UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

November 2, 2010

Mr. Ashok S. Bhatnagar
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and Construction
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SUBJECT: WATTS BAR NUCLEAR PLANT, UNIT 2 – FACTORY ACCEPTANCE TEST OF EAGLE-21 AUDIT REPORT (TAC NO. ME2731)

Dear Mr. Bhatnagar:

The U.S. Nuclear Regulatory Commission (NRC) staff performed an audit during the factory acceptance test of the Eagle-21 system to be used at the Watts Bar Nuclear Plant, Unit 2. The audit took place from May 10 to May 13, 2010 at Westinghouse's facility located in New Stanton, Pennsylvania. Enclosed is the audit summary report prepared by the NRC staff.

If you should have any questions, please contact me at 301-415-2048.

Sincerely,

Justin C. Poole, Project Manager
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Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-391

Enclosure:
As stated

cc w/encl: Distribution via Listserv

REGULATORY AUDIT SUMMARY OF THE

FACTORY ACCEPTANCE TEST OF THE EAGLE-21 SYSTEM USED AT

WATTS BAR NUCLEAR PLANT, UNIT 2

BACKGROUND

By letter dated December 5, 2008 (Agencywide Documents Access and Management System (ADAMS) Accession Number ML083440224), as supplemented by letter dated February 28, 2009 (ADAMS Accession Number ML090570741), the Tennessee Valley Authority (TVA) requested the approval of the Eagle-21 System, which is to be used for the Reactor Protection System and the Engineered Safety Features Actuation System in Watts Bar Unit 2 (WBN2). The request was based on the fact that the Unit 2 Eagle-21 system is the same as the Unit 1 Eagle-21 system except for some minor hardware differences. There are no differences in the software configuration of the Eagle-21 system for both Watts Bar Units.

An audit was necessary to identify and confirm design and process information that supports the evaluation of claims by TVA that the Eagle-21 System for WBN2 is identical to the Eagle-21 System used at Unit 1 and, therefore, does not require additional detailed staff review beyond that provided to approve the Watts Bar Unit 1 (WBN1) Eagle-21 Reactor Protection System/Emergency Safety Features Actuation System.

The Nuclear Regulatory Commission (NRC) staff performed the audit at the Westinghouse facility in New Stanton, Pennsylvania between May 10 and May 13, 2010. The staff involved included Hukam Garg (Division of Engineering, Instrumentation and Controls Branch (EICB)), Norbert Carte (EICB), Patrick Milano (Division of Operating Reactor Licensing, Watts Bar Special Projects Branch), Lisa Castelli (Region II, Division of Construction Inspection) and Derek Halverson (on rotation to EICB). During this time Westinghouse was conducting the Factory Acceptance Test (FAT). The staff performed the audit in accordance with the Factory Acceptance Test Audit Plan dated April 26, 2010, which had been transmitted to TVA (ADAMS Accession Number ML101121039).

Individuals the staff interacted with included:

John Kunicky	Westinghouse
Jeremy Paxton	Bechtel/TVA
John Craig	Bechtel/TVA
David Langley	TVA
Jay Anderson	Westinghouse
Nicholas Norante	Westinghouse
Andrew Drake	Westinghouse
James Doyle	Westinghouse
Frank Rizzi	Westinghouse
Steve Hilmes	TVA

ENCLOSURE

AUDIT SUMMARY

This audit was done based on WBN1 licensing basis, and its conclusions are based on that. These conclusions may have not been the same if they were based on the current regulatory criteria identified in the Standard Review Plan chapter seven and the Interim Staff Guidance that have been published to clarify the requirements. As described in the audit plan, seven audit focus areas were covered.

1. Software V&V (Verification and Validation)
2. Configuration Management
3. Software Quality Assurance
4. Software Safety
5. Hardware, Software, and Procedure changes
6. Software SDOE (Secure Development and Operational Environment)
7. Hardware Qualification

Summaries of the specific audit activities and conclusions follow, categorized by their focus area. These were briefly described at the exit briefing.

1. Software V&V:

The NRC staff audited the final V&V reports for the Eagle-21 software (WCAP-13191 Revision 2.0 dated October 1992 and WCAP-13191 Supplement 1 dated August 1994) and compared the software version and revision against the drawing applicable to both Unit 1 and Unit 2. The NRC staff verified that the same software is used in both WBN1 and WBN2. The NRC staff also verified that all the software versions are the same as indicated in the V&V reports. Based on the fact that the software is the same on both Unit 1 and Unit 2, the NRC staff verified that the WBN2 application software V&V program is identical to the WBN1 software V&V program.

Mislabeled EPROM

As part of the NRC verification activities, the NRC staff compared the version identification on the erasable programmable read only memory (EPROM) chips to the version on the configuration drawings. One EPROM was identified as having the wrong socket number on the label. Westinghouse subsequently checked every label against every drawing, and it was determined that the NRC found the only mislabeled chip. The NRC witnessed the verification that the chip had the correct software, and that the error was on the label, which was typed.

Functional Requirements

The staff also reviewed the functional requirements for the control and protection system detailed in Westinghouse Report WAT/WBT 300/Series, "Functional Requirements."

The staff then compared these requirements with the specifications for the factory acceptance testing to determine whether they were properly translated into the test specifications. In

general, the staff found that the functional requirements were appropriately incorporated into the test specification.

Ambient Temperature and Relative Humidity Not Monitored in Test Procedures

In its review of the test specification, the staff then assessed how requirements were translated into specific test procedures. In particular, the staff noted that Section 5.5, "System Surveillance," of WNA-DS-01963-WBT, Revision 0, "Eagle-21 Factory Acceptance Test Specification," states that surveillance configuration tests will be required for each cabinet-specific input/output configuration and will consist of functional tests, checks, calibration verification, time response, and dynamics to demonstrate that the tester subsystem is operating within Eagle-21 specifications. Although the specifications were adequately incorporated into the procedures, the staff observed that the test specifications required that the testing be done within a specific range of ambient temperature and relative humidity. However, the test procedures did not include these initial conditions nor were the temperature and humidity being monitored in the test shop. The staff does not consider this as a significant issue because if temperature and relative humidity would have been out of range then testing would have been stopped because that would have been uncomfortable to the test personnel.

Steam Line Pressure and Containment Pressure Requirements

The staff reviewed the functional requirements for steam line pressure and containment pressure. These requirements were traced into the FAT specification and then into FAT Procedures, Surveillance Functional Test, E21-SRV-216, Revision 5, and E21-SRV-217, Revision 3, for steam line pressure and containment pressure, respectively. In this regard, the staff reviewed the completed configuration and surveillance test procedures for steam line and containment pressure to determine if out of specification conditions existed. In both cases, acceptance criteria were met for trip point verification and response time testing. Also, the steam line pressure rate is used to actuate the closure of the main steam line isolation valves. The functional requirements for the method of conducting the time response test of this calculated parameter did not specifically translate into the documentation for the surveillance test, in terms of initial and final test points and the time constants were set to a value of 1. The units of measure for the acceptance criteria for rate were listed as 100 psi rather than 100 psi/second. Although the documentation of the initial and final test points in the printout of the test results were not in terms of rate, the test process for measuring the response time appears to be adequate. Also, the time constants will be established and set during field testing and the acceptance results for response time of the rate function will be verified.

Over Temperature Delta T and Reactor Coolant System Flow Calculation Requirements

In addition, in order to better understand the Westinghouse documentation system for Eagle-21, the NRC sampled the requirements for the Over Temperature Delta T and the Reactor Coolant System Flow calculation and traced them from the requirements documentation to the FAT procedures. The WBN2 FATs witnessed by the staff confirm that the hardware and software are working properly. The Validation of the Software is documented in the final V&V reports.

2. Configuration Management:

In the process of determining that the software for Unit 2 is identical to the software for Unit 1, the NRC staff also confirmed that the configuration management system for Unit 2 is identical to Unit 1.

Drawing Review

Also, the NRC staff audited Eagle-21 drawings in order to identify any additional differences between the two units. The drawings reviewed were those identified by Westinghouse as being different between Unit 1 and Unit 2.

These drawings were:

1. "Eagle-21 Cabinet Configuration" Drawing 1C83609(Unit 2)/8252C10(Unit 1)

2. "I/O Board Location" Drawing 6D31444(Unit 2)/2007E88(Unit 1)

3. "Termination Frame Configuration" Drawing 6D31443(Unit 2)/3D22123(Unit 1)

4. "EAO-01 Board Configuration" Drawing 3D21663(Unit 2)/ "EAO-02 Board Configuration" Drawing 3D21664(Unit 1)

The differences in the drawings were then compared to the list of differences documented in the Engineering Design Change Request (EDCR) Unit Difference Form (EDCR# 52319, Revision A, pages 79-82).

The staff noted that a number of specific changes were not identified in the EDCR. Specifically that the jumper designations on the input boards and the connecter key combinations on the termination frame for the output cards have changed. However the higher level causes for these changes, the different input current and the use of a different output card, were indicated. The staff noted some additional changes that did not raise concerns. These changes were that the artwork and labeling has been updated, and in Unit 2 a shelf life statement is only required to be supplied with cards designated as spare parts, as opposed to all cards as in Unit 1.

Finally the staff noted that the EAO-01 Board Configuration Drawing no longer mentions applying a conformal coating to the output card, whereas the original version of the EAO-02 Board Configuration Drawing, used in Unit 1, did have that step and included a list of materials needed to apply the coating. However the Unit 1 drawing had been revised to have the list of conformal coating materials crossed out.

The staff concluded that the differences identified in the drawings were consistent with previously identified changes.

3. Software Quality Assurance:

During the FAT audit, Westinghouse informed the audit team that during the FAT of the WBN2 Eagle-21 System Loop Calculation Processor (LCP), diagnostic failures have been experienced

on Rack 5 while performing a parameter update. The failure causes the LCP to halt and enter error handling mode. Investigation has shown that Rack 5, which is a heavily loaded rack, has less cycle time margin than other racks, and testing has confirmed that a parameter update request coincident with a long LCP loop cycle can cause the loop time to be exceeded. This failure occurred during the FAT because the test requires a large number of parameter updates to be done. Westinghouse has analyzed this failure for WBN1 and determined that this failure does not have any potential impact on the operation of the WBN1 Eagle-21 system because LCP lock up will not occur without a parameter update. When performing a parameter update the cabinets are placed in either the bypass or partial trip conditions.

Investigation and testing are proceeding to find the cause of the problem. Westinghouse has made a commitment to keep TVA informed of their progress in resolving this issue. The audit team will keep this issue open until the cause and fix for the problem is documented by Westinghouse for the WBN2 Eagle-21 system.

4. Software Safety:

In the process of determining that the software for Unit 2 is identical to the software for Unit 1, the NRC staff also confirmed that there was no change to any analysis that supported software safety.

5. Hardware, Software, and Procedure changes:

Unidirectional Communications Interface

By letter dated December 5, 2007 (ADAMS Accession Number ML073440022), TVA notified the NRC that TVA intended to use the Westinghouse Eagle-21 process protection system on WBN2. Furthermore, TVA stated: "The Watts Bar Unit 2 Westinghouse Eagle-21 process protection system will be constructed to the same specification and standards as the Watts Bar Unit 1 Eagle-21 system. Watts Bar Unit 2 hardware will be identical or equivalent to Unit 1. Watts Bar Unit 2 safety related firmware will be identical to the Watts Bar Unit 1 firmware...TVA has made one design change to the Unit 1 Eagle-21 system under 10 CFR 50.59 [Title 10 of the *Code of Federal Regulations* Section 50.59] after initial licensing. An external unidirectional communications interface was installed between the Eagle-21 test subsystem and the plant process computer. This nonsafety-related change allows the process computer to acquire data from the Eagle-21 system. This same modification will be performed for the Unit 2 Eagle-21 system."

By letter dated December 27, 2007 (ADAMS Accession Number ML073610443), the NRC requested additional information regarding the external unidirectional communications interface. By letter dated February 28, 2008 (ADAMS Accession Number ML080640269), TVA responded to this request for information. By letter dated May 7, 2008 (ADAMS Accession Number ML081210506), the NRC documented that it had reviewed the information previously provided and determined that additional information was required. By letter dated August 25, 2008 (ADAMS Accession Number ML082410088), TVA responded to this request for additional information.

In order to verify the information provided by TVA in the letters identified above, the NRC staff reviewed design documentation to verify that the external communications interface was, in fact, unidirectional. The Eagle-21 internal wiring diagrams 1856E57 through 70 show the Serial to Ethernet Controller (SEC) is connected to the Eagle-21 system in three ways: (1) SEC Multibus card edge, (2) serial port J2, and (3) parallel port J1. Each of the connections was examined as described below.

(1) The iSBC® 286/12 manual (see page 4-20) describes the removal of jumper E19-E20 and installation of jumper E20-E21, which will disable Multibus communication of the SEC board. This jumper configuration was verified to be used in the Watts Bar application and is shown on the board configuration drawing 5D93433.

(2) The iSBC® 286/12 manual (see page 3-17) describes the pin-out of the serial port J2. Watts Bar uses a cable whose wiring is described by drawing 3D20355 to connect to this port. The transmit (from SEC) wires are omitted in the manufacturing of this cable.

(3) The iSBC® 286/12 manual (see page 5-10) describes placing a jumper on E138-E140, which will configure the parallel port J1 as a receive port. This jumper configuration was verified to be used in the Watts Bar application and is shown on the board configuration drawing 5D93433.

However the staff did not confirm that the testing demonstrated that two way communication is impossible. The staff considers this item open until TVA confirms testing has demonstrated that two way communication is impossible with the described configurations.

Testing in Bypass

During the entrance meeting Westinghouse presented a brief overview of the Eagle-21 system used at WBN2. During this presentation Westinghouse stated that the Eagle-21 system is designed such that it can be tested in bypass with administrative controls.

The NRC staff was concerned about whether administrative control can prevent bypassing more than one channel. Westinghouse identified that the individual must have access to the following:

- Man-Machine Interface (MMI) test cart
- Key for the process rack door. A status light on the control board alerts the operator that the protection set has been entered. If a technician opens the doors of two protection sets, the operator is alerted by an annunciator.
- Key for the rack mounted test panel selector switch.
- Password that is entered through the MMI keyboard.

TVA further stated that based on these same design features, testing in bypass has been approved by the staff for Eagle-21 functions in the WBN1 Technical Specifications. Therefore,

the staff considers this issue resolved for WBN2. The staff verified the TVA statement and based on this, consider this issue closed.

Obsolescence, Availability and FAT Procedures

The NRC staff reviewed a sample of the changes identified by Westinghouse since the approval of the Eagle-21 system approved at WBN1 with the appropriate Westinghouse representative.

Various hardware changes were made to address obsolescence and availability issues. A couple of these hardware changes were discussed in sufficient detail to understand that they had no impact on the WBN2 application. The hardware changes were made in accordance with equivalency evaluations.

The Unit 2 FAT procedures were created from the Unit 1 procedures, and incorporate some minor changes. All changes that were identified as part of the audit were examined and determined to have been made appropriately. No V&V procedures changed since V&V was performed on Unit 1 and the software did not change.

6. Software SDOE:

TTL Compatibility

Prior to the FAT, when the newly built Eagle-21 racks were undergoing energization testing, the trouble and channel set failure test panel status indicator lights and the trouble and channel set failure annunciator contact outputs would cycle on and off. These alarms indicated that there was a problem with the communication between the power supply and the DDC Multibus card. The problem was traced to the fact that the newer version of the power supply that was specified for this cabinet had a power fail contact output that was not TTL compatible. The problem did require additional rework in order to modify the circuitry to accommodate the lack of TTL compatibility. The additional work was to add a pull-up resistor to the +15V power supply failure circuits for the primary and secondary power supply failure circuits. The NRC staff determined that Westinghouse properly initiated the corrective action program that documented the failure, identified the root cause, and identified the corrective action needed to fix the problem.

Procedure/Attachment Mismatch

The NRC staff also reviewed the FAT test data and followed to determine how problems identified during FAT were processed at the facility. The NRC staff picked configuration test E21-CON-210, Rev. 5 for pressurizer pressure channel test. The technician determined that a bistable output identified in the procedure, and Attachment 1 of the procedure, did not match and stopped further testing until the mismatch was resolved. The NRC staff was interested in finding out how this issue was handled for other Eagle-21 systems. Westinghouse looked into the document and informed the staff that the procedure was generic and Attachment 1 is plant specific, where plant specific information is identified, such as using a 10-50 milliAmpere versus a 4-20 milliAmpere transmitter. Westinghouse also determined that the problem was with Attachment 1 and not with the original procedure that is generic to all plants; therefore this

problem was not applicable to other plants. Based on this explanation the staff finds this issue closed.

7. Hardware Qualification:

The NRC staff audited the qualification of the power supply used in the Eagle-21 system. TVA had previously identified that Westinghouse had replaced the original power supply with a power supply from a different vendor. These power supplies are safety related and Westinghouse has qualified them for environmental and seismic requirements in a test report dated June 2006 and for Electromagnetic Interference/Electromagnetic Compatibility requirements in a test report dated December 17, 2008.

These reports do not discuss the compliance with the guidance provided in Regulatory Guide1.209, "Guidelines for Environmental Qualification of Safety-Related Computer-Based Instrumentation and Control Systems in Nuclear Power Plants" (ADAMS Accession Number ML070190294). TVA believes these power supplies have also been used in WBN1 and they have performed a form, fit, and function evaluation to qualify these new power supplies. TVA did not produce any document to support this assertion.

The NRC staff concluded that this item will remain open until TVA provides documentation to demonstrate that these power supplies have been used and qualified in Unit 1 and, therefore, meet the licensing basis for Unit 2. If TVA has not used and qualified these power supplies in Unit 1 then TVA will have to discuss the new licensing basis for Unit 2, which will require it to address the guidance provided in Regulatory Guide 1.209 (ADAMS Accession Number ML070190294).

OPEN ITEMS/CLOSURE PATHS:

1. The audit team will keep the Rack 5 LCP diagnostic failure issue open until the cause and fix for the problem is documented by TVA for WBN2 Eagle-21 system (Corrective Action Program Number 10-123-M015).

2. The audit team will keep the power supply item open until TVA provides documentation to demonstrate that these power supplies have been used and qualified in Unit 1 and, therefore, meet the licensing basis for Unit 2. If TVA has not used and qualified these power supplies in Unit 1 then TVA will have to discuss the new licensing basis for Unit 2, which will require it to address the guidance provided in Regulatory Guide 1.209 (ADAMS Accession Number ML070190294).

3. The staff will keep the unidirectional communications interface issue open until TVA confirms testing has demonstrated that two way communication is impossible with the described configurations.

MATERIALS REVIEWED

1. "Eagle-21 Cabinet Configuration" Drawing 1C83609(Unit 2)/8252C10(Unit 1)

2. "I/O Board Location" Drawing 6D31444(Unit 2)/2007E88(Unit 1)

3. "Termination Frame Configuration" Drawing 6D31443(Unit 2)/3D22123(Unit 1)
4. "EAO-01 Board Configuration" Drawing 3D21663(Unit 2)
5. "EAO-02 Board Configuration" Drawing 3D21664(Unit 1)
6. Drawing 108D408 "Process Control Block Diagrams"
7. EDCR# 52319, Revision A
8. iSBC® 286/12 Manual
9. Drawing 5D93433
10. Drawing 3D20355
11. Wiring Diagrams 1856E57 through 70
12. WNA-DS-01963-WBT, Revision 0, "Eagle-21 Factory Acceptance Test Specification"
13. FAT Procedures, Surveillance Functional Test, E21-SRV-216, Revision 5, and E21-SRV-217, Revision 3
14. Westinghouse Report WAT/WBT 300/Series, "Functional Requirements."

REFERENCES

1. Standard Review Plan (NUREG-0800), Chapter 7, "Instrumentation and Controls"

2. Regulatory Guide 1.152, Revision 2, dated January 2006, "Criteria for Use of Computers in Safety Systems of Nuclear Power Plants"

3. Regulatory Guide 1.153, Revision 1, dated June 1996, "Criteria for Safety Systems"

4. Regulatory Guide 1.168, Revision 1, dated February 2004, "Verification, Validation, Reviews, and Audits for Digital Computer Software Used in Safety Systems of Nuclear Power Plants"

5. Regulatory Guide 1.169, dated September 1997, "Configuration Management Plans for Digital Computer Software Used in Safety Systems of Nuclear Power Plants"

6. Regulatory Guide 1.173, dated September 1997, "Developing Software Life Cycle

7. Regulatory Guide 1.180, dated October 2003, "Guidelines for Evaluating Electromagnetic and Radio-Frequency Interference in Safety-Related Instrumentation & Control Systems"

8. Processes for Digital Computer Software Used in Safety Systems of Nuclear Power Plants"

9. Institute of Electrical and Electronic Engineers (IEEE) Standard (Std) 7-4.3.2-2003, "IEEE Standard Criteria for Digital Computers in Safety Systems of Nuclear Power Generating Stations"

10. IEEE Std 603-1991, "IEEE Standard Criteria for Safety Systems for Nuclear Power Generating Stations"

11. IEEE Std 730-1998, "IEEE Standard for Software Quality Assurance Plans"

12. IEEE Std 828-1990, "IEEE Standard for Software Configuration Management Plans"

13. IEEE Std 1012-1998, "IEEE Standard for Software Verification and Validation"

14. IEEE Std 1028-1997, "IEEE Standard for Software Reviews and Audits"

15. American National Standard Institute/IEEE Std 1042-1987, "IEEE Guide to Software Configuration Management"

16. IEEE Std 1074-1995, "IEEE Standard for Developing Software Life Cycle Processes"

17. Regulatory Guide 1.209, Dated March 2007, "Guidelines for Environmental Qualification of Safety-Related Computer-Based Instrumentation and Control Systems in Nuclear Power Plants"

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If you should have any questions, please contact me at 301-415-2048.

Sincerely,

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