Project:	TRICON v10 NUCLEAR QUALIFICATION PROJECT

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ELECTROSTATIC DISCHARGE (ESD) TEST REPORT

Document No: 9600164-522

Revision 1

April 30, 2008

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Approval:	Naresh Desai		Project Manager

Document Change History			
Revision	**Date**	**Change**	**Preparer**
0	07/18/07	Initial Issue	M. Albers
1	04/30/08	Revised Reference 9.22 in response to NUPIC audit corrective action (Reference CAR 2528-1). Updated References 9.1 and 9.7 accordingly.	F. Kloer

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1.0 EXECUTIVE SUMMARY

The TRICON v10 Nuclear Qualification Project Electrostatic Discharge (ESD) Test was performed on April 4 to 6, 2007 at National Technical Systems (NTS) Laboratories in Boxborough, Massachusetts. As required by Triconex Document No. 9600164-500, "Master Test Plan," (Reference 9.1), the ESD Test was executed to demonstrate the ESD withstand capability of the TRICON v10 Programmable Logic Controller (PLC).

MPR Procedure No. 9600164-512, "Electrostatic Discharge (ESD) Test Procedure," (Reference 9.2), was developed in accordance with the requirements of EPRI TR-107330, "Generic Requirements Specification for Qualifying a Commercially Available PLC for Safety-Related Applications in Nuclear Power Plants," (Reference 9.3), International Electrotechnical Commission (IEC) Standard 61000-4-2, "Electromagnetic Compatibility (EMC), Part 4-2: Testing and Measurement Techniques, Electrostatic Discharge Immunity Test," (Reference 9.4), Triconex Document No. 9600164-500, "Master Test Plan," (Reference 9.1), and Triconex Document No. 9600164-002, "Nuclear Qualification Quality Plan," (Reference 9.5). The procedure included steps to direct: 1) proper setup of the TRICON-Under-Test (TUT) and test system prior to testing, 2) application of ESD disturbance signals to the TUT components, 3) acquisition of TUT operational parameters during testing, and 4) evaluation of acceptable TUT performance during testing. The TUT executed a verified and validated Test Specimen Application Program (TSAP) throughout ESD Testing. The TSAP revision used was "V10_TSAP_REV_0". ESD Testing was performed by MPR certified Project Test Engineers and witnessed by Triconex Project Quality Assurance.

Triconex Drawing No. 9600164-100, "TRICON v10 Nuclear Qualification Project TRICON-Under-Test, General Arrangement," (Reference 9.6), shows the basic configuration of the TUT components for ESD Testing.

The following ESD Tests were performed:

ESD Direct Contact Discharges: ± 2 kV, ± 4 kV, ± 6 kV and ± 8 kV

- Chassis 1 Battery Cover (4 points)
- Chassis 1 Control Keyswitch (1 point)
- All ETP Cable Chassis Connectors, Top Thumbscrews (25 points)
- All Chassis, Front Horizontal and Vertical Edges (32 points)
- Each Chassis Power Supply Module Type, Faceplate (3 points)
- Each Chassis Power Supply Module Type, Top Thumbscrew (3 points)
- Main Processor, Communication, RXM and I/O Modules, Top Thumbscrews (38 points)
- Model 4352A TCM Module Serial 1 Port, Metal Cable Connector (1 point)

ESD Direct Air Discharges: ± 2 kV, ± 4 kV, ± 8 kV and ± 15 kV

- Model 4352A TCM Module Net 1 Port, Plastic Cable Connector (1 point)
- Model 4352A TCM Module Net 2 Port, Plastic Cable Connector (1 point)

ESD Indirect Contact Discharges: ± 2 kV, ± 4 kV, ± 6 kV and ± 8 kV

- Horizontal Coupling Plane, Parallel to Chassis Bottom Faces (4 points)
- Vertical Coupling Plane, Parallel to Chassis Front Faces (12 points)
- Vertical Coupling Plane, Parallel to ETPs (4 points)

The TUT performance was monitored throughout each applied ESD Test. The ESD Test results demonstrate that the Triconex TRICON v10 PLC will not experience operational failures or susceptibilities due to exposure to electrostatic discharges to the components listed above. The specific TRICON v10 PLC hardware which was tested (chassis, power supplies, modules, external termination assemblies and interconnecting cabling) is identified in Triconex Document No. 9600164-540, "Master Configuration List," (Reference 9.7).

2.0 PURPOSE

The purpose of this test report is to summarize the results of Electrostatic Discharge (ESD) Testing of the TRICON v10 Nuclear Qualification Project TRICON-Under-Test (TUT) to meet the requirements of Section 6.4.2 of EPRI TR-107330 (Reference 9.3). The format of this test report conforms to Section 8.3.(4) of IEEE Standard 323-1974, "Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations," (Reference 9.8).

Details regarding the performance and results of the ESD Testing are recorded in the completed MPR Procedure No. 9600164-512, "Electrostatic Discharge (ESD) Test Procedure," (Reference 9.9). Conclusions from the ESD Testing are provided in Section 8.0 of this test report.

3.0 TEST OBJECTIVE

EPRI TR-107330 (Reference 9.3) states that ESD Testing shall be performed to assure that the PLC system does not have failures due to service conditions for the ESD levels specified in the EPRI TR. Appendix 8 of Triconex Document No. 9600164-500 (Reference 9.1) states that ESD Testing is conducted to demonstrate the withstand capability of the TUT as required in EPRI TR-107330. MPR Procedure No. 9600164-512 (Reference 9.2) states that ESD Testing demonstrates the suitability of the TRICON v10 PLC for qualification as a safety-related, Class 1E device with respect to immunity to electrostatic discharge exposure.

4.0 DESCRIPTION OF TEST SPECIMEN

The equipment tested consists of four TRICON v10 PLC chassis populated with selected main processor, input, output, communication, chassis interface and chassis power supply modules. The tested equipment also includes external termination panels (ETPs) provided for connection of field wiring to the TRICON v10 input and output modules, and interfacing cable assemblies for connection of the ETPs to the TRICON v10 chassis and for interconnection of the TRICON v10 chassis.

Triconex Drawing No. 9600164-100 (Reference 9.6), shows the basic configuration of the TUT components for ESD Testing. Triconex Drawing No. 9600164-103, "TRICON v10 Nuclear Qualification Project System Block Diagram," (Reference 9.10), shows the general arrangement and interconnection of the TUT chassis. Triconex Document No. 9600164-541, "TRICON v10 Nuclear Qualification Project, System Description," (Reference 9.11), provides an overview and description of the TUT and test system. A detailed identification of the tested equipment is provided in Triconex Document No. 9600164-540 (Reference 9.7).

During testing, the TUT was executing a Test Specimen Application Program (the TSAP) developed specifically for the qualification project and designed to support the test procedures, which demonstrate the functionality of the TUT during all phases of qualification testing. Requirements for operation of the TSAP are defined in Triconex Document No. 9600164-517, "Test Specimen Application Program (TSAP) Software Requirements Specification (SRS)," (Reference 9.12). The completed MPR Procedure No. 9600164-512 (Reference 9.9) identifies the TSAP revision used during this testing as "V10_TSAP_REV_0". Triconex Document No. 9600164-540 (Reference 9.7) identifies the revision level of all TUT firmware.

5.0 TEST SETUP AND INSTRUMENTATION

The following sections describe the setup of the TUT during ESD Testing, the instrumentation used to generate and measure the applied ESD test conditions, and the instrumentation used to measure TUT performance during and after testing. The TUT setup is documented in the completed MPR Procedure No. 9600164-512 (Reference 9.9). Specifications for test instrumentation supplied by NTS Laboratories are included in NTS Test Procedure No. TP62987-07N-EMI, "Test Procedure for EMI/RFI Testing of the TRICON v10 Nuclear Qualification Project TRICON-Under-Test," (Reference 9.13).

5.1 TRICON-Under-Test Mounting

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The mounting and grounding configuration described above meets the requirements of Section 7.1 of IEC Standard 61000-4-2 (Reference 9.4), which specifies the test set-up for type tests performed in laboratories

5.2 TRICON-Under-Test Chassis and Module Configuration

Section 4.0 above describes the general arrangement of the TUT which was maintained throughout all of the qualification testing. Chassis configurations for ESD Testing are documented in Triconex Document No. 9600164-540 (Reference 9.7).

5.3 TRICON-Under-Test Power Supply and Wiring Configuration

EPRI TR-107330 (Reference 9.3) does not include specific requirements for configuration of equipment power supplies or wiring during ESD Testing. Section 8.2 of IEC Standard 61000-4-2 (Reference 9.4) specifies that all normal modes of operation of the equipment-under-test shall be exercised during testing.

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5.4 NTS Instrumentation

NTS provided the test instrumentation for generating, applying, and monitoring the ESD Test signals. NTS also provided instrumentation for measuring temperature and relative humidity inside the anechoic test chamber during ESD Testing. These instruments are identified in NTS Test Report No. TR62987-07N-EMI (Reference 9.22).

5.5 Triconex and MPR Instrumentation

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Details on the identification, configuration and calibration of the test instrumentation described above are included in:

- The completed MPR Procedure No. 9600164-512 (Reference 9.9),
- The completed MPR Procedure No. 9600164-510 (Reference 9.21), and,

- The completed Pre-EMI/RFI Testing Run No. 3.6 of Triconex Procedure No. 9600164-502, "System Setup and Checkout Procedure," (Reference 9.24).

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5.6 Instrument Calibration

All tests were performed using calibrated test instruments. Calibration certifications are held by NTS, MPR and Triconex. NTS Test Report No. TR62987-07N-EMI (Reference 9.22) documents the calibration status of the test instrumentation used by NTS. The completed MPR Procedure No. 9600164-512 (Reference 9.9) documents the calibration status of the test instrumentation used by MPR. The completed Triconex Procedure No. 9600164-502 (Reference 9.24) documents the calibration status of the test instrumentation used by Triconex.

6.0 TEST PROCEDURES

ESD Testing of the TUT was performed to the requirements of Section 6.4.2 of EPRI TR-107330 (Reference 9.3), which invokes EPRI TR-102323-R1, "Guidelines for Electromagnetic Interference Testing in Power Plants," (Reference 9.25). Appendix B, Section 3.5 of EPRI TR-102323-R1 identifies IEC Standard 801-2 as the applicable test method for ESD Testing of the PLC under qualification. This version of the IEC Standard has been superceded by IEC Standard 61000-4-2 (Reference 9.4). ESD Testing of the TUT was performed in accordance with IEC Standard 61000-4-2, using the test levels defined in Appendix B, Section 3.5 of EPRI TR-102323-R1 (Reference 9.25).

The following sections describe the approach to satisfying the requirements of the referenced documents for ESD Testing of the TUT. The test procedure used by NTS to perform ESD Testing of the TUT is NTS Test Procedure No. TP62987-07N-EMI (Reference 9.13). The test procedure used by MPR to perform ESD Testing of the TUT is MPR Procedure No. 9600164-512 (Reference 9.2).

6.1 Test Sequence

Figure 2 of Triconex Document No. 9600164-500 (Reference 9.1) shows the sequence of qualification testing performed on the TUT. In accordance with the test sequence shown in Figure 2, ESD Testing was performed after Radiation Exposure, Environmental, Seismic, EMI/RFI, EFT and Surge Withstand Testing, and prior to Class 1E to Non-1E Isolation Testing.

6.2 Test Method

ESD Testing of the TUT was performed in accordance with IEC Standard 61000-4-2 (Reference 9.4). The points specified for application of electrostatic discharges to the TUT are as identified by Triconex in an E-mail to MPR dated January 12, 2007 (Reference 9.26). These points were selected to meet the criteria for direct application of electrostatic discharges to the equipment under test as stated in Section 8.3.1 of IEC Standard 61000-4-2 (Reference 9.4). In addition, electrostatic discharges were applied to horizontal and vertical edges of coupling planes setup in proximity to the TUT in accordance with Sections 8.3.2.1 and 8.3.2.2 of IEC Standard 61000-4-2.

6.3 Test Levels

Appendix B, Section 3.5 of EPRI TR-102323-R1 (Reference 9.25) recommends maximum ESD test levels of ± 15 kV for air discharges and ± 8 kV for contact discharges for safety-related instrumentation to be installed in a nuclear plant control room. These levels correspond to Level 4 installations of IEC Standard 61000-4-2 (Reference 9.4). Section 5 of IEC Standard 61000-4-2 further requires that ESD testing of instrumentation at a specific test level also satisfy all lower levels. For Level 4 contact discharges at 8 kV, these lower levels include 6 kV, 4 kV and 2 kV. For Level 4 air discharges at 15 kV, these lower levels include 8 kV, 4 kV and 2 kV. The applied ESD test levels met these requirements.

6.4 TRICON-Under-Test Operation

Section 8.2 of IEC Standard 61000-4-2 (Reference 9.4) specifies that all normal modes of operation of the equipment-under-test shall be exercised during testing. During ESD Testing, the TUT was powered with the TSAP operating in a mode which cycled a number of the discrete output points on timed ON/OFF cycles, and also held a number of the discrete output points in the ON (closed) position. The TSAP also cycled a number of the analog output points between high and low values, and continually exercised the peripheral communication interfaces including the TRICON Communication Module (TCM) Peer-to-Peer and MODBUS ports. Loop back circuits from the TUT analog and discrete outputs, and analog and discrete input signal simulators exercised a number of the TUT analog and discrete input points.

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6.5 TRICON-Under-Test Performance Monitoring

Appendix 8 of Triconex Document No. 9600164-500 (Reference 9.1) and Section 6.6 of this test report list the ESD Test acceptance criteria. Appendix 8 states that monitoring of normal TUT operation during ESD Testing will demonstrate satisfaction of the acceptance criteria. To clarify the definition of normal operation, the following additional acceptance criteria from Section 4.3.7 of EPRI TR-107330 (Reference 9.3) were applied during ESD Testing:

i.) The main processors shall continue to function.
ii.) The transfer of I/O data shall not be interrupted.
iii.) The applied ESD disturbances shall not cause the discrete I/O to change state.
iv.) Analog I/O levels shall not vary more than 3% (of full scale).

During ESD Testing, NTS Laboratories was responsible for generating and exposing the test system to the required levels of ESD disturbances given in Appendix B, Section 3.5 of EPRI TR-102323-R1 (Reference 9.25) and Section 5 of IEC Standard 61000-4-2 (Reference 9.4). During ESD Testing, MPR and Triconex were responsible for monitoring operation of the test system and determining the susceptibility of the TUT to the applied levels of ESD disturbances.

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6.6 Test Acceptance Criteria

The following ESD Test acceptance criteria are as given in Appendix 8 of Triconex Document No. 9600164-500 (Reference 9.1), and Sections 4.3.7 and 4.3.8 of EPRI TR-107330 (Reference 9.3).

(a) Applying the ESD Test voltages to the specified TUT interfaces will not damage any other module or device in the TUT, or cause disruption of the operation of the backplane signals or any other data acquisition signals.

(b) The TUT shall operate as intended during and after application of the IEC Standard 61000-4-2 Level 4 ESD test levels specified in Appendix B, Section 3.5 of EPRI TR-102323-R1 (Reference 9.25) and Section 5 of IEC Standard 61000-4-2. Specifically:

IEC Standard 61000-4-2:	Air Discharges	Test Voltage Level: ± 15 kV max.
IEC Standard 61000-4-2:	Contact Discharges	Test Voltage Level: ± 8 kV max.

Evaluation of normal operating performance data (inputs, outputs and diagnostic indicators) shall demonstrate operation as intended, including the following specific operational performance from Section 4.3.7 of EPRI TR-107330 (Reference 9.3):

i.) The main processors shall continue to function.
ii.) The transfer of I/O data shall not be interrupted.
iii.) The applied ESD disturbances shall not cause the discrete I/O to change state.
iv.) Analog I/O levels shall not vary more than 3% (of full scale).

(c) Per Section 4.3.8 of EPRI TR-107330 (Reference 9.3), failures of one or more redundant devices due to application of ESD test voltages are acceptable so long as the failures do not result in the inability of the TUT to operate as intended.

7.0 TEST RESULTS

This section summarizes the results of ESD Testing of the TUT. This section also discusses performance or data anomalies which were observed or recorded during the testing.

7.1 Electrostatic Discharge Test Setup and Checkout Testing

Triconex Procedure No. 9600164-502, "System Setup and Checkout Procedure," (Reference 9.27) directs setup of the TUT for the different qualification tests to be performed, and verifies proper operation of the TUT and test system prior to start of testing. ESD Testing of

the TUT was performed following EMI/RFI Testing. The configuration of the test system for ESD Testing remained the same as that for EMI/RFI Testing, as documented in Reference 9.24. Therefore, the System Setup and Checkout Procedure was not required to be performed prior to start of ESD Testing.

7.2 Electrostatic Discharge Testing

ESD Testing of the TUT was performed in accordance with MPR Procedure No. 9600164-512, (Reference 9.2), and NTS Test Procedure No. TP62987-07N-EMI (Reference 9.13). All testing was performed with the TUT energized and operating under control of the executing TSAP software. The following ESD Tests were performed to the test method defined in IEC Standard 61000-4-2 test method (Reference 9.4):

ESD Direct Contact Discharges

For each test point, the applied ESD voltages were stepped up through the IEC Standard 61000-4-2 Level 1, 2, 3 and 4 contact discharge test voltages of 2 kV, 4 kV, 6 kV and 8 kV. Each test voltage was first applied to the test point ten times in the positive polarity, with 1 second between each discharge, followed by ten times in the negative polarity, with 1 second between each discharge. The following TUT points were tested:

- Chassis 1 Battery Cover (4 points)
- Chassis 1 Control Keyswitch (1 point)
- All ETP Cable Chassis Connectors, Top Thumbscrews (25 points)
- All Chassis, Front Horizontal and Vertical Edges (32 points)
- Each Chassis Power Supply Module Type, Faceplate (3 points)
- Each Chassis Power Supply Module Type, Top Thumbscrew (3 points)
- Main Processor, Communication, RXM and I/O Modules, Top Thumbscrews (38 points)
- Model 4352A TCM Module Serial 1 Port, Metal Cable Connector (1 point)

ESD Direct Air Discharges

For each test point, the applied ESD voltages were stepped up through the IEC Standard 61000-4-2 Level 1, 2, 3 and 4 air discharge test voltages of 2 kV, 4 kV, 8 kV and 15 kV. Each test voltage was first applied to the test point ten times in the positive polarity, with 1 second between each discharge, followed by ten times in the negative polarity, with 1 second between each discharge. The following TUT points were tested:

- Model 4352A TCM Module Net 1 Port, Plastic Cable Connector (1 point)
- Model 4352A TCM Module Net 2 Port, Plastic Cable Connector (1 point)

ESD Indirect Contact Discharges

For each coupling plane test point, the applied ESD voltages were stepped up through the IEC Standard 61000-4-2 Level 1, 2, 3 and 4 contact discharge test voltages of 2 kV, 4 kV, 6 kV and 8 kV. Each test voltage was first applied to the coupling plane test point ten times in the positive polarity, with 1 second between each discharge, followed by ten times in the negative polarity, with 1 second between each discharge. The following coupling plane points were tested:

- Horizontal Coupling Plane, Parallel to Chassis Bottom Faces (4 points)
- Vertical Coupling Plane, Parallel to Chassis Front Faces (12 points)
- Vertical Coupling Plane, Parallel to ETPs (4 points)

7.3 TRICON-Under-Test Performance Monitoring

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Data sheets included in the completed MPR Procedure No. 9600164-512 (Reference 9.9) provide a detailed listing of the TUT input, output and peripheral communication points that were monitored during ESD Testing, and document the results of analysis of the monitored operational data. Attachment 1 of this test report includes a set of figures showing the normal operation of the data points which were monitored.

The data analysis shows that the TUT continued to operate in accordance with the test acceptance criteria given in Section 6.6 of this test report during and after application of the ESD test voltages. Specifically:

a) Application of the ESD test voltages did not result in damage to any modules installed in the TUT, including the main processor modules, the RXM modules, the input/output modules and the communication modules.

b) Application of the ESD test voltages did not result in disruption of the operation of the TUT, including the ability to correctly acquire input signals and generate output signals.

c) Evaluation of TUT normal operating performance data (inputs, outputs and diagnostic indicators) during and after each ESD test demonstrated operation as intended, including the following specific operational performance from Section 4.3.7 of EPRI TR-107330 (Reference 9.3):

i.) The main processors continued to function.
ii.) The transfer of I/O data was not interrupted.
iii) The applied ESD disturbances did not cause the discrete I/O to change state.
iv.) Analog I/O levels did not vary more than 3% (of full scale).

d) The data sheets included in the completed MPR Procedure No. 9600164-512 (Reference 9.9) record several instances of module fault alarms that occurred during ESD testing. Section 7.5 of this test report provides an evaluation and disposition of each module fault alarm received during testing. The evaluations conclude that the indicated module faults were transient, no module damage occurred, and there was no affect on the expected operation of the TUT, which is consistent with the fault tolerant design of the TRICON v10 PLC.

7.4 Procedure Deviations

There were no significant procedural deviations taken during ESD Testing.

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8.0 CONCLUSIONS

1. ESD Testing of the TUT was performed in accordance with the applicable requirements of Appendix B, Section 3.5 of EPRI TR-102323-R1 (Reference 9.25) and IEC Standard 61000-4-2 (Reference 9.4). The following ESD tests were performed:

   ESD Direct Contact Discharges: ± 2 kV, ± 4 kV, ± 6 kV and ± 8 kV

   - Chassis 1 Battery Cover (4 points)
   - Chassis 1 Control Keyswitch (1 point)
   - All ETP Cable Chassis Connectors, Top Thumbscrews (25 points)
   - All Chassis, Front Horizontal and Vertical Edges (32 points)
   - Each Chassis Power Supply Module Type, Faceplate (3 points)
   - Each Chassis Power Supply Module Type, Top Thumbscrew (3 points)
   - Main Processor, Communication, RXM and I/O Modules, Top Thumbscrews (38 points)
   - Model 4352A TCM Module Serial 1 Port, Metal Cable Connector (1 point)

   ESD Direct Air Discharges: ± 2 kV, ± 4 kV, ± 8 kV and ± 15 kV

   - Model 4352A TCM Module Net 1 Port, Plastic Cable Connector (1 point)
   - Model 4352A TCM Module Net 2 Port, Plastic Cable Connector (1 point)

   ESD Indirect Contact Discharges: ± 2 kV, ± 4 kV, ± 6 kV and ± 8 kV

   - Horizontal Coupling Plane, Parallel to Chassis Bottom Faces (4 points)
   - Vertical Coupling Plane, Parallel to Chassis Front Faces (12 points)
   - Vertical Coupling Plane, Parallel to ETPs (4 points)

2. The TUT met the Test Acceptance Criteria given in Section 6.6 of this test report. Specifically, during ESD Testing:

   (a) Applying the ESD Test voltages to the specified TUT points did not damage any other module or device in the TUT, or cause disruption of the operation of the backplane signals or any other data acquisition signals.

   (b) Evaluation of normal operating data showed that the TUT operated as intended during and after exposure to the IEC Standard 61000-4-2 Level 4 ESD test levels specified in Appendix B, Section 3.5 of EPRI TR-102323-R1 (Reference 9.25) and Section 5 of IEC Standard 61000-4-2. Specifically, in accordance with Section 4.3.7 of EPRI TR-107330 (Reference 9.3):

i.) The main processors continued to function.
ii.) The transfer of I/O data was not interrupted.
iii.) The applied ESD disturbances did not cause the discrete I/O to change state.
iv.) Analog I/O levels did not vary more than 3% (of full scale).

3. The ESD Test results demonstrate that the Triconex TRICON v10 PLC will not experience operational failures or susceptibilities due to exposure to electrostatic discharges to the components listed above. The specific TRICON v10 PLC hardware which was tested (chassis, power supplies, modules, external termination assemblies and interconnecting cabling) is identified in Triconex Document No. 9600164-540 (Reference 9.7).

9.0 REFERENCES

Note: Triconex qualification project documentation and hardware is configuration controlled under the Triconex Quality Assurance Program. Triconex Document No. 9600164-540, "Master Configuration List," (Reference 9.7) provides a record of the currently applicable revision level of all Triconex documents, procedures and drawings throughout performance of the qualification program. As recorded in the completed MPR Procedure No. 9600164-512 (Reference 9.9), Triconex Document No. 9600164-540, Rev. 15 was in effect at the start of ESD Testing.

9.1 Triconex Document No. 9600164-500, "Master Test Plan," Rev. **5**

9.2 MPR Procedure No. 9600164-512, "Electrostatic Discharge (ESD) Test Procedure," Rev. 1

9.3 EPRI TR-107330, "Generic Requirements Specification for Qualifying a Commercially Available PLC for Safety-Related Applications in Nuclear Power Plants," Final Report dated December, 1996

9.4 IEC Standard 61000-4-2, "Electromagnetic Compatibility (EMC), Part 4-2: Testing and Measurement Techniques, Electrostatic Discharge Immunity Test," 2001

9.5 Triconex Document No. 9600164-002, "Nuclear Qualification Quality Plan," Rev. 3

9.6 Triconex Drawing No. 9600164-100, "TRICON v10 Nuclear Qualification Project TRICON Under Test - General Arrangement," Rev. 1

9.7 Triconex Document No. 9600164-540, "Master Configuration List," Rev. **21**

9.8 IEEE Standard 323-1974, "Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations"

9.9 Completed MPR Procedure No. 9600164-512, "Electrostatic Discharge (ESD) Test Procedure," Rev. 1, MPR Review and Approval Dated July 18, 2007

9.10 Triconex Drawing No. 9600164-103, "TRICON v10 Nuclear Qualification Project System Block Diagram," Rev. 2

9.11 Triconex Document No. 9600164-541, "TRICON v10 Nuclear Qualification Project, System Description," Rev. 0

9.12 Triconex Document No. 9600164-517, "Test Specimen Application Program (TSAP) Software Requirements Specification (SRS)," Rev. 3

9.13 National Technical Systems Test Procedure No. TP62987-07N-EMI, "Test Procedure for Electromagnetic Compatibility Qualification of the TRICON v10 Nuclear Qualification Project TRICON-Under-Test," Rev. 0

9.14 Triconex Drawing No. 9600164-201, Sheets 1 and 2, "TRICON v10 Nuclear Qualification Project - Power Distribution Wiring Diagram," Rev. 1

9.15 Triconex Drawing No. 9600164-202, Sheet 1, "TRICON v10 Nuclear Qualification Project - Test Chassis #1 Power Distribution Wiring Diagram," Rev. 0

9.16 Triconex Drawing No. 9600164-203, Sheets 1 and 2, "TRICON v10 Nuclear Qualification Project - Test Chassis #2 Power Distribution Wiring Diagram," Rev. 0

9.17 Triconex Drawing No. 9600164-204, Sheets 1 and 2, "TRICON v10 Nuclear Qualification Project - Test Chassis #3 Power Distribution Wiring Diagram," Rev. 0

9.18 Triconex Drawing No. 9600164-205, Sheets 1 and 2, "TRICON v10 Nuclear Qualification Project - Test Chassis #4 Power Distribution Wiring Diagram," Rev. 2

9.19 Triconex Drawing No. 9600164-206, Sheet 1, "TRICON v10 Nuclear Qualification Project - Simulator Chassis #5 Power Distribution Wiring Diagram," Rev. 0

9.20 Triconex Drawing No. 9600164-207, Sheet 1, "TRICON v10 Nuclear Qualification Project - Simulator Chassis #6 Power Distribution Wiring Diagram," Rev. 0

9.21 Completed MPR Procedure No. 9600164-510, "EMI/RFI Test Procedure," Rev. 0, MPR Review and Approval Dated July 16, 2007

9.22 National Technical Systems Test Report No. TR62987-07N-EMI, "Test Report for Electromagnetic Compatibility Qualification of the TRICON v10 Nuclear Qualification Project TRICON-Under-Test," Rev. **1**

9.23 Triconex Document No. 9600164-700, "TRICON v10 Nuclear Qualification Project Wiring Schedule," Rev. 3

9.24 Completed Pre-EMI/RFI Testing Run No.3.6 of Triconex Procedure No. 9600164-502, "System Setup and Checkout Procedure," Rev. 4

9.25 EPRI TR-102323-R1, "Guidelines for Electromagnetic Interference Testing in Power Plants"

9.26 Triconex E-Mail from S. Landas to M. Albers (MPR Associates) dated January 12, 2007, "Electrostatic Discharge Test Points"

9.27 Triconex Procedure No. 9600164-502, "System Setup and Checkout Procedure," Rev. 4

9.28 E-Mail from Mr. G. Hufton (Triconex) to Mr. M. Albers (MPR Associates) dated April 12, 2007, "Electrostatic Discharge Test Results"

10.0 ATTACHMENTS

Attachment 1: Example Plots of TUT Normal Operating Data

ATTACHMENT 1

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