Désignation du document *Document name*	**System Integration and Factory Test Plan**

Affaire *Product*	☐	**US Template**
Equipement *Equipment*	☐	
Sous-ensemble *Subassembly*	☐	
Classé 1E ou équiv. *Safety classification*	☐	

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Record of revisions

Indice /date **Rédigé par** *Revision letter / date* *Written by*	**Pages modifiées** *Modified pages*	**Origine et désignation de la modification** *Origin and designation of the modification*
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TABLE DES MATIERES

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Guidance for Use of this Template

This section provides guidance for customizing this template for a specific project. This guidance section is deleted after the plan is customized.

Rolls-Royce Civil Nuclear SAS (RRCN) will use this template as the basis for preparing the corresponding plant-specific plan that will define specific life cycle processes for ***SPINLINE 3*** systems for use in nuclear power plants located in the United States (US). RRCN engineers will customize this plan for each plant-specific safety I&C system. The customization replaces symbols defined in this section, as necessary, to reflect the actual scope of the plant-specific project. The basic process defined in this template may not be changed.

Guidance is provided in this template as *italic text* and is either removed or replaced by appropriate normal text in the actual plan. Symbols are used to indicate places where changes are required to customize this template into a project-specific plan. These symbols must be replaced by names relevant to the actual project. The symbols defined in this template are as follows:

Project_Name	*Example:*	MYPROJECT
System_Name (project composed of one or more systems)	*Example:*	RPS
Processing_Unit_Name	*Example:*	FUx
Manager_Name	*Example:*	P. DUPONT
Document_Number (in RRCN format)	*Example:*	3 300 000

1 INTRODUCTION

This System Integration and Factory Test Plan is one of a set of software and system life cycle plans that govern the life cycle for plant-specific ***SPINLINE 3*** systems. This Plan is compliant with the requirements and guidance documents listed in Section 2.

1.1 Purpose

This document is the System Integration and Factory Test Plan for the ***SPINLINE 3*** digital safety Instrumentation and Controls (I&C) system*(s)* developed by Rolls Royce Civil Nuclear SAS (RRCN) for *Project_Name*.

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1.2 Relationship of this Plan to the Plans Defined in BTP 7-14

The USNRC NUREG-0800, “Standard Review Plan,” Branch Technical Position (BTP) 7-14 (Reference 6) defines twelve software life cycle plans, with an additional cyber security plan defined in Regulatory Guide (RG) 1.152 (Reference 7). RRCN uses fewer software life cycle plans that still cover all aspects of the plans defined by BTP 7-14 and USNRC Regulatory Guide 1.152. [[

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1.3 Project Summary

1.3.1 Project objectives

The System Integration and Factory Test Plan is specific to the following ***SPINLINE 3*** systems of *Project_Name*:

Safety Systems – Class 1E

- *System_Name_1*

  Processing_Unit_Name, … (*SPINLINE 3 software*)
- *System_Name_n*

  Processing_Unit_Name, … (*SPINLINE 3 software*)

Nonsafety Systems

- *Monitoring and Maintenance Unit*

  MMU *(PC software)*
- *Other system (to be determined))*

  Processing_Unit_Name, … *(software to be determined)*

1.3.2 System description

Insert a brief description of each of the systems to be installed at Nuclear_Power_Plant_Name.

1.3.3 Deliverables

The primary deliverables from the activities described in this Plan are the completed system integration and factory test documentation and the digital safety I&C system(s) identified in Section 1.3.1, ready to ship to the designated customer site for installation. The system integration and factory test documentation listed in Table 1 is produced in accordance with this Plan.

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1.3.4 Constraints and assumptions

The constraints for the start of hardware integration of *System_Name_1* to *System_Name_n* are listed below:

1. The hardware scheduled for integration was procured in accordance with the detailed design documentation of *System_Name_1* to *System_Name_n* and the RRCN Quality Manual (Reference 9).
2. *Add other constraints as appropriate.*

The constraints for the start of integration of *System_Name_1* to *System_Name_n* are listed below:

1. The software scheduled for integration was built and/or configured in accordance with the detailed design of *System_Name_1* to *System_Name_n* and the *Project_Name* application software life cycle plans (References 1, 10, 11 and 12).
2. Application software testing have been completed. All activities required by the *Project_Name* Software Verification and Validation Plan (Reference 1) before starting system integration and validation have been completed.
3. *Identify if there will be a licensee participation in hardware integration tests, system integration and factory interconnected systems tests. If so, define and incorporate the appropriate roles and responsibilities into this Plan.*

4. *Identify the required training for licensee participants in system integration and factory testing if any.*
5. The plant-specific Operations and Maintenance Manuals (OMMs) for *System_Name_1* to *System_Name_n* have been completed and are available to be exercised during integration and factory testing.
6. *Add other constraints as appropriate.*

This Plan makes the following assumptions about the integration and factory testing of *System_Name_1* to *System_Name_n*:

1. Integration and factory testing will occur in the RRCN factory.
2. RRCN is responsible for managing integration and factory testing.
3. *Add other assumptions as appropriate.*

1.4 Definitions and Abbreviations

1.4.1 Definitions

The following definitions are important for understanding the scope and applicability of this software plan.

Equipment technology	This plan considers two equipment technologies: ▪ ***SPINLINE 3*** is a proprietary Rolls-Royce Civil Nuclear SAS technology designed to implement safety functions ▪ A personal computer (PC) is a commercially available technology based on Intel or equivalent microprocessors, run under a commercial operating system, and used to implement nonsafety control, monitoring, or communication functions
Software category	This plan considers two categories of software: safety (Class 1E) and nonsafety (non Class 1E)

1.4.2 Abbreviations

The following abbreviations are used in this plan.

A	Ampere
AC	Alternating current
BTP	Branch Technical Position
DC	Direct current
EEPROM	Electrically Erasable Programmable Read Only Memory
FAT	Factory acceptance test
IEEE	Institute of Electrical and Electronics Engineers
I&C	Instrumentation and Control
mA	Milliampere

NPP	Nuclear Power Plant
OMM	Operations & Maintenance Manual
PC	Personal Computer
PCR	Problem/Change Report
QA	Quality Assurance
RG	Regulatory Guide
RRCN	Rolls-Royce Civil Nuclear SAS (Société Anonyme Simplifié)
STP	Software Test Plan (BTP 7-14)
SVVP	Application Software Verification and Validation Plan
USNRC	United States Nuclear Regulatory Commission
V	Volt
VAC	Volts AC
VDC	Volts DC
V&V	Verification and Validation

1.5 Creation and Update of this Plan

The System Integration and Factory Test Plan is created by RRCN. The Chief Engineer of the *Nuclear_Power_Plant_Name* approves the System Integration and Factory Test Plan.

Subject to the approval noted above, this Plan is updated as required to reflect the as-built system at the time of factory testing.

2 REFERENCE DOCUMENTS

Reference Standards:

The following standards and guides apply to the factory testing activities described in this Plan.

Branch Technical Position 7-14 (Reference 6)	“Guidance on Software Reviews for Digital Computer-based Instrumentation and Control Systems”, Section B.3.1.12, “Software Test Plan (STP)”
Regulatory Guide 1.152, Revision 2 (Reference 7)	"Criteria for Use of Computers in Safety Systems of Nuclear Power Plants"
IEEE Std 7-4.3.2-2003 (Reference 13)	IEEE Standard Criteria for Digital Computers in Safety Systems of Nuclear Power Generating Stations, Clause 5.4.1, Computer System Testing
Regulatory Guide 1.170 Revision 0 (Reference 14)	“Software Test Documentation for Digital Computer Software Used in Safety Systems of Nuclear Power Plants”
IEEE Standard 829-1983 (Reference 15)	“IEEE Standard of Software Test Documentation”

Project Documents:

The following documents define the project execution processes.

Mnemonic	Reference	Designation
[CSP]	*Document_Number*	Cyber Security Plan (project-specific)
[PQP]	*Document_Number*	Project Quality Plan (project-specific)
[PMP]	*Document_Number*	Project Management Plan (project-specific)
[SVVP]	*Document_Number*	Software Verification and Validation Plan (project-specific)
[SDP]	*Document_Number*	Software Development Plan (project-specific)
[SCMP]	*Document_Number*	Software Configuration Management Plan (project-specific)
[SQAP]	*Document_Number*	Software Quality Assurance Plan (project-specific)
	Document_Number	System Installation and Site Test Plan (project-specific)
	Document_Number	System Operations and Maintenance Plan (project-specific)

RRCN Quality Management System reference documents:

The following documents provide detailed engineering instructions to implement this system plan.

Mnemonic	Reference	Designation
[MQ]	8 303 186 P (Reference 9)	RRCN Quality Manual *Manuel Qualité de RRCN*
[PRA]	8 303 314 J	Project Development Process *Processus Réalisation d'Affaire*
	8 307 032 C	Principles for Control of Design (safety systems) *Principes de Maîtrise de la Conception (système classé sûreté)*
	8 303 334 F	System Design (Safety Systems) *Ingénierie Système (Système classé sûreté)*

3 INTEGRATION AND FACTORY TEST ROLES AND RESPONSIBILITIES

3.1 System Supplier Integration and Factory Test Roles and Responsibilities

RRCN will execute its integration and factory testing roles and responsibilities consistent with the terms of the regulations and its contract with the licensee. These roles and responsibilities include the following *(list to be updated as needed for Project_Name)*:

- Provide the factory space and associated services and equipment for integration and factory testing
- Provide the integration and factory test manager and staff.
- Prepare the system integration and factory test procedures.
- Prepare the packing lists for shipping the system(s) at the conclusion of factory testing.
- Coordinate all system integration activities
- Perform a system configuration audit as the preliminary step to formal factory testing and resolve any audit discrepancies.
- Execute factory testing and record any variances observed during testing.
- Work with the customer to accept, prioritize, and schedule resolution of variances observed during factory testing.
- Resolve agreed variances.
- Prepare the factory test reports
- At the conclusion of factory testing, dismantle, pack and ship the system to the NPP.

3.2 Utility Integration and Factory Test Roles and Responsibilities

The utility's role during integration and factory testing will be specified in the contract and may range from being a witness to being an active participant in running the test procedures. The NPP is responsible for the following:

- *Provide an adequate number of staff trained and ready to support integration and factory testing.*
- Approve the factory test procedures and the packing lists.
- Agree the plan for closure of variances noted during factory testing.
- Approve shipping at the conclusion of factory testing.
- *Update as needed for Project_Name.*

4 RISKS MANAGEMENT

The NPP and RRCN will jointly prepare a risk register for integration and factory testing of *System_Name_1* to *System_Name_n*. The risk register will identify sources of risk, mitigating measures, and residual risk. This risk register will be established prior to the start of integration and factory testing activities and will be updated in accordance with a process that will be jointly agreed by NPP and RRCN.

Cyber security risks and mitigating measures to be implemented during integration and factory testing are identified in the *Project_Name* Cyber Security Plan (Reference 5).

5 BASIC HARDWARE INTEGRATION TESTS

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6 SYSTEM INTEGRATION

This section defines the system integration that precedes factory interconnected tests. The scheduling of these activities will be defined in Section 11.

System integration occurs at the end of the system life cycle production phase, which includes industrial implementation of the designed hardware and software items and checks of compliance of the produced items.

System integration is carried out on hardware and software of *System_Name_1* to *System_Name_n* which have been individually manufactured and validated.

6.1 Software Integration with the Hardware in Individual Cabinets

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6.2 Integration of Interconnected Systems

The system integration activity establishes a representative interconnected assembly of *System_Name_1* to *System_Name_n*, which is used to perform interconnected systems tests.

A representative configuration is for instance one division of System_Name_1 to System_Name_n and network simulation from the other divisions to the voting logic of the first division, if it is demonstrated that the other divisions are identical to the first one, based on hardware and software configuration management.

Identify in this section:

- *The representative interconnected assembly for System_Name_1 to System_Name_n, including any test and measurement device needed to perform interconnected systems testing (for instance to simulate inputs to or acquire outputs from the systems)*
- *The system integration procedure that is used to assemble the representative configuration.*

6.3 System Configuration Audit

At the completion of system integration, a configuration audit will be performed to document the as-built configuration of the system. An audit report will be prepared, indicating:

- The list of reference documents which are applicable for the interconnected tests, with indication of their revision
- Number and revision of the hardware elements (cabinets, racks, boards)
- Identification of software embedded in racks (the software identification is the number and revision of the document allowing EEPROM manufacturing).
- References of all test and measurement devices.

7 FACTORY INTERCONNECTED SYSTEMS TESTS

7.1 Purpose and Scope of Factory Interconnected Systems Testing

Factory interconnected tests are the last step of the general factory testing process. They are performed on the representative interconnected assembly obtained after system integration as described in section 6.

Factory interconnected tests include:

- Functional tests - second step: their aim is to verify that functional requirements of the system, as described in system specification documentation, are met. Functional requirements include main functions, accuracy, response time, and cyber security requirements.
- Maintenance and troubleshooting: their aim is to evaluate the effectiveness of actions for maintenance and troubleshooting purposes. These tests include performance of periodic tests, checks of system behavior in case of failure.

7.2 Definition of “Normal State” of the Interconnected Assembly

The normal state is a state where neither postulated initiating event nor alarm are set.

7.3 Factory Interconnected Tests Conditions

Interconnected tests are performed in standard atmospheric conditions:

- ambient temperature : 15°C to 35°C,
- humidity : 45% to 75%,
- atmospheric pressure : 860 hPa to 1060 hPa

Except for specific indications in the test procedures, each test is performed starting with the “normal state” of the test configuration (as defined in section 7.2).

7.4 Interconnected System Tests Program

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7.5 Factory Acceptance Testing

The final step of the interconnected tests is the Factory Acceptance Test (FAT). The FAT is performed with a representative of the Customer.

The aim of the FAT tests is to provide a comprehensive test framework upon which system acceptance can be based. FAT includes the following:

- Customer examination of Test Documentation,
- Customer follow-up of Manufacturing Documentation,
- Customer performance of a subset of Factory Tests.

After completing the interconnected system tests and resolution of variances agreed with the customer, the system is ready to ship to the designated customer's site.

7.6 Re-run after Installation at the NPP

The interconnected system tests establish a test baseline for *System_Name_1* to *System_Name_n*. Therefore, the interconnected system tests defined in this section will serve as the core set of tests for site testing, which is governed by the System Installation and Site Test Plan (Reference 4).

Identify the interconnected system tests that will serve as the core set of tests for site testing

The NPP and RRCN will agree on additional end-to-end tests that can only be performed after installation has been completed. These new final acceptance test procedures will be identified in the System Installation and Site Test Plan.

8 SYSTEM DISASSEMBLY, PACKING, AND SHIPPING

Packing lists will be prepared for shipping the system*(s)* at the conclusion of factory testing.

The packing lists identify system subassemblies that will be handled separately for shipping. For instance, EEPROMs are removed from the hardware and handled separately.

Packing will be performed on the system subassemblies according to practices identified in the *Project_Name* Quality Plan (Reference 16).

9 PROBLEM REPORTING AND CORRECTIVE ACTION

All variances logged at any time during integration or testing will be documented in a test log and in Problem/Change Reports (PCRs) or similar records.

These records will be handled in accordance with QA Procedures and the Project_Name Quality Plan (Reference 16).

RRCN will implement a formal process to evaluate and resolve the observed variances.

10 INSTRUMENTATION AND TOOLS

Any instrumentation and installation tools needed during integration and factory testing will be identified in the applicable procedures and provided by RRCN.

As appropriate, quality procedures for calibration, handling, and storage apply to such instrumentation and tools.

11 SCHEDULE

This section of the Plan will define the plant-specific milestones for system integration and factory testing activities for *System_Name_1* to *System_Name_n*.

Tasks on the critical path will be identified.

12 RECORDS RETENTION

RRCN will retain integration and factory test records in accordance with contractual requirements stipulated by the NPP. If not otherwise stipulated, RRCN will maintain installation records for the operating life of the system.

13 REFERENCES

1. "*Project_Name* Software Validation & Verification Plan", based on Rolls-Royce Civil Nuclear SAS Software Validation & Verification Plan template 8 307 210 B, June 30, 2009
2. "Equipment Qualification Plan", Document No. 3 006 501C, Rolls-Royce Civil Nuclear SAS, June 2009
3. "*Project_Name* Qualification Plan", Document No. *Document_Number*
4. "*Project_Name* System Installation and Site Test Plan", based on Rolls-Royce Civil Nuclear SAS System Installation and Site Test Plan template 8 307 243 A, June 30, 2009
5. "*Project_Name* Cyber Security Plan", based on Rolls-Royce Civil Nuclear SAS Cyber Security Plan template 8 307 255 A, June 30, 2009
6. USNRC NUREG-0800, "Standard Review Plan," Branch Technical Position 7-14, Revision 5, "Guidance on Software Reviews for Digital Computer-based Instrumentation and Control Systems"
7. Regulatory Guide 1.152, Revision 2, "Criteria for Use of Computers in Safety Systems of Nuclear Power Plants"
8. Regulatory Guide 1.171, Revision 0, "Software Unit Testing for Digital Computer Software Used in Safety Systems of Nuclear Power Plants"
9. "Quality Manual", Document No. 8 303 186 P, Rolls-Royce Civil Nuclear SAS, June 2009
10. "*Project_Name* Software Development Plan", based on Rolls-Royce Civil Nuclear SAS Software Development Plan template 8 307 211 B, June 30, 2009
11. "*Project_Name* Software Configuration Management Plan", based on Rolls-Royce Civil Nuclear SAS Software Configuration Management Plan template 8 307 209 B, June 30, 2009
12. "*Project_Name* Software Quality Assurance Plan", based on Rolls-Royce Civil Nuclear SAS Software Quality Assurance Plan template 8 307 208 B, June 30, 2009
13. IEEE Std 7-4.3.2-2003, "IEEE Standard Criteria for Digital Computers in Safety Systems of Nuclear Power Generating Stations", Institute of Electrical and Electronics Engineers.
14. Regulatory Guide 1.170, Revision 0, "Software Test Documentation for Digital Computer Software Used in Safety Systems of Nuclear Power Plants"
15. IEEE Standard 829-1983, "IEEE Standard of Software Test Documentation" , Institute of Electrical and Electronics Engineers.
16. "*Project_Name* Quality Plan", Document No. *Document_Number*

APPENDIX A - BASIC HARDWARE INTEGRATION TEST DESCRIPTIONS

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APPENDIX B - INTERCONNECTED SYSTEM TEST DESCRIPTIONS

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