AUDIT REPORT

Pressurized Water Reactor Owners Group
Topical Report WCAP-17867-P, Revision 0,
"Westinghouse SSPS Board Replacement Licensing Summary Report"

(TAC No. MF3550)

Background: By letter dated February 21, 2014 (Agencywide Documents Access and Management System (ADAMS) Accession Number ML14057A289), Pressurized Water Reactor Owners Group (PWROG) submitted Topical Report (TR) WCAP-17867-P, Revision 0, "Westinghouse SSPS [Solid State Protection System] Board Replacement Licensing Summary Report." The PWROG submitted this TR to the U.S. Nuclear Regulatory Commission (NRC) for review and approval for licensees to reference the NRC approved TR in their Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50.59 Screens/Evaluations that will be completed to install the new design SSPS circuit boards. The NRC staff conducted an audit April 7-11, 2014, to support the review of the TR (described below).

Material Audited: (a list of specific documents audited is included):

- Schematic Diagrams of Boards (new and old)
- List of all documents exchanged with each vendor (design and fabrication)
- Westinghouse Specifications, Test Procedures, and Test Reports
- Documentation associated with vendor controls

Team Assignments: Norbert Carte: Team Lead

Royce Beacom:
- Regulatory Evaluation of Software Development Processes
  - Complex Programmable Logic Device (CPLD)
- Programming Verification & Validation
  - Configuration Management
- Lead for Vendor Controls
  - Technical Controls for CPLD Programming

Norbert Carte:
- Review Planned Response to Request for Additional Information
- Requirements Tracing
- Lead for Testing Analysis

Stephen Wyman:
- Circuit Comparisons (new versus old)
- Independence Analysis

Shavon Edmonds
- Assist with Vendor Controls
- Vendor Control and Quality Assurance
- Assist with Testing Analysis
- Assist with Requirements Tracing

Logistics: Audit started 1:00 pm on Monday, April 7, 2014 (Kickoff, Introductions, and Tour)
Audit hours were generally 8:00 am to 5:00 pm, except as noted
Audit was completed by 10:30 am on Friday, April 11, 2014.

Audit Guidance: The audit plan (ADAMS Accession Number ML14083A627) was used as guidance during the audit.

Audit Summary

The subject TR includes some discussion of PWROG member activities to ensure the CPLD-based SSPS cards, provided by Westinghouse Electric Company (Westinghouse), met the various plant needs. During the audit some descriptions of these activities were provided. However, no PWROG member documentation was reviewed and no effort was made to confirm any of the PWROG member activities. Therefore, the NRC staff will not take any credit for PWROG member activities in the safety evaluation. The safety evaluation will only rely upon Westinghouse docketed material.

Regulatory Compliance Matrix: During the audit, a "SSPS New-Design Boards Licensing Action Items" list was started. This list includes items completed during the audit and other items that were to be discussed in the bi-weekly telephone conferences. One of these action items included a regulatory compliance matrix. Based on the high-level-summary nature of the regulatory evaluation in the TR and the action item to provide a detailed regulatory compliance matrix, the regulatory review of the TR will focus on other areas until the regulatory compliance matrix is provided.

Technical Requirements Traceability Matrix: As stated in the audit plan, several technical requirements were traced, starting from the "Westinghouse Design Specification…" for each card (i.e., TR reference Nos. 78-85). These requirements were traced to the associated "…Functional Test Procedures" (i.e., TR reference Nos. 86-93) and the associated "…System Functional Test Procedures" (i.e., TR reference Nos. 95-102). The tracing activity ran into a few challenges such as: (1) tracing requirements from original/vintage board drawings to new-board drawings, (2) some text identified as a requirement had several aspects, and the documented tracing did not demonstrate how all aspects were addressed, and (3) requirements tracing to the design vendor documentation was not to the same level as it was done internally to Westinghouse. Based on these observations, the PWROG decided to complete a comprehensive technical requirements traceability matrix.

Test Analysis: The TR contains Section 5, "Testing for Regulatory Compliance," which is supported by Appendix B, **[**

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Draft Request for Additional Information: A draft of the first set of Requests for Additional Information (RAIs) was discussed during the audit. No clarification was requested, and the PWROG did not identify any proprietary material in the RAI questions.

Circuit Comparison & Independence Analysis: The NRC staff found that auxiliary features will not impede the safety function in accordance with the Institute of Electrical and Electronics Engineers standard (IEEE Std) 603-1991 Clause 5.12. Further, the NRC staff also identified that new design cards eliminates a significant number of single point vulnerabilities that existed in the original card designs. New design cards also offer broad fault detection capability that will improve debug times both on and off the cards. This is a known issue with the vintage cards. The NRC staff was not able to identify any failures that would impede the safety function that are not detectable. Finally, the NRC staff examined the mean time between failures (MTBF) calculations and confirmed the reliability of the new design cards is improved over the original design.

Circuit Comparison & Independence Analysis

There are three circuit boards in the SSPS systems that are required to perform the safety function: the Universal Logic Board (ULB), the Safeguard Driver board (SGD), and the Under Voltage Driver board (UVD). The Auxiliary Features (as defined in IEEE Std 603-1991) on each board were examined to ensure they do not interfere with the safety function (i.e., comply with IEEE Std 603-1991 Clause 5.12).

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To determine whether the safety function is protected, the audit examined the auxiliary features of the ULB, SGD, and UVD boards. It was determined that the auxiliary features on these boards do not impact the safety function.

Universal Logic Board

The ULB performs the coincidence voting for the SSPS.

Westinghouse Documentation Used:

- New ULB board
  - 3D91481 Revision 3, Sheets 1-5, ULB Schematic Diagram
  - 3D91475 Revision 1, Sheets 1-2, ULB test CPLD Schematic Diagram

  - 1TR1014 Revision 0, "Failure Modes and Effects Analysis [(FMEA)] for Solid State Protection System Universal Logic Board."
  - 1TR1015 Rev 1, "MTBF Estimate for Solid State Protection System Universal Logic Board,"
- Original ULB boards
  - 1046F57 Revision A, Sheet 1, Schematic Diagram Universal Board

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Under Voltage Driver board

Westinghouse Documentation Used:

- New UVD board
  - 418A51, Revision 1, "Westinghouse Design Specification SSPS Under Voltage Drive Board Replacement"
  - 1TS2925, Revision 2, "Under Voltage Driver Board 6D3035G01/G02 Functional Test Procedure."
  - 1TR1019, Revision 0, "Failure Modes and Effects Analysis for Solid State Protection System Under Voltage Driver Board."
- Original UVD boards
  - 6058090 Revision F, Sheet 1, Schematic Diagram UVD

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Safeguard Driver board

Westinghouse Documentation Used:

- New SGD board
  - 418A50, Rev 2, "Westinghouse Design Specification Safeguards Driver Board Replacement."
  - 1TR1017 Rev 0, "Failure Modes and Effects Analysis for Solid State Protection System Safe Guards Driver Board,"
- Original SGD boards
  - 6057D48 Rev A Sheet 1, Schematic Diagram SGD

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Summary Observations on the Auxiliary Features

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Overall, the NRC staff found some measure of protection between the components required to perform the safety function and the auxiliary circuits that were reviewed. The NRC staff found, pending the resolution of the open action items, there is reasonable assurance the new design SSPS cards auxiliary functions will not impede the safety function and therefore meet the criteria of IEEE Std 603-1991 Clause 5.12.

Vendor Controls and Quality Assurance

The following two subsections document how audit activities addressed vendor controls by Westinghouse with regard to the original design vendor of the circuit boards, **[ ]**, as well as the manufacturing vendors of the circuit boards, **[ ]**. The NRC staff expected these vendor activities to be clearly under the Westinghouse 10 CFR Part 50 Appendix B program. However, the NRC staff noted the design vendor produced commercial products and operated under Westinghouse's approved 10 CFR Appendix B program while the manufacturer vendors operated under their own 10 CFR Appendix B program. Components purchased for the fabrication of the SSPS cards were purchased commercially and dedicated under Westinghouse commercial dedication instructions (CDI) and various design and test procedures which were delivered though purchase orders to the manufacturer vendor. Also, in the case of the SSPS CPLD boards, WCAP-17867 takes credit for the interactions with these vendors as part of the commercial grade dedication process and the digital computer quality life cycle process of IEEE Std 7-4.3.2 as endorsed by Regulatory Guide (RG) 1.152. The NRC staff also reviewed multiple receipt inspections of various SSPS boards to ensure that Westinghouse has in place a method of assuring that commercial grade dedication activities are carried out correctly.

Design Vendor

The NRC staff examined the Westinghouse activities and interactions with the design vendor, **[ ]**. The NRC staff examined the documentation for the commercial grade surveys and design reviews. The NRC staff observed this documentation as referenced by the WCAP-17867 (unless noted otherwise):

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- Design Reviews (May 2004, August 2006, and February 2009)
- Design Hold Points (documentation not available):
    - Conceptual Design
    - Schematic Capture
    - Prototype Board Operation
    - Prototype Testing

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Manufacturing Vendors

The NRC staff reviewed the Westinghouse activities and interactions with the manufacturing vendors: **[ ]** The NRC staff reviewed the commercial dedication instruction, qualified supplier listings, corrective actions, non-conformances, supplier quality program audit report, and samples of purchase orders and certificates of compliance.

The NRC staff reviewed the following documentation (not referenced by the WCAP):

- Commercial Grade Instruction 3015, Revision 3, dated 7/12/2010
- P.O. 4500459649 dated 1/10/2013
- P.O. 4500463546 dated 2/12/2013
- Certificate of Conformances dated 10/08/2013, 10/21/2013, and 12/31/2013
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- Supplier Quality Program Audit Report, WES-2012-318-R, dated 2/14/2013
- Issue Report WEC IR#11-117-M001, "Vogtle plant Trip," dated 7/21/11
- Issue Report WEC IR#13-275-M006 "Shearon Harris NRC Violation for using 10 CFR 50.59 to install new SSPS cards" dated 2/1/14
- Issue Report IR#13-129-M012 "S.O 80785, RMA 70006286- Warranty Repair, SSPS UPGRADED ULB" dated 7/18/13
- Issue Report IR#12-045-M045 "Warranty return of two SSPS PC cards" dated 7/1/12
- Issue Report IR#11-276-M052 "Discrepancy in Seismic Test Levels for SSPS Cabinet Components" dated 3/16/12
- Issue Report IR#12-123-M025 "Salem Unit 1 SSPS Train A unexpected SI and trip during testing" dated 8/17/12

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Additional Documents Examined

1. 3D91471- Undervoltage Driver Schematic Diagram-Revision1, Sheet 1
2. 3D91472- Safeguards Driver Schematic Diagram- Revision1, Sheet 1-5
3. 3D91474- Universal Logic Board Main CPLD Schematic Diagram- Revision 0, Sheet 1
4. 3D91475- Universal Logic Board Test CPLD Schematic Diagram- Revision 1, Sheet 1-2
5. 3D91476- Safeguards Output Driver Main CPLD Schematic Diagram- Revision 0, Sheet 1-2
6. 3D91477- Safeguards Output Driver Test CPLD Schematic Diagram- Revision 0, Sheet 1-2
7. 3D91478- Undervoltage Driver Board Main CPLD Schematic Diagram- Revision 0, Sheet 1
8. 3D91479- Undervoltage Driver Board Test CPLD Schematic Diagram- Revision 1, Sheet 1-2
9. 3D91481- Universal Logic Board Schematic Diagram- Revision 3, Sheet 1-5

10. 418A49 -Design Specification- Universal Logic Board Replacement-Revision 3, Sheet 1-28

11. 418A49- Design Specification - Universal Logic Board Replacement- Revision 4, Sheet 1-27

12. 1046F57- Schematic Diagram Universal Board - Revision A, Sheet 1

13. 6057D48 - Schematic Diagram Safeguards Output Board- Revision A, Sheet 1

14. 6058D90- Schematic UV Output Board Solid State Protection System- Revision F, Sheet 1

15. 6069D07 -Schematic Diagram Safeguards Driver Solid State Protection System- Revision E, Sheet 1

16. 6101D28-Schematic U.V. Output Board Solid State Protection System- Revision B, Sheet 1

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20. RFDS-NST-10-377- Universal Logic Board Assembly Index for drawing #6D30225-R10-S1-2

21. 1TS2870 - Universal logic Board 6D30225G01/G02 Functional Test Procedure- Revision 0, Sheet 1-88

22. 1TR1015 MTBF Estimate for Solid State Protection System Module Universal logic Board 6D30225-Revision1, Sheet 1-54

23. 1TR1017 -Failure Mode and Effects Analysis for Solid State Protection System Module- Revision 0, Sheets 1-70

24. 1TR1019 -Failure Mode and Effects Analysis for Solid State Protection System Module - Revision 0, Sheets 1-63

25. 1TR1014-Failure Mode and Effect Analysis for Solid State Protection System Module Universal Logic Board Rev 0

26. 1TS2871_COMP- Complete Universal Logic Board 6D30225G01/G02 System Functional Test Procedure - Rev 0

27. Westinghouse Document TDH121803001, Revision 2, "Project Plan, SSPS Circuit Boards Re-Design," July 17, 2006.

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37. Corrective action report 100000313 “Twenty audit reports not completed within 30 days as required by WEC 7.1” dated 1/23/2013

38. 10-147-M027- Alarms on the plant process computer with new design SSS boards installed

39. 11-028-M048- SSPS Cards failed functional testing- Krsko

40. 11-117-M001- Vogtle Plant Trip

41. 11-276-M052 & 12-005-MOll- Discrepancy in Seismic Test Levels for SSPS Cabinet Components

42. 12-045-M045- Warranty Return of two SSPS PC cards

43. 14-044-M029- Shearon Harris informed that installing new design SSPS cards should have prior NRC approval

44. 13-275-M006- Shearon Harris NRC Violation for using 10CFR 50.59 to install new design SSPS Circuit boards

45. Purchase Order No. 4500463546 1

46. Purchase Order No. 4500463546 0

47. Purchase Order No. 4500459649 3

48. Purchase Order No. 4500459649 0

49. SW0-13-092-M042 - Stop Work Order 4-8-13

50. SW0-13-092-M042.1- Stop Work Order 4-30-13

51. SWO 13-092-M042.2- Stop Work Order 6-27-13

52. 1TS2963- Universal logic Board Revision 4

53. 1TS2963- Universal logic Board Revision 1

54. QMS Revision 7

55. WEC 3.6.9

56. WEC 15.5

57. P.O. 4500379660, P.O. 4500379660_1, P.O. 4500379660_2

58. Dedication Package for Batch 136951 which included: RIR, Vendors C of C CDI Datasheets for S\N P117131,Test Procedure Datasheet for S\N P1117131

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62. TEST PROCEDURES:1TS2958 Revision 3,1TS2963 Revision 4,1TS3107 Revision 3

63. DEDICATION PACKAGE FOR BATCH 88553: Vendor C of C, Test Data Sheets, CDI Data Sheets

64. Batch 174440 and Batch 207086: Vendor C of C, Test Data Sheets, CDI Data Sheets

65. CAP IR's

66. 3QNS:60054004,60061169,60058400

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