UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION II
101 MARIETTA STREET, N.W.
ATLANTA, GEORGIA 30323

Report Nos.: 50-259/91-07, 50-260/91-07, and 50-296/91-07

Licensee: Tennessee Valley Authority
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Docket Nos.: 50-259, 50-260, and 50-296

License Nos.: DPR-33, DPR-52, and DPR-68

Facility Name: Browns Ferry Units 1, 2, and 3

Inspection at Browns Ferry Site near Decatur, Alabama

Inspection Conducted: February 22 - March 13, 1991

Inspector: _____ 3/26/91
C. A. Patterson, Senior Resident Inspector — Date Signed

Accompanied by: E. Christnot, Resident Inspector
W. Bearden, Resident Inspector
K. Ivey, Resident Inspector
G. Humphrey, Resident Inspector
P. Burnett, Reactor Inspector

Approved by: _____ 3/26/91
Paul Kellogg, Section Chief, — Date Signed
Inspection Programs,
TVA Projects Division

SUMMARY

Scope:

This special inspection included those activities associated with the February 21, 1991 through March 6, 1991 Fuel Loading. Those activities included a review of reload design, on shift coverage activities and a review of the conditions that led to the beginning of fuel load and loading of one fuel assembly into the Unit 2 reactor core with a fuel load chamber spiking to alarm conditions.

Results:

One refueling violation was identified for failure to follow the refueling procedure, paragraph two. Indications of a fuel load chamber causing alarm conditions due to noise were available prior to commencing fuel load and during movement of the first fuel assembly into the reactor vessel. Fuel loading was not stopped until after the first fuel assembly was seated into its designated core position. The B Fuel Load Chamber was then declared inoperable and fuel loading stopped for approximately 50 hours during maintenance and eventually replacement of the B Fuel Load Chamber.

The Plant Operations Review Committee review of this event contained several discrepancies. The sequence of events was different from control log entries and resident inspector observations.

After the initial problem with the B Fuel Load Chamber the remainder of the refueling was completed in a professional and conservative manner. Fuel loading was completed on March 6, 1991 at 9:49 p.m.

A review of the Reload Licensing Report, reconstitution program summaries, and the Revised Reload Technical Specification by regionally based inspectors did not result in any concerns with operating Unit 2 with reconstituted fuels.

REPORT DETAILS

1. Persons Contacted

Licensee Employees:

*O. Zeringue, Site Director
L. Myers, Plant Manager
*M. Herrell, Operations Manager
J. Rupert, Project Engineer
R. Johnson, Modifications Manager
*M. Bajestani, Technical Support Manager
R. Jones, Operations Superintendent
A. Sorrell, Maintenance Manager
G. Turner, Site Quality Assurance Manager
*P. Carier, Site Licensing Manager
*P. Salas, Compliance Supervisor
J. Corey, Site Radiological Control Manager
R. Tuttle, Site Security Manager
T. Beu, BWR Fuel Engineering

Other licensee employees or contractors contacted included licensed reactor operators, auxiliary operators, craftsmen, technicians, and public safety officers; and quality assurance, design, and engineering personnel.

NRC Personnel

*C. Patterson, Senior Resident Inspector
*E. Christnot, Resident Inspector
*W. Bearden, Resident Inspector
*K. Ivey, Resident Inspector
G. Humphrey, Resident Inspector
P. Burnett, Reactor Inspector
M. McCoy, NRR/SRXB
T. Ross, NRR/PD2-4

*Attended exit interview

Acronyms and initialisms used throughout this report are listed in the last paragraph.

2. Sequence of Events for Fuel Load

After an extended shutdown of over six years in duration, Unit 2 fuel loading commenced at 6:39 a.m. (CST) on February 21, 1991.

The reactor nuclear instrumentation included four SRM channels to provide neutron monitoring during fuel loading. Two of the SRM channels, A and B, were electrically wired, using temporary cabling, to FLCs. The FLCs were placed in the core in the same quadrants, respectively, as SRM C and D.

The two channels wired to the FLCs were considered operable by the licensee. SRMs can be declared operable when they indicate greater than 3 cps. The SRM channels attached to FLCs were reading 100 cps on channel B and 250 cps on channel A. The following events were observed, all times are approximate CST.

a. 4:00 p.m. Wednesday, February 20, 1991, two inspectors attended a PORC meeting chaired by the Plant Manager. Also present were the Site Director and the Vice President Nuclear Operations. The PORC decided that adequate systems were operable to support fuel loading. The RPS shorting links for the SRMs would be in the non-coincident logic pattern. In this configuration a single Hi-Hi Set Point Trip from the SRMs would cause a full scram.

b. 2:00 a.m. Thursday, February 21, 1991. Hi-Hi Set Point Trip from SRM B and erratic operation was observed by a RI. This was discussed with the licensee. An entry in the operator's log at 2:50 a.m. indicated that WR CO 42091 was initiated to troubleshoot and repair SRM B as necessary. The WR was closed out with no root causes being identified.

c. 6:30 a.m. Thursday, February 21, 1991. An entry in the operators log indicated that 2-SOI-100-1, Fuel Load Prerequisites Checklist, was completed; the prerequisites for 2-GOI-100-3, Refueling Operations, were completed; and that permission had been received from the Plant Manager to load fuel into the Unit 2 reactor vessel.

d. 6:39 a.m. Thursday, February 21, 1991. Permission was given to the refueling bridge personnel to commence loading fuel and the bridge reported the commencing of step 1 of the fuel loading procedure.

e. 6:41 a.m. Thursday, February 21, 1991. The refueling bridge personnel reported that the fuel bundle was clear of the spent fuel pool. The control room operator reported to the SOS that SRM B was spiking. The control room RI observed that the SRM B cps meter was ramping up from a reading of approximately 100 cps to 500 cps.

f. 6:43 a.m. Thursday, February 21, 1991. Refueling bridge personnel reported that the fuel bundle was stopped at the cattle chute to await the completion of a radiation control survey of the drywell. The control room RI observed that the SRM B cps meter was still reading approximately 500 cps and the period meter was erratic. The control room RI discussed this with licensee personnel and was informed that this was not considered a problem because both SRMs were not receiving electronic noise. The control room RI noted that the operator had informed the SOS that the SRM A count rate was steady.

g. 7:05 a.m. Thursday February 21, 1991. Fuel loading resumed. The control room RI noted that the SRM B cps meter had returned to an indication of approximately 100 cps prior to resuming fuel movement. The operator reported to the SOS, and the control room RI observed, a

Hi-Hi Trip on the SRM B channel. The SOS ordered the refueling bridge personnel to stop moving fuel. The control room RI observed a discussion among control room licensee personnel as to whether a full scram should have been received, and whether the shorting links were in the coincidence or non-coincidence logic pattern. The SOS asked the refueling bridge personnel where the fuel bundle was located. The refueling bridge personnel replied that the fuel bundle was approximately 2 feet from the top of the grid.

h. 7:10 a.m. Thursday February 21, 1991. The SOS informed the refueling bridge personnel and all control room personnel that he was directing the refueling bridge personnel to install the bundle into the reactor vessel using the jogging mode.

i. 7:21 a.m. Thursday, February 21, 1991. The refueling bridge personnel reported that the bundle was in the vessel and upgrappled. During this eleven minute time frame the control room RI observed that the SRM B cps meter was indicating between approximately 800 to 1000 cps, SRM Channel A was steady, and SRM B period meter was erratic.

j. 7:23 a.m. Thursday, February 21, 1991. The operator reported and the control room RI observed another SRM B Hi-Hi trip. The control room RI observed that the SRM B cps meter was indicating approximately 800 to 1000 cps, the SRM A was steady and the SRM B period meter was erratic.

k. 7:24 a.m. Thursday, February 21, 1991. The SOS declared SRM B inoperable and stopped all fuel movement. Both the RO and SRO logged this time as when the B FLC was declared inoperable and refueling stopped.

The inspector concluded that the refueling procedure was not followed. Technical Specification 6.8.1.1 requires that written procedures shall be established, implemented, and maintained covering the applicable procedures in Appendix A of Regulatory Guide 1.33, Revision 2, February 1978. Appendix A of Regulatory Guide 1.33 includes procedures for refueling.

Refueling Operations Procedure, 2-GOI-100-3, implements this requirement for refueling. Procedure step 3.1, under Precautions and Limitations, require that refueling shall be immediately halted upon occurrence of unexplained or abnormal increase in SRMs or FLCs readings (procedure step 3.1.1), or loss of neutron monitoring with less than two SRMs/FLCs operable and responding with one in the fuel handling quadrant and one in an adjacent quadrant (procedure step 3.1.3).

The inspector concluded that a violation of TS had occurred. Refueling was not stopped after questionable and erratic response of the B FLC. This is identified as VIO 260/91-07-01, Failure to Follow Refueling Procedure.

The 'B' FLC was again declared inoperable due to spiking on February 27, 1991 and remained inoperable for the remainder of the fuel loading. When the spiking occurred this time, the bundle being moved was returned to the spent fuel pool. The licensee is conducting an incident investigation of these problems which will be reviewed by the resident inspectors.

The remainder of fuel loading was carried out in a professional and conservative manner. Fuel loading was completed at 9:49 p.m., on March 6, 1991.

3. PORC Review Discrepancies

The inspector reviewed an event description of B FLC problem on February 21, 1991. The description was approved by PORC on February 23, 1991, and a copy was given to the inspector. This PORC was chaired by the Plant Operations Manager. Numerous discrepancies and inaccuracies were noted as follows:

a. The licensee's events and causal factor chart stated a high alarm was received at 2:50 a.m.

The inspector reviewed the SRO log and the entry at 2:50 a.m. was for a high-high alarm and not a high alarm. The control room RI stated that at approximately this time he observed the operators resetting a Hi Hi Trip on the SRM B channel because a clear, distinct Red Light was on. When the RI discussed this observation with the licensee he was informed that a SI on the FLC was in progress and this was expected. A later review by the control room RI indicated that the SI was being performed on an FLC for the A SRM and not the B SRM at this time.

b. The licensee's events and causal factor chart and event description narrative stated that the B FLC was determined to be inoperable at 7:18 a.m. and before a second high-high alarm was received when the bundle was placed into the core.

The inspector reviewed both the RO and SRO log and the B FLC was not declared inoperable until 7:24 a.m. after the bundle was placed in the core and after several high-high alarms. The inspector in the control room also heard the announcement that the 'B' FLC was inoperable after the bundle was released.

c. The assessment of personnel performance concluded that the decision to lower the bundle into the core was made in accordance with Step 3.2 of 2-GOI-100-3 which requires that if core alterations are suspended for any reason other than a fire alarm or medical emergency, a fuel bundle being moved will be lowered and placed in a safe condition immediately.

The inspector noted that lowering a fuel bundle into the core meets the definition of a core alteration and Step 3.2 is not applicable.

d. The actions to be taken to preclude future occurrences stated that changes were being made to 2-GOI-100-3 and 2-TI-147A to include a precaution that if erratic or unexplained SRM/FLC response is observed, fuel loading shall be immediately stopped.

The inspector reviewed 2-GOI-100-3 procedure Step 3.1.1 and the precaution already existed in the procedure.

In general, the inspector concluded that the PORC assessment contained several discrepancies. The assessment did not critically assess operations, actions, or troubleshooting of the WR written. The assessment did not adequately assess the significance of proceeding with fuel handling after a high-high alarm was received and an expected scram signal was not received. Although later it was learned from GE that spiking can result in an alarm without a scram signal, the PORC did not specifically conclude that this event was the phenomenon described by GE.

4. Related Matters

a. Shift Turnover During Movement of First Fuel Assembly

Refueling began during shift turnover of operations personnel. The Plant Operations Manager was present in the control room during this time of the movement of the first bundle into the vessel. The oncoming shift relieved the watch during movement of the first fuel assembly. The inspector concluded that during a major evolution was not the best time to conduct shift relief. In addition, the oncoming crew may not have been fully aware of the spiking problem on the B FLC.

b. Noise Problem Known Related to Bridge Movement Prior to Fuel Load

Planners who process WRs were aware of the FLC spiking problem and the relationship to bridge movement prior to beginning fuel movement. An entry into the planners log at 5:00 a.m. stated "FLC B spikes appear to be related to bridge work (Ops says they will buy it off)". Evidently, this information was not fully communicated to all management.

c. System Engineer Not Notified

During this event, the system engineer was not notified of the spiking problem. In the past, the involvement of the system engineer in problem resolution has been effective.

5. Fuel Handling Problems at Other Sites

An inspector reviewed events involving failures of the fuel handling bridge at other nuclear plants to determine if they could be potential problems for BFN. The inspector discussed these events with the cognizant system engineer and the SRO responsible for refuel floor activities. The events and the BFN actions are addressed below:

a. At another facility in early January, 1991, a fuel bundle was released from the main hoist grapple while it was being lowered into the core when the refuel bridge electrical power was lost. The loss of power to the bridge removed the air from the grapple and the grapple opened. The grapple is designed to remain closed upon a loss of air, but the licensee discovered that the grapple air lines had been reversed during previous work.

   At BFN the refuel grapple is designed to fail in the closed position. Procedure EPI-0-079-CRA001, Refueling Platform and Jib Crane Inspection, includes a main grapple failsafe check. This procedure is conducted within 30 days of fuel movement. The check includes opening the grapple and removing power to verify that the grapple fails closed, and using test weights to determine if the grapple will open while in a loaded condition. The licensee stated there had been no recent maintenance on the grapple airlines or switch. No problems were identified during the performance of the EPI prior to beginning Unit 2 fuel load.

b. At another facility the refuel bridge main hoist emergency and motor brakes failed while lowering a bundle into the core. This resulted in the bundle being put into the core in an uncontrolled manner.

   At BFN the Unit 2 refuel bridge main grapple hoist has a double set of brakes which are the disc type. An inspection was performed on the brakes and extensive wear was noted. The brake was reassembled using a new coil and operating assembly and the original pressure plate and fiber brake disk. In addition, MMI-34, Refueling Platform and Grapple Assembly Inspection, includes inspection of the main hoist grapple and EPI-0-079-CRA001 includes checking the electrical and mechanical integrity of the brakes using test weights. Both of these procedures are performed within 30 days of fuel movement. No problems were identified during the performance of these inspections prior to beginning Unit 2 fuel load.

The inspector concluded that the licensee had adequately addressed both of these events prior to beginning Unit 2 fuel load. No violations or deviations were identified in this area.

6. Browns Ferry Unit 2, Cycle 6, Fuel Selection and Core Load (60710, 61702)

a. References

(1) TVA-BCD-906, SUMMARY REPORT FOR THE BROWNS FERRY NUCLEAR PLANT, UNIT 2, CYCLE 6, INSPECTION AND RECONSTITUTION PROGRAM, August 1988 (Revision 0).

(2) TVA-RLR-002, BROWNS FERRY NUCLEAR PLANT, RELOAD LICENSING REPORT, UNIT 2, CYCLE 6.

(3) USNRC, REVISED RELOAD TECHNICAL SPECIFICATIONS (TS254) BROWNS FERRY NUCLEAR PLANT, UNIT 2, September 13, 1989.

b. Introduction

Reconstitution of BWR fuel by replacing damaged or failed fuel pins with pins of like initial enrichment, similar exposure, and similar residual enrichment from a donor fuel assembly is not new. Prior to reconstituting fuel at Browns Ferry, successful reconstitution programs had been conducted at least three other BWR facilities. However, the program conducted at Browns Ferry was much larger in the number of fuel assemblies and fuel pins affected than the earlier programs. Consequently, when the program was proposed, NRR initiated a dialogue and exchange of technical documents with TVA. That exchange culminated in issuance of new Technical Specifications (Reference a.(3)) with conservatively reduced MAPLHGR limits for the reconstituted fuel.

TVA submitted both Reference a.(1) and Reference a.(2) in support of TS amendment 172, but the NRR review of the neutronic analyses presented by TVA was limited to confirmation that approved computer codes were used in the analyses.

The analyses described in Reference a.(1) were reviewed in the Region II office and discussed by Region II personnel with the responsible TVA analyst. The Region II staff concluded that the strategy of using the codes to confirm that replacement pins had neutronic characteristics similar to the replaced pins was sound. A similar conclusion was that the strategy for analyzing the current neutronic characteristics of the reconstituted bundles and predicting their future behavior was also sound.

No concerns or caveats about operating Browns Ferry Unit 2 with the reconstituted fuels described in Reference a.(1) were identified. It was also noted that the use of reconstituted fuel has placed no special or additional surveillance requirements on the facility staff.

c. Core Design Predictions

Calculations for Cycle 6 show that the lead fuel assembly will produce from 1.35 to 1.45 times the core average power at any point in the cycle. The relative power production for R2/R3 fuel will range from 1.2 to 1.05 at any time in the cycle. During parts of the cycle, the leading R2/R3 bundle will be a reconstituted bundle, but many of the reconstituted bundles will operate at less than core average power throughout the cycle.

The effects of the long shutdown on fission product and transuranic isotope concentrations were calculated for the unreconstituted core. Bundle power distributions were essentially unchanged. At BOC, SDM increased by approximately 0.5% dk/k, but that effect burned out by mid-cycle. These results are consistent with those reported for Sequoyah.

The analyses did not identify a need for any special core monitoring as a result of the fuel reconstitution. Two conservatisms were introduced into the plant computer to provide conservative monitoring of the reconstituted fuel. MAPLHGR curves were lowered 3.2%. The R-factors to be used in CPR determination were increased by 0.02.

d. Corrective Actions

Changes in feedwater chemistry have been instituted to prevent the recurrence of the CILC observed in U2C5. The condensers were retubed with stainless steel to eliminate the copper in the brass tubes. The system has undergone considerable flushing to eliminate residual copper. The method of precoating the demineralizers may be changed to improve copper removal by the demineralizers. Previously, the demineralizers were ineffective in removing copper. There will be online monitoring of the copper content in the feedwater. Plant activities to reduce CILC will be inspected during the power ascension phase of plant activities.

7. Exit Interview

The inspection scope and findings were summarized on March 15, 1991, with other persons indicated in paragraph 1 above. The inspectors described the areas inspected and discussed in detail the inspection findings listed below. The licensee did not identify as proprietary any of the material provided to or reviewed by the inspectors during this inspection. Dissenting comments were not received from the licensee.

Item Number	Description and Reference
259, 260, 296/91-07-01	VIO, Failure to Follow Refueling Procedures, paragraph 2.

8. Acronyms and Initialisms

BOC	Beginning of Cycle
BFN	Browns Ferry Nuclear
BWR	Boiling Water Reactor
CFR	Code of Federal Regulations
CILC	Crud Inducted Localized Corrosion
CPR	Critical Power Ratio
CPS	Counts Per Second
CST	Central Standard Time
EPI	Electrical Preventive Instruction
FLC	Fuel Load Chamber
FSAR	Final Safety Analysis Report
GOI	General Operating Instruction
GE	General Electric
MAPLHGR	Maximum Average Planar Heat Generation Rate
NRC	Nuclear Regulatory Commission
PORC	Plant Operations Review Committee
RI	Resident Inspector
RO	Reactor Operator
RPS	Reactor Protection System
SI	Surveillance Instruction
SOI	Special Operating Instruction
SOS	Shift Operations Supervisor
SDM	Shutdown Margin
SRM	Source Range Monitor
SRO	Senior Reactor Operator
SRXB	Reactor Systems Branch, NRR
TI	Technical Instruction
TS	Technical Specification
TVA	Tennessee Valley Authority
VIO	Violation
WR	Work Request