Attachment 22

Non-proprietary Westinghouse Electric Company document WNA-VR-0279-WBT-P, Revision 5, "Requirements Traceability Matrix for the Post-Accident Monitoring System (Non-Proprietary)" dated October 2011 (Letter Item 12)

Westinghouse

Westinghouse Non-Proprietary Class 3

Nuclear Automation
Watts Bar Unit 2 NSSS Completion Program I&C Projects

Requirements Traceability Matrix for the Post-Accident Monitoring System

WNA-VR-00279-WBT-NP,
Rev. 5

October 2011

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REVISION HISTORY

RECORD OF CHANGES

Revision	Author	Description	Completed
0	Shawn M. Downey	Original Issue.	03/10
1	Shawn M. Downey	Updated for WNA-DS-01617-WBT, Rev. 2, WNA-DS-01667-WBT, Rev. 2, and WNA-SD-00239-WBT, Rev. 2. Corrected references and links between documents and added comments and clarifications to links. Added the Software Requirements RTM Table in Appendix B. Note that rev-bars are not shown in the RTM tables in Appendices A and B. These tables have been updated entirely.	10/10
2	Shawn M. Downey	Updated for WNA-DS-01617-WBT-P, Rev. 3, WNA-DS-01667-WBT-P, Rev. 3, and WNA-SD-00239-WBT-P, Rev. 3. Corrected references and links between documents.	11/10
3	Terrence C. Tuite	Included test linkages for the integration phase in Appendices A and B; and added Appendix C.	12/10
4	Terrence C. Tuite	Updated for WNA-DS-01617-WBT-P, Rev. 4; WNA-DS-01667-WBT-P, Rev. 4; and WNA-SD-00239-WBT-P, Rev. 4. Closed Open Items P058, P059, P060, P062 and P091. Included updates per V&V-888 Error Report.	02/11
5	Terrence C. Tuite	Closed Open Items P092 and P093. Included updates per NRC audit. Updated reference revisions as appropriate. Deleted Reference 70.	3/2011
5-NP	Terrance C. Tuite	Added proprietary markings to WNA-VR-00279-WBT, Rev. 5.	See EDMS

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REVISION HISTORY (cont.)

OPEN ITEMS

Item	Description	Status
None		

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ACRONYMS AND TRADEMARKS

Acronyms used in the document are defined in WNA-PS-00016-GEN, "Standard Acronyms and Definitions" (Reference 1), or included below to ensure unambiguous understanding of their use within this document.

Acronym	Definition
AI	Analog Input
CET	Core Exit Thermocouple
Common Q	Common Qualified Platform
CPCE	Custom Process Control Element
d/p	Differential Pressure
DI	Digital Input
DP	Differential Pressure Transducer
EUDH	Expected Uncompensated Dynamic Head
FE	Function Enable
FPD	Flat Panel Display
FPDS	Flat Panel Display System
HJTC	Heated Junction Thermocouple
I/O	Input/Output
ICC	Inadequate Core Cooling
INDH	Initial Normalized Dynamic Head
MCR	Main Control Room
MTP	Maintenance and Test Panel
NDH	Normalized Dynamic Head
NSSS	Nuclear Steam Supply System
OM	Operator's Module
PAMS	Post-Accident Monitoring System
PDH	Power Compensated Dynamic Head
P_{SAT}	Saturation Pressure
RCP	Reactor Coolant Pump
RCS	Reactor Coolant System
RJT	Reference Junction Temperature
RSED	Reusable Software Element Document
RTD	Resistance Temperature Detector
RVL	Reactor Vessel Level
RVLIS	Reactor Vessel Level Indication System
RVLMS	Reactor Vessel Level Monitoring System
SLE	Software Load Enable
SMM	Saturation Margin Monitor
T_{SAT}	Saturation Temperature
UDH	Uncompensated Dynamic Head
VF	Pseudo-Void Fraction

ACRONYMS AND TRADEMARKS (cont.)

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GLOSSARY OF TERMS

Standard terms used in the document are defined in WNA-PS-00016-GEN, "Standard Acronyms and Definitions" (Reference 1), or included below to ensure unambiguous understanding of their use within this document.

Term	Definition
AC160 Station	The entire **Advant®** Controller 160 (AC160) controller station, which is made up of a single base station subrack (CI631, PM646A, and S600 input/output [I/O] modules) and any optional I/O station or extension subrack (S600 I/O modules only). All processor modules (PMs) within the same AC160 station share the same Advant Fieldbus 100 (AF100) bus address (base station subrack thumbwheel switch).
AI687	The AI687 is a high-speed analog input module that processes 0-100 mV resistance temperature detector (RTD) and thermocouple signals.
AI688	The AI688 is a high-speed analog input module that processes 0-1V, 0-10V, and 4-20 mA input signals.
AO650	Analog output module that converts digital signals from the PM into analog signals. This module has eight output channels with can be configured to 0-20 mA, 4-20 mA, -20-20 mA, -10-10V, 0-5 V, 1-5V, and 0-10V ranges.
CI527	AF100 communications interface module that provides the AF100 high-speed bus control for the PC node box (FPDS).
CI631	AF100 communications interface module that provides the AF100 high-speed bus control for the AC160 station.
DI620	Digital input module that provides an interface for 32 hardwired digital input signals up to 48 Vdc.
DO620	Digital output module that converts internal binary signals from the PM to binary signals for use by an external process application. Each module supports up to 32 digital output channels.
IV&V	Verification and validation performed by an organization that is technically, managerially, and financially independent of the development organization.
PM646A	A processor module for the AC160 system used for safety applications. Usually shortened to simply "PM."

GLOSSARY OF TERMS (cont.)

Term	Definition
QNX®	Real-time operating system intended for use in the flat panel display system (FPDS).

REFERENCES

Following is a list of references used throughout this document.

1. WNA-PS-00016-GEN, Rev. 5, "Standard Acronyms and Definitions," Westinghouse Electric Company LLC.

2. WNA-PV-00009-GEN, Rev. 3, "Verification & Validation Process for the Common Q Safety Systems," Westinghouse Electric Company LLC.

3. WNA-DS-01617-WBT-P, Rev. 4, "Post Accident Monitoring System – System Requirements Specification," Westinghouse Electric Company LLC.

4. WNA-SD-00239-WBT-P, Rev. 4, "Software Requirements Specification for the Post Accident Monitoring System," Westinghouse Electric Company LLC.

5. WNA-DS-01667-WBT-P, Rev. 4, "Post Accident Monitoring System – System Design Specification," Westinghouse Electric Company LLC.

6. 00000-ICE-3889, Rev. 12, "Coding Standards and Guidelines for Common Q Systems," Westinghouse Electric Company LLC.

7. WCAP-16097-P-A, Rev. 0, "Common Qualified Platform Topical Report," Westinghouse Electric Company LLC.

8. 00000-ICE-30155, Rev. 9, "System Requirements Specification for the Common Q Generic Flat Panel Display," Westinghouse Electric Company LLC.

9. WNA-DS-01070-GEN, Rev. 5, "Application Restrictions for Generic Common Q Qualification," Westinghouse Electric Company LLC.

10. 00000-ICE-3239, Rev. 13, "Software Requirements Specification for the Common Q Generic Flat Panel Display Software," Westinghouse Electric Company LLC.

11. 00000-ICE-30157, Rev. 18, "Software Design Description for the Common Q Generic Flat-Panel Display Software," Westinghouse Electric Company LLC.

12. WNA-DS-00315-GEN, Rev. 2, "Reusable Software Element Document CRC for Calibration Data," Westinghouse Electric Company LLC.

13. WNA-DS-01150-GEN, Rev. 0, "Standard General Requirements for Cyber Security," Westinghouse Electric Company LLC.

14. AN03007Sp, Rev. 0, "AC160 CPU Loading Restrictions," ABB Process Automation Corporation.

REFERENCES (cont.)

15. 00000-ICE-30156, Rev. 08, "System Requirements Specification for the Common Q Post Accident Monitoring System," Westinghouse Electric Company LLC.

16. WNA-PD-00073-WBT, Rev. 0, "Project Plan Common Q Post Accident Monitoring System," Westinghouse Electric Company LLC.

17. 00000-ICE-3238, Rev. 5, "Software Requirements Specification Post Accident Monitoring System," Westinghouse Electric Company LLC.

18. WNA-CD-00018-GEN, Rev. 3, "Commercial Dedication Report for QNX 4.25G for Common Q Applications," Westinghouse Electric Company LLC.

19. WNA-IP-00152-GEN, Rev. 8, "Generic Common Q Software Installation Procedure," Westinghouse Electric Company LLC.

20. 00000-ICE-30152, Rev. 5, "Software Design Description Post Accident Monitoring System AC160 Station," Westinghouse Electric Company LLC.

21. 3BDS 005 665R401, Rev. A, "Data Base Elements, Advant Controller 160, Version 1.3 Reference Manual," ABB, Asea Brown Boveri.

22. 3BDS 005 666R101, Rev. C, "PC Elements Advant Controller 160, Version 1.3, Reference Manual," ABB, Asea Brown Boveri.

23. ANSI/IEEE Standard 754-1985, "IEEE Standard for Binary Floating-Point Arithmetic," Institute of Electrical and Electronics Engineers, Inc., 1985.

24. WNA-DS-01715-GEN, Rev. 4, "Standard Reusable Software Element Document for PM Diagnostics Type Circuit," Westinghouse Electric Company LLC.

25. WNA-CD-00029-GEN, Rev. 1, "Commercial Grade Dedication Report for the ABB Advant PM646A/PM646B Firmware/Base System Software Version 1.3/8, ACC Advanced Version 1.7/1, AC160 PC and DB Element Library Version 1.5/1 for Common Q Applications," Westinghouse Electric Company LLC.

26. WNA-DS-01564-GEN, Rev. 2, "Standard Reusable Software Element Document for Exclusive Module Error Type Circuit," Westinghouse Electric Company LLC.

27. WNA-DS-01838-GEN, Rev. 3, "Standard Reusable Software Element Document for Fourth-Order Polynomial Fluid Density Curve Fit Custom PC Element," Westinghouse Electric Company LLC.

28. WNA-DS-01839-GEN, Rev. 4, "Standard Reusable Software Element Document for Summation of Reference Leg Density Correction Custom PC Element," Westinghouse Electric Company LLC.

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29. WNA-DS-01840-GEN, Rev. 2, "Standard Reusable Software Element Document for 2-Input Maximum Comparison with Status Control Custom PC Element," Westinghouse Electric Company LLC.

30. WNA-DS-01841-GEN, Rev. 2, "Standard Reusable Software Element Document for 2-Input Minimum Comparison with Status Control Custom PC Element," Westinghouse Electric Company LLC.

31. WNA-DS-01842-GEN, Rev. 4, "Standard Reusable Software Element Document for RVLIS Static Level Calculation Custom PC Element," Westinghouse Electric Company LLC.

32. WNA-DS-01845-GEN, Rev. 6, "Standard Reusable Software Element Document for Dynamic Head Compensation Calculation Custom PC Element," Westinghouse Electric Company LLC.

33. WNA-DS-01846-GEN, Rev. 2, "Standard Reusable Software Element Document for Normalized Dynamic Head Compensation Custom PC Element," Westinghouse Electric Company LLC.

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35. WNA-DS-01848-GEN, Rev. 4, "Standard Reusable Software Element Document for the Reactor Vessel Level Monitoring Custom PC Element," Westinghouse Electric Company LLC.

36. WNA-DS-01849-GEN, Rev. 2, "Standard Reusable Software Element Document for the Reactor Coolant Pump Status Custom PC Element," Westinghouse Electric Company LLC.

37. WNA-DS-01994-GEN, Rev. 0, "Standard Reusable Software Element Document for a First Order Lag Filter Custom PC Element," Westinghouse Electric Company LLC.

38. WNA-DS-00306-GEN, Rev. 5, "Reusable Software Element Document Engineering Units Conversion," Westinghouse Electric Company LLC.

39. WNA-DS-02065-GEN, Rev. 2, "Standard Reusable Software Element Document for Reactor Vessel Level Alarm Custom PC Element," Westinghouse Electric Company LLC.

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41. WNA-CR-00010-WBT, Rev. 2, "User Configurable Setpoints for the Post Accident Monitoring System," Westinghouse Electric Company LLC.

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42. WNA-SD-00248-WBT, Rev. 3, "Software Design Description for the Post Accident Monitoring System Flat Panel Display," Westinghouse Electric Company LLC.

43. WNA-SD-00250-WBT, Rev. 3, "Software Design Description for the Post Accident Monitoring System AC160 Software," Westinghouse Electric Company LLC.

44. WNA-SD-00277-WBT, Rev. 3, "Post Accident Monitoring System Flat Panel Display System Screen Design Details," Westinghouse Electric Company LLC.

45. WNA-DS-01505-GEN, Rev. 0, "Standard Reusable Software Element Document for Reflash Type Circuit," Westinghouse Electric Company LLC.

46. WNA-RL-00272-GEN, Rev. 3, "Common Q Generic Flat Panel Display System Software Release Record," Westinghouse Electric Company LLC.

47. WNA-RL-00327-GEN, Rev. 1V, "Software Release Record for the PAMS01 AC160 Library," Westinghouse Electric Company LLC.

48. WNA-RL-00441-GEN_Rev7_Verified, Rev. 0, "Software Release Record for the RVLIS AC160 Library - Verified," Westinghouse Electric Company LLC.

49. WNA-RL-00530-GEN, Rev. 0V, "Software Release Record for the STDADD05 AC160 Library," Westinghouse Electric Company LLC.

50. WNA-RL-00646-WBT_Rev 5_Verified, Rev. 0, "Common Q Software Release Record for Watts Bar Unit 2 PAMS Train A, PAMA," Westinghouse Electric Company LLC.

51. WNA-RL-00648-WBT_Rev3_Verified, Rev. 0, "Common Q Software Release Record for Watts Bar Unit 2 PAMS Train B, PAMB," Westinghouse Electric Company LLC.

52. WNA-RL-00743-WBT_Rev5_Verified, Rev. 0, "Software Release Record for Watts Bar Unit 2 PAMS FPDS," Westinghouse Electric Company LLC.

53. WNA-LI-00058-WBT-P, Rev. 3, "Post-Accident Monitoring System (PAMS) Licensing Technical Report," Westinghouse Electric Company LLC.

54. WNA-VR-00283-WBT-P, Rev. 4, "IV&V Summary Report for the Post Accident Monitoring System," Westinghouse Electric Company LLC.

55. WNA-WD-00814-WBT, Rev. 1, "Post Accident Monitoring System Field Termination List," Westinghouse Electric Company LLC.

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56. WNA-TR-02389-WBT, Rev. 0, "Processor Module Software Test Report for the Post Accident Monitoring System," Westinghouse Electric Company LLC.

57. WNA-TP-02955-WBT, Rev. 0, "Post Accident Monitoring System Flat Panel Display Software Test Procedure," Westinghouse Electric Company LLC.

58. WNA-TP-02772-WBT, Rev. 0, "Post Accident Monitoring System Cabinet Hardware Test Procedure," Westinghouse Electric Company LLC.

59. WNA-TR-02413-WBT, Rev. 1, "Post-Accident Monitoring System Channel Integration Test/ Factory Acceptance Test Report," Westinghouse Electric Company LLC.

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61. EQ-QR-68-WBT-P, Rev. 0, "Qualification Summary Report for Post-Accident Monitoring System (PAMS)," Westinghouse Electric Company LLC.

62. WNA-PT-00138-WBT-P, Rev. 0, "Post Accident Monitoring System Test Plan," Westinghouse Electric Company LLC.

63. NABU-DP-00014-GEN, Rev. 2, "Design Process for Common Q Safety Systems," Westinghouse Electric Company LLC.

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65. WNA-AR-00201-WBT, Rev. 0, "Post Accident Monitoring System – Compliance to the Common Q Application Restrictions Document," Westinghouse Electric Company LLC.

66. 00000-ICE-37764, Rev. 3, "Summary Qualification Report of Hardware Testing for Common Q Applications," Westinghouse Electric Company LLC.

67. 00000-ICE-37722, Rev. 0, "Commercial Grade Dedication Report for the QNX Operating System for Common Q Applications," Westinghouse Electric Company LLC.

68. WNA-RL-00327-GEN, Rev. 1V, "Software Release Record for the PAMS01 AC160 Library," Westinghouse Electric Company LLC.

69. WNA-VR-00261-GEN, Rev.0, "Code Review Report for PAMS01 AC160 Option Library," Westinghouse Electric Company LLC.

70. DELETED

71. WNA-AR-00196-WBT, Rev. 0, "Regression Analysis for the Post Accident Monitoring System," Westinghouse Electric Company LLC.

72. WNA-AR-00209-WBT, Rev. 1, "Regression Analysis for the Post Accident Monitoring System," Westinghouse Electric Company LLC.

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SECTION 1
INTRODUCTION

1.1 OVERVIEW

This document presents the Requirements Traceability Matrix (RTM) for the Watts Bar 2 Post-Accident Monitoring System (PAMS) for the following development phases as defined per NABU-DP-00014-GEN, "Design Process for Common Q Safety Systems" (Reference 63):

- Concept
- Definition
- Design
- Implementation
- Integration

1.2 SCOPE

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There are three RTM tables in this document prepared for the concept, definition, and design implementation and integration phases, as defined in WNA-PV-00009-GEN, "Verification & Validation Process for the Common Q Safety Systems" (Reference 2) as referenced per WNA-PD-00073-WBT, "Project Plan Common Q Post Accident Monitoring System" (Reference 16).

The first RTM table (see Appendix A) traces the system requirements defined in WNA-DS-01617-WBT-P (Reference 3) forward to both:

- The software requirements in WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 4)

- The hardware requirements in WNA-DS-01667-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Post Accident Monitoring System – System Design Specification" (Reference 5)

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The second RTM table (see Appendix B) traces the software requirements defined in the Software Requirements Specification, WNA-SD-00239-WBT-P (Reference 4) backward to the system

requirements defined in WNA-DS-01617-WBT-P (Reference 3). [

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The third RTM table (see Appendix C) includes the test coverage for the Hardware Requirements included in the System Design Specification, WNA-DS-01667-WBT-P (Reference 5). [

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1.3 OBJECTIVE

This RTM is prepared by the Watts Bar 2 PAMS project design team for review by the independent verification and validation (IV&V) team overseeing the Watts Bar 2 PAMS project to ensure that the requirements are traceable and testable.

The test cases referenced within the Appendices are only intended to provide evidence of test coverage for the requirements specified. These references are not in any way intended to demonstrate pass/fail status for the tests corresponding to the requirement. Specific pass/fail criteria and status for each item under test throughout the software test lifecycle [ ]^{a,c} is contained within respective Test Reports and Regression Analysis Reports.

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SECTION 2
RTM DETAILS

This document shows the Watts Bar 2 PAMS requirements traced from three different perspectives and captured in three different RTM tables. The first RTM table – documented in Appendix A – traces the system requirements defined in WNA-DS-01617-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Post Accident Monitoring System – System Requirements Specification" (Reference 3) forward to both:

- The hardware requirements in WNA-DS-01667-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Post Accident Monitoring System – System Design Specification" (Reference 5)

- The software requirements in WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 4)

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The second RTM table – documented in Appendix B – focuses on the software requirements defined in the Software Requirements Specification: WNA-SD-00239-WBT-P (Reference 4). This RTM traces software requirements both:

- Backward to the system requirements defined in WNA-DS-01617-WBT-P (Reference 3)
- Forward to the software design documentation and test procedure(s)

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The third RTM table – documented in Appendix C – focuses on the hardware requirements and hardware design statements defined in the System Design Specification: WNA-DS-01667-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Post Accident Monitoring System – System Design Specification" (Reference 5). [

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In some cases, annotations or explanations were added to facilitate the IV&V team review of these three RTM tables.

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APPENDIX A
SYSTEM REQUIREMENT RTM TABLE

The following RTM traces the system requirements in WNA-DS-01617-WBT-P (Reference 3) forward to lower-level requirements documents and finally to the test documentation for the following Watts Bar 2 PAMS project implementation and integration phases:

- Concept
- Definition
- Design
- Integration

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APPENDIX B
SOFTWARE REQUIREMENT RTM TABLE

The following RTM traces the software requirements in WNA-SD-00239-WBT (Reference 4) backward to upper-level requirements and forward to the design documentation and finally to the test documentation for the following Watts Bar 2 PAMS project implementation and integration phases:

- Concept
- Definition
- Design
- Implementation
- Integration

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APPENDIX C
SYSTEM DESIGN SPECIFICATION RTM TABLE

The following RTM traces the system requirements and design statements in WNA-DS-01667-WBT (Reference 5) forward to the test procedure documents for the Watts Bar 2 PAMS project integration phase.

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