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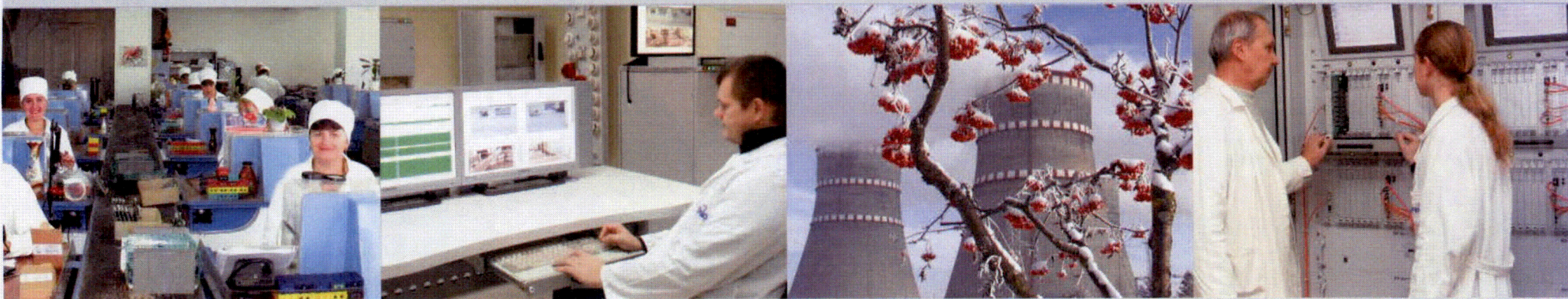


Technical Part 4: RadICS Digital I&C Platform Topical Report

RadICS Qualification Test Plan

(Closed Session)

July 14, 2015, Rockville, Maryland



Agenda

- Foundational Testing During Development
- US Qualification Test Plan
- US Qualification Test Elements
- Regulatory Alignment

Foundational Testing during Development

- RadICS equipment previously qualified to European and US standards

- Previous qualification tests provided good confidence for successful US qualification testing program

US Qualification Test Specimen

- Equipment to be Tested

- Industrial-grade data acquisition system and test specimen application program will exercise QTS during qualification testing
 - Generate a series of known inputs to the QTS
 - Monitor the corresponding outputs of the QTS
- Correct correspondence between input and output before, during, and after qualification tests and lack of spurious behavior are key

US Qualification Test Plan (1/5)

- QTS Factory Acceptance Testing
 - Demonstrate compliance of RadICS QTS and Test System with QTS Specification
- Pre-Qualification Acceptance Testing
 - Based on EPRI TR-107330 Section
- Radiation Exposure Withstand Testing
 - Based on EPRI TR-107330 Section 4.3.6
- Environmental Testing
 - Based on EPRI TR-107330 Section 4.3.6
- Seismic Testing
 - Based on EPRI TR-107330 Section 4.3.9

US Qualification Test Plan (2/5)

- Electromagnetic Compatibility Testing

- Based on RG 1.180, Revision 1, and EPRI TR-107330 Section 4.3.7
- EMC Emissions Tests to MIL-461E Series Tests

- Electrical Fast Transient Testing

- Based on RG 1.180, Revision 1, and EPRI TR-107330 Sections 4.6.2 and 4.3.7

- Surge Withstand Testing

- Based on RG 1.180, Revision 1, and EPRI TR-107330 Sections 4.6.2 and 4.3.7

US Qualification Test Plan (3/5)

- Electrostatic Discharge (ESD) Testing
- Class 1E to Non-Class 1E Isolation Testing
 - Based on IEEE Standard 384-1992 and EPRI TR-107330 Sections 4.6.4 and 6.3.6
- Performance Proof Testing
 - Following completion of all hardware qualification testing based on EPRI TR-107330, Section 5.5

US Qualification Test Plan (4/5)

- Operability Testing

- Based on EPRI TR-107330 Sections 5.3 and 5.5
- Operability testing is performed at the following :
 - With Pre-Qualification Acceptance Testing
 - At completion of Radiation Exposure Withstand Testing
 - At completion of the high temperature, high humidity phase of Environmental Testing
 - At completion of the low temperature phase of Environmental Testing
 - At completion of the low humidity phase of Environmental Testing
 - At completion of Environmental Testing
 - During Seismic Testing
 - During EMC Testing (except accuracy test portion)
 - With Performance Proof Testing

US Qualification Test Plan (5/5)

- Prudency Testing
 - Based on EPRI TR-107330 Sections 5.4 and 5.5
 - Prudency testing is performed at the following :
 - With Pre-Qualification Acceptance Testing
 - At completion of Radiation Exposure Withstand Testing
 - At completion of the high temperature, high humidity phase of Environmental Testing
 - During Seismic Testing
 - During EMC Testing (Burst of Event test portion only)
 - With Performance Proof Testing

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US Qualification Test Schedule

Regulatory Alignment

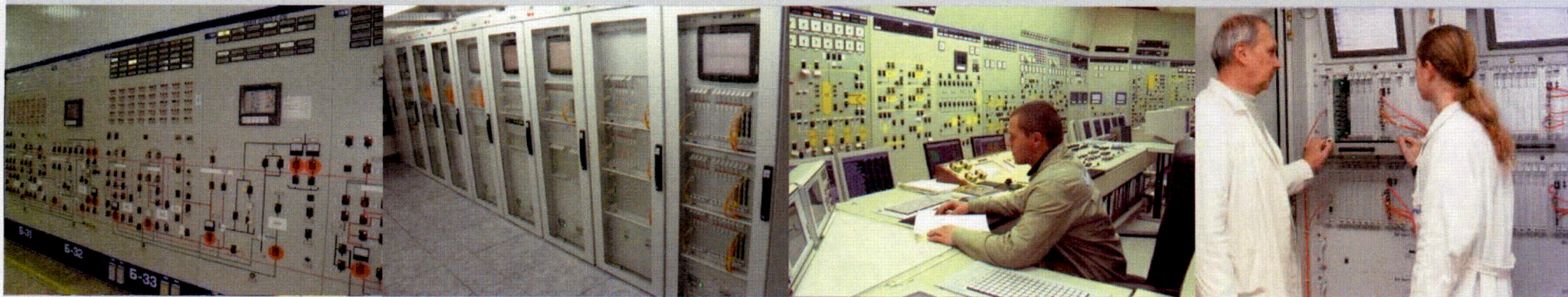
- Environmental qualification testing of the RadICS QTS will be performed in accordance with
 - Regulatory Guide 1.209 and IEEE Standard 323-2003
 - Regulatory Guide 1.152, Revision 3, and IEEE Standard 7-4.3.2-2003
 - EPRI TR-107330
- Seismic qualification testing will be performed in accordance with Regulatory Guide 1.100 and IEEE Standard 344-1987 to the generic seismic spectra provided in TR-107330
- Electromagnetic compatibility (EMC) qualification testing will be performed in accordance with Regulatory Guide RG 1.180, Revision 1

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Thank you for your attention!

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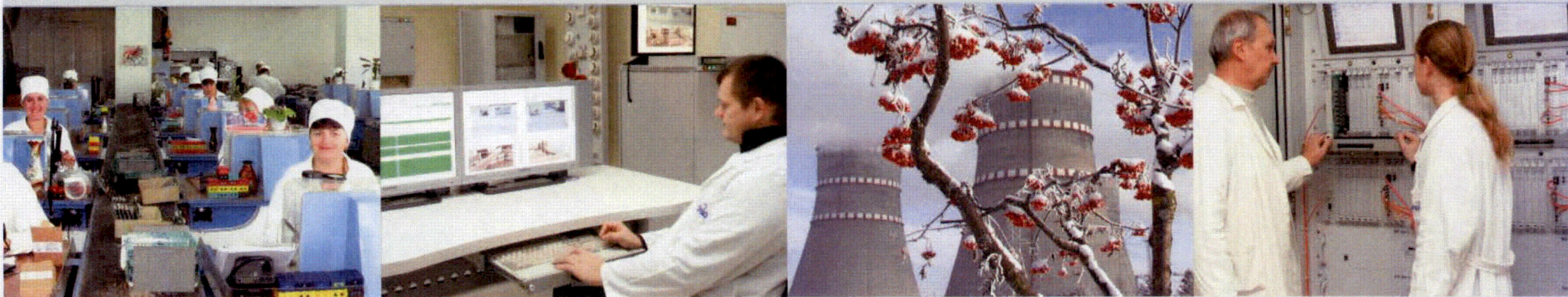


Technical Part 5: RadICS Digital I&C Platform Topical Report

Commercial Grade Dedication Plan

(Closed Session)

July 14, 2015, Rockville, Maryland



Agenda

- Commercial Grade Dedication Strategy
- EPRI TR-106439 for Commercial Dedication Framework
- EPRI TR-107330 for Method 1 Special Tests and Inspections of Critical Characteristics
- Approach to Method 2 Commercial-Grade Survey of Critical Characteristics
- Use of RadICS Development Documents
- Operating Experience

Commercial Grade Dedication Strategy

- Commercial Grade Dedication (CGD) Plan for RadICS Platform will be based on established guidance:
 - EPRI Handbook 1011710 for the independent Critical Design Review of the technology
 - EPRI TR-106439 for the CGD of the platform developed to the Radiy Quality Management System and IEC Requirements
 - EPRI TR-107330 for the equipment qualification tests.
- IEEE Std 7-4.3.2-2003 recognizes the acceptability of EPRI TR-106439 for commercial grade dedication
- Maintenance of RadICS commercial dedication (required by IEEE 7-4.3.2 Section 5.4.2.3) will be accomplished by RadICS QA Program to be certified to meet 10 CFR Part 50 Appendix B requirements.

EPRI TR-106439 for CGD Framework

- EPRI TR-106439 will be used to structure the CGD effort
 - Compliance with EPRI TR-106439 process will be demonstrated using a checklist, which provided a mapping that shows where the elements of the dedication process are addressed in licensing documentation
- RadICS CGD plan will use a combination of three acceptance methods described in EPRI TR-106439 to verify the adequacy of the platform:
 - Method 1: Special Tests and Inspections of the equipment
 - Method 2: Commercial Grade Survey of hardware and electronic design development processes
 - Method 4: Acceptable Performance Record of the RadICS platform

EPRI TR-107330 for Method 1 Special Tests and Inspections of Critical Characteristics

- Qualification testing of the RadICS Platform Test Specimen will be used to address Method 1

- Testing will demonstrate that the RadICS platform functioned correctly during and/or after exposure to the series of stress tests outlined in EPRI TR-107330

Approach to Method 2 Commercial-Grade Survey of Critical Characteristics (1/3)

Method 2 critical characteristics for will based on three US benchmarks

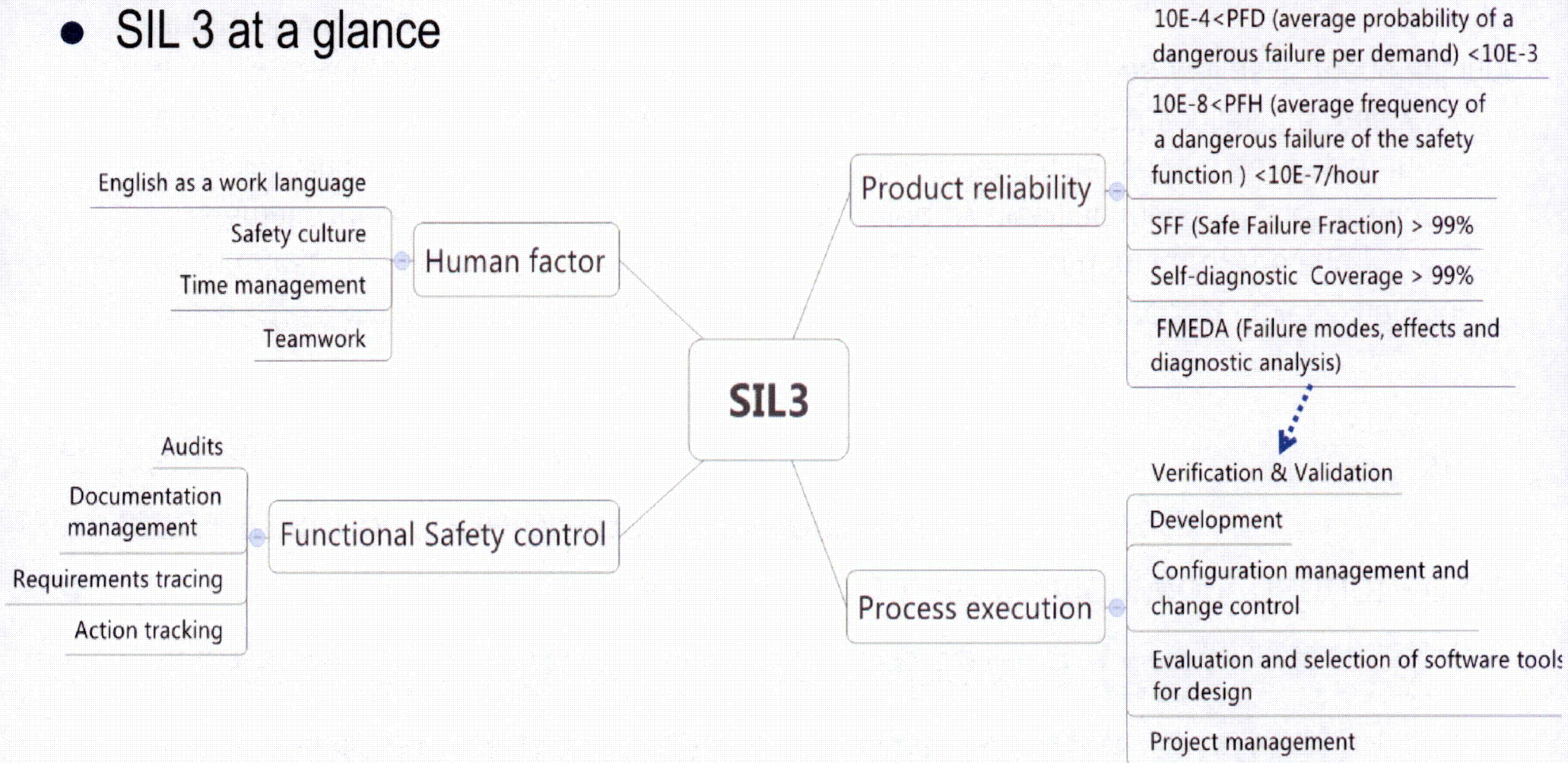
Approach to Method 2 Commercial-Grade Survey of Critical Characteristics (2/3)

- Radiy will also use the recent IEC SIL 3 Certification work performed by **exida** to support the Method 2 assessment
- Relevance to RadICS CGD assessment:

IEC 61508 defines the requirements for suppliers to follow during product development to ensure that their products have a high level of resistance to random hardware and “systematic” design failures. Compliance is evaluated by qualified third party certification agencies which assess and certify that a product has been designed and developed in accordance with the standard. **exida** follows a rigorous process that verifies the Safety Integrity Level (SIL) of a product’s hardware and software design, as well as its manufacturing and quality control procedures.

Approach to Method 2 Commercial-Grade Survey of Critical Characteristics (3/3)

- SIL 3 at a glance



Use of RadICS Development Documents

- Method 2 reviews will assess existing verification and validation records for critical safety features of the RadICS platform
- EPRI TR-106439 envisions the approach of using the historical development records as a basis for acceptance in a commercial grade dedication review.
 - High quality records that are readily retrievable and maintained within an effective configuration management system are essential for use in the RadICS CGD effort.

Operating Experience

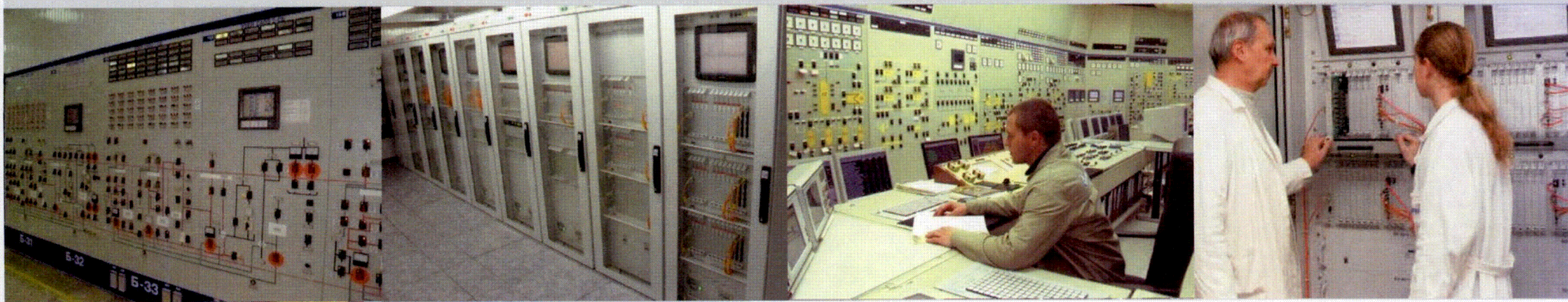
- Method 4 will be used based on the Radiy 3 operating experience to demonstrate satisfactory performance with the platform technology.
- Operating experience will not be used to compensate for shortcomings in legacy electronic design nor will it be used as a basis for establishing module failure rates

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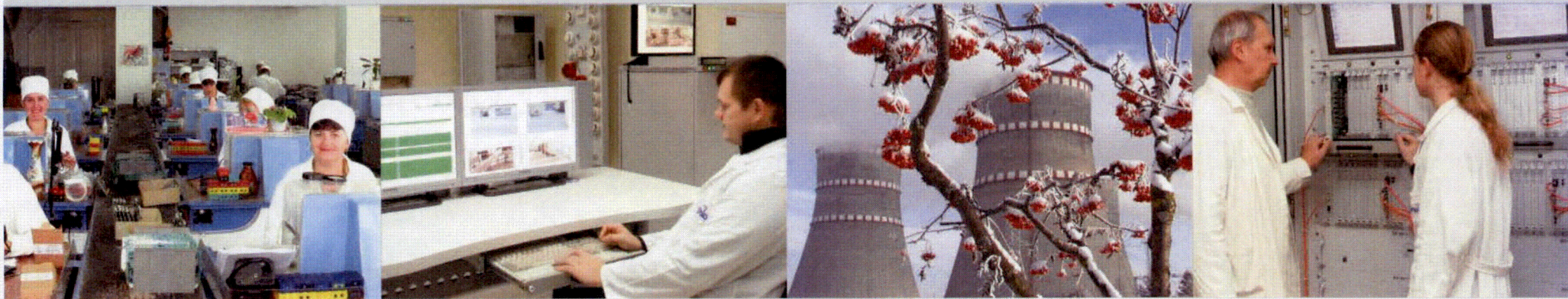


Technical Part 6: RadICS Digital I&C Platform Topical Report

Details of RadICS Licensing Program

(Closed Session)

July 14, 2015, Rockville, Maryland



Agenda

- Licensing Strategy Concept
- Overview of Safety Application
- RadICS Licensing Strategy
 - Phase 0
 - Phase 1
 - Phase 2
 - Phase 3
- RadICS Topical Report Contents
- Overview of Support Documents
- Licensing Review Schedule

Licensing Strategy Concept (1/4)

- Pre-Application Activities (Phase 0) - Goal is to reach general agreement with NRC that:
 - RadICS conceptual design is acceptable
 - Equipment qualification plans are appropriate
 - Commercial grade dedication strategy is acceptable
 - Document submittal plans are understood
 - Overall RadICS project schedule is reasonable
- Radiy Phase 0 Activities
 - Topical Report preparation
 - Equipment qualification plan development
 - Commercial grade dedication plan development
 - 10 CFR Part 50 Appendix B QA Plan certification and implementation

Licensing Strategy Concept (2/4)

- RadICS Topical Report Submittal (Phase 1) - Goal is to have application accepted for review and get early feedback on acceptability of Equipment Qualification Plan :
 - RadICS Topical Report
 - RadICS Equipment Qualification Plan
 - RadICS Commercial Grade Dedication Plan
 - DI&C-ISG-06 Phase 1 Submittals
- Radiy Phase 1 Activities
 - Topical Report review support
 - Equipment qualification plan implementation
 - Commercial grade dedication plan implementation
 - Respond to NRC Round 1 requests for additional information
 - Prepare Phase 2 Documents for submittal

Licensing Strategy Concept (3/4)

- Pre-Application Activities (Phase 2) - Goal is to provide timely responses and have successful audits :
 - RadICS Equipment Qualification Summary Report
 - RadICS Commercial Grade Dedication Summary Report
 - DI&C-ISG-06 Phase 2 Submittals
- Radiy Phase 2 Activities
 - Topical Report review support
 - Support NRC audits, as necessary
 - Respond to NRC Round 2 requests for additional information
 - Prepare Final Topical Report Update
 - Review draft safety evaluation report for proprietary information

Licensing Strategy Concept (4/4)

- Pre-Application Activities (Phase 3) - Goal is to provide timely issuance of approved RadICS Topical Report:
 - RadICS Topical Report (–A Versions)
- Radiy Phase 3 Activities
 - None, project complete

RadICS Topical Report (1/2)

- Chapter 1 – Introduction
- Chapter 2 - Development and Operational History
- Chapter 3 – Regulatory Design Criteria
- Chapter 4 - Description of the RadICS Platform
- Chapter 5 - Development Process for RadICS Platform Hardware
- Chapter 6 - Software Development Process for Programmable Logic
- Chapter 7 - Equipment Qualification
- Chapter 8 - Diversity and Defense in Depth
- Chapter 9 - Compliance with Standards and Interim Staff Guidance
- Chapter 10 - Secure Development and Operational Environment

RadICS Topical Report (2/2)

- Appendix A - RadICS Platform Application Guide
- Appendix B - IEEE Standard 603–1991 Compliance Matrix
- Appendix C - IEEE Standard 7-4.3.2-2003 Compliance Matrix
- Appendix D - DI&C-ISG-04 Compliance Matrix
- Appendix E - DI&C-ISG-06 Compliance Matrix
- Appendix F - Documentation Cross-Reference Matrix

Overview of Phase 1 Documents (1/2)

DI&C-ISG-06 Reference		Radiy Document
1.1	Hardware Architecture Descriptions	
1.2	Quality Assurance Plan for Digital Hardware	
1.3	Software Architecture Descriptions	
1.4	Software Management Plan	
1.5	Software Development Plan	
1.6	Software QA Plan	
1.7	Software Integration Plan	
1.8	Software Safety Plan	
1.9	Software V&V Plan	
1.10	Software Configuration Management Plan	
1.11	Software Test Plan	
1.12	Software Requirements Specification	
1.13	Software Design Specification	

Overview of Phase 1 Documents (2/2)

DI&C-ISG-06 Reference		Radiy Document
1.14	Equipment Qualification Testing Plans	
1.15	D3 Analysis	
1.16	Design Analysis Reports	
1.17	System Description (To block diagram level)	
1.18	Design Report on Computer Integrity, Test and Calibration, and Fault Detection	
1.19	System Response Time Analysis Report	
1.20	Theory of Operation Description	
1.21	Setpoint Methodology	
1.22	Vendor Software Plan	
1.23	Software Tool Verification Program	
1.24	Software Project Risk Management Program	
1.25	Commercial Grade Dedication Plan	
1.26	Vulnerability Assessment	
1.27	Secure Development and Operational Environment Controls	

Licensing Review Schedule

- Proposed Schedule

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