Project:	TRICON v10 NUCLEAR QUALIFICATION PROJECT

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ELECTRICAL FAST TRANSIENT (EFT) TEST REPORT

Document No: 9600164-521

Revision 1

April 30, 2008

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Document Change History			
Revision	**Date**	**Change**	**Preparer**
0	07/17/07	Initial Issue	M. Albers
1	04/30/08	Revised Reference 9.23 in response to NUPIC audit corrective action (Reference CAR 2528-1). Updated References 9.1 and 9.8 accordingly.	F. Kloer

TABLE OF CONTENTS

1.0 EXECUTIVE SUMMARY

The TRICON v10 Nuclear Qualification Project Electrical Fast Transient (EFT) Test was performed on March 26 to 28, 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 EFT Test was executed to demonstrate the EFT withstand capability of the TRICON v10 Programmable Logic Controller (PLC).

MPR Procedure No. 9600164-514, "Electrical Fast Transient (EFT) Test Procedure," (Reference 9.2) was developed in accordance with the requirements of U.S. Nuclear Regulatory Commission (NRC) Regulatory Guide (RG) 1.180, Revision 1, "Guidelines for Evaluating Electromagnetic and Radio-Frequency Interference in Safety-Related Instrumentation and Control Systems," (Reference 9.3), EPRI TR-107330, "Generic Requirements Specification for Qualifying a Commercially Available PLC for Safety-Related Applications in Nuclear Power Plants," (Reference 9.4), International Electrotechnical Commission (IEC) Standard 61000-4-4, "Electromagnetic Compatibility (EMC), Part 4-4: Testing and Measurement Techniques, Electrical Fast Transient/Burst Immunity Test," (Reference 9.5), Triconex Document No. 9600164-500, "Master Test Plan," (Reference 9.1), and Triconex Document No. 9600164-002, "Nuclear Qualification Quality Plan," (Reference 9.6). The procedure included steps to direct: 1) proper setup of the TRICON-Under-Test (TUT) and test system prior to testing, 2) application of EFT 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 EFT Testing. The TSAP revision used was "V10_TSAP_REV_0". EFT 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 9.7), shows the basic configuration of the TUT components for EFT Testing. The

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The following EFT Tests were performed:

- 120 VAC Chassis Power Supplies: ± 0.5 kV, ± 1.0 kV, ± 1.5 kV and ± 2.0 kV
- 230 VAC Chassis Power Supplies: ± 0.5 kV, ± 1.0 kV, ± 1.5 kV and ± 2.0 kV
- 24 VDC Chassis Power Supplies: ± 0.5 kV, ± 1.0 kV, ± 1.5 kV and ± 2.0 kV
- Peripheral Communications Cables: ± 0.5 kV and ± 1.0 kV
- ETP Input Power Wires: ± 0.5 kV and ± 1.0 kV
- Analog Input/Output Wires: ± 0.5 kV and ± 1.0 kV
- RTD, /T/C and Pulse Input Wires: ± 0.5 kV and ± 1.0 kV
- Discrete Input/Output Wires: ± 0.5 kV and ± 1.0 kV

The TUT performance was monitored throughout each applied EFT Test. The EFT Test results demonstrate that the Triconex TRICON v10 PLC will not experience operational failures or susceptibilities due to exposure to repetitive electrical fast transients on the power and signal input/output leads. 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 9.8).

2.0 PURPOSE

The purpose of this test report is to summarize the results of Electrical Fast Transient (EFT) Testing of the TRICON v10 Nuclear Qualification Project TRICON-Under-Test (TUT) to meet the requirements of NRC Regulatory Guide 1.180, Rev. 1 (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 9.9).

Details regarding the performance and results of the EFT Testing are recorded in the completed MPR Procedure No. 9600164-514, "Electrical Fast Transient (EFT) Test Procedure," (Reference 9.10). Conclusions from the EFT Testing are provided in Section 8.0 of this test report.

3.0 TEST OBJECTIVE

NRC RG 1.180 (Reference 9.3) states that Electromagnetic Interference / Radiofrequency Interference (EMI/RFI) Testing (including EFT Testing) is required to demonstrate compliance with NRC regulations on testing to address the effects of EMI/RFI and power surges on safety-related instrumentation and control systems. Appendix 8 of Triconex Document No. 9600164-500 (Reference 9.1) states that EFT Testing is conducted to demonstrate the withstand capability of the TUT as required in NRC RG 1.180. MPR Procedure No. 9600164-514 (Reference 9.2) reiterates this test objective.

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 9.7), shows the basic configuration of the TUT components for EFT Testing. Triconex Drawing No. 9600164-103, "TRICON v10 Nuclear Qualification Project System Block Diagram," (Reference 9.11), shows the general arrangement and interconnection of the TUT chassis. Triconex Document No. 9600164-541, "TRICON v10 Nuclear Qualification Project, System Description," (Reference 9.12), 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 9.8).

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 9.13). The completed MPR Procedure No. 9600164-514 (Reference 9.10) identifies the TSAP revision used during this testing as "V10_TSAP_REV_0". Triconex Document No. 9600164-540 (Reference 9.8) identifies the revision level of all TUT firmware.

5.0 TEST SETUP AND INSTRUMENTATION

The following sections describe the setup of the TUT during EFT Testing, the instrumentation used to generate and measure the applied EFT 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. 9600164-514 (Reference 9.10). 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 9.14).

5.1 TRICON-Under-Test Mounting

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The mounting and grounding configuration described above meets the requirements of Section 7.2 of IEC Standard 61000-4-4 (Reference 9.5), 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 EFT Testing are documented in Triconex Document No. 9600164-540 (Reference 9.8).

5.3 TRICON-Under-Test Power Supply and Wiring Configuration

NRC RG 1.180 (Reference 9.3) does not include specific requirements for configuration of equipment power supplies or wiring during EFT Testing. Section 8.2 of IEC Standard 61000-4-4 (Reference 9.5) specifies that the equipment-under-test shall be in the normal operating conditions.

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5.4 NTS Instrumentation

NTS provided the test instrumentation for generating, applying, and monitoring the EFT Test signals. NTS also provided instrumentation for measuring temperature and relative humidity inside the anechoic test chamber during EFT Testing. These instruments are identified in NTS Test Report No. TR62987-07N-EMI (Reference 9.23).

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. 9600164-514 (Reference 9.10),
- The completed MPR Procedure No. 9600164-510 (Reference 9.22), and,

- The completed Pre-EMI/RFI Testing Run No. 3.6 of Triconex Procedure No. 9600164-502, "System Setup and Checkout Procedure," (Reference 9.25).

The completed MPR Procedure No. 9600164-510 (Reference 9.22) includes Test Exception and Resolution Report Nos. 13, 14 and 15 which describe modifications made to several of the signal simulation devices during EMI/RFI Testing. These modifications were maintained during EFT Testing.

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 9.23) documents the calibration status of the test instrumentation used by NTS. The completed MPR Procedure No. 9600164-514 (Reference 9.10) documents the calibration status of the test instrumentation used by MPR. The completed Triconex Procedure No. 9600164-502 (Reference 9.25) documents the calibration status of the test instrumentation used by Triconex.

6.0 TEST PROCEDURES

EFT Testing of the TUT was performed to the requirements of NRC RG 1.180 (Reference 9.3). Section 5.3 of NRC RG 1.180 specifies testing to either IEEE C62.41-1991, "Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits," (Reference 9.26) or IEC Standard 61000-4-4 (Reference 9.5). EFT susceptibility testing of the TUT power supplies was done to the IEC Standard 61000-4-4 test method. Section 4.2 of NRC RG 1.180 includes the requirements for EFT Testing of the signal leads of safety related instrumentation and control (I&C) systems. Section 4.2 specifies testing to either Department of Defense Interface Standard MIL-STD-461E, "Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment," (Reference 9.27) or IEC Standard 61000-4-4. EFT susceptibility testing of the TUT signal leads was done to the IEC Standard 61000-4-4 test method.

The following sections describe the approach to satisfying the requirements of NRC RG 1.180 (Reference 9.3) and IEC Standard 61000-4-4 (Reference 9.5) for EFT Testing of the TUT. The test procedure used by NTS to perform EFT Testing of the TUT is NTS Test Procedure No. TP62987-07N-EMI (Reference 9.14). The test procedure used by MPR to perform EFT Testing of the TUT is MPR Procedure No. 9600164-514 (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, EFT Testing was performed after Radiation Exposure, Environmental, Seismic and

EMI/RFI Testing, and prior to all other qualification testing (i.e., Surge Withstand, Electrostatic Discharge and Class 1E to Non-1E Isolation Testing).

6.2 Test Method

Section 5.3 of NRC RG 1.180 (Reference 9.3) includes the requirements for EFT Testing of the AC and DC power supplies of safety related instrumentation and control (I&C) systems. Section 5.3 specifies testing to either IEEE C62.41-1991 (Reference 9.26) or IEC Standard 61000-4-4 (Reference 9.5). EFT susceptibility testing of the TUT power supplies was done to the IEC Standard 61000-4-4 test method.

Section 4.2 of NRC RG 1.180 (Reference 9.3) includes the requirements for EFT Testing of the signal leads of safety related instrumentation and control (I&C) systems. Section 4.2 specifies testing to either Department of Defense MIL-STD-461E (Reference 9.27) or IEC Standard 61000-4-4 (Reference 9.5). EFT susceptibility testing of the TUT signal leads was done to the IEC Standard 61000-4-4 test method.

6.3 Test Levels

Table 22 of NRC RG 1.180 (Reference 9.3) defines the IEC Standard 61000-4-4 EFT withstand levels for the AC and DC power supplies of safety related instrumentation installed in various plant locations. Based on the discussion in Section 5.3 of NRC RG 1.180, the AC and DC power supplies of a TRICON v10 PLC system are expected to be installed in *Category B* locations with EFT *Low Exposure* levels. The corresponding EFT withstand level is 2 kV.

Table 15 of NRC RG 1.180 (Reference 9.3) defines the IEC Standard 61000-4-4 EFT withstand levels for the signal leads of safety related instrumentation installed in various plant locations. Based on the discussion in Section 4.2 of NRC RG 1.180, the signal circuits of a TRICON v10 PLC system are expected to be installed in *Category B* locations with EFT *Low Exposure* levels. The corresponding EFT Withstand level is 1 kV.

The applied EFT test levels were stepped up from 0.5 kV to the maximum specified test voltage in 0.5 kV increments.

6.4 TRICON-Under-Test Operation

Section 8.2 of IEC Standard 61000-4-4 (Reference 9.5) specifies that the equipment-under-test shall be in the normal operating conditions. During EFT 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 EFT Test acceptance criteria. Appendix 8 states that monitoring of normal TUT operation during EFT Testing will demonstrate satisfaction of the acceptance criteria. To clarify the definition of normal operation, the following acceptance criteria from Section 4.3.7 of EPRI TR-107330 (Reference 9.4) were applied during EFT Testing:

i.) The main processors shall continue to function.
ii.) The transfer of I/O data shall not be interrupted.
iii.) The applied EFT 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 EFT Testing, NTS Laboratories was responsible for generating and exposing the test system to the required levels of EFT disturbances given in Sections 4.2 and 5.3 of NRC RG 1.180 (Reference 9.3). During EFT 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 EFT disturbances.

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6.6 Test Acceptance Criteria

The following EFT Test acceptance criteria are as given in Appendix 8 of Triconex Document No. 9600164-500 (Reference 9.1), and Section 4.3.7 of EPRI TR-107330 (Reference 9.4).

(a) Applying the EFT 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 61000-4-4 EFT test levels specified in Sections 4.2 and 5.3 of NRC RG 1.180 (Reference 9.3) for low exposure applications. Specifically:

IEC 61000-4-4: Power Leads, Level 3 Test Voltage Level: 2 kV max.
IEC 61000-4-4: Signal Leads, Level 3 Test Voltage Level: 1 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 9.4):

i.) The main processors shall continue to function.
ii.) The transfer of I/O data shall not be interrupted.
iii.) The applied EFT 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).

7.0 TEST RESULTS

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

7.1 Electrical Fast Transient Test Setup and Checkout Testing

Triconex Procedure No. 9600164-502, "System Setup and Checkout Procedure," (Reference 9.28) 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. EFT Testing of the TUT was performed following EMI/RFI Testing. The configuration of the test system for EFT Testing remained the same as that for EMI/RFI Testing, as documented in the completed Pre-EMI/RFI Testing Run No. 3.6 of Triconex Procedure No. 9600164-502 (Reference 9.25). Therefore, the System Setup and Checkout Procedure was not required to be performed prior to start of EFT Testing.

7.2 Electrical Fast Transient Testing

EFT Testing of the TUT was performed in accordance with MPR Procedure No. 9600164-514 (Reference 9.2), and NTS Test Procedure No. TP62987-07N-EMI (Reference 9.14). All testing was performed with the TUT energized and operating under control of the executing TSAP software. The following EFT tests were performed to the test method defined in IEC Standard 61000-4-4 (Reference 9.5):

120 VAC and 230 VAC Chassis Power Supplies

- Test Levels: ± 0.5 kV, ± 1.0 kV, ± 1.5 kV and ± 2.0 kV
- Test Signal: Applied through a coupling/decoupling device
- Test Sequence: Line to Neutral, Line to AC Ground, Neutral to AC Ground

24 VDC Chassis Power Supplies

- Test Levels: ± 0.5 kV, ± 1.0 kV, ± 1.5 kV and ± 2.0 kV
- Test Signal: Applied through a coupling/decoupling device
- Test Sequence: Positive to Negative, Positive to AC Ground, Negative to AC Ground

Peripheral Communications Cable Group

- Test Levels: ± 0.5 kV and ± 1.0 kV
- Test Signal: Applied through a capacitive coupling device

External Termination Panel Power Wire Group

- Test Levels: ± 0.5 kV and ± 1.0 kV
- Test Signal: Applied through a capacitive coupling device

Analog Input/Output Wire Group

- Test Levels: ± 0.5 kV and ± 1.0 kV
- Test Signal: Applied through a capacitive coupling device

RTD/Thermocouple/Pulse Input Wire Group

- Test Levels: ± 0.5 kV and ± 1.0 kV
- Test Signal: Applied through a capacitive coupling device

Discrete Input/Output Wire Group

- Test Levels: ± 0.5 kV and ± 1.0 kV
- Test Signal: Applied through a capacitive coupling device

7.3 TRICON-Under-Test Performance Monitoring

During EFT Testing, the TUT was operating in accordance with execution of the Test Specimen Application Program (TSAP). The TUT operation was monitored by the DAS and the Trilogger/TriStation Console interface during and after each application of the EFT test signals.

a.

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 EFT test voltages. Specifically:

a) Application of the EFT test voltages to the chassis power supply modules did not result in damage to any other 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 EFT test voltages to the chassis power supply modules did not result in disruption of the operation of the TUT, including the ability to correctly acquire input signals and generate output signals.

c) Application of the EFT test voltages to the peripheral communications cable group did not result in damage to any other modules installed in the TUT, including the main processor modules, the RXM modules, the input/output modules and other communication modules.

d) Application of the EFT test voltages to the peripheral communications cable group did not result in disruption of the operation of the TUT, including the ability to correctly receive input signals from other communication module ports, and to transmit output signals to other communication module ports.

e) Application of the EFT test voltages to the ETP power wire group did not result in damage to any other modules installed in the TUT, including the main processor modules, the RXM modules, other input/output modules and the communication modules.

f) Application of the EFT test voltages to the ETP power wire group did not result in disruption of the operation of the TUT, including the ability to correctly acquire the input signals associated with any other input module points, and to generate the output signals associated with any other output module points.

g) Application of the EFT test voltages to the input/output module wire groups did not result in damage to any other modules installed in the TUT, including the main processor modules, the RXM modules, other input/output modules and the communication modules.

h) Application of the EFT test voltages to the input/output module wire groups did not result in disruption of the operation of the TUT, including the ability to correctly acquire the input signals associated with any other input module points, and to generate the output signals associated with any other output module points.

i) Evaluation of TUT normal operating performance data (inputs, outputs and diagnostic indicators) during and after each EFT test demonstrated operation as intended, including the following specific operational performance from Section 4.3.7 of EPRI TR-107330 (Reference 9.4):

i.) The main processors continued to function.
ii.) The transfer of I/O data was not interrupted.
iii.) The applied EFT 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).

7.4 Procedure Deviations

There were no significant procedural deviations taken during EFT Testing.

7.5 Test Anomalies

There were no TUT material condition, operational or performance anomalies observed during EFT Testing.

8.0 CONCLUSIONS

1. EFT Testing of the TUT was performed in accordance with the applicable requirements of NRC RG 1.180 (Reference 9.3) and IEC Standard 61000-4-4 (Reference 9.5). The following EFT tests were performed:

- 120 VAC Chassis Power Supplies: ± 0.5 kV, ± 1.0 kV, ± 1.5 kV and ± 2.0 kV
- 230 VAC Chassis Power Supplies: ± 0.5 kV, ± 1.0 kV, ± 1.5 kV and ± 2.0 kV
- 24 VDC Chassis Power Supplies: ± 0.5 kV, ± 1.0 kV, ± 1.5 kV and ± 2.0 kV
- Peripheral Communications Cables: ± 0.5 kV and ± 1.0 kV
- ETP Input Power Wires: ± 0.5 kV and ± 1.0 kV
- Analog Input/Output Wires: ± 0.5 kV and ± 1.0 kV
- RTD, /T/C and Pulse Input Wires: ± 0.5 kV and ± 1.0 kV
- Discrete Input/Output Wires: ± 0.5 kV and ± 1.0 kV

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

(a) Applying the EFT Test voltages to the specified TUT interfaces 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 EFT test levels specified in Sections 4.2 and 5.3 of NRC RG 1.180 (Reference 9.3). Specifically, in accordance with Section 4.3.7 of EPRI TR-107330 (Reference 9.4):

i.) The main processors continued to function.
ii.) The transfer of I/O data was not interrupted.
iii.) The applied EFT 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 EFT Test results demonstrate that the Triconex TRICON v10 PLC will not experience operational failures or susceptibilities due to exposure to repetitive electrical fast transients on the power and signal input/output leads. 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 9.8).

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 9.8) 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. 9600164-514 (Reference 9.10), Triconex Document No. 9600164-540, Rev. 13 was in effect at the start of EFT Testing.

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

9.2 MPR Procedure No. 9600164-514, "Electrical Fast Transient (EFT) Test Procedure," Rev. 0

9.3 U.S. Nuclear Regulatory Commission Regulatory Guide 1.180, Revision 1, "Guidelines for Evaluating Electromagnetic and Radio-Frequency Interference in Safety-Related Instrumentation and Control Systems," October 2003

9.4 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

9.5 IEC Standard 61000-4-4, "Electromagnetic Compatibility (EMC), Part 4-4: Testing and Measurement Techniques, Electrical Fast Transient/Burst Immunity Test," 2004

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

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

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

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

9.10 Completed MPR Procedure No. 9600164-514, "Electrical Fast Transient (EFT) Test Procedure," Rev. 0, MPR Review and Approval Dated July 16, 2007

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

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

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

9.14 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

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

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

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

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

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

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

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

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

9.23 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**

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

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

9.26 IEEE Standard C62.41-1991, "IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits," 1991, Reaffirmed 1995

9.27 Department of Defense Interface Standard MIL-STD-461E, "Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment," August 20, 1999

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

10.0 ATTACHMENTS

Attachment 1: Example Plots of TUT Normal Operating Data

Document:	9600164-521	Title:	EFT TEST REPORT: ATTACHMENT 1		
Revision:	0	Page:	1 of 14	Date:	07/17/07

ATTACHMENT 1

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Document:	9600164-521	Title:	EFT TEST REPORT: ATTACHMENT 1		
Revision:	0	Page:	3 of 14	Date:	07/17/07

a

a

Document:	9600164-521	Title:	EFT TEST REPORT: ATTACHMENT 1		
Revision:	0	Page:	5 of 14	Date:	07/17/07

a

Document:	9600164-521	Title:	EFT TEST REPORT: ATTACHMENT 1		
Revision:	0	Page:	6 of 14	Date:	07/17/07

a

Document:	9600164-521	Title:	EFT TEST REPORT: ATTACHMENT 1		
Revision:	0	Page:	7 of 14	Date:	07/17/07

a

Document:	9600164-521	Title:	EFT TEST REPORT: ATTACHMENT 1		
Revision:	0	Page:	8 of 14	Date:	07/17/07

a

Document:	9600164-521	Title:	EFT TEST REPORT: ATTACHMENT 1		
Revision:	0	Page:	9 of 14	Date:	07/17/07

a

Document:	9600164-521	Title:	EFT TEST REPORT: ATTACHMENT 1		
Revision:	0	Page:	10 of 14	Date:	07/17/07

a

Document:	9600164-521	Title:	EFT TEST REPORT: ATTACHMENT 1		
Revision:	0	Page:	11 of 14	Date:	07/17/07

a

Document:	9600164-521	Title:	EFT TEST REPORT: ATTACHMENT 1		
Revision:	0	Page:	12 of 14	Date:	07/17/07

a

Document:	9600164-521	Title:	EFT TEST REPORT: ATTACHMENT 1		
Revision:	0	Page:	13 of 14	Date:	07/17/07

a

Document:	9600164-521	Title:	EFT TEST REPORT: ATTACHMENT 1		
Revision:	0	Page:	14 of 14	Date:	07/17/07

a