Constellation

Peach Bottom Atomic Power Station

ECCS Compensated Level System Replacement Project

NRC Pre-Submittal Meeting

November 22, 2024

Open Meeting

Introductions – Project Team

- Constellation Energy
- Pablo Guardado, Principal PM, PEA Project Management
- Steve Flickinger, Sr. Reg. Specialist, Corporate Licensing

- Curtiss-Wright
- Robert Ammon – Technical Director / Project Engineer
- Dan Hunt – QA Director

- Sargent & Lundy
- Pareez Golub – Project Director, Digital Licensing SME

Meeting Purpose

- Clarify the Peach Bottom Atomic Power Station (PBAPS) ECCS Compensated Level System (CLS) Scope: Comparison of Existing vs Replacement System and System Implementation
- Clarify the consistency of the Curtiss-Wright platform (i.e., hardware and software) and application development methodology for installation of the RadICS system at PBAPS with the NRC-approved Topical Report (TR) platform hardware, software, and application development methodology/process.
- Listen to and understand NRC feedback on their review of the NRC-approved RadICS TR for application development process completeness.
- Align with the NRC on the submittal contents for the PBAPS ECCS CLS License Amendment Request (LAR), including supplement for equipment qualification test reports.
- Summarize key points of CEG's direction with respect to the two options described in NRC meeting notes dated July 29, 2024 (i.e., as a starting point for a more detailed discussion during a subsequent pre-submittal meeting).

Agenda

Open Meeting

- Introductions – Project Team
- NRC-Approved RadICS Topical Report Consistency
- ECCS Compensated Level System (CLS) Comparison: Existing vs Replacement Scope
- Proposed LAR Submittal Contents
- NRC Feedback on NRC-Approved RadICS Topical Report

Closed Meeting

- CEG’s direction with respect to two options described in NRC meeting notes dated July 29, 2024

Project Schedule Update

- VOP Audit for QA Program (ongoing) - December 2024
- VOP Audit for In person Curtiss-Wright facility, Idaho Falls - December 2024
- LAR Submittal – April 2025
- Equipment Qualification Test Report Summary – March 2026
- Factory Acceptance Test – May 2026
- Requested LAR Approval – July 2026
- Installation Unit 2 (Start) – October 2026
- Installation Unit 3 (Start) – October 2027

ECCS Compensated Level System (CLS) Comparison: Existing vs Replacement Scope and System Implementation

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ECCS Compensated Level System (CLS) Existing vs Replacement Scope: Design and System Functions

Key Takeaway: *The replacement ECCS CLS is equivalent to the existing system.*

- Like for Like Functional Replacement
  - Digital to digital replacement
  - No changes in any safety function
  - No significant functional changes
  - No significant design changes
  - No Technical Specification or Technical Specification Bases changes
  - No changes in Setpoint Methodology
- Actuation Logic Identical
  - External to the ECCS CLS system
  - Not modified as part of the replacement
- Software functions identical
  - Exact same calculations and setpoints
- Replacement System Functional Differences
  - All operational and status data transferred via a digital link

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ECCS Compensated Level System (CLS) Existing vs Replacement Scope: Operations and Maintenance

- No Main Control Room (MCR) changes
- No changes to Operator interfaces or subsequent Control Room Human Factor Engineering (HFE) impacts
  - Same devices
  - Same information
  - Same system failure indication
- Equivalent maintenance testing functions
- Same information provided via hardwired inputs to the Plant Process Computer (PPC)
  - Additional digital link for expanded status and data
- Expanded maintenance functions
  - Monitoring and Tuning System (MATS)
    - Maintenance Video Display Screens

ECCS Compensated Level System (CLS) Existing vs Replacement Scope: Plant Interface

- Input signals identical
  - Number and type of sensors unchanged
- Output signals identical
  - Number and type of output devices unchanged
- Field Instrument Wiring reused
  - Input signal wiring reused
  - Output signal wiring reused
- Redundant Input Power Reused
  - No modifications planned
- Existing HVAC Reused
  - No modifications planned
- Same plant location
  - Cable Spreading Room (ECCS CLS channels) / Computer Room (MATS only)

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ECCS Compensated Level System (CLS) Existing vs Replacement Scope: Plant Interface (cont'd)

- New Cabinets
  - One cabinet per ECCS CLS channel
  - PAMS-A combined into ECCS-A cabinet
  - PAMS-B combined into ECCS-B cabinet

- MATS Cabinet
  - Reuse existing spare cabinet

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NRC-Approved RADICS Topical Report Consistency: Hardware

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Hardware Consistency

Key Takeaway: *The project maintains consistency with the RadICS Topical Report, except for a single minor difference.*

- RadICS components
  - Chassis
  - Logic Module
  - I/O Modules
  - I/O Cabling

- The RadICS components can be used for the ECCS CLS under the Curtiss-Wright Digital Safety System QA Program because the RadICS components are identical to those reviewed and approved by the NRC in the RadICS Topical Report

- The RadICS components are sourced by Curtiss-Wright from RPC Radics LLC as Basic components. The RadICS components can be acquired as Basic components under the Curtiss-Wright Digital Safety System QA Program because the RPC Radics LLC QA program has been audited by Curtiss-Wright and added to the Curtiss-Wright Approved Supplier List (ASL).

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Hardware Consistency

- The RadICS components utilized for the ECCS CLS are identical to those reviewed in the RadICS Topical Report (TR). Specifically:
  - RadICS I/O Chassis is the same P/N with the same platform Electronic Design (ED)
  - RadICS Logic Module is the same P/N with the same platform ED
  - RadICS I/O Modules are the same P/N with the same platform ED
    - AIM, AOM, DIM, DOM and WAIM
  - Radics I/O Protection Modules (IOPM) are the same P/N (non digital device, no ED)

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NRC-Approved RadICS Topical Report Consistency: System Development Methodology

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System Development Methodology Comparison

- RadICS Topical Report covers two system development methodologies
  - Platform
  - Application
- Curtiss-Wright is using the same Platform and Application Development methodology, processes, and procedures approved in the RadICS TR
  - Two minor differences
    - Hardware
      - 2 m I/O cables (ECCS CLS) instead of 20 m I/O cables (TR)
        - Manufactured form same components using same manufacturing process.
        - Cables will be included with commercial equipment is Seismic and EMC EQ testing
    - Codes and Standards
      - IEEE 1012-2016 (ECCS CLS) instead of IEEE 1012-2004 (TR)
      - The V&V requirements imposed by IEEE 1012-2016 are a superset of the requirements imposed by IEEE 1012-2004.

System Development Methodology Comparison

- Platform Development Methodology
  - Utilized by RPC Radiy / RPC Radics LLC to development RadICS components
  - Reviewed and approved by the NRC as part of the RadICS TR

- Application Development Methodology
  - Defined by RPC Radiy / RPC Radics LLC to develop safety systems and application based upon the RadICS components
  - Reviewed by the NRC as part of the RadICS TR
  - Utilized by Curtiss-Wright to implement the ECCS CLS replacement system
  - Defined in Chapters 7, 8, 9, 10 and 11 of the RadICS TR

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NRC Feedback on NRC-Approved RadICS Topical Report

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Planned LAR Submittal Contents

Planned LAR Approach and Contents

- Hybrid Alternate Review Process
  - Approach will be a hybrid DI&C ISG-06 Alternate Review Process due to submittal schedule of equipment qualification test results. LAR submittal and supplement contents will be consistent with information presented by NRC during October 29, 2024 public meeting. This includes resolution of the RadICS TR PSAIs.
  - Planned LAR submittal contents
    - 1.1 Summary of Application Planning and Processes (D.4)
    - 1.2 Summary of Vendor Oversight Plan (C.2.2)
    - 1.3 Approved Topical Report Safety Evaluation (D.5)
    - 1.4 System Description (D.1)
    - 1.5 System Architecture (D.2)
    - 1.6 Summary of Hardware Equipment Qualification (D.3) (the plan)
    - 1.7 Unified Compliance Matrix for IEEE Stds 603-1991 and 7.4.3.2-2003 (D.6)
    - *1.8 Changes to Technical Specifications (D.7)**
    - 1.9 Setpoint Methodology and Calculations (D.7)
    - 1.10 Secure Development and Operational Environment (D.8)

* At current time, proposed design will not require any changes to the PBAPS Technical Specifications

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Planned LAR Approach and Contents (cont.)

- Planned LAR Submittal Contents
  - SER PSAI 7.1 RadICS Platform Changes
    - LAR Submittal 1.13 Design Analysis Repots for Platform Changes (D.9.3)
  - SER PSAI 7.2 Application Logic Development Process
  - SER PSAI 7.3 System Cycle Time
    - LAR Submittal 1.14 System Response Time Analysis Report (D.9.7)
  - SER PSAI 7.4, 7.4.1, 7.4.2, 7.4.3, 7.4.4 Plant-Specific Equipment Environmental Qualification
    - LAR Submittal 1.6 Summary of Hardware Equipment Qualification (D.3)
  - SER PSAI 7.5 Failure Modes and Effects Analysis
    - LAR Submittal 2.6 System Level Failure Modes and Effects Analysis (D.9.8)
  - SER PSAI 7.6 Application Specific System Reliability
  - SER PSAI 7.7 Setpoint Methodology
    - LAR Submittal 1.9 Setpoint Methodology and Calculations (D.7)
  - SER PSAI 7.8 System Testing and Surveillance
  - SER PSAI 7.9, 7.9.1, 7.9.2, 7.9.3 Diversity and Defense In Depth
  - SER PSAI 7.10 Communications (DI&C ISG-04)

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Planned LAR Approach and Contents (cont.)

- Planned LAR Submittal Contents (cont.)
  - SER PSAI 7.11 IEEE Std. 603
    - LAR Submittal 1.7 Unified Compliance / Conformance Matrix for IEEE Stds 603-1991 and 7.4.3.2-2003 (D.6)
  - SER PSAI 7.12 IEEE Std. 7.4-3-2
    - LAR Submittal 1.7 Unified Compliance / Conformance Matrix for IEEE Stds 603-1991 and 7.4.3.2-2003 (D.6)
  - SER PSAI 7.13 Secure Development and Operational Environment
    - LAR Submittal 1.10 Secure Development and Operational Environment (D.8)

- Planned LAR Submission Addendum
  - SER PSAI 7.4, 7.4.1, 7.4.2, 7.4.3, 7.4.4 Plant-Specific Equipment Environmental Qualification
    - LAR Submittal 2.9 Summary of Electromagnetic Interference, Temperature, humidity and Seismic Testing Results (D.9.3)

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Acronyms

- AIM – Analog Inputs Module
- AMS – Analysis and Measurement Services
- AOM – Analog Outputs Module
- ASL – Approved Supplier List
- C-W – Curtiss-Wright
- CEG – Constellation Energy Generation
- CLS – Compensated Level System
- DIM – Discrete Inputs Module
- DOM – Discrete Outputs Module
- DSS – Digital Safety System
- ECCS – Emergency Core Cooling System
- ED – Electronic Design
- EMC – Elector-Magnetic Compatibility
- HFE – Human Factors Engineering
- IOPM – I/O Protection Module
- LAR – License Amendment Request
- LTR – Licensing Technical Report
- MATS – Monitoring and Tuning System
- MCR – Main Control Room
- NRC – Nuclear Regulatory Commission
- PAMS – Post Accident Monitoring System
- PBAPS – Peach Bottom Atomic Power Station
- PPC – Plant Process Computer
- PSAI – Plant Specific Action Items
- QA – Quality Assurance
- QAPD – Quality Assurance Program Description
- QP – Quality Procedure
- RTM – Requirements Traceability Matric
- SME – Subject Matter Expert
- TR – Topical Report
- WI – Work Instruction
- WAIM – Wide Range Analog Inputs Module

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Definitions

- RPC Radiy – designer of the RadICS digital safety platform. Parent company of RPC Radics LLC
- RPC Radics LLC – RadICS Topical Report Submitter
- RadICS – digital safety system platform developed by RPC Radiy

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PEA Response to
NRC Meeting Notes dated July 29, 2024

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Text from NRC Meeting Minutes dated July 29, 2024

The NRC staff also described actions that Constellation or its supplier would need to take in order to support a review of the planned LAR by the NRC staff using the ARP described in DI&C-ISG-06, Revision 2. The licensee's supplier could submit a QAPD topical report to the NRC for review and approval. If approved by the NRC staff, the licensee's supplier could either:

(1) perform commercial grade dedication of the RadICS platform and develop the safety-related application software using the dedicated platform. This allows Constellation to submit the LAR with the content expected of a request being reviewed by the NRC staff in accordance with the ARP described in DI&C-ISG-06, Revision 2. Use of the guidance in Regulatory Guide 1.250, "Dedication of Commercial-Grade Digital Instrumentation and Control Items for Use in Nuclear Power Plants," Revision 0, October 2022 (ML22153A408), would provide a means for the licensee's supplier to use the International Electrotechnical Commission (IEC) 61508, "Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems, Edition 2.0," safety integrity level certification of the vendor of the instrumentation and controls (I&C) platform topical report components in lieu of performing a commercial grade survey to satisfy the dependability critical characteristic; or

(2) rely on the I&C platform topical report's vendor's Appendix B compliant QA program for the manufacturing of the I&C platform components, and the licensee or its supplier performs onsite triennial audits of the vendor of the I&C platform under their QA programs.

C-W Quality Assurance Program Background

- Curtiss-Wright QA Program Digital Safety System (DSS) Quality Procedures (QPs)
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Thank you!

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System Development Slide Backups

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Application Development Methodology Comparison

- *TR 7.2 Standard Requirements in the RadICS Life Cycle*
  - *Standardized Class 1E hardware Modules*
  - *Standardized Class 1E EDs*
  - *A Class 1E FBL including*
    - *The RadICS PFBL that includes functional blocks used for the ED of the RadICS Modules*
    - *The RadICS AFBL that includes functional blocks used in the Application ED*
  - *A non-Class 1E set of tools integrated in a software development environment called RPCT*
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Application Development Methodology Comparison

- *TR 7.3.1 RadICS Safety Life Cycle*
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- *TR 7.3.4 RadICS System Integration and Validation*
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Application Development Methodology Comparison

- *TR 7.3.5 Project Specific Application Process*
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  - Development of the Application ED by Curtiss-Wright conforms to the requirements specified in the TR, specifically:
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Application Development Methodology Comparison

- *TR 7.4 RadICS Platform Verification and Validation*
  - The C-W implementation follows the requirements of this section
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Application Development Methodology Comparison

- *TR 7.5 RadICS Configuration Management Process*
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Application Development Methodology Comparison

- *TR 7.6 Requirements for the RadICS Platform and Applications*
  - Requirements specified as defined in Figure 7-8 of this section of the TR.
- *TR 7.6.1 Allocation of Requirements*
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- *TR 7.6.2 Documentation of Design Requirements*
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- *TR 7.6.3 Maintainability and User Requirements*
  - Requirements define maintainability and user requirements in addition to functional and performance requirements.
  - The criteria in Table 7.3 are addressed as applicable for the system being developed.

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Application Development Methodology Comparison

- *TR 7.6.4 Requirements Tracing Tool*
  - Requirements are automatically traced using a tracing tool (Reqtracer) from
    - Higher-level requirements documents to the lower-level requirements documents
    - Requirements documents to design documents
    - Requirements documents to testing documents
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- *TR 7.8 Development Process Training*
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Application Development Methodology Comparison

- *Section 8 Electronic Design Development*
- *8.4 Application Electronic Design*
  - RPCT tool is used to develop the Application Electronic Design.
  - Utilizes the AFBL provided by the RPCT tool to develop the Application Electronic Design.

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Application Development Methodology Comparison

- *Section 9 Equipment Qualification and Analysis*
- *9.1 Equipment Qualification*
  - RadICS components qualified during TR
    - Generic environment
    - Generic environment verified as bounding for SER PSAI
  - Commercial components qualified as part of the ECCS CLS replacement
    - Seismic
    - EMC
    - Environmental

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Application Development Methodology Comparison

- *Section 10 Diversity and Defense-In-Depth*
- *10.2 Digital Common Cause Failures*
- *10.3 Defense Against Common Cause Failures*
- *10.3.1 Electronic Design Development Process Quality*
- *10.3.2 Hardware Independence Principles*
- *10.3.3 RadICS Platform Diversity Assessment*
- *10.3.4 Defense-in-Depth*
- *10.4 RadICS Diversity Summary*
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  - LAR includes D3 Analysis that covers these sections of the TR

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Application Development Methodology Comparison

- *Section 11 Secure Development and Operational Environment*
- *11.1 Development Environment Vulnerability Assessment*
- *11.2 RadICS Secure Development Environment*
- *11.3 Operating Environment Vulnerability Assessment*
- *11.4 RadICS Platform Secure Operational Environment*
- *11.5 Technology Advantages for FPGAs and CPLDs*
- *11.6 Project-Specific Vulnerability Assessments*
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Application Development Methodology Comparison

- *Appendix A: RadICS Platform Application Guide*
- *A.1.2 Response to Platform Failures*
- *A.1.3 User Designed Response to Platform Failures*
  - As required in the TR, the C-W developed application logic shall detect and respond to the following platform failures:
    - 1) Any failure of a field input signal,
    - 2) Any failure of an individual I/O channel on a module,
    - 3) Any complete failure of a module,
    - 4) Any failure in a remote RadICS Chassis which has switched to the RUN (SAFE) mode and that communicates with the local chassis under consideration (the resulting stale data from such a remote chassis must be detected by Application Logic in the local chassis), and
    - 5) EEPROM failure after STARTUP (Note: These EEPROMs are used only at power-up, so a detected failure occurring during operation is an early warning that the next power-up will not succeed).

Application Development Methodology Comparison

- *A.2 System Design Guidance*
- *A.2.2 Power Supplies*
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- *A.2.3 Environmental Conditions*
  - The RadICS component environmental conditions referenced in the RadICS TR will be verified as bounding for the PBAPS installed location.
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- *A.2.4 Inputs and Outputs*
  - The C-W implementation will only include I/O modules that were evaluated in the RadICS TR
    - LM, AIM, WAIM, AOM, DIM, and DOM

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Application Development Methodology Comparison

- *A.2.5 Operational Features*
- *A.2.5.1 Safety Override Operation*
  - The replacement ECCS CLS does utilize the SOR function
  - Consistent with the design of the existing ECCS CLS
- *A.2.5.2 Access Control Features*
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- *A.2.6 Setpoint Accuracy Calculations*
  - The LAR will address 1.9 “Setpoint Methodology and Calculations” (D.7)

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Application Development Methodology Comparison

- *A.2.7 Reliability Calculations*
  - The LAR will address SER PSAI 7.6 Application Specific System Reliability and 7.8 System Testing and Surveillance
- *A.2.8 Equipment Qualification Envelope*
  - The LAR will address PSAIs 7.4, 7.4.1, 7.4.2, 7.4.3 and 7.4.4
- *A.2.9 Application Logic Development*
  - The LAR submittal will include
    - 1.1 Summary of Application Software Planning and Process (D.4)
    - SER PSAI 7.2 Application Logic Development Process

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Application Development Methodology Comparison

- *A.2.9 Application Logic Development (cont.)*
  - The C-W implementation will follow the Application Logic Development process defined by RPC Radics LLC for RadICS based digital safety systems and detect and respond to:.
    - Any failure of a field input signal
    - Any failure of an individual I/O channel on a Module
    - Any complete failure of a Module
    - Loss of communications between the LM and a DOM or AOM
    - EEPROM failure after STARTUP

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Application Development Methodology Comparison

- *A.2.9.1 Verification of Chassis Configuration*
  - The C-W implementation will include application logic to detect and respond to these conditions.
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- *A.2.9.2 Verification of I/O Module Status*
  - The C-W implementation will include application logic to detect and respond to these conditions
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Application Development Methodology Comparison

- A.2.9.3 Detection of Safety-Critical I/O Failures
  - The C-W implementation will include application logic to detect and respond to these conditions
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- A.2.9.4 Analog Input Signal Tolerance
  - The C-W implementation will include application logic to incorporate these specific considerations
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Application Development Methodology Comparison

- A.2.9.7 Monitoring Module Temperature
  - The C-W implementation will include application logic to detect and respond to these conditions

- A.3.1 Physical Security
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- A.3.2 Mounting
  - The C-W implementation will meet the requirements specified by this section.
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Application Development Methodology Comparison

- A.4.1 Periodic Inspection
- A.4.2 Periodic Testing
- A.4.3 Periodic Calibration
  - The ECCS CLS will continue to utilize the existing surveillance procedures which will be updated as needed for the specifics of the replacement system

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Application Development Methodology Comparison

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Application Development Methodology Comparison

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Application Development Methodology Comparison

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QA Slide Backups

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Quality Assurance Program

- Curtiss-Wright QA Program
  - Curtiss-Wright Nuclear Division Quality Assurance Manual (QAM) for Scientech Products and Services
    - Requirements for 10 CFR 50 Appendix B, NQA-1 2008/2009a and 10 CFR 21
    - Implementing procedures defined by a set of Standard Operating Procedures (SOPs)
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Quality Assurance Program Differences

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Quality Assurance Program Differences

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Quality Assurance Program Maintenance

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Quality Assurance Program Comparison

- Curtiss-Wright / RPC Radics LLC Implementing Procedures
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Quality Assurance Program Comparison

- Curtiss-Wright / RPC Radics LLC Implementing Procedures
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Quality Assurance Program Comparison

- Curtiss-Wright / RPC Radics LLC Implementing Procedures
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Quality Assurance Program Comparison

- Curtiss-Wright / RPC Radics LLC Implementing Procedures
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Quality Assurance Program Comparison

- Curtiss-Wright / RPC Radics LLC Implementing Procedures
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