

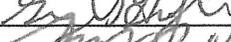
Project: TRICON v10 NUCLEAR QUALIFICATION PROJECT

**NUCLEAR QUALIFICATION
 QUALITY PLAN**

Document No.: 9600164-002

Revision 3

11/08/06

	Name	Signature	Title
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Approvals:	Gary Hufton		Director, Platform Technology Development
	Jeff Larson	 11/8/06	IPS Nuclear Quality Director

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Revision History

Revision	Date	Description of Change	Author
0	12/06/05	Initial issue.	Ted Porfilio
1	09/26/06	In general, Revision 0 was modified to: 1) Update the Project Organization (Section 3.0), including MPR Associates; 2) Adjust Project personnel Responsibilities (Section 4.0) consistent with the Organization; 3) Add requirements for the procurement of materials and equipment that support Project testing activities; 4) Clearly define the responsibilities of the TSAP V&V Team, including the review and approval of associated documents; 5) Delineate the requirements associated with the verification and validation of test software; 6) Delete the requirement for the use of QPARs in association with procedure corrections; 7) Add the requirement for QPARs in association with assembly and configuration inspections; 8) Provide the requirements for Tricon-Under-Test shipping and receipt inspections; 9) Implement the requirements for TSAP configuration management; 10) Ensure that format and content appendices are considered as guidelines and are consistent with Project objectives; and 11) Ensure overall document editorial consistency. Revision 1 basically represents a complete rewrite of Revision 0 and, therefore, for clarity change bars have not been included in Revision 1.	Ted Porfilio
2	10/31/06	Minor changes to enhance NQQP clarity. Added a paragraph to describe the methodology used for assembly of the nuclear qualification test system. Deleted the requirement for emulation testing of the TSAP during V&V Team verification activities and allowed for such testing to be optional. Regarding shipping and handling of the nuclear qualification test system: 1) Added a requirement for the use of tamper-resistant tape to secure TUT shipping crates; 2) Added a requirement for the use of shock indicators on TUT shipping crates; 3) Added a requirement for packaging spare TUT components; and 4) Deleted the requirement for the use of a dedicated, air-ride truck.	Ted Porfilio
3	11/08/06	Revision 2 was modified to: 1) Shift responsibility for assembly inspections of the nuclear qualification test system from Quality Control to the Project with monitoring by Quality Assurance. Methodology,	Ted Porfilio

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		<p>terminology and documentation were adjusted accordingly; 2) Adjusted the responsibility for TUT configuration inspections from Quality Control to the Project with witnessing by Quality Assurance. Methodology, terminology and documentation were adjusted accordingly; 3) Revised the Project Organization (Section 3.0) consistent with direction provided by the Director, Platform Technology Development. The indicated organization changes will transition gradually between 11/08/06 and 11/18/06; 4) Adjusted shipping requirements to address the nuclear qualification test system; and 5) Added requirements for documenting the TUT's chain of custody during the conduct of nuclear qualification testing activities.</p>	
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1.0 PURPOSE AND SCOPE

1.1 PURPOSE

Invensys Triconex nuclear qualification activities address the qualification of a commercial Tricon programmable logic controller (PLC) system for use in nuclear safety-related applications.

The purpose of this Nuclear Qualification Quality Plan (NQQP) is to establish quality requirements for the Tricon v10 Nuclear Qualification Project consistent with the applicable requirements of 10CFR50, Appendix B; Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants, and EPRI TR-107330, Generic Requirements for Qualifying a Commercially Available PLC for Safety-Related Applications in Nuclear Power Plants. In addition to the quality requirements of EPRI TR-107330, the quality requirements of other applicable industry standards, as indicated in Section 13.0, have also been considered in the preparation of this NQQP.

1.2 SCOPE

The requirements established by this NQQP are applicable to all Tricon v10 Nuclear Qualification Project activities conducted by Invensys Triconex. The major activities of the Project included within the scope of this NQQP are:

1. Establish nuclear industry needs relative to safety-related PLCs.
2. Define a generic Tricon system that satisfies nuclear industry requirements.
3. Develop an Engineering Project Plan (EPP), an NQQP and a Master Test Plan (MTP).
4. Develop specifications based upon nuclear industry requirements.
5. Develop hardware procurement documents.
6. Manufacture commercial Tricon hardware.
7. Develop a Test Specimen Application Program (TSAP).
8. Prepare Test Specimen drawings.
9. Assemble and integrate the Tricon system to be tested.
10. Develop test plans and test procedures.
11. Select qualified vendors and procure services for qualification testing.
12. Establish and maintain configuration management of Project documents, software and hardware.
13. Conduct Pre-Qualification Tests to establish baseline data.
14. Conduct Pre-Qualification Tests as required to support Qualification Tests conducted by MPR Associates.
15. Conduct Performance Proof Tests to confirm the maintenance of baseline data.
16. Prepare technical analyses and reports.
17. Develop the Equipment Qualification (EQ) Summary Report.

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18. Prepare the Nuclear Qualification Document Package.

19. Place qualified Tricon hardware on the Nuclear Qualified Equipment List (NQEL).

Figure 1, Tricon v10 Nuclear Qualification Project Overview, expands upon these major activities and delineates the process flow associated with the Tricon v10 Nuclear Qualification Project.

This NQQP applies to the following Invensys Triconex Departments:

- Platform Technology Development
- Quality Assurance
- Business Development

2.0 OBJECTIVES AND REQUIREMENTS

2.1 OBJECTIVES

The objectives of this Nuclear Qualification Quality Plan (NQQP) are to:

1. Ensure that nuclear qualification activities conform to applicable regulations and standards.
2. Establish the quality assurance requirements applicable to the Tricon v10 Nuclear Qualification Project and implement process controls consistent with these requirements.
3. Provide supplementary guidance on nuclear qualification activities.
4. Ensure that Quality Assurance Records of nuclear qualification activities are developed, captured and maintained.

2.2 REQUIREMENTS

This NQQP shall be implemented in conjunction with the requirements of the Invensys Triconex Quality Assurance Manual (QAM), the Engineering Department Manual (EDM), the Projects Procedure Manual (PPM) and the Quality Procedures Manual (QPM), as specified. All Tricon v10 Nuclear Qualification Project activities shall be conducted in accordance with the requirements of the QAM; the specified procedures of the EDM, PPM and QPM; and the requirements of this NQQP. Requirements established by this NQQP are intended to supplement the requirements of these procedures. In the event of conflict between these documents, the requirements of the NQQP shall govern.

Individuals associated with Tricon v10 Nuclear Qualification Project shall be qualified and such qualification shall be documented. In addition, these individuals shall have documented training with respect to this NQQP, the QAM and those procedures that govern the conduct of their activities. As a minimum, training shall be accomplished by either classroom instruction, on-the-job training or required reading. These forms of training shall be documented on class attendance sheets, including attached instructional materials, if applicable; in accordance with EDM 11.02, Training Process; or on a Required Reading List, Figure 6; respectively. Qualification and training records are Quality Records and shall be controlled in accordance with Section 12.0.

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- Provides managerial and technical direction to Platform Technology Development staff in support of the Project.

4.3 TRICONEX PROJECT OFFICE MANAGER

The Triconex Project Office Manager:

- Approves the EPP.
- Ensures overall Project performance in accordance with the approved Project Schedule.
- Ensures that Project technical personnel are appropriately qualified.
- Provides Project technical staff resource management.

4.4 PROJECT MANAGER

The Project Manger (PM):

- Approves all Project documents, unless otherwise specified.
- Approves all vendor documents submitted for approval in accordance with Invensys Triconex Purchase Orders.
- Provides overall management of nuclear qualification activities.
- Provides Project technical direction.
- Prepares the EPP, including the Project Schedule.
- Procures the commercial Tricon components for nuclear qualification.
- Procures vendor services for nuclear qualification activities.
- Coordinates activities associated with the Independent Qualification Project Assessment.
- Provides the managerial and technical interface with other Invensys Triconex Departments and MPR Associates.
- Develops and maintains the Master Configuration List (MCL).
- Ensures that only approved documents are used by Nuclear Qualification Project personnel.
- Ensures that all nuclear qualification requirements are satisfied, i.e., ensures the overall quality of the Project.
- Witnesses, as necessary, qualification testing activities performed by MPR Associates.
- Chairs the Test Review Board (TRB), which reviews and approves test documents and results.
- Approves the disposition of Qualification Project Anomaly Reports (QPAR).
- Develops the Nuclear Qualification Document Package.
- Provides Project specific technical training, as necessary.

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4.5 PROJECT ENGINEER

The Project Engineer (PE):

- Prepares the Master Test Plan (MTP), including design of the Tricon-Under-Test (TUT).
- Directs preparation of design documents, e.g., drawings, associated with the nuclear qualification test system.
- Oversees assembly of the nuclear qualification test system.
- Directs preparation of the Operability, Prudency and System Setup & Checkout Test Procedures.
- Prepares Test Specimen Application Program (TSAP) design documents, including the Software Requirements Specification (SRS) and Software Design Description (SDD).
- Generates the TSAP based on the Software Design Description (SDD).
- Controls configuration of the TSAP.
- Dispositions Qualification Project Anomaly Reports (QPAR).
- Reviews Engineering Reports and analyses, e.g., Reliability Analysis.
- Prepares the Equipment Qualification (EQ) Summary Report.
- Participates as a member of the Test Review Board (TRB).

4.6 RESEARCH AND DEVELOPMENT ENGINEERS

Research and Development (R&D) Engineers, including Platform Technology Development, Invensys Process Systems (IPS), and Invensys India Private Limited (I IPL) Engineers:

- Assemble the nuclear qualification test system.
- Prepare Project drawings.
- Prepare the Operability, Prudency and System Setup & Check-Out Test Procedures.
- Review the TSAP code prior to Verification & Validation (V&V) activities.
- **Perform nuclear qualification test system assembly and configuration verifications during the initial execution of the System Setup & Checkout Procedure and, as required, during the conduct of Pre-Qualification Test, Qualification Test and Performance Proof Test testing activities.**
- Perform Operability, Prudency and System Setup & Checkout testing.
- Prepare Test Reports for test activities conducted under their cognizance.
- Prepare Engineering Reports and analyses, e.g., FMEA, as assigned.
- Prepare the EPRI TR-107330 Requirements Compliance and Traceability Matrix (CTM).
- As required, participate as members of the Test Review Board (TRB).

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4.7 MPR ASSOCIATES

MPR Associates:

- Prepares Qualification Test Procedures, e.g., seismic and radiation test procedures.
- Assumes responsibility for Qualification Tests and prepares the associated Test Reports.
- Procures test lab services to support nuclear qualification test activities under their cognizance.
- Designs and procures the Data Acquisition System (DAS).
- Prepares the Critical Digital Review (CDR).
- Performs independent review of the MTP.
- As required, provides technical support to the PM.
- As required, participates as a member of the Test Review Board (TRB).

Note: The responsibilities delineated above are descriptive and included to ensure completeness of this quality plan; specific details of MPR Associates’ responsibilities and associated quality requirements are contained in Purchase Order 113803.

4.8 INDEPENDENT REVIEW ENGINEERS

Independent Review Engineers (IRE) shall not have immediate supervisory responsibility for the individual performing the design being verified and shall not have specified a singular design approach, ruled out certain design considerations, or established the design inputs for the design being verified. Independent Review Engineers:

- Perform design verification or independent review, as applicable, of hardware related test documents, i.e., drawings and test specifications, plans and procedures that are not specific to the Test Specimen Application Program (TSAP).
- Perform design verification of analyses, e.g., Analog Input/Output Count Value Calculation.
- Perform independent review of Engineering Reports.
- As required, participate as members of the Test Review Board (TRB).

4.9 IPS NUCLEAR QUALITY DIRECTOR

The IPS Nuclear Quality Director:

- Approves the Nuclear Qualification Quality Plan (NQQP) and Software Quality Assurance Plan (SQAP).
- Approves TSAP V&V documents, including test documents and reports.
- Releases the TSAP for Tricon v10 Nuclear Qualification Project testing activities.
- Approves the Nuclear Qualification Document Package.

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- Provides Project quality staff resource management.
- Ensures that Project quality personnel are appropriately qualified and trained.
- Provides overall quality direction to the Project Quality Assurance Engineer (PQAE), Quality Control Inspectors and the TSAP V&V Team.
- Provides an independent path for the resolution of potential quality problems.

4.10 PROJECT QUALITY CONTROL INSPECTORS

Project Quality Control Inspectors :

Perform required receipt inspections.

- Verify TUT assembly and configuration prior to Software Validation Testing and Pre-Qualification Testing, i.e., Operability, Prudency and System Setup & Checkout testing.
- Verify TUT assembly and configuration, as necessary, during the conduct of Qualification Testing and prior to the conduct of Performance Proof Testing.

4.11 PROJECT QUALITY ASSURANCE ENGINEER

The Project Quality Assurance Engineer (PQAE):

- Advises the Project Manager on potential quality problems and recommends appropriate solutions.
- Prepares the Nuclear Qualification Quality Plan (NQQP) to define the quality requirements for the Tricon v10 Nuclear Qualification Project.
- Reviews Tricon v10 Nuclear Qualification Project documents to ensure that quality requirements are appropriately incorporated and the requirements of this NQQP are being implemented.
- Manages the programmatic control of Qualification Project Anomaly Reports (QPAR) and participates in the verification of their closure.
- Provides Tricon v10 Nuclear Qualification Project quality oversight to help ensure that the requirements of this NQQP are satisfied.
- **Monitors or witnesses, as applicable, nuclear qualification test system Project conducted assembly and configuration verifications during the initial execution of the System Setup & Checkout Procedure and, as such verifications are required, during the conduct of Pre-Qualification Test, Qualification Test and Performance Proof Test testing activities.**
- Provides the quality interface with MPR Associates.
- Provides programmatic direction to the TSAP V&V Team.

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- Schedules, as necessary, surveillances of Tricon v10 Nuclear Qualification Project activities to help ensure that nuclear qualification activities are in compliance with quality requirements.
- Reviews the Nuclear Qualification Document Package.
- Ensures that nuclear qualification Quality Assurance Records are complete.
- Monitors, as necessary, qualification testing activities performed by Invensys Triconex.
- Witnesses, as necessary, qualification testing activities performed by MPR Associates.
- Participates as a member of the Test Review Board (TRB).
- Provides Project specific quality training, as necessary.

4.12 TSAP VERIFICATION & VALIDATION (V&V) TEAM

The V&V Team:

- Prepares the Software Quality Assurance Plan (SQAP) and the Software Verification and Validation Plan (SVVP).
- Prepares, reviews and approves Test Specifications and Test Plans, as necessary, and V&V Test Procedures.
- Performs independent verification of software design documents.
- Performs independent V&V of the TSAP, including associated testing.
- Prepares the IEEE 1012 Software Traceability Analyses (STA).
- Prepares Verification and Validation (V&V) Reports.
- As required, participates as a member of the Test Review Board (TRB).

5.0 QUALITY REVIEW

The Project Quality Assurance Engineer (PQAE) shall review all Tricon v10 Nuclear Qualification Project documents to ensure the inclusion of quality requirements and that they are being prepared, reviewed, approved and controlled in accordance with the requirements of this NQQP. This review shall be documented on a Document Review Comment Sheet (DRCS), Figure 2, and/or by signature on the document prior to its approval.

6.0 PROCUREMENT

6.1 TRICON COMPONENTS

Based upon the Engineering Project Plan (EPP) or Tricon v10 Nuclear Qualification Project Capital Expenditure (CapEx), as appropriate, the Project Manager (PM) shall procure all required commercial Tricon components using an Internal Purchase Order (IPO). The IPO shall be reviewed by the Project Quality Assurance Engineer (PQAE) and approved by the System Integration and

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Test (SI&T) Manager for the Platform Technology Development Director. The PM shall ensure that approved IPOs are listed on the MCL in accordance with Section 7.0.

Commercial Tricon components shall be subject to inspection by a Quality Control Inspector upon receipt by the Project. This receipt inspection shall be performed and documented in accordance with PPM 5.02, Receiving & Receipt Inspection; however, Section 4.1, Receiving, is not applicable and deficiencies identified during receipt inspection shall be documented on a Qualification Project Anomaly Report (QPAR), Figure 5, in accordance with the applicable requirements of Section 9.9. Inspection Reports are Quality Records and shall be controlled in accordance with Section 12.0.

6.2 NUCLEAR SAFETY-RELATED SERVICES/ITEMS

Based upon the EPP and the associated Master Test Plan (MTP), the PM shall identify all nuclear safety-related services/items required to support the Tricon v10 Nuclear Qualification Project and select appropriate vendors to provide these services/items. The selected vendors shall be qualified as evidenced by inclusion on the Invensys Triconex Nuclear Approved Supplier List (NASL). If a selected vendor is not on the NASL, the vendor shall be qualified in accordance with the requirements of QPM 6.1, Source Evaluation and Vendor Selection, prior to procurement of nuclear safety-related services/items in support of the Project.

The procurement of all nuclear safety-related services/items in support of the Tricon v10 Nuclear Qualification Project shall be in accordance with the requirements of QAM 6.0, Purchasing, and the applicable requirements of PPM 5.0, Materials & Services; namely, the Purchase Requisition (PR).

When vendor services are procured in support of Tricon v10 Nuclear Qualification Project testing activities, the Purchase Orders (PO) shall require that vendor test procedures are subject to the review and approval of Invensys Triconex prior to test execution. As a minimum, the PE, PQAE and PM shall review vendor test procedures. Review comments and their resolutions and test procedure approval shall be documented by formal correspondence. Additionally, POs shall require a Test Report as a deliverable. Test results, including reports, shall be reviewed and approved by the Test Review Board (TRB) in accordance with Section 9.11.

The PM shall ensure that approved procurement documents for nuclear safety-related services/items are listed on the MCL in accordance with Section 7.0.

6.3 MATERIALS AND EQUIPMENT

Materials and equipment that are required to support Tricon v10 Nuclear Qualification Project test activities, e.g., test cabinets, wire, measuring and test equipment (M&TE), power supplies, computers and circuit breakers, shall be purchased in accordance with standard Platform Technology Development Department purchasing practices. Measuring and test equipment (M&TE) that is purchased by the Platform Technology Development Department in support of the Tricon v10 Nuclear Qualification Project shall be controlled in accordance with the requirements of QAM 11.0, Control of Inspection, Measuring and Test Equipment, upon receipt by the Department.

7.0 CONFIGURATION MANAGEMENT AND DOCUMENT CONTROL

The Project Manager (PM) shall develop and maintain a Master Configuration List (MCL) that identifies all approved Tricon v10 Nuclear Qualification Project documents, including documents

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prepared by MPR Associates and their vendors, and documents the configuration of the final Tricon-Under-Test (TUT).

The MCL is a key element in maintaining Tricon v10 Nuclear Qualification Project document control and, therefore, only documents listed on the MCL shall be used for the conduct of Project activities. The MCL shall identify the current revision of all Tricon v10 Nuclear Qualification Project documents, including software.

The MCL is also a key element in documenting the configuration of the TUT. The PM shall use the MCL to document TUT configuration not represented by Project drawings and documents, e.g., Tricon board serial numbers and TSAP version. For example, the MCL shall include software, module, termination panel, connecting cable, RTD termination panel signal conditioner, third party material, if applicable, and chassis configuration data. The configuration information shall include, as applicable, the model/part number, serial number or other unique identification number, and Tricon board serial numbers. Third party items, e.g., circuit breakers, which are uniquely identified on Project developed documents, need not be itemized on the MCL, but reference to these documents shall be included. Depending upon the exact configuration of the TUT, more or less data may be required. Only the configuration of the TUT used for qualification testing activities shall be documented on the MCL.

The MCL is an electronic document developed and maintained by the PM. The format of the MCL is optional, but as a minimum, the MCL shall categorize and positively identify each Tricon v10 Nuclear Qualification Project document and each system configuration item by its number, revision, title description, manufacturer and date, as applicable. The MCL shall list only those documents that are current, i.e., as a document is superseded, it shall be deleted from the MCL. The PM shall ensure that the MCL is available electronically on a common network drive; namely, <U:\Public2All2\Nuclear Qualification\v10 Nuclear Qualification Project\Current Documents\Master Configuration List>.

Additionally, all documents listed on the MCL shall also be available electronically on this common network drive for use by Project participants. These documents, excluding software, shall be scanned and posted on the network drive in .pdf format, or similar, tamper-resistant format.

A hardcopy of the MCL shall be reviewed by the PQAE and approved by the PM prior to the commencement of Project testing activities (Section 9.8). This hardcopy shall be identified as Revision 0. Subsequent changes to the MCL shall be uniquely identified by incremented revision levels and reissued as approved hardcopies. All revisions of the MCL are Quality Records and shall be controlled in accordance with Section 12.0.

The PM shall release a hardcopy of the MCL through Agile, in accordance with EDM 12.00, Product Development Process, at the conclusion of all Tricon v10 Nuclear Qualification Project activities.

8.0 DRAWINGS AND ANALYSES

8.1 DRAWINGS

Drawings, including schedules, shall be prepared by Research and Development Engineers.

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Drawings shall be reviewed by the Project Engineer (PE) to ensure that they are accurate, complete and correct. This review shall be documented by the PE’s dated initials on the reviewed drawing prior to its approval.

Upon completion of the PE’s review, drawings shall be design verified by an Independent Review Engineer (IRE). Design verification activities shall be documented on a DRCS, Figure 2, and a Design Review Checklist (DRC), Figure 3. The design verifier shall initial and date verified drawings to indicate that verification was performed with all previous comments incorporated.

The PM shall approve and issue all Project drawings thereby releasing the drawings for use on the Project.

The PM shall ensure that approved drawings are listed on the MCL in accordance with Section 7.0.

Changes to drawings shall be prepared, reviewed, approved and controlled in accordance with the requirements of Section 9.7.

The PM shall release all Project drawings through Agile, in accordance with EDM 12.00, at the conclusion of all Tricon v10 Nuclear Qualification Project activities.

8.2 ANALYSES

8.2.1 TECHNICAL ANALYSES

Technical analyses, e.g., Failure Modes and Effects Analysis (FMEA) and Reliability Analysis, shall be prepared by Research and Development Engineers.

Technical analyses shall be reviewed by the PE to ensure that they are accurate, complete and correct. This review shall be documented on a DRCS, Figure 2, prior to document approval.

Technical analyses shall be design verified by an IRE. Design verification activities shall be documented on a DRCS, Figure 2, and a DRC, Figure 3. The design verifier shall sign verified analyses to indicate that verification was performed with all previous comments incorporated.

The PM shall approve and issue all Project technical analyses.

The PM shall ensure that approved technical analyses are listed on the MCL in accordance with Section 7.0.

Changes to analyses shall be by revision. Revisions shall be prepared, reviewed, approved and controlled in the same manner as the original issue.

The PM shall release all Project technical analyses through Agile, in accordance with EDM 12.00, at the conclusion of all Tricon v10 Nuclear Qualification Project activities.

8.2.2 PROJECT TECHNICAL REQUIREMENTS ANALYSIS

A Research and Development Engineer shall prepare an analysis of the technical requirements applicable to the Tricon v10 Nuclear Qualification Project. This analysis shall be prepared in the form of a matrix beginning with the requirements of EPRI TR-107330. This EPRI TR-107330 Requirements Compliance and Traceability Matrix (CTM) shall delineate and trace all Tricon v10 Nuclear Qualification Project technical requirements from the source document through Project design documents, e.g., Specifications and Plans, to their method of implementation and/or

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satisfaction. The traceability shall be sufficiently documented to allow a technically qualified individual to follow from requirements to implementation and/or satisfaction without recourse to the preparer.

The CTM shall be reviewed by an IRE. This review shall be documented on a DRCS, Figure 2.

The PM shall approve and issue the CTM.

The CTM shall be prepared, reviewed and approved prior to the preparation of the Equipment Qualification (EQ) Summary Report (Section 11.1).

The PM shall ensure that the approved CTM is listed on the MCL in accordance with Section 7.0.

Changes to the CTM shall be by revision. Revisions shall be prepared, reviewed, approved and controlled in the same manner as the original issue.

The PM shall release the CTM through Agile, in accordance with EDM 12.00, at the conclusion of all Tricon v10 Nuclear Qualification Project activities.

9.0 **TEST CONTROL**

Nuclear qualification testing is performed to verify satisfactory hardware, software and system performance in accordance with EPRI TR-107330 and NRC Regulatory Guide 1.180, Revision 1. Tests performed as part of the Tricon v10 Nuclear Qualification Project, which are within the Scope (Section 1.2) of this NQQP, include, but are not limited to:

1. Operability Testing
2. Prudency Testing
3. System Setup & Checkout Testing
4. TSAP V&V Testing

9.1 **TEST SPECIFICATIONS**

Invensys Triconex Specification 9600121-001, Tricon System Test Requirements Specification, has been developed by Platform Technology Development to delineate the specific test requirements and associated acceptance criteria that are applicable to nuclear qualification testing activities. In general, these test requirements and acceptance criteria were based upon industry standards, e.g.; EPRI TR-107330; however, they may also be based upon lessons learned for previous qualification activities and other requirements contained in various Invensys Triconex documents such as an MRD and/or EPP. This specification is the Master Test Specification for the Tricon v10 Nuclear Qualification Project and it shall form the basis, at least in part, for the MTP (Section 9.2); no other Test Specifications are required for the Project, except as noted in the next paragraph.

For TSAP V&V testing, the TSAP V&V Team shall develop a Test Specification(s). This Test Specification(s) shall be prepared using the format and content guidelines established in Appendix 1.

9.2 **TEST PLANS**

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A Master Test Plan (MTP) shall be developed by the Project Engineer (PE) to describe in detail the equipment to be qualified, the configuration of the system to be tested, what testing will be performed, how the testing will be conducted, and what test documents will be generated. The Master Test Plan shall address all required Tricon v10 Nuclear Qualification Project tests, including those to be conducted by MPR Associates. As the MTP must address many special considerations related to testing activities for the Tricon v10 Nuclear Qualification Project, e.g., various test types, multiple organizations and different test system configurations, the format and content of the MTP shall be at the discretion of the PE. The PE may consider the content guidelines established in Appendices 1 and 2 during the preparation of the MTP.

For TSAP V&V testing, the TSAP V&V Team shall develop a Test Plan(s). This Test Plan(s) shall be prepared using the format and content guidelines established in Appendix 2. The TSAP V&V Team, at its discretion, may combine the required Test Specification(s) and Test Plan(s) into a single document; however, the combined Test Specification and Test Plan shall address all applicable content requirements of both Appendices 1 and 2.

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9.3 TEST PROCEDURES

Test Procedures shall be developed by R&D Engineers or the TSAP V&V Team, as appropriate, to control the conduct of test activities. An individual Test Procedure shall be prepared for each required nuclear qualification test to be conducted by Invensys Triconex.

Test Procedures shall be prepared using the format and content guidelines established in Appendix 3; however, as the format established by this Appendix may not be suitable for all procedures, e.g., the Operability Procedure, the format of Test Procedures shall be at the discretion of the PE. The PE shall use the content guidelines established in Appendix 3 during the preparation of the Test Procedures to ensure that they address all requirements for test procedures.

Test procedures for the conduct of TSAP V&V test activities shall be prepared using the format and content guidelines established in Appendix 3.

9.4 TEST REVIEW BOARD

The Test Review Board (TRB) shall be chaired by the Project Manager (PM) and consist, as a minimum, of the Project Engineer (PE), the Project Quality Assurance Engineer (PQAE) and the responsible Independent Review Engineer (IRE) or TSAP V&V Team member, if applicable. In addition, a representative of MPR Associates shall participate in TRB activities when the results of testing performed under their cognizance are being reviewed (Section 9.11).

9.5 TEST DOCUMENT REVIEW AND APPROVAL

9.5.1 PRE-QUALIFICATION, QUALIFICATION AND PERFORMANCE PROOF TEST DOCUMENTS

All Tricon v10 Nuclear Qualification Project test documents, i.e., Test Specifications, Test Plans, Test Procedures, Test Reports, etc., excluding TSAP V&V test documents (Paragraph 9.5.2), shall be reviewed by all members of the TRB. Other reviewers, e.g., a representative of MPR Associates, may be included as determined necessary by the PM. If the PM or PE is the preparer of the document to be reviewed, then the PM shall designate another technically qualified individual to review the document and ensure that it is accurate, complete and correct.

If the TRB will convene to execute its assigned responsibilities, each reviewer shall review, if practical, the test document(s) in preparation for the meeting. All review comments shall be resolved at the meeting. The PM shall ensure that meeting minutes are prepared to document these TRB activities. Minutes of TRB meeting activities shall be prepared and controlled in accordance with the requirements of Section 9.11.

If the TRB will not convene to execute its assigned responsibilities, the document preparer shall send a copy of the document(s) to each member of the TRB for review. Each reviewer shall document their review comments, including “no comments”, on a DRCS, Figure 2, and return the comments to the document preparer for comment resolution. The document preparer shall obtain concurrence of comment resolution from each reviewer and document satisfactory resolution of all review comments prior to the test document’s approval.

Upon satisfactory completion of the TRB’s responsibilities, the PM shall approve the test document(s).

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The PM shall document all approved Tricon v10 Nuclear Qualification Project test documents on the Master Configuration List (MCL) in accordance with the requirements Section 7.0.

The PM shall release all Tricon v10 Nuclear Qualification Project test documents through Agile, in accordance with EDM 12.00, at the conclusion of all Tricon v10 Nuclear Qualification Project activities.

9.5.2 TSAP V&V TEST DOCUMENTS

All Tricon v10 Nuclear Qualification Project TSAP V&V test documents, i.e., Test Specifications, Test Plans, Test Procedures, V&V Phase Summary Reports, Test Reports, etc., shall be reviewed, as a minimum, by the PQAE and a technically qualified reviewer. These reviews shall be documented on a DRCS, Figure 2.

The IPS Nuclear Quality Director shall approve and issue the all TSAP V&V test documents.

The IPS Nuclear Quality Director shall advise the PM of approved TSAP V&V test documents and the PM shall ensure that the approved test documents are listed on the MCL in accordance with Section 7.0.

The PM shall release all TSAP V&V test documents through Agile, in accordance with EDM 12.00, at the conclusion of all Tricon v10 Nuclear Qualification Project activities.

9.6 TEST SOFTWARE

Software developed for the Tricon v10 Nuclear Qualification Project to perform automatic testing functions, excluding the TSAP (Section 10.0), shall be controlled, verified, validated and approved for use when such software is relied upon for acceptance criteria. Correctness of input stimuli and output responses by the test software shall be verified and validated to the degree necessary to ensure that a test is being conducted in accordance with its associated Test Procedure and Test Specification and that test results are accurate compared to the inputs. Verification and validation of test software shall be performed by the V&V Team in accordance with a Test Software V&V Procedure developed exclusively for this purpose. Test Software V&V Procedures shall be prepared using the format and content guidelines established in Appendix 3. Test software anomalies, which are identified during V&V activities, shall be documented, dispositioned and controlled in accordance with the requirements of Paragraph 10.4.3.

The degree of test software V&V is dependent upon the complexity of its functionality, but in all cases, the V&V effort shall be documented in a Test Software V&V Report. The Test Software V&V Report shall include, as a minimum, positive identification of the software; the purpose of the software; references; input requirements; a description of the verification and validation methods; acceptance criteria; results; and dated signature of the individual performing the verification and validation. The Test Software V&V Report shall be reviewed by the PQAE and approved by the IPS Nuclear Quality Director. Upon approval of the report, the test software may be used to support Tricon v10 Nuclear Qualification Project testing activities.

The IPS Nuclear Quality Director shall advise the PM of approved test software V&V documents and the PM shall ensure that these are listed on the MCL in accordance with Section 7.0.

Configuration control shall be maintained for Tricon v10 Nuclear Qualification Project test software. The Software Development Checklist (SDC), Figure 7, shall be used for this purpose.

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Current, released test software versions shall be listed on the MCL in accordance with the requirements of Section 7.0.

The identity and version of approved test software to be used in support of Tricon v10 Nuclear Qualification Project testing activities shall be clearly specified in associated test procedures.

Test software and associated verification and validation documentation are Quality Records to be handled in accordance with the requirements of QAM 16.0.

Software developed as a testing aid, e.g., debugging, that is not relied upon for acceptance criteria, is not subject to the above requirements. Also, where the test data is measured externally such that the outputs of the program are fully verifiable and/or measurable, the software is considered a testing aid and is not subject to the above requirements.

9.7 CHANGES TO TEST DOCUMENTS

When a change to a Tricon v10 Nuclear Qualification Project test document is required, the document preparer shall initiate a revision to the test document. The revision shall be prepared, reviewed, approved and controlled in the same manner as the original issue of the document; changes implemented by revision shall be highlighted to ensure their positive identification. However, when a change, other than editorial, to a Test Procedure or drawing is required to support in-process test activities, including V&V test activities, the individual conducting the test shall initiate an Interim Change Notice (ICN), Figure 4, as opposed to initiating a revision.

When processing an ICN for a Test Procedure or drawing, the individual conducting the test shall complete Figure 4 identifying the affected Test Procedure or drawing by number, revision and title. An ICN number shall be obtained from the PQAE. The PQAE shall ensure that ICN numbers are unique, reconcilable and associated with the parent document.

The individual conducting the test, i.e., ICN Preparer, shall provide a complete description of the proposed change(s) as well as a reason for the change(s). The ICN Preparer shall also provide a statement regarding the ICN’s impact, if any, on completed Test Procedure activities or other Test Procedures, including those under the cognizance of MPR Associates. The description of change(s) shall include positive identification of the change(s), e.g., marked-up copies of affected pages may be attached to the ICN or referenced in the ICN. Each page of the ICN shall be identified by the ICN number and a sequential page number. The total number of pages shall be indicated on the ICN.

The ICN shall be reviewed and approved in the same manner as the original Test Procedure or drawing. Any significant comments and their resolutions, noted during the review process, shall be recorded in the “Comments” Section, or on continuation sheets, as necessary, of the ICN. The completion of all required reviews, including the satisfactory resolution of associated comments, if any, is recorded by the reviewers’ signature on the ICN. All comments shall be resolved prior to approval. All ICNs shall be approved by the Project Manager (PM) or the IPS Nuclear Quality Director, as applicable.

The approved ICN original shall be attached to the affected Test Procedure or drawing to reflect the change. As the ICN is a permanent change to the affected Test Procedure or drawing, it does not require incorporation into the Test Procedure or drawing unless the Test Procedure or drawing is subsequently revised.

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The individual conducting the test shall record all approved ICNs in the Test Log (Paragraph 9.8.5).

For editorial changes, e.g., spelling and format errors; procedure paragraph references; data inconsistencies within the procedure; obvious dimensional errors on drawings; and a referenced document’s revision level, an ICN is not required. These editorial changes shall be marked in red on the Test Procedure by the individual conducting the test, including initials and date. As editorial changes are directly marked on the Test Procedure or drawing, they represent permanent changes to the Test Procedure or drawing and no further document control action is required.

Revisions to Project test documents shall be recorded on the Master Configuration List (MCL) and processed in accordance with the requirements of Section 7.0. As a Test Procedure or drawing being executed is an in-process document and associated ICNs are physically attached to these documents, ICNs are not required to be recorded on the MCL. Interim Change Notices (ICN) shall be processed, with the affected Test Procedure or drawing, at the conclusion of TRB activities (Section 9.11) or V&V activities, as applicable.

9.8 NUCLEAR QUALIFICATION TESTING ACTIVITIES

9.8.1 TEST PROCEDURES AND DRAWINGS

Prior to conducting formal Project testing activities, the PM shall ensure that the Test Procedure(s) and drawing(s), if any, to be used are approved and current as indicated on the MCL.

The original Test Procedure(s) and drawing(s), if any, used to perform the test and record test data will be the official test record when completed.

9.8.2 PREREQUISITES/PRECAUTIONS

Test personnel shall review the Test Procedure for any prerequisite conditions that need to be established prior to entering the test and ensure that these conditions are satisfied. This review should also include identifying any precautions that need to be taken to protect test personnel and/or equipment.

9.8.3 MEASURING AND TEST EQUIPMENT (M&TE)

All M&TE used during the performance of a Project test shall be appropriate for the test and be within the specified calibration cycle. The M&TE name, identification number, calibration date, calibration due date, range and accuracy shall be recorded in the Test Procedure.

9.8.4 NUCLEAR QUALIFICATION TEST SYSTEM

9.8.4.1 Assembly of the Nuclear Qualification Test System

The nuclear qualification test system is defined as the Tricon-Under-Test (TUT) and all supporting equipment, e.g., the Simulation Tricon(s), load resistor banks and power supplies. The Master Test Plan (MTP) (Section 9.2) provides a detailed description of the TUT proper and its test system.

Initial assembly of the nuclear qualification test system shall be in accordance with the drawings contained in the approved and issued MTP, which are reviewed and approved via its review and approval process. Prior to the initial **execution of the System Setup & Checkout Procedure** assembly inspection of the nuclear qualification test system (Paragraph 9.8.4.2), all nuclear

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qualification test system drawings shall be prepared, reviewed, approved and controlled in accordance with the requirements of Section 8.1.

9.8.4.2 Tricon-Under-Test Nuclear Qualification Test System Configuration and Assembly Inspections

The configuration of the Tricon-Under-Test (TUT) is uniquely identified and documented on the MCL (Section 7.0) prior to entering into nuclear qualification testing activities. If changes to the TUT’s configuration occur during subsequent nuclear qualification tests, the MCL shall be updated and approved prior to acceptance of the associated test results by the TRB (Section 9.11).

Prior to **During initial execution of the System Setup & Checkout Procedure** performance of the Software Validation Test (SVT) (Paragraph 10.4.2), the configuration of the TUT shall be verified by **R&D Engineers** a Quality Control Inspector based on the latest, approved MCL. **This verification activity shall be conducted in accordance with the System Setup & Checkout Procedure and it shall be witnessed by the PQAE.** At this time, the assembly of the nuclear qualification test system shall also be verified by **R&D Engineers** based upon design documents listed on this MCL. **This verification activity shall also be conducted in accordance with the System Setup & Checkout Procedure and it shall be monitored by the PQAE.** Any discrepancies identified during these inspections **verifications** shall be documented on a QPAR, Figure 5, in accordance with the applicable requirements of Section 9.9 and **dispositioned** corrected prior to proceeding with the **System Setup & Test Procedure** SVT. The successful completion of these inspections **verifications, including supporting documentation**, shall be documented in the initial run of **System Setup & Checkout Procedure** Section 6.0, Test Prerequisites, of the SVT..

In addition, the assembly and configuration of the **nuclear qualification test system** TUT shall be verified, as necessary, by a Quality Control Inspector **R&D Engineers**, based on the latest, approved MCL, whenever the TUT **nuclear qualification test system** is disassembled and reassembled for the conduct of test activities, e.g., seismic testing. **These verification activities shall be conducted in accordance with the System Setup & Checkout Procedure and they shall be witnessed or monitored, as applicable, by the PQAE.** Any discrepancies identified during these inspections **verifications** shall be documented on a QPAR, Figure 5, in accordance with the applicable requirements of Section 9.9 and corrected **dispositioned** prior to proceeding with the associated test. **The successful completion of these verifications, including supporting documentation, shall be documented in the associated run of the System Setup & Checkout Procedure.**

Prior to conduct of Performance Proof Testing, the assembly, as necessary, and configuration of the TUT shall be verified in accordance with the previous paragraph. The successful completion, **including supporting documentation**, of this **these** required inspection **sverifications** shall be documented **in the associated run of the System Setup & Checkout Procedure**.in Section 6.0, Test Prerequisites, of the associated Test Procedure(s).

9.8.5 CONDUCT OF QUALIFICATION TESTING

Test personnel shall record all test activities on a Test Log, including test activities conducted by MPR Associates. A Test Log shall be prepared for each individual test; however, where multiple tests types constitute the performance of a single test, e.g., Environmental and Operability tests, only one Test Log need be maintained. The Test Log shall constitute a continuous, hand-written

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journal of all test activities from the point of initial entry into the Test Procedure until the conclusion of all testing, including any required retesting. The Test Log shall include entries for sign-in and sign-out of all participating personnel, establishment of indicated prerequisites and initial conditions for testing, performance of testing/retesting, identification of problems, etc. The Test Log is intended to be a detailed journal of all testing activities that is sufficient to fully document the actual sequence of testing performed, the test results achieved and any problems that occurred, including their impact on test performance. The Test Log shall be reviewed by the TRB as part of its evaluation of the test results (Section 9.11).

Each Step in a Test Procedure shall be performed in sequence unless otherwise authorized by the Test Procedure. At the completion of each Step, responsible test personnel shall initial in the provided space to positively indicate completion of the Step. At the completion of each Section, responsible test personnel shall sign and date in the provided space to indicate its completion. Only authorized test personnel shall sign off performance steps.

When a Step in a Test Procedure establishes verification requirement, i.e., hold point, the verification Step shall be completed and signed/initialed and dated by the appropriate personnel prior to proceeding with the test.

When a Test Procedure cannot be followed, an ICN shall be prepared, reviewed and approved in accordance with the requirements of Section 9.7. However, for testing activities where the PE is not available, the PM shall assume the review responsibilities of the PE and sign the ICN in the appropriate space on the form.

The PE and/or PQAE shall monitor test activities, including test activities conducted by MPR Associates, to ensure that testing is being conducted in accordance with applicable requirements and to independently verify the acceptable completion of Test Procedure Sections when such verification is required.

9.8.6 SHIPPING, RECEIPT INSPECTIONS AND ASSEMBLY INSPECTIONS

9.8.6.1 Tricon-Under-Test Shipping Nuclear Qualification Test System Shipping

As the TUT will be subject to certain qualification tests at facilities other than the Invensys Triconex Irvine Facility, shipping conditions must be controlled in order to ensure that **the nuclear qualification test system** it is protected from damage.

The following requirements shall apply to shipments of the **nuclear qualification test system** TUT, including supporting test equipment in racks, from and to the Invensys Triconex Irvine Facility:

1. The TUT shall be shipped in its test cabinets;
2. Spare **or loose** TUT components shall be shipped in standard Invensys Triconex packaging materials;
3. Test racks shall not be disassembled for shipping;
4. The test cabinets and test racks shall be protected from adverse weather conditions;
5. Edge and corner protectors shall be provided for the test cabinets and equipment in test racks;

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6. Supporting equipment, e.g., power supplies, shall be shipped in packaging that provides protection from damage;
7. Packaged spares, **loose components** and supporting equipment shall be strapped to pallets designed for lifting;
8. The test cabinets and test racks shall be strapped to pallets designed for lifting and crated;
9. Shipping crates shall be designed to prevent their damage during uncrating activities and for their reuse in multiple shipments;
10. Shipping crates for the TUT shall include shock indicators and be secured with tamper-resistant tape; these items shall be initialed and dated by the PQAE;
11. Crated test cabinets and test racks shall be shipped upright; and
12. The truck used for conveying the test cabinets and test racks **nuclear qualification test system** shall be secured in a manner that prevents unauthorized access.

The following requirements shall apply to shipments of the TUT, including supporting test equipment, **nuclear qualification test system** between the a vendor’s test facilities:

1. The TUT in its test cabinets and supporting equipment in racks shall be shipped in their crates whenever possible;
2. When it is necessary or expedient to ship the TUT disassembled, standard Invensys Triconex packaging materials shall be used to protect components from damage;
3. The truck used for conveying the TUT and supporting equipment **nuclear qualification test system** shall be secured in a manner that prevents unauthorized access.

9.8.6.2 Tricon-Under-Test Receipt Inspections and Chain of Custody

For testing conducted at a vendor’s location(s), the TUT shall be subject to inspection by a Quality Control Inspector upon receipt by the Project at the vendor’s location(s) and, upon return from the vendor’s location, at the Invensys Triconex Irvine Facility. These **receipt** inspections shall ensure that the TUT was not damaged or tampered with during shipping between test facilities and shall serve to document its chain of custody. In addition, the final receipt inspection, conducted at the Invensys Triconex Irvine Facility, shall verify that the configuration of the TUT sent to the vendor for nuclear qualification testing is the exact TUT, excluding documented changes, returned from the vendor. The configuration of the TUT returned from the vendor shall be verified based on the latest, approved MCL. Receipt inspections shall be performed and documented in accordance with PPM 5.02, Receiving & Receipt Inspection; however, Section 4.1, Receiving, is not applicable and deficiencies identified during receipt inspections shall be documented on a QPAR, Figure 5, in accordance with the applicable requirements of Section 9.9. Deficiencies identified during receipt inspections shall be corrected, as necessary, prior to proceeding with the next test, except for deficiencies identified during the final receipt inspection, which shall be corrected, as necessary, commensurate with the timing specified on the associated QPAR(s). **Inspection Reports are Quality Records and shall be controlled in accordance with Section 12.0.**

As established by the MTP and its implementing procedures, certain nuclear qualification testing activities will be conducted alternately by MPR Associates and Invensys Triconex. In

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accordance with the requirements of Purchase Order 113803, these activities will require that responsibility for the nuclear qualification test system be transferred between MPR Associates and Invensys Triconex consistent with their responsibility for test execution. Receipt inspections, conducted in accordance with the applicable requirements of the previous paragraph, shall be utilized to ensure that the TUT received from MPR Associates was not damaged or tampered with during their test activities and to document its chain of custody.

9.8.6.3 Nuclear Qualification Test System Assembly Inspections

An assembly inspection **verification** of the nuclear qualification test system shall be conducted by **R&D Engineers** a Quality Control Inspector for any components of the system that were disassembled for shipping. This assembly inspection **verification** shall be based upon design documents listed on the latest, approved MCL and it **shall be conducted in accordance with the System Setup & Checkout Procedure**. The PQAE shall monitor these verification activities. Any discrepancies identified during this inspection shall be documented on a QPAR, Figure 5, in accordance with the applicable requirements of Section 9.9 and corrected **disposed** prior to proceeding with testing activities. **The successful completion of this verification, including supporting documentation, shall be documented in the associated run of the System Setup & Checkout Procedure.** The successful completion of this inspection shall be documented in Section 6.0, Test Prerequisites, of the next Test Procedure to be executed.

Inspection Reports are Quality Records and shall be controlled in accordance with Section 12.0.

9.9 DEFICIENCIES IDENTIFIED DURING TESTING

If a hardware, software, test equipment or test deficiency, e.g., failure to meet acceptance criteria and failure to execute a procedure as written, is identified during nuclear qualification testing, the deficiency shall be documented on a Qualification Project Anomaly Report (QPAR), Figure 5. This includes all deficiencies identified during nuclear qualification test activities whether they are conducted by Invensys Triconex or MPR Associates.

A QPAR number shall be obtained from the PQAE. The PQAE shall ensure that QPAR numbers are unique and that QPARs are reconcilable. Qualification Project Anomaly Report (QPAR) numbers shall be annotated in their associated Test Log. In-process originals of QPARs shall be maintained by the PQAE until their closure.

For software deficiencies, i.e., anomalies, testing shall stop until an anomaly classification is assigned to the deficiency in accordance with Paragraph 10.4.3.4. The individual conducting the test shall evaluate the extent of the deficient condition and determine its impact on subsequent testing. The individual conducting the test shall provide justification, on the QPAR, to support this determination. The anomaly classification and justification shall be reviewed by either the PM or PE. Testing may proceed as governed by the assigned anomaly classification.

For all other deficiencies, e.g., test equipment failure and failure to meet acceptance criteria, testing shall stop until the associated QPAR disposition has been approved. During the disposition process, the PE shall evaluate the extent of the deficient condition; determine its impact on subsequent testing; and specify, as appropriate, any limits on continued testing. The PE shall provide justification, on the QPAR, to support these disposition activities. The QPAR disposition

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must be approved, but the QPAR does not have to be closed, in order for testing to proceed within the limits, if any, specified by the disposition.

Following the actions required to allow the continuation of testing with a deficient condition, the QPAR shall be processed to closure. Closed QPARS shall be reviewed by the TRB as part of its evaluation of the test results (Section 9.11).

Completed QPARs are Quality Records and shall be controlled in accordance with Section 12.0.

9.10 TEST REPORTS

Test Reports, as specified by the Master Test Plan, shall be developed to summarize the results of testing activities, including an evaluation of any deviations, deficiencies or exceptions. Test Reports may clarify, amplify, combine or further interpret test results. Test Reports shall be supported by completed Test Procedures and data.

At the conclusion of a nuclear qualification test, the PE or a Research and Development Engineer, as appropriate, shall prepare a Test Report to summarize the results of the test. Test Reports shall be prepared using the format and content guidelines established in Appendix 4. Test Reports shall be reviewed, approved and controlled in accordance with Section 9.5.

9.11 TEST RESULTS REVIEW AND APPROVAL

Upon completion of a nuclear qualification test conducted by either Invensys Triconex or MPR Associates, the TRB shall review the test results for completeness, accuracy and acceptability. This review shall be conducted in accordance with Section 9.5 and include, as a minimum, the completed Test Procedure, Test Log, the associated Test Report and all related QPARs/deficiency documents. In addition, the TRB shall ensure that the MCL (Section 7.0) has been updated, as necessary, to accurately document the as-tested configuration of the TUT (Paragraph 9.8.4).

Test results shall not be accepted by the TRB with an open Invensys Triconex or vendor deficiency document, which is associated with the nuclear qualification test system (Paragraph 9.8.4) or with nuclear qualification testing activities.

When the test results, including all supporting documentation, are determined to be acceptable, the TRB shall sign and date Section 11.0, Test Approval, of the associated Test Procedure.

The PM shall ensure that meeting minutes are prepared to document all TRB post test activities. As a minimum, these minutes shall include; 1) the meeting subject; 2) the meeting date; 3) the meeting attendees; 4) all items reviewed during the meeting; 5) any discrepancies identified during the meeting and their resolution; 6) conclusions reached; and 7) actions taken. Test Review Board (TRB) meeting minutes are Quality Records and shall be controlled in accordance with the requirements of Section 12.0.

Completed and approved Test Procedures shall be controlled in accordance with Section 7.0.

The PM shall release all completed and approved Test Procedures through Agile, in accordance with EDM 12.00, at the conclusion of all Tricon v10 Nuclear Qualification Project activities.

10.0 TEST SPECIMEN APPLICATION PROGRAM

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The Test Specimen Application Program (TSAP) utilized for the Tricon v10 Nuclear Qualification Projects is developed using established TriStation 1131 software expressly designed for this purpose. The TriStation 1131 software is fully verified and validated and provides the necessary structure, functions and limitations for application programs written for Tricon main processors. Thus, the controls necessary for TSAP development are considerably simpler than those that would be required for software developed from the ground up. The Tricon v10 Nuclear Qualification Project TSAP shall be developed in accordance with the programmatic requirements of this NQQP and the functional requirements of EPRI TR-107330.

10.1 TEST SPECIMEN APPLICATION PROGRAM PLANNING

10.1.1 SOFTWARE QUALITY ASSURANCE PLAN

A Software Quality Assurance Plan (SQAP) shall be developed for the Tricon v10 Nuclear Qualification Project. The SQAP shall address all software associated with the Project and form the basis for subsequent verification and validation activities and required Critical Digital Reviews (CDR).

The SQAP shall be prepared by the V&V Team. The SQAP shall be uniquely identified to the Tricon v10 Nuclear Qualification Project and be prepared using the format and content guidelines established in Appendix 5.

The SQAP shall be reviewed, as a minimum, by the Project Engineer (PE), the Project Quality Assurance Engineer (PQAE) and a technically qualified reviewer and it shall be approved by the IPS Nuclear Quality Director.

The IPS Nuclear Quality Director shall advise the PM upon approval of the SQAP and the PM shall ensure that the approved SQAP is listed on the MCL in accordance with Section 7.0.

Revisions to the SQAP shall be prepared, reviewed, approved and controlled in the same manner as its initial issue.

The PM shall release the SQAP through Agile, in accordance with EDM 12.00, at the conclusion of all Tricon v10 Nuclear Qualification Project activities.

10.1.2 SOFTWARE VERIFICATION AND VALIDATION PLAN

A Software Verification and Validation Plan (SVVP) shall be developed for the Tricon v10 Nuclear Qualification Project TSAP.

The SVVP shall be prepared by the V&V Team. The SVVP shall be uniquely identified to the Tricon v10 Nuclear Qualification Project. The SVVP shall delineate appropriate testing activities and the methodology and scope of such activities. The SVVP shall be prepared using the format and content guidelines established in Appendix 6.

The SVVP shall be reviewed, as a minimum, by the Project Quality Assurance Engineer (PQAE) and a technically qualified reviewer and it shall be approved by the IPS Nuclear Quality Director.

The IPS Nuclear Quality Director shall advise the PM upon approval of the SVVP and the PM shall ensure that the approved SVVP is listed on the MCL in accordance with Section 7.0.

Revisions to the SVVP shall be prepared, reviewed, approved and controlled in the same manner as its initial issue.

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The PM shall release the SVVP through Agile, in accordance with EDM 12.00, at the conclusion of all Tricon v10 Nuclear Qualification Project activities.

10.1.3 SOFTWARE DESIGN DOCUMENTS

The Software Requirements Specification (SRS) and Software Design Description (SDD) shall be prepared by the Project Engineer (PE). The PE may use the format and content guidelines of PPM 2.04, Application Software Specification Content and Format; however, in any case, the SRS and SDD shall be sufficiently detailed to allow development of the TSAP and traceability from EPRI TR-107330 to the TSAP.

The SRS and SDD shall be reviewed by a technically qualified individual to ensure that they are accurate, complete and correct. Additionally, the SRS and SDD shall be reviewed, as a minimum, the PQAE and PM. All reviews shall be documented on a DRCS, Figure 2, prior to document approval.

The SRS and SDD shall be design verified by the V&V Team. Design verification activities shall be documented on a DRCS, Figure 2, and a Design Review Checklist (DRC), Figure 3. The design verifier shall sign the verified document to indicate that verification was performed with all previous comments incorporated.

The PM shall approve and issue the SRS and SDD.

The PM shall ensure that the approved SRS and SDD are listed on the MCL in accordance with Section 7.0.

Changes to the SRS and SDD shall be by revision. Revisions shall be prepared, reviewed, approved and controlled in the same manner as the initial issue.

The PM shall release the SRS and SDD through Agile, in accordance with EDM 12.00, at the conclusion of all Tricon v10 Nuclear Qualification Project activities.

10.2 APPLICATION PROGRAM DEVELOPMENT

The PE shall develop the TSAP in accordance with the requirements delineated in the SRS and SDD. The TSAP shall be uniquely identified to the Tricon v10 Nuclear Qualification Project.

The TSAP shall be verified and validated in accordance with the requirements of Section 10.4. Verification and validation activities and subsequent release of the TSAP for use on the Tricon v10 Nuclear Qualification Project shall be documented using a Software Development Checklist (SDC), Figure 7. The instructions for completing the SDC are also included with Figure 7.

The V&V Team shall prepare an analysis of the technical requirements applicable to the TSAP. This analysis shall be prepared in the form of a matrix beginning with the requirements of EPRI TR-107330. This IEEE 1012 Software Traceability Analysis (STA) shall delineate and trace all technical requirements from the source document through Invensys Triconex design documents, e.g., the SRS and SDD, to their method of implementation and/or satisfaction. The STA shall consider the Requirements, Design, Implementation and Test Life Cycle Phases of the TSAP. The traceability shall be sufficiently documented to allow a technically qualified individual to follow from requirements to implementation and/or satisfaction without recourse to the preparer. The STA shall be prepared in descending drafts as specified by the SVVP.

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The STA shall be reviewed to ensure that it is accurate, complete and correct. As a minimum, the PE, the PQAE and a technically qualified individual shall review the STA. These reviews shall be documented on a DRCS, Figure 2. The STA shall be approved by the IPS Nuclear Quality Director.

The STA shall be approved and issued prior to TSAP use in nuclear qualification testing activities.

The IPS Nuclear Quality Director shall advise the PM upon approval of the STA and the PM shall ensure that the approved STA is listed on the MCL in accordance with Section 7.0.

Revisions to the STA shall be prepared, reviewed, approved and controlled in the same manner as its initial issue.

The PM shall release the STA through Agile, in accordance with EDM 12.00, at the conclusion of all Tricon v10 Nuclear Qualification Project activities.

10.3 CONFIGURATION MANAGEMENT

The Test Specimen Application Program (TSAP) is ready for verification and validation when it is considered to be fully functional by the PE. The TSAP shall be subject to configuration management at this time.

Configuration management of the TSAP shall be maintained throughout verification, validation and Tricon v10 Nuclear Qualification Project testing activities. The requirements applicable to and the methodologies used for configuration management of the TSAP are delineated in Figure 7. The PE shall initiate an SDC for the TSAP, in accordance with the requirements of Figure 7, when it is considered to be ready for V&V activities.

Upon completion of the TSAP SDC, in accordance with the requirements of Figure 7, the IPS Nuclear Quality Director shall advise the PM that the TSAP has been released for use in nuclear qualification testing activities. At this time, the PM shall ensure that the released TSAP is listed on the MCL in accordance with Section 7.0.

Revisions to the TSAP shall be prepared, reviewed, approved and controlled in the same manner as its initial issue.

The PM shall release the TSAP through Agile, in accordance with EDM 12.00 and EDM 24.00, Software Configuration and Change Control, at the conclusion of all Nuclear Qualification Project activities.

10.4 VERIFICATION AND VALIDATION

Test Specimen Application Program (TSAP) verification and validation activities shall be performed by the V&V Team in accordance with the requirements of the SVVP (Paragraph 10.1.2)..

Individuals performing verification and validation activities shall not have immediate supervisory responsibility for the individual performing the TSAP design, specified a singular design approach, ruled out certain design considerations, or established the design inputs for the TSAP being verified. In addition, these individuals shall be sufficiently competent in software engineering to ensure that the software V&V is adequately performed and shall have sufficient documented training, as necessary, to ensure that suitable proficiency is achieved and maintained.

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The results of verification and validation activities shall be clearly documented with the identification of the individual performing each activity clearly indicated. The successful completion of a verification or validation activity shall be indicated by the signature and date of the individual performing the activity.

A Test Specification and a Test Plan, which are designed to control V&V testing activities, shall be prepared, reviewed, approved and controlled in accordance with the applicable requirements of Sections 9.1 through 9.7.

Verification and validation of the TSAP shall be complete prior to its use in nuclear qualification testing activities. Furthermore, there shall be no open items, e.g., QPARs (Paragraph 10.4.3), associated with the TSAP at the time of its release to the Project.

10.4.1 VERIFICATION

The TSAP shall be independently verified by the V&V Team to ensure that design documents are appropriately prepared and accurately translate requirements into the TSAP and its associated drawings, specifications and procedures.

Verification activities shall be conducted in accordance with the requirements of this NQQP, the SVVP, the Verification Test Specification and the Verification Test Plan.

The TSAP verification process, as delineated by the SVVP, includes reviews of the associated SRS, SDD and Function Block Diagrams (FBD), i.e., TSAP source code.

During TSAP verification activities, each requirement of the SDD shall be verified. Use of the IEEE 1012 Software Traceability Analysis (STA) (Section 10.2) may be helpful in verifying that each software requirement is adequately addressed by the TSAP. In addition, during these activities, the TSAP source code may be run in the emulation mode using simulated inputs and parameters to exercise the logic and confirm expected outputs. The SVVP shall specify the use of emulation testing for TSAP verification. If utilized, emulation tests shall be documented such as by drawing markups or simulation data tables and this documentation shall be included in the Nuclear Qualification Document Package (Section 11.2).

During the TSAP source code verification process, potential program errors, problems and deviations from requirements, i.e., anomalies, shall be documented on a QPAR by the reviewing V&V Team member for each required change, or group of changes, in accordance with the requirements of Paragraph 10.4.3.

Upon satisfactory completion of the verification process, including closure of all QPARs associated with this process, the TSAP is ready for validation in accordance with Paragraph 10.4.2.

Satisfactory completion of TSAP verification activities shall be documented on the associated SDC in accordance with Figure 7.

As part of the TSAP verification process, the V&V Team shall generate V&V Phase Summary Reports in accordance with the requirements of the SVVP. The PM shall release approved and issued V&V Phase Summary Reports through Agile, in accordance with EDM 12.00, at the conclusion of all Tricon v10 Nuclear Qualification Project activities.

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10.4.2 VALIDATION

Upon satisfactory completion of the verification process, further testing is performed by the V&V Team to validate the TSAP. Validation activities shall be conducted in accordance with the requirements of this NQQP, the SVVP, the Validation Test Specification and the Validation Test Plan.

A Software Validation Test (SVT) Procedure shall be developed by the V&V Team. The SVT Procedure shall be prepared, reviewed, approved and controlled in accordance with the applicable requirements of Sections 9.3 through 9.7. All aspects of TSAP design shall be included in the SVT. Review by a technically qualified individual shall verify that the SVT will exercise all functions of the nuclear qualification test system and that system operation, as defined by input requirements, will be fully validated. The TSAP shall be downloaded to the TUT after nuclear qualification test system configuration and assembly have been verified (Paragraph 9.8.4). Conditions representing the required operating modes, I/O data taken and the results shall be evaluated to confirm that all requirements of the TSAP have been met. The PQAE shall monitor conduct of the SVT to help ensure that testing is being conducted in accordance with the requirements of the SVT Procedure and this NQQP.

Hardware, test equipment and test deficiencies, e.g., failure to meet acceptance criteria and failure to execute a procedure as written, identified during TSAP validation testing shall be documented, dispositioned and controlled using QPARs in accordance with the requirements of Section 9.9.

Software anomalies identified during TSAP validation testing shall be documented, dispositioned and controlled using QPARs in accordance with Paragraph 10.4.3. A QPAR shall be initiated by the V&V Team for each required change, or group of changes, to the TSAP.

The PE, a technically qualified reviewer, the PQAE and the IPS Nuclear Quality Director shall review the results of the SVT, including the associated Test Report and all related QPARs, for completeness, accuracy and acceptability. Upon successful completion of this review, the PE, reviewer, and PQAE shall sign and date Section 11.0, Test Approval, of the SVT Procedure and the IPS Nuclear Quality Director shall approve the test results by also signing this Section of the SVT Procedure. The completed and approved SVT Procedure shall be controlled in accordance with Section 7.0.

Upon satisfactory completion of the TSAP validation process, including closure of all QPARs associated with this process, the TSAP is ready to be released for use in nuclear qualification testing activities. Satisfactory completion of TSAP validation activities shall be documented on the associated SDC in accordance with Figure 7. The TSAP shall be released for use in accordance with Section 10.5.

As part of the TSAP validation process, the V&V Team shall generate a V&V Phase Summary Report(s) in accordance with the requirements of the SVVP. The PM shall release the approved and issued V&V Phase Summary Report(s) through Agile, in accordance with EDM 12.00, at the conclusion of all Tricon v10 Nuclear Qualification Project activities.

10.4.3 SOFTWARE ANOMALY REPORTING

An anomaly is any condition that deviates from expectations based on requirements specifications, design documents, user documents, standards, etc. or from an individual's perceptions or

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experiences. Anomalies may be found during, but not limited to, review, test, analysis, compilation, or use of software products or applicable documentation. An anomaly is not necessarily a problem in the software product; it may be another method of manifesting correct behavior in which case changing the software would be an enhancement. An anomaly may also be caused by something other than the software, e.g., hardware malfunctions or test measurement equipment.

A QPAR, Figure 5, shall be prepared when a variance from specification requirements or other approved design documentation is identified during verification, validation, review or use of the software. A QPAR shall be used to document a variance that will be returned to a conforming condition by revision of the software prior to its use in nuclear qualification testing activities.

A QPAR number shall be obtained from the PQAE. The PQAE shall ensure that QPAR numbers are unique and that QPARs are reconcilable. Qualification Project Anomaly Report (QPAR) numbers shall be annotated in their associated SDC. In-process originals of QPARs shall be maintained by the PQAE until their closure.

In addition to the data required by Figure 5, the QPAR shall include:

1. The time and date when the anomaly was discovered.
2. As applicable, appropriate references to the Test Procedure.
3. As applicable, a description of the test conditions at the time the anomaly was detected.
4. Classification of the anomaly. The anomaly shall be assigned to one of the following classes, depending on impact:
 - **Class 1 – High Impact:** A failed function or unexpected result of the software. If a Class 1 anomaly is identified during a test activity, testing of the affected function shall stop and the anomaly shall be corrected prior to the resumption of this testing.
 - **Class 2 – Medium Impact:** An expected result that is not consistent with the intended function of the software, e.g., incorrect measurement units. If a Class 2 anomaly is identified during a test activity, testing may continue pending disposition of the anomaly.
 - **Class 3 – Low Impact:** An enhancement to the software. If a Class 3 anomaly is identified during a test activity, testing may continue pending disposition of the anomaly.
 - **Class 4 – No Impact:** An editorial or administrative error in the software. If a Class 4 anomaly is identified during a test activity, testing may continue and the anomaly shall be corrected as delineated by the associated QPAR disposition.

Resolution of an anomaly shall include documentation of the corrective actions taken to return the software to a conforming condition and retest requirements. The anomaly shall be corrected and the associated software function shall be appropriately retested; testing interaction with any previously tested function(s) shall be evaluated; and all related documentation shall be updated.

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10.4.4 FINAL V&V REPORT

Upon successful completion of the verification and validation process, a Final V&V Report, which summarizes all TSAP verification and validation activities, shall be prepared by the V&V Team. This report shall include all verification and validation records and completed QPARs. As a minimum, the Final V&V Report shall contain the following:

1. A cover page that is uniquely identified to the Tricon v10 Nuclear Qualification Project and identifies the specific TSAP by name and validated version. The cover page shall include identification of the preparer, reviewer(s) and approver.
2. A description of the verification and validation activities that were performed.
3. A summary of verification and validation results.
4. A summary of all anomalies and their associated corrective actions.
5. An assessment, based upon a review of the V&V Phase Summary Reports, of the TSAP’s overall quality.
6. Recommendations, if any, regarding the overall development process of TSAPs for future nuclear qualification projects.
7. A copy of or reference to completed V&V documents.

The Final V&V Report shall be reviewed, as a minimum, by a technically qualified individual and the Project Quality Assurance Engineer (PQAE) and be approved by the IPS Nuclear Quality Director.

Upon approval of the Final V&V Report, the IPS Nuclear Quality Director shall advise the PM that the report has been approved. At this time, the PM shall ensure that the released TSAP is listed on the MCL in accordance with Section 7.0.

The PM shall release the Final V&V Report through Agile, in accordance with EDM 12.00, at the conclusion of all Tricon v10 Nuclear Qualification Project activities.

10.5 RELEASE FOR USE

Upon completion of all V&V activities, the PE shall create a Master Disk of the fully verified and validated TSAP. The PE shall document completion of this activity on the SDC in accordance with Figure 7.

The IPS Nuclear Quality Director shall release the fully verified and validated TSAP for use in nuclear qualification testing activities upon completion of the SDC in accordance with Figure 7.

11.0 NUCLEAR QUALIFICATION

11.1 EQUIPMENT QUALIFICATION (EQ) SUMMARY REPORT

At the successful conclusion of all Tricon v10 Nuclear Qualification Project activities, the Project Engineer (PE) shall prepare the Equipment Qualification (EQ) Summary Report. This report shall summarize the nuclear qualification process, including a summary of all executed tests and their results, a summary of all required reports and analysis, positive identification of the fully tested TUT

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configuration, and a conclusion as to the ability of the tested Tricon components to meet all qualification requirements. The EQ Summary Report shall also clearly identify all maximum values applicable to the tested Tricon components and may specify limits on their qualification.

The EQ Summary Report shall be reviewed, approved and controlled in accordance with Section 9.5.

11.2 NUCLEAR QUALIFICATION DOCUMENT PACKAGE

The PM shall assemble the Nuclear Qualification Document Package. This package shall consist of all documents, in their final revision, necessary to demonstrate and substantiate the qualification of the qualified Tricon components and, as a minimum, include:

- Marketing Requirements Document (MRD).
- Engineering Project Plan (EPP).
- Nuclear Qualification Quality Plan (NQQP).
- Procurement documents.
- Inspection Reports.
- Tricon component manufacturing package(s), if applicable.
- Analyses.
- Test Specimen drawings.
- Simulator Panel drawings.
- Software Quality Assurance Plan (SQAP).
- Software Verification and Validation Plan (SVVP).
- Software Requirements Specification (SRS).
- Software Design Description (SDD).
- Test Specimen Application Program (TSAP).
- Master Test Plan (MTP).
- Test Specifications and Test Procedures.
- Review and comment documentation.
- Design Review Checklists (DRC).
- Test Review Board (TRB) records.
- Test records.
- Test Reports.
- Vendor Test Procedures, test records and Test Reports.

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- TSAP Verification and Validation records and reports.
- Master Configuration List (MCL).
- Qualification Project Anomaly Reports (QPAR).
- Engineering Reports.
- IEEE 1012 Software Traceability Analysis (STA).
- EPRI TR-107330 Requirements Compliance and Traceability Matrix (CTM).
- Independent Qualification Project Assessment documents.
- Equipment Qualification (EQ) Summary Report.

The Nuclear Qualification Document Package shall be reviewed by the PQAE for inclusion of all required documents and the satisfaction of requirements related to Quality Records (Section 12.0) and it shall be approved by the IPS Nuclear Quality Director. This review and approval shall be documented in a memorandum to the Tricon v10 Nuclear Qualification Project file. The memorandum shall be processed in accordance with Section 12.0.

11.3 NUCLEAR QUALIFIED EQUIPMENT LIST

Upon satisfactory completion of all Tricon v10 Nuclear Qualification Project requirements, the TUT (Paragraph 9.8.4), i.e., its components, shall be placed on the Nuclear Qualified Equipment List (NQEL) in accordance with the requirements of EDM 75.00, Maintenance of Nuclear 1E Qualification.

The Nuclear Qualified Equipment List (NQEL) and associated documentation shall be included in the Nuclear Qualification Document Package.

12.0 QUALITY RECORDS

As a minimum, all documents, including changes thereto, included in the Nuclear Qualification Document Package (Section 11.2) shall be considered Quality Records. These documents shall be controlled, collected, maintained and retained in accordance with the requirements of QAM 16.0, Quality Records.

All Quality Records associated with the Tricon v10 Nuclear Qualification Project shall be maintained as authenticated, i.e., signed, documents. Quality Records shall include original signatures; electronic signatures are not acceptable. If electronic copies are used as Quality Records or to satisfy duplicate storage requirements, the copies shall be scanned from the original, authenticated documents.

13.0 APPLICABLE INDUSTRY STANDARDS

ASME NQA-1-1994	Quality Assurance Requirements for Nuclear Facility Applications
IEEE Std 323-1974	Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations



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IEEE Std 344-1987 Recommended Practice for Seismic Qualification of Class 1E Equipment
for Nuclear Power Generating Stations

IEEE Std 1012-1998 IEEE Standard for Software Verification and Validation

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APPENDIX 1

TEST SPECIFICATION FORMAT AND CONTENT GUIDELINES

1.0 PURPOSE

Describe the purpose of the test specification. The purpose is typically to identify the requirements that require testing and demonstrate how these requirements will be satisfied by testing. This section typically identifies the boundaries of the system, individual software units, applicable input/output, internal to internal as well as internal to external interfaces and graphic displays, if applicable to the test.

2.0 TEST OUTLINE

2.1 SCOPE

Identify the test system and describe each design feature or combination of features to be included in the test. For each required operational or design feature or combination of features, a reference to its associated source documents should be provided.

2.2 TEST APPROACH

Specify the general approach to testing. Include specific test techniques to be used, any special test equipment required to perform the testing, and the method(s) to be utilized to evaluate the test results.

2.3 TEST ELEMENTS

List the test procedures, test cases, or test modules that are required to accomplish the indicated testing and provide a brief description of each listed item.

2.4 ACCEPTANCE CRITERIA

Specify the criteria that are necessary to determine acceptability of the test results.

3.0 TEST REQUIREMENTS

Describe in detail the basis for the test requirements. Describe each test input requirement and the expected corresponding output. The input/output requirements should have sufficient detail in order to produce the procedure(s) that will be used to perform the testing.

4.0 REFERENCES

List all documents used to develop the specification, e.g., industry standards, the Marketing Requirements Document (MDR) and the Engineering Project Plan (EPP).

5.0 DEFINITIONS

As necessary for clarity, list the terms, definitions and acronyms that are used in the specification.

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APPENDIX 2

TEST PLAN FORMAT AND CONTENT GUIDELINES

1.0 PURPOSE AND SCOPE

1.1 PURPOSE

Describe the purpose of the plan.

1.2 SCOPE

Describe the scope of the plan. Describe what the plan is intended to accomplish. Identify the equipment to be tested. Summarize the software items to be tested, or not to be tested. Describe how the plan will be implemented. An overview of the system should be included.

2.0 REFERENCE DOCUMENTS

List all documents used as references to develop the plan, all documents referenced in the plan, and all documents that will be used to implement the plan. Examples of these documents are:

- Engineering Project Plan
- Marketing Requirements Document
- Test Specification
- Relevant Policy Documents
- Relevant Codes and Standards
- Tricon System Test Requirements Specification
- Software Requirements Specification
- Software Design Description

3.0 DEFINITIONS

List, as necessary for clarity, the terms, definitions and acronyms used in the specification. If not required, indicate “None”.

4.0 TEST OVERVIEW

4.1 ORGANIZATION

Describe the testing organization, including staffing and training needs.

4.2 SCHEDULE

Provide a schedule for plan implementation. Identify any milestone dates that need to be met; reference to the Schedule may be included.

4.3 RESOURCES

Identify the resources needed to implement the plan, including personnel and equipment requirements.

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4.4 RESPONSIBILITIES

Define responsibilities for implementing the plan. Identify the applicable groups and personnel by title.

4.5 TOOLS, TECHNIQUES AND METHODOLOGIES

Describe the tools, techniques, and methodologies that will be used to implement the plan. Specify the necessary and desirable attributes of the test environment. This will include any measuring and test equipment (M&TE) required to conduct the testing.

5.0 TEST REQUIREMENTS

Identify the source of the testing requirements; this is generally described in the design specification(s). Identify any risks or contingencies associated with testing. Develop test items, features, and tasks in more detail, if necessary.

6.0 TEST IMPLEMENTATION

Describe the overall approach to testing and the test methods. Identify the set of tasks necessary to prepare and perform testing. Describe how the testing is to be implemented. List the sequential steps necessary to implement this test plan. Identify any milestone dates that have to be met; reference to the schedule may be included.

7.0 ACCEPTANCE CRITERIA

Identify the criteria to be used to determine acceptability of the test. This can be qualitative (on/off, open/close, etc.) and/or quantitative (numerical). If the acceptance criteria are quantitative, list the minimum/maximum values (tolerance). Also describe the process for handling test failures or deviations from test requirements. Include suspension and resumption criteria. Specify which activities, or types of activities, must be repeated when testing is resumed.

8.0 TEST IMPLEMENTATION AND DOCUMENTATION

List the documents that need to be developed to implement and document the plan, i.e., test procedures and test reports. Specify the test process deliverables.

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APPENDIX 3
TEST PROCEDURE FORMAT AND CONTENT GUIDELINES

1.0 PURPOSE

Describe the purpose of the Test Procedure.

2.0 OBJECTIVE

Describe the objective of the test(s) to be executed in accordance with the Test Procedure.

3.0 SCOPE

Identify the scope of the Test Procedure. An overview of the test should be included.

4.0 ACCEPTANCE CRITERIA

Identify the qualitative and/or quantitative criteria that will be used to determine the acceptability of the test results. Where applicable, express the criteria in terms of quantitative measurement, e.g., mA, volts and in-lbs. When specifying such quantitative criteria, identify the minimum and maximum values, i.e., tolerance. Where practical, also specify expected operational ranges.

5.0 REFERENCES

List any references related to the Test Procedure, including any references used during its development. Include reference to the basis for test requirements and acceptance criteria, e.g., design documents and industry standards.

6.0 PREREQUISITES

Describe all conditions that must be satisfied prior to the start of testing. This Section shall include, as applicable, calibrated instrumentation; appropriate test equipment and fixtures; trained personnel; condition of the test equipment; test system configuration requirements such as mechanical and electrical lineups, applicable layout drawings/sketches, system documentation, software installation, etc.; suitable environmental conditions; and provisions for data acquisition.

As a prerequisite to Pre-Qualification Testing, the configuration of the Tricon-Under-Test shall be completely documented on the MCL and the current revision of the MCL shall be recorded in this Section of the Test Procedure. Provisions to record the verification of system configuration shall also be included in this Section of the procedure.

7.0 PRECAUTIONS

When applicable, precautions should be established to alert test personnel of any measures that should be taken to protect personnel and/or equipment. If there are no precautions, this Section shall indicate “None”.

8.0 MEASURING AND TEST EQUIPMENT

Specify the required types of instruments, their required ranges, accuracies and tolerances. Include provisions to record the actual M&TE used in the test by the manufacturer’s name, model number, serial number, ranges, accuracies and tolerances, as applicable, and to record M&TE calibration dates.

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9.0 TEST SET-UP

Detail the design of the test set-up required to implement the Test Procedure. Provide details that relate the arrangement of the Tricon-Under-Test to the test equipment and fixtures. Also include details related to test system arrangement, including the location of its individual components. This Section may include or reference layout drawings/sketches for clarity. In part, test prerequisites (Section 7.0) will be verified against the details provided in this Section.

10.0 PROCEDURE

List the sequential steps necessary to perform the test in sufficient detail to allow the test to be performed by qualified test personnel with minimum supervision and without recourse to the preparer. Include provisions for test personnel to sign/initial each step, or sequence of steps, to signify satisfactory completion of the step, or sequence of steps. Include provisions to document the name and version of software used to perform automatic testing functions, if applicable. Also include provisions for any Quality Assurance (QA) witness points and sign-off of those points by QA. As applicable, include provisions for recording data and for verification of important information/data. The procedure shall also provide provisions for identification of the data recorder.

11.0 TEST RESULTS REVIEW AND APPROVAL

This Section shall document Test Review Board (TRB) review and approval of the test results, including the conclusion that all acceptance criteria were met and all test deficiencies/deviations have been resolved. Provisions to record TRB review and approval of the test results, i.e., each member's dated signature, shall be included in this Section.

12.0 ATTACHMENTS

Identify all attachments to the Test Procedure, e.g., diagrams and test data.

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APPENDIX 4

TEST REPORT FORMAT AND CONTENT GUIDELINES

1.0 EXECUTIVE SUMMARY

Provide a concise statement addressing the test objective, results and conclusions. The statement should be written such that the reader need only refer to the body of the report for specific details regarding the test.

2.0 PURPOSE

Describe the purpose of the Test Report.

3.0 TEST OBJECTIVE

State the objective(s) of the testing, e.g., what the test is intended to demonstrate.

4.0 DESCRIPTION OF THE TEST SYSTEM

Describe the test system, including its test configuration.

5.0 TEST SET-UP AND INSTRUMENTATION

Describe the set-up of the test system and the instrumentation used to monitor the applied test conditions.

6.0 TEST PROCEDURE

Describe what testing was performed and what approach was taken to satisfy the requirements of the governing documents.

7.0 TEST RESULTS

Provide a summary of the test results and a discussion of test results compared to the stated acceptance criteria.

8.0 CONCLUSIONS

Describe the applied test conditions and acceptance criteria for each applied test condition. Discuss the rationale for determining acceptability of each applied test condition.

9.0 REFERENCES

List all documents that were used or referred to during the testing activities. This includes all industry standards used to determine test methods.

10.0 APPENDICES

List all documents that will be included as attachments to the report.

11.0 ATTACHMENTS

List all documents that are included as Attachments to the report.

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APPENDIX 5
SOFTWARE QUALITY ASSURANCE PLAN (SQAP)
FORMAT AND CONTENT GUIDELINES

1.0 Purpose

Describe the purpose of the Plan:

- a. Intended use of the Plan.
- b. Scope of the Plan.
- c. Why the Plan is being written.
- d. Software items covered by the Plan.
- e. Portions of the software lifecycle that apply to each item addressed by the Plan.

2.0 Reference Documents

List all documents referenced in the Plan.

3.0 Management

Describe the organization, tasks and responsibilities as they relate to software quality assurance.

4.0 Documentation

Identify the documents governing the development, verification and validation, use and maintenance of the application software. These will be the software design documents, e.g., the Software Requirements Specification (SRS), Software Design Description (SDD) and Software Verification and Validation Plan (SVVP). Define how these documents are to be prepared, reviewed approved and controlled.

5.0 Standards, Practices, Conventions and Metrics

List the standards, practices, conventions, and metrics to be applied, and describe how compliance of these items will be monitored and assured.

6.0 Reviews and Audits

Describe the managerial and technical reviews and audits to be conducted, and describe what further actions are required and how they are to be implemented and verified.

7.0 Test

Identify any tests that are not part of the validation testing and what methods will be used.

8.0 Problem Reporting and Corrective Action

Describe the practices and procedures to be followed for reporting, tracking and resolving problems identified in both software items and the software development and maintenance process.

9.0 Tools, Techniques, and Methodologies

Identify any special software tools, techniques, and methodologies that support the Plan, and describe their purpose and use.

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10.0 Code Configuration Management and Control

Delineate the requirements for configuration management of the TSAP beginning with TSAP verification activities and continuing through completion of all nuclear qualification testing activities.

Define the methods and facilities used to maintain, store, secure and document controlled versions of the TSAP during all applicable phases of its lifecycle.

11.0 Media Control

Define the methods and facilities to be used to store the media, including the copy and restore process, and the methods to be used to protect the media from unauthorized access or inadvertent damage or degradation.

12.0 Supplier Control

Describe the provisions for assuring that software provided by suppliers, if any, meets established requirements.

13.0 Records Collection, Maintenance and Retention

Identify the software documentation to be retained; the methods and facilities to be used to assemble, safeguard and maintain this documentation; and designate the retention period for the documents. This will usually be defined in the associated Engineering Project Plan (EPP) and/or the Nuclear Qualification Quality Plan (NQQP).

14.0 Training

Identify any training requirements necessary to meet the needs of the Plan. This will usually be defined in the associated EPP.

15.0 Risk Management

Define the methods and procedures to be used to identify, assess, monitor and control areas of risk arising during software development; identify, as applicable, technical, economic, schedule, managerial, marketing or any other area of risk.

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APPENDIX 6
SOFTWARE VERIFICATION & VALIDATION PLAN (SVVP)
FORMAT AND CONTENT GUIDELINES

1.0 Purpose

Describe the purpose and scope of the Plan. Identify the specific Project that the Plan applies to and the Test Specimen Application Program addressed by the Plan. Also define the goals of the Plan.

2.0 Referenced Documents

Identify all documents referenced in the Plan and any supporting documents required to supplement or implement the Plan.

3.0 Definitions

Describe or provide reference to the definition of terms required to interpret or implement the Plan.

4.0 Verification and Validation Overview

4.1 Describe the V&V organization(s).

4.2 Identify the schedule.

4.3 Describe resources required.

4.4 Define responsibilities.

4.5 Identify the tools, techniques, and methodologies necessary to implement the Plan.

5.0 Life Cycle Verification and Validation

5.1 V&V Tasks

Identify the tasks for each life cycle phase covered by the Plan.

5.2 Methods and Criteria

Describe the specific methods and procedures for each task. Define the detailed criteria for evaluating task results.

5.3 Inputs/Outputs

Identify the inputs required for each task. Specify the source and format of each input. Identify each output with respect to each input.

5.4 Schedule

Identify the schedule for the V&V tasks. Establish milestones for initiating and completing each task, for the receipt of each input, and for the delivery of each output.

5.5 Resources

Identify the resources needed to implement the Plan. This would include personnel, facilities, equipment, etc.

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5.6 Risk and Assumptions

Identify any risks or assumptions associated with the tasks, including schedule, resources or approach. Specify a contingency plan for each risk.

6.0 Software V&V Reporting

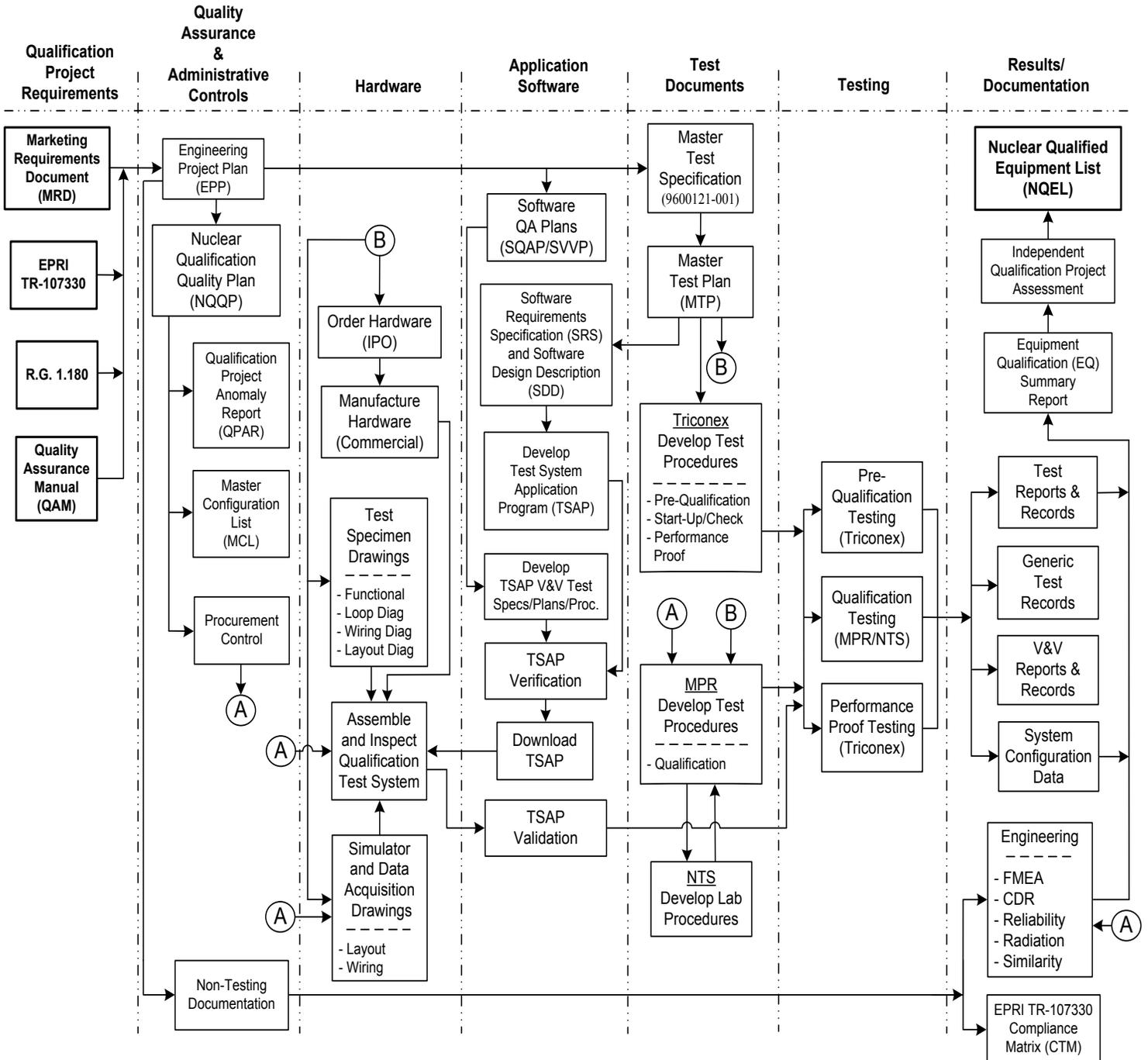
Describe how the results of implementing the Plan will be documented. Delineate the requirements for V&V Phase Summary Reports and the Final V&V Report. Define the format and content of these reports.

7.0 Verification and Validation Administrative Procedures

Describe the procedures used to implement the Plan. Also include a description of the standards, practices and conventions used in performing the V&V tasks, including company standards, practices and policies.

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FIGURE 1
TRICON v10 NUCLEAR QUALIFICATION PROJECT OVERVIEW



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FIGURE 3
DESIGN REVIEW CHECKLIST (DRC)

Document Title:	Document Number:	Rev.:
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Item	Review Question	Yes	No	N/A
1.	Were the design inputs correctly selected and incorporated?			
2.	Are the design outputs reasonable compared to the design inputs?			
3.	Are the system interfaces adequately described and appropriate?			
4.	Are assumptions adequately described and reasonable?			
5.	Where necessary, will the assumptions be available for re-verification after the design is completed?			
6.	Were appropriate design methods and computer programs used?			
7.	Are suitable materials, parts, processes, and inspection and testing criteria specified?			
8.	Are the applicable codes, standards and regulatory requirements, including issue and addenda, identified and are their requirements for design met?			
9.	Are the design documents clear and concise and mutually consistent, i.e., each conclusion is supported by a discussion or analysis; the document formats are consistent; and recommended actions are consistent with the conclusion statement?			
10.	Are the necessary design input and verification requirements for interfacing organizations specified in the design documents or in supporting procedures?			
11.	Are applicable quality, statutory, and regulatory safety requirements adequately addressed?			
12.	Are acceptance criteria incorporated in the design documents sufficient to allow verification that design requirements have been satisfactorily accomplished?			
13.	For design changes, were the changes adequately evaluated to ensure that the impact of the change or cumulative effect of multiple changes were carefully considered, i.e., material substitutions, performance, interchangeability, EQ/seismic, test, and Equipment Qualification.			

Comments: (Provide details for any “No” or “N/A” answers.)

Performed By:	Date:
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FIGURE 4
INTERIM CHANGE NOTICE (ICN)

Procedure/Drawing Number:	ICN No.	Page 1 of
Procedure/Drawing Title:		Revision No.:
Description of Change:		
Reason for Change:		
Comments/Impact on Testing:		
Preparer:		Date:
Project Engineer (PE):		Date:
PQAE:		Date:
Independent Reviewer:		Date:
Approval:		Date:

SAMPLE

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FIGURE 5
QUALIFICATION PROJECT ANOMALY REPORT (QPAR)

Project: Tricon v10 Nuclear Qualification Project	Page __ of __
QPAR No. _____	Reported By: _____
Date: _____	
Item Description: _____	
Part/Revision No. _____	
Problem Description:	
QPAR Type: Hardware (H) _____ Software (S) _____ Test (T) _____ Other (O) _____	
Software Anomaly Classification: Class 1 ____ Class 2 ____ Class 3 ____ Class 4 ____ N/A ____	
Testing Impact: Stop Testing ____ Proceed with Testing ____ N/A ____	
Justification for Anomaly Classification:	
Prepared By: _____ Date _____ N/A _____	
Reviewed By: _____ Date _____	
Safety Related: Yes ____ No ____ Potential 10CFR21 Reportable: No ____ Yes ____ If Yes, see QAM 13.3.	
Cause (If Known):	
<div style="text-align: center;"> <p>Hardware (H) Disposition:</p> <p>(NOTE: Use As-Is and repair dispositions constitute a design change and require customer approval and design document revision.)</p> <p>____ Rework (Provide rework instructions.)</p> <p>____ Repair (Provide repair instructions and justification.)</p> <p>____ Use-As-Is (Provide justification.)</p> <p>____ Reject (Specify final disposition below, e.g., scrap, RTV, etc.)</p> </div>	
Required Action:	
Significance/Project Impact/Comments:	
Retest Requirements:	
<input type="checkbox"/> No Retest Required (Provide justification.) <input type="checkbox"/> Complete Retest <input type="checkbox"/> Partial Retest (Provide justification and retest steps/instructions.)	
Document Change Required:	
No ____ Yes ____ (Identify document(s))	
Disposition Prepared By: PE _____ Date _____	
Disposition Approved:	
PM _____ Date _____	QA _____ Date _____
Disposition Implementation Complete and Verified/QPAR Closed:	
PE _____ Date _____	QA _____ Date _____

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FIGURE 7
SOFTWARE DEVELOPMENT CHECKLIST (SDC)

¹ Program Title	² SDC No./Revision	³ Page Number
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⁴ Program Identification Number		⁵ Version
⁶ Program Revision		
<input type="checkbox"/> Initial Program Release <input type="checkbox"/> Program Revision		If this is a revision, enter the anomaly report(s). QPAR(s):
⁷ Description of Program/Program Revision		
⁸ Initial Release Input Documents/Revision Input Documents		
⁹ Attachments		
¹⁰ Responsible Individual	Name	Signature
Project Engineer		
		Date

SAMPLE



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¹ Program Title	² SDC No./Revision	³ Page Number
Tricon v10 Nuclear Qualification Project TSAP	9600164-515/	Page __ of __

¹¹ Program Verification Complete			
<input type="checkbox"/> Yes <input type="checkbox"/> No		If No, enter the associated anomaly report(s). QPAR(s):	
¹² Responsible Individual	Name	Signature	Date
V&V Engineer			
Project QA Engineer			

¹³ Program Validation Complete			
<input type="checkbox"/> Yes <input type="checkbox"/> No		If No, enter the associated anomaly report(s). QPAR(s):	
¹⁴ Responsible Individual	Name	Signature	Date
V&V Engineer			

¹⁵ Master Disk(s)			
<input type="checkbox"/> a. Labeling verified correct.			
<input type="checkbox"/> b. Duplication verified correct.			
¹⁶ Responsible Individual	Name	Signature	Date
Project Engineer			

¹⁷ Comments

¹⁸ Responsible Individual	Name	Signature	Date
Project QA Engineer			

TSAP Released for Nuclear Qualification Testing

¹⁹ Responsible Individual	Name	Signature	Date
IPS Nuclear Quality Director			

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FIGURE 7 (CON'T)
INSTRUCTIONS FOR COMPLETING THE SDC

To initiate the SDC, the Project Engineer shall assign a revision number to the SDC. The revision number for the initial SDC shall be “0” and this number shall be increased by one (1) with each revision to the SDC.

The SDC shall be completed as follows (List Numbers correspond to Item Numbers on the SDC):

1. Project Engineer: Enter Program Title if other than shown.
2. Project Engineer: Enter SDC revision number.
3. Page numbering is automatic.
4. Project Engineer: Enter the Program Identification Number.
5. Project Engineer: Enter the version of the TSAP being released for V&V activities. The PE shall ensure that version identification for the TSAP is developed such that its initial release and any subsequent revisions are uniquely identified.
6. Project Engineer: Check either “Initial Program Release” or “Program Revision”. If “Program Revision” is checked, enter the anomaly report(s) that identified the deficiency resolved by this version of the Program in the space labeled “QPAR(s)”.
7. Project Engineer: For initial Program release, enter a complete description of the Program, including its assigned name and functionality, and attach the TriStation “User Documents” and “Library Documents” Reports which identify the version of all programs and functions associated with the Program. For a Program revision, the Enter a complete description of the revision, including the problem resolved, and attach the TriStation Reports.
8. Project Engineer: For initial Program release, enter all input documents, including the SDD and associated Function Diagrams (FD), which were used as a basis for developing the Program. For a Program revision, enter all anomaly reports QPARs and/or other applicable revision input documents that were used as a basis for revising the Program.
9. Project Engineer: Identify all attachments, including their total number of pages.
10. Project Engineer: Sign and date the SDC where indicated and forward a Master Disk of the TriStation .pt2 file, along with the SDC, to the V&V Team for Program verification and validation activities.
11. V&V Engineer: Review the SDC controlled Program and implement necessary verification testing in accordance with the SVVP. If the verification is successfully completed, the V&V Engineer shall check “Yes”. If an anomaly in the Program is identified during verification activities, the V&V Engineer shall check “No” and enter the anomaly report(s) in the space labeled “QPAR(s)”. The V&V Engineer shall leave the remainder of the SDC blank; N/A is not required. The V&V Engineer shall forward the SDC to PQAE. Upon resolution of the QPAR(s), the PE shall initiate a revision to the SDC, in accordance with these instructions, to ensure that configuration control is maintained for the Program.
12. V&V Engineer: Upon successful completion of Program verification, sign and date the SDC and forward the signed SDC to the PQAE. The PQAE shall review the SDC to ensure that it is has been processed in accordance with the requirements of these instructions. The PQAE shall sign and date the SDC to document successful completion of this review. The Program is now released for validation activities.
13. V&V Engineer: Validate the Program in accordance with the SVVP. If the program validation is successfully complete the V&V Engineer shall check “Yes”. If an anomaly in the Program is identified



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during validation activities, the V&V Engineer shall check “No” and enter the anomaly report(s) in the space labeled “QPAR(s)”. The V&V Engineer shall leave the remainder of the SDC blank; N/A is not required. The V&V Engineer shall forward the SDC to PQAE. Upon resolution of the QPAR(s), the PE shall initiate a revision to the SDC, in accordance with these instructions, to ensure that configuration control is maintained for the Program.

14. V&V Engineer: Upon successful completion of Program validation, sign and date the SDC and forward the signed SDC to the PE.
15. Project Engineer: Verify that (a) the Master Disk is correctly labeled and (b) that its duplication for records is correct. The PE shall check the appropriate box for each activity.
16. Project Engineer: Upon successful completion of Master Disk verification and duplication activities, sign and date the SDC and forward the signed SDC, along with the Master Disk and its duplicate, to the PQAE.
17. Comments may be entered by any individual associated with SDC processing.
18. Project Quality Assurance Engineer: Review the SDC to ensure that it is complete and has been processed in accordance with the requirements of these instructions. The PQAE shall sign and date the SDC to document successful completion of this review.
19. IPS Nuclear Quality Director: Sign and date the SDC to indicate that all Program V&V activities have been successfully completed, including approval of the Final V&V Report; Program configuration management has been maintained; and the Program is released for use on the Tricon v10 Nuclear Qualification Project.