



**UNITED STATES
NUCLEAR REGULATORY COMMISSION**
REGION II
245 PEACHTREE CENTER AVENUE NE, SUITE 1200
ATLANTA, GEORGIA 30303-1257

November 30, 2012

Mr. Joseph W. Shea
Vice President, Nuclear Licensing
Tennessee Valley Authority
1101 Market Street, LP 3D-C
Chattanooga, TN 37402-2801

**SUBJECT: BROWNS FERRY NUCLEAR PLANT - NRC SUPPLEMENTAL INSPECTION
REPORT 05000259/2012015**

Dear Mr. Shea:

On October 17, 2012, the U.S. Nuclear Regulatory Commission (NRC) completed a supplemental inspection pursuant to Inspection Procedure 95001, "Supplemental Inspection for One or Two White Inputs in a Strategic Performance Area," at your Browns Ferry Nuclear Power Plant, Unit 1. The enclosed inspection report documents the inspection results, which were discussed at the exit meeting on October 17, 2012, with Mr. Phillip Summers and other members of your staff.

In accordance with the NRC Reactor Oversight Process action matrix, this supplemental inspection was performed to follow-up on a White Mitigating Systems Performance Index – High Pressure Injection Performance Indicator which crossed a threshold from Green to White safety significance in the second quarter of 2012. The NRC was informed on September 18, 2012, of your staff's readiness for this inspection.

The objectives of this supplemental inspection were to provide assurance that: (1) the root causes and the contributing causes for the risk-significant issues were understood; (2) the extent of condition and extent of cause of the issues were identified; and (3) corrective actions were or will be sufficient to address and preclude repetition of the root and contributing causes.

Based on the results of this inspection, we concluded that you have adequately completed a root cause analysis of the issue, and have identified appropriate corrective actions to prevent recurrence of the issue. No findings were identified concerning the root cause evaluation and corrective actions.

The NRC has determined that inspection objectives stated above have been met. Therefore in accordance with IMC 0305, "Operating Reactor Assessment Program," the performance issue shall not be considered in the Action Matrix after the end of the third quarter 2012.

J. Shea

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In accordance with 10 CFR 2.390 of the NRC's "Rules of Practice," a copy of this letter and its enclosure will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records (PARS) component of NRC's Agencywide Document Access and Management System (ADAMS). ADAMS is accessible from the NRC Web site at <http://www.nrc.gov/reading-rm/adams.html> (the Public Electronic Reading Room).

Sincerely,

/RA/

Eugene F. Guthrie, Chief
Special Project, Browns Ferry
Division of Reactor Projects

Docket Nos.: 50-259
License Nos.: DPR-33

Enclosure: Inspection Report 05000259/2012015
w/Attachment: Supplemental Information

cc w/encl: (See page 3)

J. Shea

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Letter to Joseph W. Shea from Eugene F. Guthrie dated November 30, 2012

SUBJECT: BROWNS FERRY NUCLEAR PLANT - NRC SUPPLEMENTAL INSPECTION
REPORT 05000259/2012015

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U.S. NUCLEAR REGULATORY COMMISSION

REGION II

Docket No.: 50-259

License No.: DPR-33

Report No.: 05000259/2012015

Licensee: Tennessee Valley Authority (TVA)

Facility: Browns Ferry Nuclear Plant

Location: Corner of Shaw and Nuclear Plant Roads
Athens, AL 35611

Dates: October 15, 2012 – October 17, 2012

Inspector: David Hardage, Resident Inspector, Region II

Approved by: Eugene F. Guthrie, Chief
Special Project, Browns Ferry
Division of Reactor Projects

Enclosure

SUMMARY OF FINDINGS

IR 05000259/2012015; 10/15/2012 – 10/17/2012; Browns Ferry Nuclear Plant, Unit 1; Supplemental Inspection – Inspection Procedure (IP) 95001.

This inspection was conducted by a resident inspector. No findings were identified. The NRC's program for overseeing the safe operation of commercial nuclear power reactors is described in NUREG-1649, "Reactor Oversight Process," Revision 4, dated December 2006.

Cornerstone: Mitigating Systems

The NRC inspector performed this supplemental inspection in accordance with Inspection Procedure 95001, "Inspection for One or Two White Inputs in a Strategic Performance Area," to assess the licensee's evaluations associated with the Mitigating Systems Performance Index (MSPI) – High Pressure Injection System, which crossed a threshold from Green to White safety significance in the second quarter of 2012. The inspector determined that the licensee's evaluation and corrective actions for the White performance indicator (PI) were adequate. The licensee's evaluation identified two root causes. The first root cause identified that plant leadership was not consistently considering risk and exercising conservative decision making relevant to long-term equipment reliability. The second root cause was identified as ineffective implementation of the corrective action program (CAP). The licensee has taken or plans to take corrective actions in these areas including: the implementation of a leadership improvement program; and revisions to the corrective action program to address the quality of causal analysis, untimely corrective measures, and more stringent screening criteria. The licensee also performed extent of condition and extent of cause reviews as part of the root cause evaluation. These evaluations identified other challenges to conservative decision making relative to safety importance and risk significance; including, operability determinations, degraded or non-conforming conditions, and refueling outage scope deletions. The inspector determined that the licensee's extent of condition and extent of cause evaluations were adequate, and that the identified corrective actions were comprehensive, properly prioritized, and sufficient to prevent recurrence of the event.

During the review of the causal analyses for the individual equipment issues, the inspector noted that the evaluation for a failed open testable check valve was evaluated using an apparent cause evaluation. The inspector found that the failure which caused over-pressurization of the high pressure coolant injection (HPCI) booster pump and suction piping had two precursor incidents which could have alerted the licensee prior to the failure of the valve. The inspector found that the casual analysis listed a direct cause of the event as the apparent cause. The licensee self-identified these as issues in their comprehensive root cause analysis (RCA) report. Additionally, the inspector found that the licensee added follow-on actions to inspect the valve internals during the fall 2012 refueling outage and to perform evaluations as necessary.

Given the licensee's acceptable performance in addressing the issues related the White High Pressure Injection PI, the White PI will only be considered in plant performance assessment until the PI returns to the Green performance band, in accordance with the guidance in IMC 0305, "Operating Reactor Assessment Program." The implementation and effectiveness of the licensee's corrective actions will be reviewed during future routine NRC inspections.

Enclosure

REPORT DETAILS

4. OTHER ACTIVITIES

4OA4 Supplemental Inspection (95001)

.01 Inspection Scope

The NRC staff performed this supplemental inspection in accordance with IP 95001 to assess the licensee's evaluation of a White High Pressure Injection PI which affected the mitigating systems cornerstone in the reactor safety strategic performance area. The licensee performed three root cause evaluations and two apparent cause determination evaluations for specific associated equipment issues. In addition, after the High Pressure Injection PI had crossed the Green/White threshold, the licensee performed a comprehensive RCA to determine why the Unit 1 HPCI system incurred multiple equipment failures and excessive unavailability, which resulted in driving the PI to White. The inspection objectives were to:

- provide assurance that the root and contributing causes of risk-significant issues were understood;
- provide assurance that the extent of condition and extent of cause of risk-significant issues were identified;
- provide assurance that the licensee's corrective actions for risk-significant issues were or will be sufficient to address the root and contributing causes and to preclude repetition.

Plant performance for Browns Ferry Unit 1 was in the Multiple/Repetitive Degraded Cornerstone column (Column 4) of the NRC's Reactor Oversight Process Action Matrix beginning in the fourth quarter 2010. This was based on the issuance of one finding classified as having high safety significance (Red) associated with the failure of the Unit 1 low pressure coolant injection (LPCI) outboard injection valve failure, (NRC Inspection Report 05000259/2011008) The Unit 1 High Pressure Injection PI changing from Green to White status did not affect the action matrix status of Unit 1.

This PI change was due to excessive unreliability and unavailability of the HPCI system. Contributors to the change include excessive unavailability due to repetitive steam admission valve leakage (PER #436575) along with the following (4) functional failures within the past three years:

- Diaphragm tore due to 10CFR Part 21 condition (Missing fiber reinforcement) on 7-24-09-PER 177206 / 1-PCV-073-0018C
- Testable Check Valve bound open and over-pressurization event short circuited the Auxiliary Oil Pump Motor 1-MTR-073-0047 on 5-20-11-PER 372659 / 1-FCV-073-0045. (Reference PER 598749 for revision)

Enclosure

- Booster Pump Bearing degradation due to incorrect bearing installation & thrust from 5-20-11 over-pressurization event on 7-20-11-PER 408067 / 1-PMP-073-0029.
- Stop Valve bound open due to too large of a gap between the upper and lower stem on 4-19-12- PER 539040 /1-FCV-073-0018.

Unit 1 HPCI exceeded the Green – White threshold in April 2012 due to the fourth failure in the 12 quarter reporting window combined with the total unavailability of 964 hours. The failures resulted in a unavailability index (UAI) = $4.67E-7 \Delta CDF$ and unreliability index (URI) = $7.27 E-7 \Delta CDF$ for a total indicator value of $1.2 E-6 \Delta CDF$, which exceeded the Green - White threshold value of $1.0 E-6 \Delta CDF$.

The licensee informed the NRC staff on September 18, 2012, that they were ready for the NRC supplemental inspection. In preparation for the inspection, the licensee performed a root cause analysis, PER 550072, Revision 2, to identify weaknesses that existed in various organizations, which allowed the High Pressure Injection PI to cross the Green - White threshold, and to determine the organizational attributes that resulted in the White performance indicator. The licensee also completed a safety culture evaluation which is documented in the root cause analysis report Section 9 and Appendix E.

The inspector reviewed the casual analyses conducted for the individual contributors, as well as the RCA to determine cultural issues which caused Unit 1 HPCI to incur the multiple equipment failures and excessive unavailability which drove the MSPI reporting indicator to White. The analysis examined what processes and behaviors failed to ensure HPCI remained reliable over the past three years. The inspector reviewed the corrective actions that were taken or planned to address the identified causes. The inspector also held discussions with licensee personnel to ensure that the root and contributing causes, as well as the contribution of safety culture components, were understood and that corrective actions taken or planned were appropriate to address the causes and preclude repetition.

.02 Evaluation of the Inspection Requirements

02.01 Problem Identification

- a. IP 95001 requires that the inspection staff determine that the licensee's evaluation of the issue documents who identified the issue (i.e., licensee-identified, self-revealing, or NRC-identified) and the conditions under which the issue was identified.

The licensee identified the performance indicator had crossed the Green - White threshold in May 2012. Three violations of very low safety significance (Green) were associated with individual events which contributed to the performance indicator exceeding the Green - White threshold. The violations for failure of the HPCI stop valve to close and for improper installation of the Unit 1 HPCI booster pump outboard thrust bearings were licensee identified. The final violation, NCV 05000259/2011003-02, Over-

Pressurization of High Pressure Coolant Injection System due to Stuck Open HPCI System Testable Check Valve, was self-revealing.

- b. IP 95001 requires that the inspection staff determine that the licensee's evaluation of the issue documents how long the issue existed and prior opportunities for identification.

The licensee's root cause evaluation documented that white High Pressure Injection PI status has existed since April 2012, when the stop valve failure event occurred. At this point the cumulative impact of the five equipment issues impacting HPCI reliability and availability forecasted the change from Green to White in the second quarter of 2012.

- c. IP 95001 requires that the inspection staff determine that the licensee's evaluation of the issue documents the plant-specific risk consequence, as applicable, and compliance concerns associated with the issue.

The NRC determined this issue was White due to the High Pressure Injection PI exceeding $1E-6 \Delta CDF$. Unit 1 HPCI passed the threshold in April 2012 due to the fourth failure in the 12 quarter reporting window combined with the total unavailability of 964 hours. This resulted in a $UAI = 4.67E-7 \Delta CDF$ and $URI = 7.27 E-7 \Delta CDF$ for a total $MSPI = 1.2 E-6 \Delta CDF$. The inspector determined that the licensee conducted a plant specific risk consequence analysis and provided its results in the RCA report. Using the "BFN PRA CAFTA" model with the HPCI pump failing to start on demand probability and the HPCI pump unavailable due to test and maintenance updated to reflect the previous 12 quarters of data, yields a change in probable core damage frequency (CDF) of $1.45 E-6$ from the baseline model. The inspector concluded that the licensee appropriately documented the risk consequences and compliance concerns associated with the issue

- d. Findings

No findings were identified.

02.02 Root Cause, Extent-of-Condition Evaluation and Extent of Cause Evaluation

- a. IP 95001 requires that the inspector determine that the licensee evaluated the issue using a systematic methodology to identify the root and contributing causes.

The licensee used the following systematic methods to complete their root cause analyses:

- Events and Causal Factor Analysis
- Barrier analysis
- Comparative Time Line
- Kepner-Tregoe analysis
- Why staircase

The inspector determined that the licensee evaluated the issue using a systematic methodology to identify the root and contributing causes.

- b. IP 95001 requires that the inspection staff determine that the licensee's root cause analysis report was conducted to a level of detail commensurate with the significance of the issue.

The licensee's root cause analysis included an extensive timeline of events and an event and causal factors chart as discussed in the previous section. Using multidisciplinary teams, the licensee identified two root causes and two contributing causes for the roll up investigation to determine why the Unit 1 HPCI system incurred multiple equipment failures and excessive unavailability. The first root cause identified that plant leadership was not consistently considering risk and exercising conservative decision making relevant to long-term equipment reliability. The second root cause was identified as ineffective implementation of the corrective action program. The contributing causes were; Engineering Leadership not adequately applying equipment monitoring and trending tools on the HPCI system and procedure /maintenance instruction quality issues on Unit 1 HPCI system. In addition, the evaluations into the five specific equipment issues identified three root causes, two apparent causes, and seven contributing causes. In reviewing the causal analyses for the individual equipment issues, the inspector noted the evaluation for the failed open testable check valve (PER 598749) was evaluated using an apparent cause evaluation. The inspector found that the valve failure was significant having caused an over-pressurization of the high pressure coolant injection (HPCI) booster pump and suction piping and that the event had two precursor incidents which could have alerted the licensee prior to the failure of the valve. Additionally, the casual analysis performed, listed a direct cause of the event as the apparent cause. However, the inspector found that the licensee self-identified these issues in the RCA report (PER 550072). Follow-on actions to inspect the valve internals during the fall 2012 outage and perform additional evaluations as necessary were in place. Based on the scope of work performed for these cause evaluations, the inspector concluded that the evaluations were conducted to a level of detail commensurate with the significance of the problem.

- c. IP 95001 requires that the inspection staff determine that the licensee's root cause analysis report include a consideration of prior occurrences of the problem and knowledge of prior operating experience (OE).

The licensee's evaluations included a review of both internal and external OE. Though some related events were identified, differences in circumstances lead to a conclusion that knowledge of operating experience was not a relative issue. Based on the licensee's detailed evaluation and conclusions, the inspector determined that the licensee's evaluations considered prior occurrences of the problem(s) and knowledge of prior OE.

- d. IP 95001 requires that the inspection staff determine that the licensee's root cause analysis report addresses the extent of condition and the extent of cause of the issue.

The licensee's RCA considered the extent of condition associated with multiple equipment failures and excessive unavailability driving the MSPI performance indicators toward White. The licensee conducted a review of all safety related systems included in the Reactor Oversight Process that are mitigating systems or key performance indicators with a declining trend toward White. Unit 1 and 2 EDG MSPI showed indicators with less than 25 percent of allowable margin left in terms of unavailability. In addition, one failure to run on any 1 of the 4 EDGs would cause the MSPI to become White. Corrective actions taken to improve material condition issues in other MSPI systems were documented in the evaluation.

The licensee's evaluation also considered the extent of cause associated with multiple equipment failures and excessive unavailability driving the MSPI performance indicators toward White. The evaluation identified other challenges to conservative decision making relative to safety importance and risk significance; including, operability determinations, degraded or non-conforming conditions, and refueling outage scope deletions. The licensee review of the actions taken in relationship to the causes was documented in the evaluation to provide assurance that the actions were sufficiently broad to address the extent of causes.

The inspector concluded the licensee's root cause analysis report adequately addressed the extent of condition and the extent of cause of the issue.

- e. IP 95001 requires that the inspection staff determine that the licensee's root cause evaluation, extent of condition, and extent of cause appropriately considered the safety culture components as described in IMC 0305.

The licensee found weaknesses in the cross-cutting areas of Human Performance and Problem Identification and Resolution, specifically in the components of Corrective Action Program, Decision-Making, and Resources. In addition, the licensee found weaknesses in other safety culture components of Accountability, and Safety Policies. The licensee identified root causes for plant leadership not consistently considering risk and exercising conservative decision making relevant to long-term equipment reliability and a second root cause of ineffective implementation of the corrective action program. In addition, procedure /maintenance instruction quality issues on Unit 1 HPCI system was a contributing cause. The licensee correlated these causes to the cross-cutting aspects, in Human Performance and Problem Identification as, described in IMC 0310, Components Within The Cross-Cutting Areas, dated October 28, 2011.

The licensee stated that overall human performance culture needs improvement. The licensee addressed the cultural elements identified through the following root cause analyses in the following PERs:

PER 516455: Identified by 95003 recovery Team: Operational Focus/Decision Making
 PER 516437: Identified by 95003 recovery Team: Management and Leadership Standards

In addition, revisions to the CAP program and CAP procedures were implemented since the time of the events leading to the PI crossing the Green – White threshold. The corrective actions taken to address quality of causal analysis, untimely corrective measures, and more stringent screening criteria, have been included to improve the CAP processes at all levels. The corrective actions to prevent recurrence focused on the following: Alignment, Infrastructure – Standardize Organization; Roles & Responsibilities; Staffing, and Implementation and Directing of the CAP processes. This evaluation is contained in PER 475878 RCA “Ineffective Corrective Action Program Across TVA Nuclear Power Group” and PER 435440 “Inadequate Causal Analyst”. The inspector determined that the licensee’s root cause analysis included a proper consideration of whether a weakness in any safety culture component was a root cause or a significant contributing cause of the issue.

f. Findings

No findings were identified.

02.03 Corrective Actions

- a. IP 95001 requires that the inspection staff determine that appropriate corrective actions are specified for each root and contributing cause or that the licensee has an adequate evaluation for why no corrective actions are necessary.

The licensee took immediate corrective actions to restore operability of the Unit 1 HPCI for the individual material issues which contributed to the White PI. The inspector determined that the corrective actions for the root and contributing causes listed in PER 550072 were appropriate. PER 550072 identified two root causes. The first identified that plant leadership was not consistently considering risk and exercising conservative decision making relevant to long-term equipment reliability. The licensee has taken or planned to take corrective actions in this area, including the implementation of a leadership improvement program. The second root cause identified an ineffective implementation of the corrective action program. Revisions to the corrective action program which address quality of causal analysis, untimely corrective measures and more stringent screening criteria have been implemented. Corrective actions taken or planned to address the contributing causes included revising the system health report process to incorporate MSPI reporting attributes, system vulnerabilities and associated system risk identified through performance of system indicators and review of Unit 1 HPCI maintenance procedures for adequacy in accordance with EPRI/vendor guidance. The inspector determined that the proposed corrective actions were appropriate and addressed each root and contributing cause.

- b. IP 95001 requires that the inspection staff determine that the licensee prioritized corrective actions with consideration of risk significance and regulatory compliance.

The licensee corrective actions to address the root and contributing causes were prioritized through the assignment of graded corrective actions types; Corrective Actions to Prevent Recurrence, Corrective Action, and Enhancement in accordance with the

licensee's procedures. The inspector determined that the licensee prioritized corrective actions with consideration of risk significance and regulatory compliance.

- c. IP 95001 requires that the inspection staff determine that the licensee established a schedule for implementing and completing the corrective actions.

The inspector determined that all of the corrective actions listed in the root cause analysis report were either scheduled or completed.

- d. IP 95001 requires that the inspection staff determine that the licensee developed quantitative and qualitative measures of success for determining the effectiveness of the corrective actions to preclude repetition.

The inspector determined that an effectiveness review for the corrective actions on leadership decision making listed in the root cause evaluation was scheduled for July 2013 (ref. PER 550072-33). An effectiveness review for the corrective actions on the corrective action program listed in the root cause evaluation was scheduled for October 2013 (ref. PER 550072-45). The inspector determined that the licensee had developed quantitative and qualitative measures of success for determining the effectiveness of the corrective actions to preclude repetition.

- e. Findings

No findings were identified.

4OA6 Exit Meeting

On October 17, 2012, the inspector presented the inspection results to Mr. Phillip Summers and other members of the staff, who acknowledged the information presented. The inspector asked the licensee if any of the material examined during the inspection should be considered proprietary. The licensee did not identify any proprietary information.

ATTACHMENT: SUPPLEMENTAL INFORMATION

SUPPLEMENTAL INFORMATION

KEY POINTS OF CONTACT

Licensee Personnel

Q. Leonard, NSSS Engineering
W. Miller, Operations
M. Oliver, Site Licensing
J. Rodriguez, Maintenance
P. Summers, Director of Safety and Licensing

NRC personnel

D. Dumbacher, Senior Resident Inspector, Browns Ferry
L. Pressley, Resident Inspector, Browns Ferry
C. Stancil, Resident Inspector, Browns Ferry
E. Guthrie, Chief, Special Projects, Browns Ferry

ITEMS OPENED, CLOSED AND DISCUSSED

None

LIST OF DOCUMENTS REVIEWED

PERs

PER 436575	PER 177206	PER 608228	PER 516437
PER 598749	PER 539040	PER 602190	PER 475878
PER 408067	PER 550072	PER 371700	PER 435440
PER 372659	PER 382507	PER 516455	

Procedures

NC-SPP-01.04, NC Oversight of Supplemental Personnel, Rev. 000
MCI-0-073-PMP002, Maintenance of the High Pressure Coolant Injection Booster Pump,
Rev. 00021

Service Requests

625205
624495
624835

Miscellaneous

DCN 51198A
Overpressure Effects on BFN Unit 1 HPCI System Components, dated 5/31/1011