Office of Health, Safety and Security
Office of Enforcement and Oversight

Independent Review of Commercial Grade Dedication Plans for the Safety Instrumented System at the Savannah River Site Waste Solidification Building Project

August 2011

Office of Safety and Emergency Management Evaluations
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Table of Contents

Acronyms

BPCS	Basic Process Control System
CGD	Commercial Grade Dedication
CHAP	Consolidated Hazard Analysis Process
DI	Discrete Input
DIN	Deutsches Institut für Normung (German Institute for Standardization)
DO	Discrete Output
FDD	Facility Design Description
HART	Highway Addressable Remote Transducer Digital Communication Protocol
HAW	High Activity Waste
HSS	Office of Health, Safety and Security
I/O	Input/Output
LAW	Low Activity Waste
LED	Light-Emitting Diode
NA-262	NNSA Site Engineering and Project Integration Division
NA-266	NNSA WSB Integrated Project Division
NC	Normally Closed
NO	Normally Open
NNSA	National Nuclear Security Administration
PDSA	Preliminary Documented Safety Analysis
PIT	Post Installation Test
QA	Quality Assurance
RICP	Receipt Inspection Criteria Package
SDD	System Design Description
SIL	Safety Integrity Level
SIS	Safety Instrumented System
SRNS	Savannah River Nuclear Solutions
SRS	Savannah River Site
UPS	Uninterruptible Power Supply
VAC	Volts, Alternating Current

VDC	Volts, Direct Current
SSIS	Safety Significant Instrumented System
WSB	Waste Solidification Building

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1.0 PURPOSE

The Office of Enforcement and Oversight (Independent Oversight) within the Office of Health, Safety and Security (HSS), conducted an independent review of selected aspects of Savannah River Nuclear Solutions' (SRNS) plans for commercial grade dedication (CGD) of the Waste Solidification Building (WSB) Safety Instrumented System (SIS) safety significant components at the Savannah River Site (SRS). The purpose of this review was to assess the adequacy of the contractor's CGD plans, including: receipt inspection scope, technical evaluation content and conclusions, critical characteristics identification, evaluation methods and acceptance criteria definition, failure modes and effects analyses, and required documentation.

The independent review was conducted during June 14-24 and July 12-13, 2011, by Independent Oversight in coordination with the U.S. Department of Energy and the National Nuclear Security Administration (NNSA), NA-266, WSB Integrated Project Division.

2.0 SCOPE

This review was limited to the stated purpose and utilized the draft HSS criteria, review, and approach document 45-12, "Nuclear Safety Component and Services Procurement Inspection Criteria, Inspection Activities, and Lines of Inquiry," to guide the evaluation. The adequacy of SRNS processes for CGD of unaltered, commercially available components was evaluated through review of the quality assurance (QA) and engineering procedures, standards, and guides applicable to CGD. The SIS safety function requirements, safety interlock design configuration, and safety significant component critical characteristics were determined through review of selected sections of the WSB consolidated hazards analysis process (CHAP), WSB preliminary documented safety analysis (PDSA), facility description document (FDD), "Process Control System" system description document (SDD), WSB safety requirements specifications, WSB SIS hardware procurement specifications, and component product data sheets. Finally, the adequacy of the 12 SRNS plans for CGD of the components designed to perform the required SIS safety significant functions was assessed through review of associated receipt inspection criteria package (RICP) reports, technical evaluation reports, safety integrity level (SIL) verification reports, and safety requirements specifications reports.

Appendix A provides supplemental information about the review. Appendix B lists the documents reviewed and summarizes Independent Oversight observations and identified opportunities for improvement. Finally, Appendix C identifies specific potential and actual deficiencies in CGD plans for individual WSB SIS components.

3.0 BACKGROUND

The WSB is a hazard category 2 nuclear facility and a Low Hazard chemical facility currently under construction at the SRS. The mission of the WSB is to treat specific high- and low-activity liquid waste streams from the SRS Mixed Oxide Fuel Fabrication Facility and from Pit Disassembly and Conversion. The WSB is designed to accept and process the liquid waste streams into solid waste forms acceptable for shipment and disposal as transuranic waste, low-level waste, or a liquid waste form that can be further treated at the SRS effluent treatment project.

The WSB design includes a safety significant SIS to provide active, reliable engineered controls to prevent or mitigate safety significant events to acceptable levels of risk. The SIS is designed as a stand-alone, independent system to monitor and control safety significant process and support systems, with sufficient redundancy to meet the availability/reliability requirements for a safety significant system. SRNS has issued the procurement for the SIS to a commercial vendor (Emerson) and intends to apply CGD to the safety significant components. SRNS has completed the final draft safety requirements specifications, RICPs, and technical evaluations, which address identification of critical characteristics, acceptance methods, and criteria. The receipt of the SIS components is expected in late fall 2011.

The SRNS plans for developing and qualifying the safety significant SIS software and for CGD of the safety class high activity waste (HAW) evaporator high temperature interlock (which is not part of the SIS) were not within the scope of this review.

4.0 RESULTS

SRNS has established an appropriate and adequate framework for CGD of unaltered, commercially available components for incorporation in safety significant designs. That framework includes but is not limited to SRS QA and engineering procedures, standards, and guides applicable to CGD.

The SRNS plans for CGD of 12 SIS components required to support safety significant SIS functions were appropriately outlined in their respective RICP reports. Each reviewed RICP required verification of the generic attributes applicable to all receipt inspections and implementation of additional tests and inspections required for CGD in accordance with referenced technical evaluation reports.

Each reviewed technical evaluation report documented the component identification, safety significant functions, design criteria, critical characteristics, and methods of verification. Each report also identified the specific report on shake-table results that must be reviewed for acceptability to verify that the component would continue to function during and after a design basis seismic event.

Although the technical evaluation reports were generally complete and acceptable, this Independent Oversight review identified potential and actual deficiencies and opportunities for improvement. For example, it was not always clear that the list of critical characteristics was complete. Further, the acceptance criteria for several critical characteristics were not described or were not consistent with other component specifications. Finally, there were some apparent inconsistencies between the lists of critical characteristics, the listed methods of verification, the hardware acceptance test instructions, and the associated RICPs. These potential and actual deficiencies and opportunities for improvement relative to each component's CGD plan are discussed further in Appendix C.

The reviewed SIL verification reports and WSB safety requirements specifications reports, taken together, demonstrated that comprehensive failure modes and effects analyses have been performed as required to support the planned CGD activities. Although the accuracy of the SIL verification calculations were not confirmed during this review, the reports documented a comprehensive evaluation of the failure modes and effects for each component involved in implementing the safety function. Further, the verification reports documented confirmation that the probability of failure on demand of the defined WSB SIS safety significant functions met the requirements for qualification as SIL-1 or SIL-2 applications, as specified for the respective safety functions.

The plan for CGD of the safety class HAW evaporator high temperature interlock was not evaluated during this review.

5.0 CONCLUSIONS

This Independent Oversight review confirmed that the WSB SIS safety functions addressed by the SRNS CGD plans were adequately defined and consistent with the PDSA, CHAP, FDD, and SDD. The review also confirmed that the technical evaluation reports, WSB safety requirements specification reports, and SIL verification reports appropriately identified the majority of WSB SIS safety significant design characteristics and credible failure modes. However, as discussed in Appendices B and C, this review identified some potential and actual deficiencies and some opportunities for improvement in the technical evaluation reports' identification of critical characteristics, methods of evaluation, and acceptance criteria.

6.0 FINDINGS AND ITEMS FOR FOLLOW-UP

There are no findings. However, SRNS is encouraged to consider revising its CGD plans to address the potential and actual deficiencies and opportunities for improvement identified in Appendices B and C.

Independent Oversight follow-up is recommended for the following items:

- Review the adequacy of the plans for CGD and periodic surveillance testing for the components involved in the safety class HAW evaporator high temperature interlock function.
- Review the adequacy of the plans to develop, qualify, and maintain the SIS safety significant software.
- Review the adequacy of the plans for post-installation testing and periodic surveillance testing of the safety significant WSB SIS.

Appendix A
Supplemental Information

Dates of Review

Offsite Review:	June 14-24, 2011
Onsite Review:	July 12-13, 2011

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Appendix B
Documents Reviewed and Observations

SRNS CGD Requirements

Independent Oversight reviewed the following SRNS QA procedures and engineering procedures, standards, and guides to understand SRNS CGD processes:

- Quality Assurance Manual 1Q, Procedure 7.3, "Commercial Grade Item Dedication," Rev-10
- Quality Assurance Manual 1Q, Procedure 7.3, "Quality Assurance Requirements for Commercial Grade Items and Services," Rev-11, For Training Purposes Only
- Quality Assurance Manual 1Q, Procedure 7.2, "Control of Purchased Items and Services," Rev-18
- Conduct of Engineering and Technical Support Procedures Manual E7, Procedure 3.46, "Replacement Item Evaluation/ Commercial Grade Item Dedication (U)," Rev-10
- Conduct of Engineering and Technical Support Procedures Manual E7, Procedure 3.46, "Replacement Item Evaluation/ Commercial Grade Item Dedication," Rev-11, For Training Purposes Only
- SRS Engineering Standards Manual WSRC-TM-95-1, "Application of ISA 84.00.01-Part 1 For SRS Non-Reactor Facilities," Rev-5
- SRS Engineering Practices Manual WSRC-IM-95-58, "Design Guidance For Instrumented Systems That Are Used In Safety Significant And Hazardous Processes," Rev-4
- NNSA Assessment of draft document for "Commercial Grade Dedication of Safety Significant Component: WSB SIS Lambda LZSA500-3 Power Supply."

WSB Design Requirements Documentation

Independent Oversight reviewed selected sections of the following WSB hazards and safety analyses, facility and system design descriptions, and procurement specifications to identify SIS equipment component critical characteristics:

- WSRC-TR-2007-00134, "Consolidated Hazards Analysis For The Waste Solidification Building (WSB)," Rev-2
- WSRC-SA-2003-00002, "Waste Solidification Building Preliminary Documented Safety Analysis," Rev-1
- J-ESR-F-00027, "Waste Solidification Building Safety Requirements Specification," Rev-1
- M-ESR-F-00131, "Safety Requirement Specification for Waste Solidification Building Active Confinement Ventilation System (U)," Rev-1
- M-ESR-F-00128, "Safety Requirement Specification for Waste Solidification Building Process Systems," Rev-2
- B-RS-F-00029, "Waste Solidification Building Safety Instrumented System Requirements Specification for Software," Rev-0
- G-FDD-F-00007, "Facility Design Description Waste Solidification Building (U)," Rev-6
- J-SYD-F-00014, "System Design Description for Process Control System (U)," Rev-5
- B-SPP-F-00004, "Procurement Specifications for WSB Safety Instrumented System Hardware," Rev-0.

WSB/SIS Receipt Inspection Criteria Packages

Independent Oversight reviewed the following RICP reports to verify the adequacy of the scope of planned generic receipt inspection activities (Note: RICP # 6 and # 12 were determined by NNSA Site Engineering and Project Integration Division or NA-262 to not exist):

- RICP # 11923 (for Package # 1), SIS TERMINALS AND SUPPORT ACCESSORIES
- RICP # 11924 (for Package # 2), SERIES 90A ANNUNCIATOR AND NOVA TONE HORN
- RICP # 11925 (for Package # 3), ALLEN BRADLEY PUSH BUTTONS (800T-A2A)
- RICP # 11948 (for Package # 4), ALLEN BRADLEY 3 POSITION SELECTOR SWITCH (800T-J42A)
- RICP # 11950 (for Package # 5), DELTAV SIS 1508 LOGIC SOLVER AND SUPPORTING COMPONENTS
- RICP # 11951(for Package # 7), WSB SIS LAMBDA LZSA500-3 POWER SUPPLY
- RICP # 11952 (for Package # 8), SOLA S4K2U1000 UNINTERRUPTIBLE POWER SUPPLY
- RICP # 11953 (for Package # 9), ABB DOUBLE POLE 15A BREAKER (S202-K15)
- RICP # 11954 (for Package # 10), SIS FERRAZ-SHAWMUT FUSESFUSE HOLDERS
- RICP # 11955 (for Package # 11), PHOENIX QUINT DIODE MODULE (2938963)
- RICP # 11956 (for Package # 13), PHOENIX PSR-SCP-24DCESP42X11X2 RELAY (2981020)
- RICP # 11957 (for Package # 14), SIS ENCLOSURES AND BACK PANELS.

WSB/SIS CGD Technical Evaluation Reports

Independent Oversight reviewed the following technical evaluation reports referenced in the above RICPs to verify the adequacy of the planned scope of additional inspections, tests, and verifications for CGD of SIS components:

- 01-Technical Evaluation of the WSB-SIS - Terminals and Supporting Accessories, Rev-0
- 02-Technical Evaluation of the WSB-SIS - Annunciator Series 90A Final, Rev-0
- 03-Technical Evaluation of the WSB-SIS - Pushbuttons Final, Rev-0
- 04-Technical Evaluation of the WSB-SIS - Selector Switch Final, Rev-0
- 05-Technical Evaluation of the WSB-SIS - Logic Solver, Rev-0
- 07-Technical Evaluation of the WSB-SIS - Lambda Power Supply, Rev-0, Final
- 08-Technical Evaluation of the WSB-SIS - UPS, Rev-0
- 09-Technical Evaluation of the WSB-SIS - S202-K15 Breaker, Rev-0
- 10-Technical Evaluation of the WSB-SIS - Fuses/Fuse Holders, Rev-0
- 11-Technical Evaluation of the WSB-SIS - Diode Module, Rev-0
- 13-Technical Evaluation of the WSB-SIS - 24 VDC [Volts, direct current] Coil Relay, Rev-0
- 14-Technical Evaluation of the WSB-SIS - Enclosures and Back Panels, Rev-0, Revised 9_23_10.

SIL Verification Reports

Independent Oversight reviewed the following SIL verification reports for SIS safety significant safety functions to verify that appropriate failure modes and effects analyses were performed to support SIS equipment component CGD:

- SCLCF00629, SIL Verification for SSIS [Safety Significant Instrumented System] Maintaining Vacuum on the Waste Solidification Building Process Vessel Vent System, Rev-0
- SCLCF00630, SIL Verification for SSIS Maintaining an Unobstructed Flowpath for the Waste Solidification Building Process Vessel Vent System, Rev-0
- SCLCF00631, SIL Verification for WSB LAW [Low Activity Waste] Evaporator Temperature and Pressure Interlock SSIS, Rev-1
- SCLCF00632, SIL Verification for WSB High Activity Waste Room Ventilation SSIS, Rev-0
- SCLCF00633, SIL Verification for WSB HAW Evaporator Pressure Interlock SSIS, Rev-0.

Observations

- The SRNS processes for CGD establish a robust foundation to verify that received, tested, and accepted commercially available components can be classified as safety class or safety significant.

- The NA-262 recommendation for establishing a summary document providing an overall description of the process and strategy for CGD of the WSB SIS should be implemented. The resulting summary should list applicable documents for the hardware to be dedicated; describe the roles and responsibilities of individuals involved in the phases of CGD (including CGD plan development and approval, site factory acceptance testing, receipt inspection, hardware acceptance testing, and post-installation testing); and identify the responsible individual or position holding final approval authority for the dedication.

- Although still draft documents, each RICP that was reviewed appropriately required verification of the generic attributes applicable to all receipt inspections and implementation of additional tests and inspections required for CGD in accordance with a referenced technical evaluation report. All 12 of the available RICPs and associated technical evaluation reports for SIS safety significant components were reviewed.

- Although still draft documents, each technical evaluation report that was reviewed documented the component identification, safety significant functions, design criteria, critical characteristics, and methods of verification. Each report also identified the specific report on shake-table results that must be reviewed for acceptability to verify that the component would continue to function during and after a design basis seismic event. Although the technical evaluation reports were generally complete and acceptable, Independent Oversight identified potential and actual deficiencies and opportunities for improvement. For example, it was not always clear that the list of critical characteristics was complete. Further, the acceptance criteria for several critical characteristics were not identified or were not consistent with other component specifications. Finally, there were some apparent inconsistencies between the lists of critical characteristics, the listed methods of verification, the hardware acceptance test instructions, and the associated RICPs. These potential and actual deficiencies and opportunities for improvement relative to each component's CGD plan are discussed further below and in Appendix C.

- The reviewed SIL verification reports evaluated whether the assigned SILs associated with each SIS safety-significant safety function were met by the design configuration of the components that comprise their fail safe circuits. Although the accuracy of the calculations was not confirmed during this review, the reports documented a comprehensive evaluation of the failure modes and effects for each component involved in implementing each safety function. Further, the reports documented confirmation that the probability of failure on demand of the defined WSB SIS safety significant functions met the requirements for qualification as SIL-1 or SIL-2 applications as specified for the respective safety function. The SIS safety-significant safety functions and SIL assignments are:
    - LAW Evaporator Interlocks - Isolates evaporator steam coil supply - Prevent Red Oil explosion
        - Prevent High Steam Supply Pressure or High Evaporator Temperature – SIL-1
    - HAW Evaporator High Steam Pressure Interlock - Isolates evaporator steam coil - Prevent Red Oil explosion
        - Prevent High Steam Supply Pressure – SIL-1
    - HAW Process Vessel Vent System - Prevent hydrogen accumulation
        - Maintain blower inlet vacuum – SIL-2
        - Maintain unobstructed ventilation flowpath – SIL-1

- HAW Process Room Ventilation System - Prevent spread of contamination
  - Maintain Confinement ventilation – SIL-1.

- The reviewed SIL verification reports and WSB safety requirements specifications reports, taken together, demonstrated that comprehensive failure modes and effects analyses have been performed as required to support the planned CGD activities.

- The plan for CGD of the safety class HAW evaporator high temperature interlock was not evaluated during this review. This interlock system is a hardwired and redundant system that is not part of the SIS.

- The reviewed SIL verification reports calculated the probability of failure on demand of each SIS safety-significant safety function based on a documented assumption that an integrated post-installation test had been conducted and verified successful. However, none of the reviewed technical evaluation reports documented a requirement for post-installation testing (PIT) as part of the CGD process for critical characteristics that could not be verified acceptable by any other reasonable means. Discussions with SRNS Design Engineering staff confirmed their understanding of the need to develop and implement a comprehensive SIS PIT to support their planned startup testing program.

- Many of the components required to implement the safety-significant safety functions of the SIS were not addressed in the reviewed RICP and technical evaluation reports: i.e., the vacuum, pressure, flow, differential pressure, and temperature sensors; the transmitters, thermo-wells, pressure sensor isolation valves, and differential pressure manifolds; the steam valves, related solenoid valves, and reset switches; the blowers, fans, variable speed drives, dampers, and timers; and the power cables, wiring, tubing, and fiber optic networks. Discussion with SRNS Design Engineering staff confirmed their understanding of the requirement to perform a CGD for any of the listed components that will be used in safety significant applications and were procured from a vendor that does not implement a Nuclear Quality Assurance 1 qualified program.

- The technical evaluation report, Attachment 1 forms that were reviewed did not provide room to clearly identify each item subjected to the specified tests for the purpose of CGD traceability. Further, many Attachment 1 steps that required the use of measuring and test equipment did not provide a place to record data for each measurement taken to allow comparison with the acceptance criteria and to support independent review and approval. For example, there are nine end-of-line resistors for each SIS cabinet for which the SIS Terminals and Support Accessories technical evaluation report requires both a series and parallel resistor measurement; however, the associated Attachment 1 provides a place for only one set of series and parallel resistor measurements and gives no indication of which end-of-line resistor was measured.

Opportunity for Improvement: SRNS should consider the need to revise the hardware acceptance test instructions, Attachment 1 to each technical evaluation report to clearly provide a place to document which component was tested to ensure component CGD traceability (description, part number, and serial number, as needed for unique component identification).

- The review confirmed that the WSB SIS safety functions addressed by the SRNS CGD plans were adequately defined and consistent with the PDSA, CHAP, FDD, and SDD.

- The review also confirmed that the technical evaluation reports, WSB safety specifications requirement reports, and SIL verification reports appropriately identified the majority of WSB SIS safety significant design characteristics and credible failure modes. However, as discussed in Appendix C, this review also identified some potential and actual deficiencies and some opportunities for improvement in the technical evaluation reports' identification of critical characteristics, methods of evaluation, and acceptance criteria. Many of the potential or actual CGD plan deficiencies identified in Appendix C can and should be addressed during a comprehensive PIT.

Opportunity for Improvement: SRNS should revise the 12 reviewed technical evaluation reports to describe the missing critical characteristics requiring verification in Section 9.0, and the plans for their verification and acceptance criteria in Table 1 and Attachment A, as appropriate. Further, for those critical characteristics to be tested for acceptability during the PIT, the Table 1 Verification Method should be listed as "Method 1 Testing (See PIT Plans)."

Appendix C
Potential and Actual WSB SIS CGD Plan Deficiencies

SIS – Terminals and Supporting Accessories

- Contrary to E-ESR-F-00053, Table 1, first verification requirement on page 9, E-ESR-F-00053, Attachment 1 and RICP# 11923 do not require verification of component "correct dimensions."
- Contrary to E-ESR-F-00053, Table 1, third verification on page 10, the Hardware Acceptance Test, Attachment 1, does not include verification of wire type and size in the cabinet versus the drawing.
- E-ESR-F-00053, Attachment 1, does not include a quantitative acceptance criterion for verifying the terminal blocks and the terminal anchor ends are securely fastened to the German Institute for Standardization (DIN) rail (steps 1 and 2).
- E-ESR-F-00053, Attachment 1, step 1 incorrectly refers to a continuity check in step 5; it actually is at step 7.
- The acceptance criteria for E-ESR-F-00053, Attachment 1, step 4 of Less-Than-Or-Equal to 0.2 ohms is not consistent with the Less-Than 0.2 ohms specified under E-ESR-F-00053, Section 9.0, "Critical Characteristics."
- E-ESR-F-00053, Attachment 1, step 7 should be revised to read "Perform continuity checks BETWEEN terminal strips and components WITHIN SIS panels…." to be consistent with the E-ESR-F-00053, Table 1, first required verification on page 10.
- E-ESR-F-00053, Attachment 1, step 8 and step 9 specification of plus or minus 10% is not supported by E-ESR-F-00053, Section 9.0, "Critical Characteristics," or the PK9GTA Product Data Sheet.
- E-ESR-F-00053, Attachment 1, does not verify insulation integrity between each terminal block terminal and between each terminal block terminal and the associated DIN rail.
- E-ESR-F-00044, Attachment 1, does not verify that safety and non-safety wiring/cables meet the separation criteria of Institute of Electrical and Electronics Engineers 384, as required by the "Procurement Specifications," B-SPP-F-00004.
- E-ESR-F-00044, Attachment 1, does not verify that signal cables are not run in close proximity to power cables or other cables that could induce voltages into the signal cables, as required by the "Procurement Specifications," B-SPP-F-00004.

SIS – Series 90A Annunciator and NOVA Horn

- E-ESR-F-00049, Section 9.0, "Critical Characteristics," does not indicate, and Attachment 1 does not test for, the desirable characteristics of whether an acknowledged alarm with a solidly illuminated panel will re-flash if the process sensor again senses an alarm condition.
- E-ESR-F-00049, Section 9.0, "Critical Characteristics," indicates that the RESET button extinguishes an alarm panel after an alarm signal is removed (a 24 VDC signal is input to the panel contacts); however, Attachment 1, step 17, indicates that a FLASHING panel should not extinguish, which is probably right but still contrary to Section 9.0.
- E-ESR-F-00049, Attachment 1, does not verify insulation integrity between each terminal point and the associated annunciator module or horn ground.

SIS – Allen Bradley Push Buttons (800T-A2A)

- E-ESR-F-00043, Attachment 1, Step 5 should be revised to include resistance readings with the pushbutton depressed, since the moving contacts may become shorted to the frame due to their movement.

SIS – Allen Bradley 3 Position Selector Switch (800T-J42A)

- E-ESR-F-00048, Attachment 1, does not verify that:
    - The key can only be removed in the NORMAL position, and
    - The switch cannot be moved left or right without a key.

- E-ESR-F-00048, Attachment 1, Step 3 and Step 4 should be revised to also verify the contact that closes and the contact that remains open are maintained in those positions after releasing the switch.
- E-ESR-F-00048, Attachment 1, Step 4 should also be revised to verify the contact that closed and the contact that remained open in Step 3 are now maintained in the opposite positions after releasing the switch.
- E-ESR-F-00048, Attachment 1, Step 5 should be revised to verify that both contacts are maintained open after releasing the switch in the NORMAL position.
- E-ESR-F-00048, Attachment 1, does not verify the insulation integrity between the left and right normally open (NO) contact terminals (4 measurements at > 5 M ohms).

SIS – DELTAV SIS 1508 Logic Solver and Supporting Components

- E-ESR-F-00044, Section 9.0, "Critical Characteristics," and Table 1 do not address the Section 3.0 safety significant functions of the logic solvers, repeaters, extender carriers, and terminator assemblies taken together for:
    - Detecting field device failures/faults (HART), and
    - Communicating status (other than failure) to redundant logic solver.
- E-ESR-F-00044, Section 9.0, "Critical Characteristics," and Table 1 do not address the Section 4.0 system-level design criteria for issuing to the basic process control system (BPCS) an integrity error alarm for each redundant logic solver pair, including:
    - Hardware failure within a logic solver
    - Communications failure between a logic solver and the SISnet
    - Communications failure between a redundant pair of logic solvers
    - Communications failure between a logic solver and an MD controller
    - Removal of a logic solver from the carrier.
- E-ESR-F-00044, Section 4.0, "System Level Design Criteria," incorrectly lists the DeltaV SIS input/output (I/O) specification for discrete input (DI) signals in the OFF state as ≤1.64 mA versus page 34 of 48 Detection Level for OFF as ≤1.65 mA.
- E-ESR-F-00044, Attachment 1, does not specify the minimum and maximum voltage criteria for verifying the ability of the discrete output (DO) channels to issue valid ON/OFF output signals.
- E-ESR-F-00044, Attachment 1, does not specify the steps in input current to be utilized in verifying the ability of the analog input channels to read analog input signals, each within 2% of span accuracy.
- The verification tests specified on E-ESR-F-00044, page 28 of 48, lack adequate documentation of results requirements. There should be a place to record the results of each test on each of the 12 logic solvers:
    - Demonstrating each logic solver's ability to process data/information for each tested I/O channel intended to be used, each tested redundant logic solver, and each tested remote logic solver.
    - Demonstrating that each logic solver operates independently of the BPCS. For example:
        - Simulate a loss of power to the BPCS.
        - Input a DI signal to a logic solver and verify that it issues the expected DO signal.
        - This may be accomplished by inputting a signal through a reset switch in the annunciator panel and lighting up an alarm panel.
    - Demonstrating that each logic solver can communicate its status (failed and otherwise as designed) to its redundant logic solver. For example:
        - Simulate a power loss to a repeater connected to the active logic solver and verify that the backup logic solver becomes active and correctly reads the same input.
    - Demonstrating that each logic solver takes over all SIS functions upon failure of its redundant logic solver. For example:
        - Simulate a loss of power to the active logic solver.

        - Verify that the backup logic solver becomes active and correctly reads the same input.
    - Demonstrating that each logic solver can communicate the required information to each remote SIS subsystem required to receive that information.
    - Demonstrating that all six redundant pairs of logic solvers see the same signal when a DI signal is put into each input channel of each logic solver (one channel and one logic server at a time).
- E-ESR-F-00044, Attachment 1, does not verify that the DeltaV SIS sends the required signals to both the operators in the control room and to the BPCS.
- Contrary to the B-SPP-F-00004, "Procurement Specifications," RICP # 11950 and Attachment 1 to E-ESR-F-00044 do not require verification that operators in the control room have the capability to manually reset a safety significant function after a trip, as required by the "WSB Process Control System SDD," J-SYD-F-00014.

SIS – Lambda LZSA500-3 Power Supply

- To satisfy a listed critical characteristic evaluation criterion, add a Step 6 to E-ESR-F-00042, Attachment 1, to require verification that the Lambda Power Supply light-emitting diodes (LEDs) indicate the output is good with no overheating or over-voltage condition at the end of Step 5, with the power supply still delivering full load current.
- E-ESR-F-00042, Attachment 1, does not verify the Section 9.0 listed electrical (output voltage) evaluation criterion of being adjustable between 18 and 29.4 VDC with no overheating or over-current.
- Revise E-ESR-F-00042, Table 1, on page 9 of 13 by replacing the reference to "Attachment II" with "Attachment 1."
- E-ESR-F-00042, Attachment 1, Step 4 should be revised to prevent exceeding the Lambda Power Supply maximum power limit of 504 watts, since (24+1 VDC)x(21 Amps) = 525 watts.

SIS – SOLA S4K2U1000 UPS

- Recommend E-ESR-F-00046, Attachment 1, Step 2 be preceded by verifying the uninterruptible power supply (UPS) stated capability to perform an auto or manual battery test (page 11 of 13, Features listing).
- Recommend E-ESR-F-00046, Attachment 1, Steps 2, 4, and 5 also require verification that the UPS is operating correctly by documenting verification that the state of the UPS LEDs are the correct results applicable to that step. The correct LED state (acceptance criteria) should be specified within each step.
- E-ESR-F-00046, Attachment 1, Step 4 should also list an acceptance criterion for the recorded data equal to 120 Volts, alternating current (VAC) +/- 3% as specified in Section 4.0.
- The instruction for E-ESR-F-00046, Attachment 1, Step 5 should be revised to clarify the expectation that the attached 120 VAC, 7.25+/-0.25 Amp load should remain energized for at least 3 minutes with the 120 VAC supply to the UPS de-energized. The instruction should also contain guidance for terminating the test shortly after exceeding 3 minutes to prevent damaging the UPS batteries, circuitry, or attached loads.
- The criteria for Recorded Data for E-ESR-F-00046, Attachment 1, Step 5, is not consistent with the Table 1, page 7 of 13 required verification that the OUTPUT VOLTAGE is maintained for at least 3 minutes, not the OUTPUT CURRENT as stated under "Recorded Data." Further, there should be a space to record verification that the specified load remained energized for at least 3 minutes.

SIS – ABB Double Pole 15A Breaker (S202-K15)

- E-ESR-F-00050, Table 1, thermal trip specification on page 11 of 23 (40-60 seconds at 3x rated current) does not agree with the Section 9.0 thermal trip evaluation criteria (10-40 seconds as current slowly rises above 3x rated). The correct thermal trip specification for this breaker, based on its "K" tripping characteristic curve, is 10-40 seconds at 3 times rated current. Table 1 and Attachment 1, Step 6 should be revised to specify the 10-40 second acceptance criteria.

- E-ESR-F-00050, Attachment 1, Step 6 should be revised to reflect Table 1 test requirements to slowly raise current above 45 amps and to record both the trip time and the current level for determining acceptability by comparison to the thermal trip element specifications.
- E-ESR-F-00050, Attachment 1, does not verify the acceptability or specify a maximum acceptance criterion for the contact resistance of each pole when closed.
- E-ESR-F-00050, Attachment 1, Step 2 should require insulation integrity measurements between each terminal and the breaker frame ground.
- E-ESR-F-00050, Attachment 1, Step 9 does not verify that the breaker can be manually opened under rated load.
- E-ESR-F-00050, Attachment 1, text below the "Instruction" header should read "Repeat steps 1 through **9** for each breaker" versus "…steps 1 through **7**…"
- E-ESR-F-00050, Attachment 1, Step 4 should be revised to read "Rapidly apply 8 to 12 times the rated current, and verify that the breaker trips in less than 3.5 milli-seconds (<3.5 ms) to be consistent with the published breaker specifications."
- E-ESR-F-00050, Table 1 and Attachment 1, Step 4 should be revised to reflect the Section 4.0 system-level design criteria for the 2-pole mini-circuit breakers with a "K" time-current characteristic, which specifies an instantaneous trip at 8 to 12 times rated, not 8 to 10 times rated.

SIS –FERRAZ-SHAWMUT Fuses/Fuse Holders

- E-ESR-F-00047, Section 9.0, Table 1 and Attachment 1 do not assess the adequacy of insulation integrity (resistance of terminals to fuse holder ground).
- E-ESR-F-00047, Section 9.0, Table 1 and Attachment 1 do not assess the adequacy of insulation between the two ends of the fuse holder without an installed fuse.
- E-ESR-F-00047, Attachment 1, does not specify if the resistance between the fuse and fuse holder includes the resistance at both ends of the fuse. If not, there should be a place to record the resistance between fuse and fuse holder at both ends of each fuse/fuse holder combination.
- E-ESR-F-00047, Attachment 1, should be revised to remove the potential confusion between the notes stating "Test a minimum of four fuses from the lot of fuses received" and "Verification methods apply to a 100% sample of components."

SIS – PHOENIX QUINT Diode Module (2938963)

- E-ESR-F-00045, Attachment 1, does not require that input currents be limited to less than 56 amps as specified on page 14 of 16 and does not require the module to be positioned to ensure adequate convection cooling during testing.
- E-ESR-F-00045, Attachment 1, does not specify required loads on each output terminal during testing and does not specify quantitative acceptance criteria for the readings to be recorded.
- E-ESR-F-00045, Section 9.0, Table 1 and Attachment 1 do not assess the adequacy of insulation integrity (resistance of terminals to the module ground).

SIS – PHOENIX PSR-SCP-24 DC/ESP4/2X1/1X2 Relay (2981020)

- E-ESR-F-00052, Section 9.0, does not list "Contacts exhibit appropriate resistance when relay is energized (both now closed NO [normally open] contacts exhibit < 0.2 ohms and the now open NC [normally closed] contact exhibits > 40 M ohms)" as a critical characteristic as it should. These resistances are addressed in Attachment 1.
- E-ESR-F-00052, Table 1, 3rd listed attribute to be tested on page 10 of 19, needs to be revised to require verification that " the resistance between contact pairs with an energized relay are appropriate," as is done in Attachment 1, Steps 4 and 5.

- E-ESR-F-00052, Section 9.0, does not list "insulation integrity" as a critical characteristic as it should, and the adequacy of insulation integrity (resistance of each terminal to relay ground) is not verified in either Table 1 or Attachment 1.
- E-ESR-F-00052, Attachment 1, Step 2 fails to appropriately include terminals A1, A2, Y1, and Y2 in the two lists of terminals for which resistance measurements between each other are required to verify acceptability. There should be > 40 M ohms resistance between each NO terminal and each NC terminal, taken one pair of NO and NC terminals at a time, for a total of 8 tests. In like manner, there should be > 40 M ohms resistance between each NO or NC terminal and each power supply terminal (A1 or A2) or feedback terminal (Y1 or Y2), taken one pair of terminals at a time, for a total of 24 tests.
- The E-ESR-F-00052, Attachment 1, Step 4 specified voltage to be used to energize the relay is outside the relay coil's permissible range, as indicated on page 14 of 19. The correct voltage should be specified as 24x0.85+0.3 = 20.7 +/-0.3 VDC.

SIS – Enclosures and Back Panels

- E-ESR-F-00051, Table 1, 2nd attribute verification on page 9 of 18, should be revised to require verification of the adequacy of mounting of the back panel on the enclosure.
- E-ESR-F-00051, Attachment 1, does not verify the adequacy of the mounting of the back panel on each enclosure.
- E-ESR-F-00051, Attachment 1, and RICP # 11957 do not require verification of the dimensions of the enclosure doors (as opposed to panels and enclosures), and whether the doors provide an adequate sealed enclosure as required by Table 1.
- E-ESR-F-00051, Attachment 1, Step 4 should be revised to require verification of the ability to securely close without binding the front doors of each enclosure.
- As noted by the NA-262 staff, the 10% tolerance listed in the acceptance criteria for the enclosures, panels, and door dimensions is excessive.