1 Cycle 7 planned steam generator inspection outage (S1P02). The results of this inspection classified each of the four SGs as category C-3, as defined in TSSR 4.4.5.2. Category C-3 was declared due to more than 1% of the tubes inspected being defective. A total of two thousand seven hundred twenty-one (2721) indications were found to contain defective conditions during this inspection. All defective tubes were removed from service by plugging or sleeving. The primary mode of the tube degradation was circumferentially oriented Outer Diameter Stress Corrosion Cracking (ODSCC) at the hot leg top of tubesheet roll transition region.

The occurrence of ODSCC at the hot leg tubesheet roll transition region was first experienced during the last refueling outage (B1R06). At that time, a total of one-hundred and thirty-two (132) tubes were found to contain circumferential cracking at the top of the tubesheet. This mode of degradation has been experienced at a number of other plants in the industry. Industry efforts are on-going to determine corrective actions to mitigate ODSCC at the top of the tubesheet.

This event is reportable per 10CFR50.73(a)(2)(ii) due to the serious degradation of a principal safety barrier.

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TEXT (If more space is required, use additional copies of NRC Form 366A) (17)

A. PLANT CONDITIONS PRIOR TO EVENT:Event Date/Time 11/7/95 / 1545Unit 1 MODE 5 - Rx Power 0% RCS [AB] Temperature/Pressure 71°F/0 psigUnit 2 MODE 1 - Power Op Rx Power 99% RCS [AB] Temperature/Pressure NOT/NOPB. DESCRIPTION OF EVENT:

During the previous Unit 1 refuel outage (B1R06), Byron identified circumferential cracking for the first time. At that time a total of one-hundred and thirty-two (132) tubes were found to contain circumferential cracking utilizing the Motorized Rotating Pancake Coil (MRPC) eddy current probe and were subsequently stabilized and plugged. During the recent planned outage (B1P02), a total of two-thousand seven hundred and twenty-one (2721) indications were found to contain defective conditions, of which a total of two-thousand six hundred and ninety-five (2695) indications were found to contain repairable degradation at the top of the tubesheet (TTS). Byron Station's definition of a defective condition is an indication that is greater than or equal to 40% through wall (TW), indications that exceed the Byron Station Interim Plugging Criteria (IPC) for Outer Diameter Stress Corrosion Cracking (ODSCC) at the tube support plates (TSP), indications that do not meet the acceptance criteria in the wedge regions of support plates, and any indication found at the top of tubesheet utilizing three coil technology (i.e., MRPC or Plus Point probes). During B1P02, the Plus Point probe was utilized for the first time to enable better characterization of degradation at the top of the tubesheet.

Prior to B1P02, a Technical Specification revision was requested to address the ODSCC concern in the tube support regions. A higher voltage repair limit of 3.0 volts was requested by Byron Station. This Technical Specification revision was approved by NRC on November 9, 1995. As a result, only one tube in all four steam generators exceeded the 3.0 volt repair limit. This tube was repaired utilizing a plug. Had 1.0 volt IPC been applied, a total of six hundred and ninety-nine (699) tubes would have been repaired due to TSP cracking.

On October 29, 1995, steam generator bobbin coil eddy current inspections began pursuant to TSSR 4.4.5.0, including the revision for the 3.0 volt IPC implementation. The initial sample consisted of 100% of the inservice hot leg and cold leg tubes in each of the four steam generators. Also, a 100% sample of the top of tubesheet hot leg commenced utilizing the Plus Point probe (a combination probe with two pancake coils and the Plus Point coil). The primary purpose of the TTS inspection was to detect and repair all top of tubesheet cracking.

At 1545, on November 7, 1995, the determination that Byron should be classified as C-3 was made based on the results of the current inspection plan. A C-3 classification is defined as more than 10% of the tubes inspected are degraded (imperfections greater than or equal to 20% TW or more than 1% of the tubes are defective (an imperfection that exceeds the repair limit, 40% TW or 3.0 volt for IPC). Byron determined that the C-3 category requirements were exceeded due to more than 1% of the tubes inspected being defective. The appropriate NRC notification via the ENS phone system was made at 1647 on November 7, 1995, pursuant to 10CFR50.72(b)(2)(i). At that time, the phone call was made based on a 1.0 volt IPC and the top of tubesheet results. On November 9, 1995, 3.0 volt IPC was approved for use at Byron Station. Byron Station completed the inspections and on November 17, at approximately 1600, a follow up red phone call was made to provide the staff with complete data on total tubes considered defective per category C-3, as specified in TS 4.4.5.2.

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B. DESCRIPTION OF EVENT: (cont.)

The table below identifies the inspection results and classification of each steam generator:

| | SG A | SG B | SG C | SG D | TOTAL |
|---|---------------|-----------------|----------------|----------------|-----------------|
| # Inspected (100%) | 4120 | 4064 | 4016 | 4360 | 16560 |
| # Defective Indications (Circumferential and mixed mode @ TTS) | 208 | 980 | 709 | 681 | 2578 |
| # Defective Indications (Axial @ TTS only) | 70 | 15 | 25 | 7 | 117 |
| # Defective Indications (Exceeds IPC for ODSCC A TSP's) | 1 | 0 | 0 | 0 | 1 |
| # Defective Indications (> / = 40% TW) | 1 | 2 | 2 | 0 | 5 |
| # Defective Indications (Located in Wedge Regions (LOCA & SSE)) | 1 | 5 | 9 | 5 | 20 |
| Total Indications Defective | 281 | 1002 | 745 | 693 | 2721 |
| Total # / (%) Tubes Defective (*) | 280 (6.8%) | 1002 (24.7%) | 742 (18.5%) | 693 (15.9%) | 2717 (16.4%) |
| Inspection Category | C-3 | C-3 | C-3 | C-3 | C-3 |

* Tube may contain more than one defective condition.

C. CAUSE OF EVENT:

Due to the complex environment at the top of the tubesheet of the Model D-4 SG, the exact cause cannot be determined. Many factors may have contributed to the TTS degradation, however, no specific root cause can be determined at this time.

As previously stated, circumferential cracking at the top of the tubesheet was first found during the Unit 1 refueling outage (B1R06). As a result, Byron Station elected to perform a 100% top of tubesheet Plus Point inspection on the hot leg side during the recent B1P02 outage. This was the first time that the Plus Point probe was utilized as an inspection technique at Byron Station. The Plus Point probe has been found to be more sensitive to circumferential cracking than the standard RPC probe.

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C. CAUSE OF EVENT: (cont.)

The primary mode of the degradation found is circumferentially and axially oriented ODSCC located at the top of the tubesheet region. The occurrence of ODSCC can be affected by tube material properties, manufacturing induced stresses, temperature, crevice conditions, operational environment, and chemical environments.

The Byron Unit 1 steam generators are Westinghouse Model D-4s that contain Inconel 600 tubing with carbon steel tube support plates and a carbon steel tubesheet. Mill-annealed Inconel-600 SG tubing has been found to be subject to axial and circumferential cracking at the top of the tubesheet at many PWRs. The cause of this cracking is not clearly known at this time.

D. SAFETY ANALYSIS

All defective tubes were repaired by tube plugging or sleeving. Tubes with circumferential indications that were not sleeved were stabilized and plugged. Stabilization prevents a postulated tube sever from damaging adjacent tubes. The acceptance criteria of Technical Specification 3/4.4.5 has been satisfied and steam generator operability has been demonstrated.

Eleven tubes with circumferential indications at the top of the tubesheet have been removed and tested from a combination B1R06 and B1P02 inspections. All tubes were found to meet structural integrity requirements. The circumferential indications found in the planned inspection (B1P02) are believed to meet structural integrity requirements because they are considered to be smaller in amplitude than those found during B1R06 which have shown to meet the structural requirements as a result of the tube pull during B1R06. During the subsequent refueling outage in Spring of 1996 (B1R07), insitu pressure testing was performed on eight tubes with circumferential and axial indications located at the top of the tubesheet. The purpose of the testing verifies the tubes met structural requirements specified by Regulatory Guide (RG) 1.121. The tubes selected for insitu testing were considered to be the most limiting of the indications found based on size, growth rate, and age. Each tube was pressurized in sequence to differential pressures associated with normal operation, main steam line break and 5000 psi, which is in excess of the RG 1.121 requirement of 3 times the normal operating differential pressure. All tubes tested were determined to be leak tight to pressures of 5000 psi. Tube integrity was demonstrated for the most limiting circumferential indications and sufficiently bounds all other indications found. Therefore, no safety concern existed for the presence of the circumferential indications at the top of the tubesheet.

Pursuant to Technical Specification 4.4.5.5.d and Generic Letter 95-05 regarding the implementation of a voltage based plugging criteria for ODSCC at tube support plates, leakage and structural assessments are required to be performed. Leakage and tube burst probability assessments were reported to the Staff in accordance with Technical Specification 4.4.5.5.d and Generic Letter 95-05. All indications found were within structural integrity voltage limits.

The primary-to-secondary leak rate is limited to 150 gpd per steam generator by the Technical Specification (TS 3.4.6.2.c). If leakage exceeds this limit, the unit will be shut down for inspection and repair of defective tubes. With the request for 3.0 volt IPC, ComEd reduced the Unit 1 RCS iodine limit from 1.0 microCurie/gm to 0.35 microCurie/gm (TS 3.4.8.a). This provides an added margin of safety to ensure that offsite doses remain a small fraction of the 10CFR100 limits.

There is no impact on the health and safety of the public. All tubes with these types of indications have been identified and dispositioned either by stabilizing and plugging or sleeving the tubes.

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| NRC FORM 366A (4-95) | | U.S. NUCLEAR REGULATORY COMMISSION | |
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E. CORRECTIVE ACTIONS

Immediate corrective actions include the removal of defective tubes from service either by plugging or sleeving the defective tubes.

Longer term corrective actions include the following:

1. Replacement of the Steam Generators

The Unit 1 steam generators are scheduled for replacement during the Spring of 1999.

2. Eddy Current Inspections

ComEd will continue to evaluate and use the appropriate eddy current technique for the SG inspections.

3. No Specific root cause has been determined for the degradation at the top of the tubesheet, however, industry efforts are on-going to understand and correct this mode of degradation. ComEd is actively involved in these efforts.

F. RECURRING EVENTS SEARCH AND ANALYSIS

This is the second occurrence of a Byron Unit 1 or Unit 2 steam generator being classified as inspection category C-3. The first time a C-3 classification for steam generator tubes was made was on October 6, 1994, during the B1R06 refueling outage. At that time the classification of C-3 was based on tubes that were greater than the IPC requirements of 1.0 volt at the tube support plates (LER #454-94-012).

Braidwood Unit 1 experienced a similar event during their Cycle 4 (Spring 1994) inspection when three of the four steam generators identified with a C-3 classification due to an increase of repairs from ODSCC at tube support plates. (LER #456-94-007) In addition to LER #456-94-007, Braidwood has categorized their steam generators as C-3 on two other occasions for an increase of repairs from ODSCC at tube support plates (LER #456-95-003 and LER #456-95-015).

ODSCC at the top of the tubesheet has been experienced at a number plants throughout the industry. Industry efforts are on-going to understand and correct this mode of degradation. ComEd is actively involved in these efforts.

G. COMPONENT FAILURE DATA

| | | |
|------------------------------|--------------|-----------------|
| Manufacturer Nomenclature | Model Number | MFG Part Number |
| Westinghouse Steam Generator | D-4 | n/a |