U.S. NUCLEAR REGULATORY COMMISSION

REGION III

Docket No:	50-456
License No.:	NPF-72
Report No:	50-456/98016(DRS)
Licensee:	Commonwealth Edison Company
Facility:	Braidwood Generating Station, Unit 1
Location:	RR #1, Box 84 Braceville, IL 60407
Dates:	September 16-18, 23-24, 30, 1998 October 5-9, 20-23, 1998 January 20-21, 1999
Inspector:	J. Schapker, Reactor Engineer
Approved by:	J. Gavula, Chief, Engineering Specialists Branch 1 Division of Reactor Safety

EXECUTIVE SUMMARY

Braidwood Generating Station, Unit 1
NRC Inspection Report 50-456/98016 (DRS)

This inspection included an announced review of the steam generator (SG) replacement program. Specifically, the inspection focused on the containment access opening and replacement activities, removal and replacement of the SGs, welding of steam generator piping, and review of Quality Control activities to assure the replacement steam generators met applicable American Society of Mechanical Engineers (ASME) Code and regulatory requirements.

SG Replacement

- The containment access opening was accomplished with minimal damage to the containment liner in accordance with applicable procedures, construction codes, and standards. Containment restoration was accomplished efficiently and effectively. Changes to procedures and equipment based on lessons learned from the Byron steam generator replacement were evident and successful in resolving previously experienced difficulties. This was particularly evident in the tendon removal and replacement work. (Section M1.1)

- Welding performance for the steam generator piping surpassed the applicable procedures and ASME Code requirements. Welding quality demonstrated good workmanship with minimal repair required. (Section M1.2)

- The pre-service inspection program, procedures and documentation complied with the ASME Code and Technical Specification requirements. Nondestructive examination personnel professionally performed assigned examinations in accordance with nondestructive examination procedure requirements. Procedures reviewed were conservative and provided the necessary assurance of material quality. (Section M1.2)

- The welder qualification program was well planned and implemented. More rigorous standards for welder qualification were apparent and contributed to the successful weld process in the field. Management and Quality Assurance oversight of the welder qualification process demonstrated a good safety perspective. (Section M5.1)

Report Details

II. Maintenance

M1 Conduct of Maintenance

M1.1 Containment Access Work Activities

a. Inspection Scope (50001, 37753)

This inspection included review of design documents, work packages, drawings, procedures, and inspection records. The inspector observed the removal of concrete for containment access, cutting of rebar, tendon sheathing, containment liner removal, and the restoration of containment after SG replacement including tendon installation.

b. Observations and Findings

A temporary access opening, 22x20 feet, was made through the containment wall to accommodate replacement of the steam generators. The inspector observed the following processes for the removal and restoration of the containment access.

1. The inspector reviewed the Design Input and Analysis Document (DIAD) 9600025 including drawings, engineering change notices (ECN) and non-conformance reports (NCR). Review of work packages, procedures, inspection reports were made throughout the work process. Work packages were maintained to the current work process, inspection reports were completed as required by applicable procedures. NCRs were reviewed for content, corrective action, review and disposition by engineering or certified personnel. NCRs reviewed were found to be dispositioned in accordance with procedural and Code requirements.

2. Concrete was removed with remotely controlled chipping equipment. The operators of the chipping machines performed the concrete removal with minimal damage to the rebar and containment liner plate. Final concrete removal at the periphery of the opening was performed using hand held chippers to prevent damage to the rebar and tendon sheathing. Foreign material exclusion (FME) practices were maintained by capping the ends of the cuts to the tendon sheathing to assure chipped concrete or other foreign material did not enter.

3. Cutting of the rebar, and tendon sheathing was performed with sufficient material left to perform cad welding/lapping of rebar and reinstallation of tendon sheathing. Special processes procedure requirements for the preparation of the joints were observed. A special designed enclosure of the containment opening was installed to control the environment, and access into the containment.

4. Cutting of the metal containment liner plate was performed per procedure GWS-Structural, Revision 2, Amendment 1. The containment liner plate had

some damage from the concrete chipping and required some minor repairs. The inspector observed repairs in process and confirmed welding performed by welders BM-04 and 05 were properly certified and utilized qualified weld procedures and materials. Nondestructive examinations were performed per procedures MT-ASME III/XI, Revision 2, RT-ASME III/XI, Revision 0, and 96-VB-001, Revision 4, by certified inspectors in accordance with ASME Code requirements.

5. The inspector observed restoration of the rebar and tendon sheathing prior to placement of concrete. Cadwelding and testing of sister splices were observed for cadwelders tensile test for #11 and #10 rebar splices. Placement of rebar met the applicable engineering drawing requirements. The inspector performed a preplacement inspection to verify that all foreign objects such as ladders and tools were removed and bonding agent was properly applied.

6. Placement of concrete, concrete slump test, air entrainment test, and compression testing were observed. The initial concrete load was not placed due to failing the initial slump test off the truck. Adjustments were made to the mix and subsequent testing prior to placing the concrete confirmed the required concrete slump was attained. The concrete was pumped to the placement forms where the tests were performed prior to placement of the concrete. Placement of the concrete into the forms was performed by pumping through to short "elephant trunks" placed in access areas in the forms which were sealed as the lifts advanced up the forms. Vibrators were used to consolidate the concrete. Vibration procedures were controlled to assure segregation of the aggregate did not occur. The completed containment placement was protected by an enclosure and portable heaters maintained the temperature for proper curing of the concrete. Concrete test cylinders were collected and tested in accordance with the American Concrete Institute recommended practices. Initial break testing of cylinders had low values due to improper storage of test cylinders on the steel floor in an outdoor trailer with no heating. The night time temperature dropped near freezing and therefore the curing did not occur as would be representative of the placed concrete. The cylinders were subsequently stored properly and the subsequent cylinder breaks were within the expected tolerance for the time of curing. The inspector observed the compression testing and verified the test results. Final testing of the test cylinders were performed at the concrete suppliers facility. Test results verified the concrete strength met design requirements.

7. The inspector observed removal of tendons and reviewed visual inspection tapes of the tendon sheathing numbers 36CB and 39BA to verify that the sheathing was not damaged during previous installation or current removal of the tendons. Obstructions were observed at the 157 foot mark (a ding in the sheathing) and at the 161 foot mark (a protrusion into the sheathing) in horizontal tendon 39BA. The licensee's inspection of the remainder of the horizontal sheathing did not find any other areas of obstruction. The obstructions observed did not appear large enough to prevent installation of the new tendons. After restoration of the

containment concrete, the inspector observed the installation of the first horizontal tendons 33BA, 33CB, 32CB, 40CB and 39BA. The installation of the new tendons was accomplished with relative ease. The inspector also observed the installation of vertical tendons which were also performed with minor difficulty. The tendons were all successfully pulled through the sheathing without having to remove any concrete. The licensee modified the tendon installation hardware as part of the lessons learned from the Byron tendon problems. The corrective measures along with additional training of the craft made the removal and replacement of the tendons much more efficient and effective. In addition, new tendons were installed in the horizontal tendons to assure ease of installation and prevent any additional damage to the tendon sheathing.

c. Conclusion

The containment access opening was accomplished with minimal damage to the containment liner in accordance with applicable procedures, construction codes, and standards. Containment restoration was accomplished efficiently and effectively. Changes to procedures and equipment based on lessons learned from the Byron SG replacement were evident and successful in resolving previously experienced difficulties. This was particularly evident in the tendon removal and replacement work.

M1.2 Steam Generator Removal and Installation

a. Inspection Scope (50001, 37755)

The inspector observed the preparation activities and the removal of the degraded steam generators and the movement and installation of the replacement SGs. The inspector also observed fit up and welding of the reactor coolant loop piping to the SG inlet and outlet nozzles, fit-up and welding of the feedwater, main steam, and SG blowdown piping and hangers. Other inspection activities included the observation of weld preparation machining, verification and maintenance of weld consumables, and nondestructive examinations (NDE) of completed welds.

b. Observations and Findings

The inspector observed the cutting of SG piping in preparation for removal of the SGs. The cutting was performed in accordance with the Bechtel Special Processes procedure GWS-1, Revision 4. Appropriate fire watch and access controls were enforced. Application of a special coating to mitigate the spread of contamination was applied to the SGs prior to removal. Rigging and lifting of the SGs for removal and installation was performed in accordance with applicable procedures. Movement of the SGs was performed without damage to any components. During the lifting of a replacement SG with the Outside Lift System (OLS), a chain link was observed by a contractor employee to have a crack. Nonconformance Report (NCR) BD-98-076 was issued and all SG lifting was suspended to investigate the flawed chain link and to perform nondestructive examination to the chain links to assure no other links had flaws. Destructive examination of the cracked link concluded the flaw had partially existed prior to the crack

progressing through the apex of the link, as evidenced by the presence of corrosion on part of the crack face. There were two links adjacent, with each link designed to carry the load with a safety margin. However, the safety margin was reduced by the presence of a flaw/crack as evidenced by the crack progression on the one link. Liquid magnetic particle examination was performed on all of the chain links prior to reassembly and resumption of SG movement with the OLS. The inspector observed the damaged chain link and reviewed the contractors' procedure "Nondestructive Examination Standard Magnetic Particle Examination MT-Chain Links," Revision 0, and NCR 98-076. Appropriate preventive measures to assure the OLS was safe to make the SG lifts were taken once the chain link crack was identified.

Welding activities were observed for SG reactor coolant hot leg and cold leg loop piping, SG feed water, main steam, SG blow down piping and piping hangers during the reassembly of the replacement SGs. The inspector observed the fit-up and welding in progress, and verified that welding consumables were as required by applicable weld procedure specification (WPS), that weld rod control was maintained, including proper storage and segregation of weld materials, that weld essential variables complied with WPS requirements, and that welders were qualified to perform the applicable welds per the qualified welders list. Welders' performance appeared to demonstrate good craftsmanship. The inspector performed visual examination of root pass welds, from the inside (when accessible) and outside of the piping, which confirmed good workmanship. Subsequent NDE verified that the quality of the welds met the applicable Code requirements with few anomalies.

The inspector observed the ultrasonic examination (UT) of main steam piping weld numbers and FW-3, of SG-C and FW-2 of SG-B and verified that the examination conformed to procedure UT NDT C-2, Revision 24. Weld surface preparation for these UTs was very good. Radiographs of the following listed welds were reviewed by the inspector and found to be acceptable. Welding quality and workmanship was considered good based on minimal weld inclusions and porosity. The welds which required repair were made to the same requirements and reexamined. Radiography and UT performance surpassed the applicable procedures and ASME Code requirements. The NDE data evaluation was considered timely and accurate.

Radiographs Reviewed

RT NO.	WELD NO.	PIPE DIAMETER	SYSTEM
RT-98-083	FW-2	6-inch	Recirculation
RT-98-084	FW-2	6-inch	"
RT-98-085	FW-2R1	6-inch	"
RT-98-214	FW-3	36-inch	Main Steam
RT-98-220	FW-3 R1	36-inch	"
RT-98-191	FW-2	31-inch	Reactor Coolant
RT-98-203	FW-2 R1	31-inch	"
RT-98-187	FW-1	34-inch	"
RT-98-206	FW-1	34-inch	"

No shipping damage to the SGs was identified during the visual examination of exposed surfaces. However, on SG-C, the NRC inspector noted a cavity in the weld surface on the water level nozzle No. 6. The licensee informed the inspector that this cavity was caused by the removal of a liquid penetrant indication, performed by the fabrication contractor, Babcock & Wilcox International (BWI), and accepted per BWI nonconformance report (NCR) 16910, prior to shipment. The inspector requested a copy of the referenced NCR, to verify the method of disposition, and compliance to the ASME Code requirements. Review of the NCR disclosed the disposition to be "accept as is" based on structural analysis performed by BWI. The calculation performed and documented in NCR 16910 referenced two additional BWI calculations which were necessary to complete the review. These calculations were requested, and acquired by the licensee for NRC review. The calculations were reviewed by an NRC specialist who determined that the analysis was in compliance with Code and regulatory requirements.

c. Conclusion

Welding and NDE performance surpassed the applicable procedures and ASME Code requirements. Welding quality demonstrated good workmanship. Process control of movement of the SG's was deliberate and conservative.

M3 Maintenance Procedures and Documentation

M3.1 Procedure and Documentation Review

a. Inspection Scope (50001, 37051)

The inspector reviewed and evaluated the Bechtel Special Processes Manual (SPM), Revision 8, for compliance with ASME Code and Technical Specification requirements, reviewed welder and NDE personnel certifications of qualification, and reviewed work process control and inspection documentation.

b. Observations and Findings

The inspectors' review of the inspection program and procedures, Bechtel Special Processes manual, work instructions and documentation of inspections, confirmed compliance to the ASME Code and Technical Specification requirements. Review of NDE data documentation verified the pre-service examinations were performed on welds in accordance with ASME Code, Section XI requirements. Examinations were performed in accordance with procedures, and documented according to ASME Section V requirements. Steam generator reactor coolant loop piping welds were examined with "P" scan automated UT, and recorded on optical disks for reference when performing future inservice inspection examinations. Documentation of welding and NDE activities, performed on the SGs prior to installation, were performed as required by approved procedures. Welding and NDE personnel qualifications were reviewed and found to be documented as required by applicable Codes and Standards.

The inspector reviewed Work Plan and Inspection Record (WPIR) C-SUB-532 process control, and inspection documentation. The documentation for the tensioning of tendon No. 40 BA was changed which indicated that the tendon's previously recorded value did not meet the tolerance for tendon elongation. (Inspection report for 40BA "B" end.) The tendon documentation indicated that the tendon was elongated to a reported 16.4 inches and changed to 17.2 inches. The inspection tolerance was 16.8 - 20.6 inches. However the change was made by the same individual on the same date and recorded in accordance with ANSI 45.2.9 and Regulatory Guide 1.88. In addition, the horizontal tendons were stressed from both ends of the tendon and inspectors were assigned to both ends to record the lift off values during tensioning. The two inspectors were in radio contact when performing the dimensional inspection to verify the measurements. Review of the inspection report 40BA "A" end had recorded the elongation of the tendon as 17.2 inches.

To ensure the tendon was properly tensioned, the licensee performed an engineering evaluation of the tendon wire elongation and determined that at 16.4 inches the tendon would be acceptable based on the elongation, was on the conservative side of the tolerance, and installation records indicated that there were no signs of broken or slipped wires. The tendon was successfully tensioned to the over stressing force and was stressed to the proper lock-off values.

The tolerance referenced in WPIR C-SUB-532 was based on the elongation monitoring requirement derived from NRC Regulatory Guide 1.35, Section 7.2, which states that for tendon surveillance: "if the elongation corresponding to a specific load differs by more than 10% from that recorded during installation of the tendons, an investigation should be made to ensure that the difference is not related to wire failures or slip of wire anchorages..." The Regulatory Guide guidance is for surveillance and not intended for new installation. The reason elongation was measured for new installation and compared to the expected elongation measurement was to determine if there were any unseen wire failures or slips of wires or anchorages during installation. This monitoring requirement was somewhat arbitrary when applied to the new tendons that were installed in the horizontal tendons. No previous elongation values exist, therefore the actual elongation was being compared to the theoretical elongation values. Other factors such as the untwisting of the tendon during installation and the effects of friction within the tendon duct cannot be accurately predicted.

c. Conclusions

The pre-service program, procedures and documentation were conducted and complied with the ASME Code and Technical Specification requirements. The special processes pre-service inspection program and procedures were conservative providing an accurate baseline for future inservice inspections.

M5 Maintenance Staff Training and Qualification

M5.1 Observation of Welder Qualifications

a. Inspection Scope (50001)

In-process training and qualification of welders for the replacement SG work were observed by the NRC inspector. Observation of welder qualification included manual and automatic welding processes, with procedure review and material control. The inspector observed in-process welding, and the testing of welder qualification coupons using bend test and radiography.

b. Observations and Findings

The welder qualification process complied with Bechtel procedure WQ-1, Revision 11. Welder candidates were initially tested on 10-inch schedule 80 pipe for the feed water elbow safe end welds, using manual gas tungsten arc welding (GTAW) for the root and hot pass, and manual shielded metal arc welding (SMAW) for the remainder. These coupons were radiographed per ASME Section IX requirements. Licensee and contractor management oversight of the welder qualification program was particularly evident. Quality Assurance oversight was also observed performing surveillance of the welder qualifications. Destructive testing and nondestructive examination of welders' coupons were performed and evaluated in accordance with the applicable procedures and ASME Code requirements.

c. Conclusions

The welder qualification program was well planned and implemented. More rigorous standards for welder qualification were apparent and contributed to the successful weld process in the field. Management and Quality Assurance oversight of the welder qualification process demonstrated a good safety perspective.

E8 Miscellaneous Engineering Issues

E8.1 (Closed) Inspection Follow-Up Item 50-456/98011-01(DRS): Review of calculation to determine adequacy of weld with cavity in water level nozzle. Based on discussion in Section M1.2, above, this item is closed.

E8.2 (Closed) Inspection Follow-Up Item 50-456/98011-02(DRS): During reviews of engineering activities for the Byron and Braidwood SG replacements, the NRC noted that the SG feedwater nozzle may not be accessible for the required ASME Code coverage for Section XI inservice inspection, due to the restraint installation on the SG.

The licensee employed the services of the corporate "C" Team (Nondestructive examination specialist) to determine whether the inspectibility of the feedwater nozzle could meet applicable Code requirements. The "C" Team contacted two NDE subcontractors to submit proposals for performing the examination using ultrasonic

examination (UT) process. The "C" Team selected the most feasible methodology and performed measurements of the UT accessible area with the restraint installed.

The inspector reviewed the proposed examination plan to inspect the feedwater nozzle with the restraint in place. The method proposed utilized a manual UT procedure using transducers with various angles. This method was able to acquire the inspection volume required by the ASME Code. The proposed inspection plan meets the required volumetric examination requirements.

V. Management Meetings

The inspector presented the inspection results to the licensee management at the conclusion of the inspection on January 21, 1999. The licensee acknowledged the findings presented and did not identify any of the report input discussed as proprietary.

PARTIAL LIST OF PERSONS CONTACTED

M. Cassidy, NRC Coordinator
G. Caul, SGRP Nuclear Oversite Inspector
J. Groth, SGR Site Manager
F. Lentime, Design Engineering Manager
S. Mullens, SGRP System Engineer
M. Riegel, Nuclear Oversight Manager
M. Sears, SG, ISI Engineer
D. Shamblin, SGR Project Manager
T. Tulon, Senior Vice President
R. Wegner, Operations Manager
D. Wheeler, SGR Construction Leader
C. Zavada, SGRP Nuclear Oversite Leader

INSPECTION PROCEDURES USED

IP50001	Steam Generator Replacement
IP37753	Inservice Inspection Observation
IP37755	Inservice Inspection Review of Data
IP37051	Inservice Inspection Procedure Review

ITEMS OPEN, CLOSED, AND DISCUSSED

Closed

IFI 456/98011-01	Review of Babcock & Wilcox calculations to determine adequacy of the weld with the cavity in the water level nozzle weld #117.
IFI 456/98011-02	Accessibility of feedwater nozzle weld for ISI with SG restraint installed.

LIST OF ACRONYMS USED

ASME	American Society of Mechanical Engineers
BWI	Babcock and Wilcox International
DIAD	Design Input and Analysis Document
ECN	Engineering Change Notice
FME	Foreign Material Exclusion
GTAW	Gas Tungsten Arc Welding
GWS	General Weld Specification
IFI	Inspection Follow-up Item
IP	Inspection Procedure
ISI	Inservice Inspection
LPT	Liquid Penetrant Examination
MT	Magnetic Particle Examination
NCR	Nonconformance Report
NDE	Nondestructive Examination
OLS	Outside Lift System
RT	Radiographic Examination
SG	Steam Generator
SMAW	Shielded Metal Arc Welding
SPM	Special Processes Manual
UT	Ultrasonic Examination
WPIR	Work Plan and Inspection Record
WPS	Weld Procedure Specification

PARTIAL LIST OF DOCUMENTS REVIEWED

DIAD 9600025	Design Input and Analysis Document
WQ-1 revision 11	Bechtel Welding Qualification Performance Specification (ASME Section XI)
RT-ASMEIII revision 1	Bechtel Nondestructive Examination Standard Radiograph Examination
GWS-1 revision 4	Bechtel General Welding Standard
WD-1 revision 3	Bechtel Welding Standard Documentation of Welds
PT (SR) - ASME III/XI	Bechtel Nondestructive Examination Standard Liquid Penetrant Examination
SPS-1 revision 5	Bechtel Special Processes Standard
WQ-2 revision 5	Bechtel Welding Performance Qualification Specification (D1.1)
WQ-7 revision 1	Bechtel Welding Performance Qualification Specification (D1.4)