

**Project:** TRICON v10 NUCLEAR QUALIFICATION PROJECT

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## SEISMIC TEST REPORT

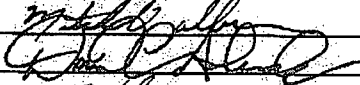


**Document No: 9600164-526**

**Revision 0**

**July 17, 2007**

### MPR ASSOCIATES QUALITY ASSURANCE DOCUMENT

This document has been prepared, reviewed and approved in accordance with the Quality Assurance requirements of 10CFR50, Appendix B, as specified in the MPR Quality Assurance Manual and in accordance with the requirements of Invensys Triconex Purchase Order No. 113803, dated March 23, 2006.

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**Attachment 1:** Example Plots of the TUT Normal Operating Data

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## 1.0 EXECUTIVE SUMMARY

The TRICON v10 Nuclear Qualification Project Seismic Test was performed on January 16 to February 16, 2007 by National Technical Systems (NTS) Laboratories using a Triaxial Seismic Simulator Table at their facility in Acton, Massachusetts. As required by Triconex Document No. 9600164-500, “Master Test Plan,” (Reference 9.1), the Seismic Test was performed to demonstrate the suitability of the TRICON v10 Programmable Logic Controller (PLC) for qualification as a (seismic) Category 1 Safety System.

MPR Procedure No. 9600164-507, “Seismic Test Procedure,” (Reference 9.2), was developed in accordance with the requirements of EPRI Report TR-107330, “Generic Requirements Specification for Qualifying a Commercially Available PLC for Safety-Related Applications in Nuclear Power Plants,” (Reference 9.3), Triconex Document No. 9600164-500, “Master Test Plan,” (Reference 9.1), and Triconex Document No. 9600164-002, “Nuclear Qualification Quality Plan,” (Reference 9.4). The procedure included steps to direct: 1) proper setup of the TRICON-Under-Test (TUT) prior to testing, 2) application of the required seismic motion test levels to the TUT components, 3) acquisition of TUT operational parameters during and after testing, and 4) evaluation of acceptable TUT performance during and after testing. The TUT executed a verified and validated Test Specimen Application Program (TSAP) throughout Seismic Testing. The TSAP revision used was “V10\_TSAP\_REV\_0”. Seismic 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 9.5), shows the basic configuration of the TUT components for Seismic Testing.

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The TUT components were exposed to a total of five tests to simulate Operating Basis Earthquakes (OBEs), followed by one test simulating a Safe Shutdown Earthquake (SSE). Each test was approximately 30 seconds in duration. TUT performance was monitored before, during and after each seismic test.

Figure 4-5 of EPRI TR-107330 (Reference 9.3) shows the recommended OBE and SSE Required Response Spectrums for Seismic Testing. Figure 8-1 of this test report shows the OBE and SSE Test Response Spectrums which were achieved during Seismic Testing of the TUT. The seismic table achieved the EPRI TR-107330 OBE and SSE Required Response Spectrum test levels throughout most of the required frequency range. In the low frequency region (below 6 Hz), limitations of the table velocity and displacement prevented achieving the full EPRI TR-107330 Required Response Spectrums.

The Seismic Test results demonstrate that the TRICON v10 PLC platform is suitable for qualification as a (seismic) Category 1 Safety System. 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 9.6).

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## 2.0 PURPOSE

The purpose of this test report is to summarize the results of Seismic Testing of the TRICON v10 Nuclear Qualification Project TRICON-Under-Test (TUT) to meet the requirements of EPRI TR-107330 (Reference 9.3). The format of this report conforms to Section 8.3.(4) of IEEE Specification 323-1974, “Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations,” (Reference 9.7).

Details regarding the performance and results of the Seismic Testing are recorded in the completed MPR Procedure No. 9600164-507, “Seismic Test Procedure,” (Reference 9.8). This completed procedure identifies additional Triconex procedures that were performed in support of Seismic Testing and provide additional testing details and results. Conclusions from the Seismic Testing are provided in Section 8.0 of this test report.

## 3.0 TEST OBJECTIVE

Section 4.3.9 of EPRI TR-107330 (Reference 9.3) states that the PLC platform shall be suitable for qualification as a Category 1 Seismic device. Section 6.3.4 of EPRI TR-107330 states that the PLC System shall meet its performance requirements for the TR-107330 specified seismic loading. MPR Procedure No. 9600164-507 (Reference 9.2) states that Seismic Testing shall demonstrate the suitability of the TRICON v10 PLC for qualification as a Category 1 Seismic device. Appendix 6 of Triconex Document No. 9600164-500 (Reference 9.1) reiterates these test objectives.

## 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. 9600164-103, “TRICON v10 Nuclear Qualification Project System Block Diagram,” (Reference 9.9), shows the general arrangement and interconnection of the TUT chassis. Triconex Document No. 9600164-541, “TRICON v10 Nuclear Qualification Project, System Description,” (Reference 9.10), 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 9.6).

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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 9.11). The completed MPR Procedure No. 9600164-507 (Reference 9.8) identifies the TSAP revision used during this testing as “V10\_TSAP\_REV\_0”. Triconex Document No. 9600164-540 (Reference 9.6) identifies the revision level of all TUT firmware.

## 5.0 TEST SETUP AND INSTRUMENTATION

The following sections describe the setup of the TUT during Seismic Testing, the instrumentation used to measure the applied seismic motion 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. 9600164-507 (Reference 9.8). Specifications for test instrumentation supplied by NTS Laboratories are included in NTS Test Procedure No. TP62987-07N-SEI, “Test Procedure for Seismic Testing of the TRICON v10 Nuclear Qualification Project TRICON-Under-Test,” (Reference 9.12).

### 5.1 TRICON-Under-Test Mounting

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## 5.2 TRICON-Under-Test Chassis and Module Configuration

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The TUT chassis configurations for Seismic Testing are documented in Triconex Document No. 9600164-540 (Reference 9.6).

## 5.3 TRICON-Under-Test Power Supply Configuration

Section 6.3.4.2 of EPRI TR-107330 (Reference 9.3) requires that Seismic Testing be performed with the power sources to the test PLC power supply modules set to operate at the following minimum AC and DC source voltages and frequencies given in Section 4.6.1.1 of the EPRI TR:

- (a) Power supply modules fed from AC sources shall remain operable at a minimum source voltage of 90 VAC and a minimum source frequency of 57 Hz.
- (b) Power supply modules fed from DC sources shall remain operable at a minimum source voltage of 20.4 VDC.

The TUT configuration for Seismic Testing met these requirements (within the manufacturer's allowable operating ranges for the chassis power supplies). The TUT includes two redundant



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power supply modules in each chassis. During Seismic Testing, both power supply modules in each chassis were energized. Chassis 1 and 2 each included a 120 VAC chassis power supply module and a 24 VDC chassis power supply module. Chassis 3 and 4 each included a 120 VAC chassis power supply module and a 230 VAC chassis power supply module. During seismic testing, the AC and DC power sources to the TUT chassis power supplies were set as follows:

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#### 5.4 NTS Instrumentation

Instrumentation supplied by NTS Laboratories for Seismic Testing included control and response accelerometers with associated signal conditioning and data recording hardware, and hand tools (torque wrenches) for verifying fastener torques.

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## 5.5 Triconex and MPR Instrumentation

During Seismic Testing, operation of the TUT was monitored and recorded

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## 5.6 Instrument Calibration

All tests were performed using calibrated test instruments. Calibration certifications are held by NTS Laboratories, MPR and Triconex. National Technical Systems Test Report No. TR62987-07N-SEI” (Reference 9.14) documents the calibration status of the test instrumentation used by NTS. The completed MPR Procedure No. 9600164-507 (Reference 9.8) documents the calibration status of the test instrumentation used by MPR. The completed Triconex Setup and Checkout and Operability Procedures (References 9.15 through 9.17) document the calibration status of the test instrumentation used by Triconex.

## 6.0 TEST PROCEDURES

Seismic Testing of the TUT was performed to the specific requirements of EPRI TR-107330 (Reference 9.3), which invokes IEEE Standard 344-1987, “Recommended Practices for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations,” (Reference 9.18), and following the guidelines provided in IEEE 381-1977, “Standard Criteria for Type Tests of Class 1E Modules Used in Nuclear Power Generating Stations,” (Reference 9.19). The following sections describe the approach to satisfying the requirements of the referenced documents during Seismic Testing of the TUT.

The test procedure used by NTS Laboratories to perform Seismic Testing is NTS Procedure No. TP62987-07N-SEI (Reference 9.12). The test procedure used by MPR to perform Seismic Testing is MPR Procedure No. 9600164-507,” (Reference 9.2). The test procedure used by Triconex to perform Operability Testing following Seismic Testing is Triconex Procedure No. 9600164-503, “Operability Test Procedure,” (Reference 9.20).

### 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, Seismic Testing was performed after Radiation Exposure and Environmental Testing, and prior to all other qualification testing (i.e., EMI/RFI, Electrical Fast Transient, Surge Withstand, Electrostatic Discharge and Class 1E to Non-1E Isolation Testing). This test sequence is in accordance with Section 6.3.1 of EPRI TR-107330 (Reference 9.3).

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## 6.2 Test Method

Seismic testing was performed to the requirements of IEEE 344-1987 (Reference 9.18) and included the following tests:

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## 6.3 Test Levels

Section 4.3.9 of EPRI TR-107330 (Reference 9.3) requires that the test PLC meet its performance requirements during and following the application of 5 OBE's and one SSE to the levels shown in Figure 4-5 of the TR. The maximum SSE and OBE levels shown in Figure 4-5 are 14 g's and 9.8 g's respectively, based on 5% damping.

Seismic Testing of the TUT was performed using the NTS Triaxial Seismic Simulator Table.

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The resulting OBE and SSE Test Response Spectrums are given in Section 7.0 of this test report, and will be documented in the Final Summary Report Application Guide prepared as part of the qualification effort.

#### 6.4 TRICON-Under-Test Operation

Section 6.3.4.2 of EPRI TR-107330 (Reference 9.3) requires that the test PLC be powered with its TSAP operating during Seismic Testing, 1/2 of its solid-state discrete outputs shall be ON and loaded to their rated current, 1/2 of its relay outputs shall be ON, and 1/2 of its relay outputs shall be OFF. In addition, 1/4 of its relay outputs shall transition from OFF to ON and 1/4 shall transition from ON to OFF during the OBE and SSE tests.

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## 6.5 TRICON-Under-Test Performance Monitoring

Section 4.3.9 of EPRI TR-107330 (Reference 9.3) requires that the test PLC operate as intended during and following the application of an SSE, that all connections and parts remain intact and in-place, and that relay output contacts not chatter.

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During Seismic Testing, operation of the TUT was monitored and recorded

Attachment 1 of this test report includes a set of figures which show the normal operation of the data points which were monitored during Seismic Testing (during and after each OBE and SSE). The data was monitored for deviations or trends from the normal operation shown in the figures.

Following each simulated OBE and SSE test, the TUT components mounted on the seismic test table were inspected for damage or degradation. The status of all TUT diagnostic indicating LED's was also reviewed and recorded to demonstrate continued correct operation or to detect system faults.

The TUT monitoring and visual inspections described above met the requirements of Section 4.3.9 of EPRI TR-107330 (Reference 9.3).

## 6.6 Test Acceptance Criteria

The Seismic Test acceptance criteria are as given below. These criteria were developed based on Section 4.3.9 of EPRI TR-107330 (Reference 9.3), and Appendix 6 of Triconex Document No. 9600164-500 (Reference 9.1).

- (a) The TUT shall operate as intended during and after application of the Operating Basis Earthquake (OBE) and Safe Shutdown Earthquake (SSE) vibrations. Evaluation of normal operating data (inputs, outputs and diagnostic indicators) shall demonstrate operation as intended.

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- (b) During and after application of the OBE and SSE vibrations, all connections on the TUT shall remain intact, all modules installed in the TUT shall remain fully inserted, and no functional or non-functional parts of the TUT shall fall off.
- (c) The operation of the chassis power supply normally open alarm relay contacts and the Model 3636T electromechanical relay module output contacts shall be monitored during application of the OBE and SSE vibrations. The relay module output contacts shall be demonstrated to change state from energized to de-energized and de-energized to energized in accordance with execution of the application program running in the TUT during testing. Any spurious change of state of the relay module output contacts shall not exceed 2 milliseconds in duration for both energized and de-energized contact states. Any spurious change of state of the power supply alarm relay contacts from open to closed shall not exceed 2 milliseconds in duration.
- (d) The TUT shall meet all acceptance criteria of the Operability Test, as implemented by Triconex Procedure No. 9600164-503 (Reference 9.20), following completion of the Seismic Testing.

## 7.0 TEST RESULTS

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

### 7.1 Seismic Test Setup and Checkout Testing

Triconex Procedure No. 9600164-502, “System Setup and Checkout Procedure,” (Reference 9.21), 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. Seismic Testing of the TUT was performed following Environmental Testing and on completion of the TUT Chassis 1 and 2 Pre-Seismic Testing Run No. 3.4 of the System Setup and Checkout Procedure. The TUT Chassis 3 and 4 Pre-Seismic Testing Run No. 3.5 of the System Setup and Checkout Procedure was performed on completion of Seismic Testing of TUT Chassis 1 and 2 and prior to Seismic Testing of TUT Chassis 3 and 4. Results of the Pre-Seismic Testing Run Nos. 3.4 and 3.5 of the System Setup and Checkout Procedure are included in the completed Triconex procedures (References 9.15 and 9.16) and show that the system was operating correctly prior to start of Seismic Testing.

### 7.2 Seismic Testing Sequence

Seismic Testing of the TUT was performed in accordance with MPR Procedure No. 9600164-507 (Reference 9.2), NTS Test Procedure TP62987-07N-SEI (Reference 9.12) and

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Triconex Procedure No. 9600164-503 (Reference 9.20).

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### 7.3 Resonance Search Testing

Resonance search testing was performed as described in Section 7.1.4 of IEEE 344-1987 (Reference 9.18). The tests were performed to provide additional information on the dynamic response of the equipment mounted on the seismic test table.

Response accelerometer output data provided in NTS Test Report No. TR62987-07N-SEI (Reference 9.14) shows the following results from the resonance search testing:

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These test results are used in the evaluation of the OBE and SSE test results as described in the next section.

## 7.4 OBE and SSE Seismic Testing

**7.4.1 Test Response Spectrum Description.** Section 4.3.9 of EPRI TR-107330 (Reference 9.3) requires the SSE test to be preceded by five OBE tests. Each OBE required response spectrum (RRS) has a peak acceleration of 9.8 g's at 5% damping. The SSE RRS has a peak acceleration of 14 g's at 5% damping. The EPRI TR-107330 OBE and SSE RRS's are shown in Figures 7-1 and 7-2 of this test report.

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## 7.5 TRICON-Under-Test Performance Monitoring

During Seismic Testing, the TUT was operating in accordance with execution of the Test Specimen Application Program (TSAP). The TUT performance was monitored continually at the start of, during and for a short period following each OBE and SSE test.

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Completed data sheets included in the completed MPR Procedure No. 9600164-507 (Reference 9.8) document the results of analysis of the operational data monitored during Seismic Testing. 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 Seismic Test conditions. No mechanical contact chatter was detected on the 32 output points of the Model 3636T Relay Output module. Although one mechanical chassis alarm relay contact was monitored during Seismic Testing, the contact was interfaced to the DAS through an interposing relay which could have masked contact chatter. Therefore, the TUT chassis alarm relays were not seismically qualified as part of Seismic Testing.

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## 7.6 TRICON-Under-Test Condition Monitoring

The TUT was visually inspected for damage or degradation following each OBE and SSE test. Results of these inspections are documented in the completed MPR Procedure No. 9600164-507 (Reference 9.8) and are summarized below.

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## 7.7 Seismic Operability and Prudency Testing

Table 5-1 of EPRI TR-107330 (Reference 9.3) requires that Operability and Prudency Testing be performed during Safe Shutdown Earthquake (SSE) Testing, or equivalent alternative methods for evaluation be used.

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Table 5-1 and Section 6.3.4.3 of EPRI TR-107330 (Reference 9.3) require post-seismic Operability Testing to assess the impact of exposure to the OBE and SSE vibrations on the operability of the test specimen. The completed Post-Seismic Test Run No. 3.6 of Triconex

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Procedure No. 9600164-503 (Reference 9.17) documents performance of the post-seismic Operability Test, and provides analysis of the test data and test results. As reported by Triconex, the test results show that exposure to the OBE and SSE vibrations had no adverse effects on the TUT performance.

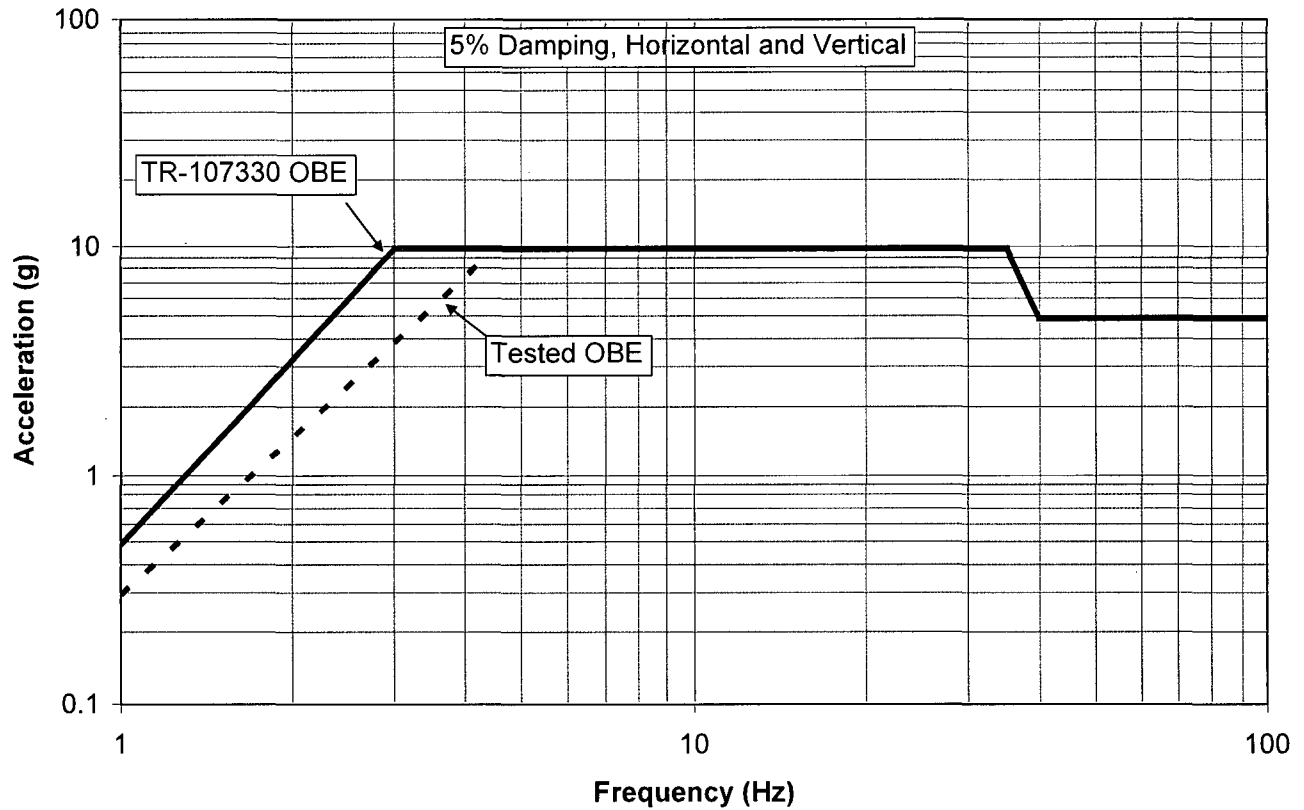
## 7.8 Procedure Deviations

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## 7.9 Test Anomalies

There were no TUT operational or performance anomalies observed during Seismic Testing. Section 7.6 of this test report provides a detailed discussion of the material condition anomalies that were observed during Seismic Testing.

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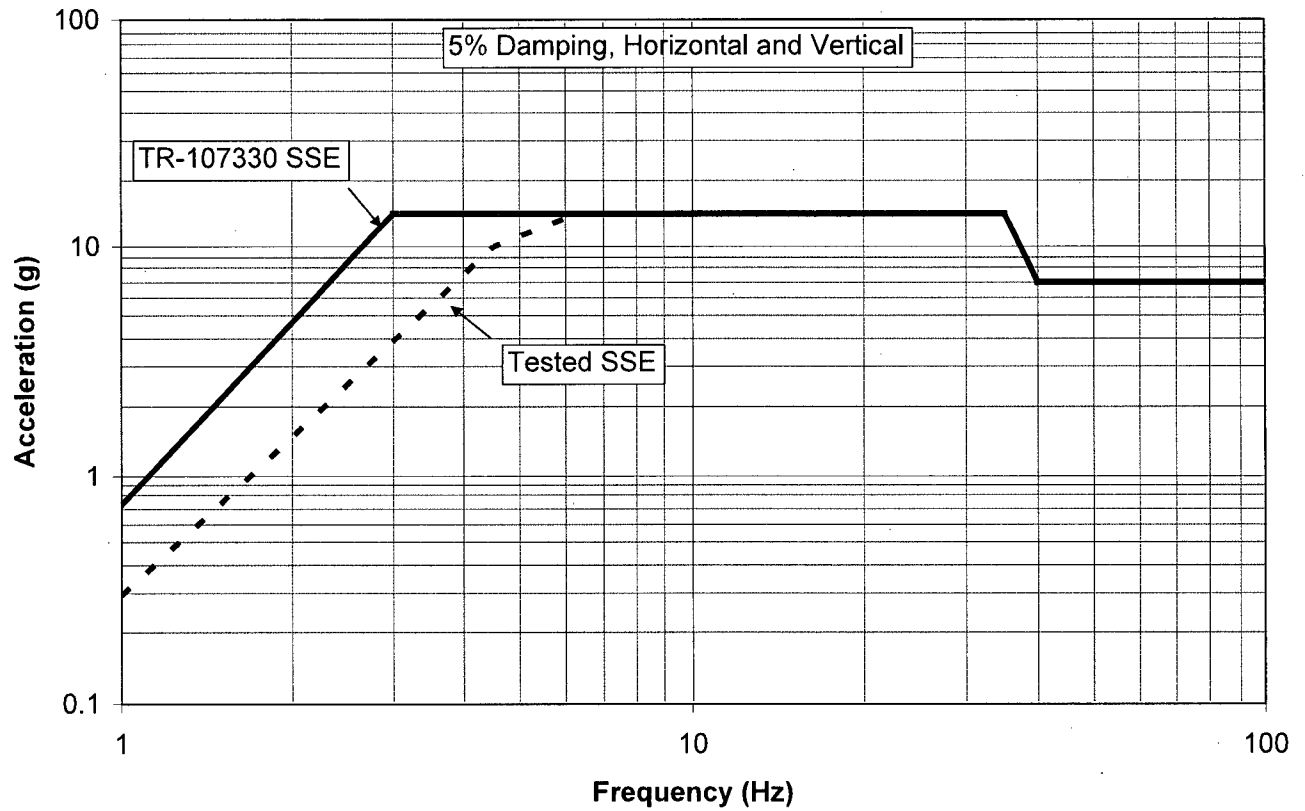


Frequency	Tested Level	TR-107330 Level
1.0 Hz	0.3 g	0.5 g
3.0 Hz	4.0 g	9.8 g
4.5 Hz	9.8 g	9.8 g
35 Hz	9.8 g	9.8 g
40 Hz	4.9 g	4.9 g
100 Hz	4.9 g	4.9 g

**Figure 7-1:** Comparison of OBE Test Levels to EPRI TR-107330 OBE Requirements



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Frequency	Tested Level	TR-107330 Level
1.0 Hz	0.3 g	0.75 g
3.0 Hz	4.0 g	14 g
4.5 Hz	10 g	14 g
6.3 Hz	14 g	14 g
35 Hz	14 g	14 g
40 Hz	7.0 g	7.0 g
100 Hz	7.0 g	7.0 g

**Figure 7-2:** Comparison of SSE Test Levels to EPRI TR-107330 SSE Requirements

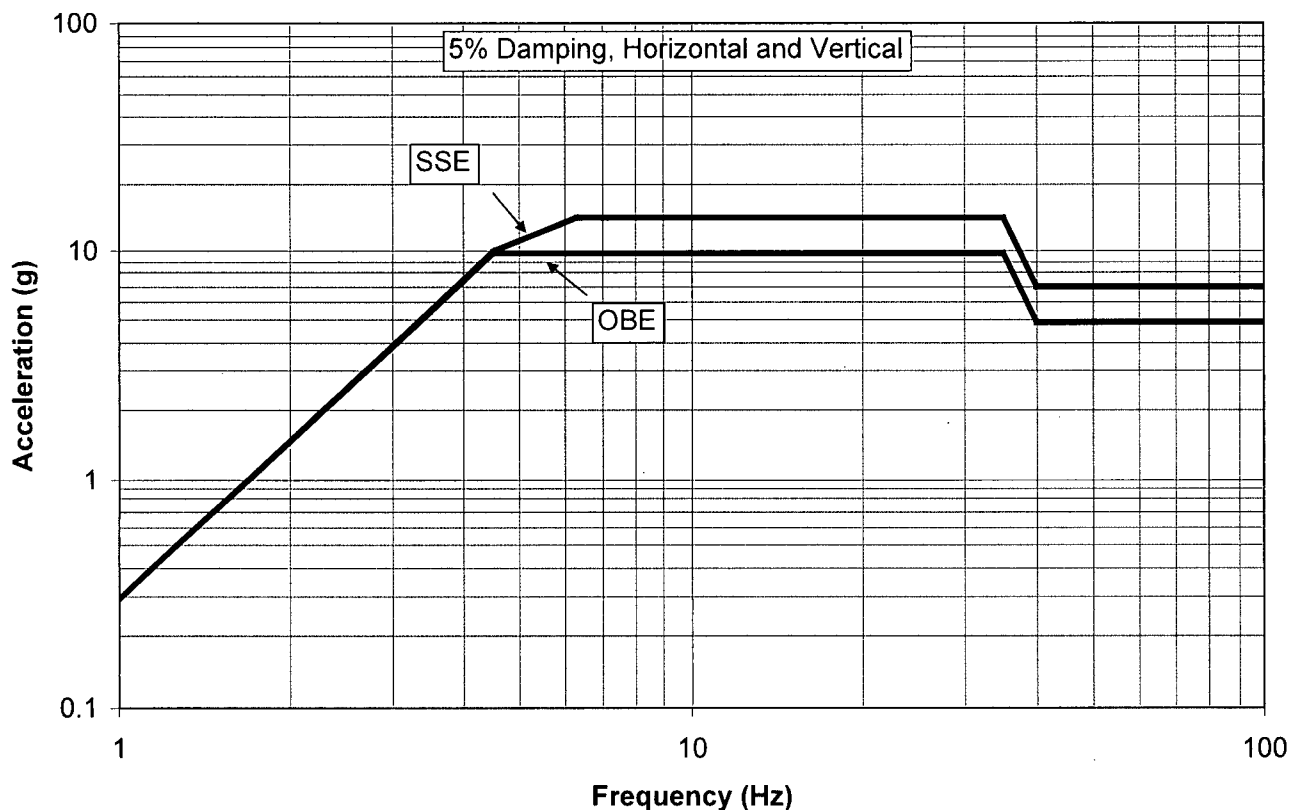
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## 8.0 CONCLUSIONS

1. Seismic Testing of the TUT was performed in accordance with the requirements of EPRI TR-107330 (Reference 9.3) as clarified in Sections 6.3 and 6.4 of this test report, and following the guidelines provided in IEEE Standard 344-1987 (Reference 9.18).
2. The TUT met the Test Acceptance Criteria given in Section 6.6 of this test report. Specifically, during Seismic Testing:
  - (a) Evaluation of normal operating data showed that the TUT operated as intended during and after exposure to the OBE and SSE vibrations.
  - (b) Visual inspections performed after each OBE and SSE test showed that, when properly installed according to Triconex direction, all connections on the TUT remained intact, all modules remained fully inserted, and no functional or non-functional parts of the TUT fell off.
  - (c) The Model 3636T electromechanical relay module output contacts correctly changed state from energized to de-energized and de-energized to energized during application of the OBE and SSE vibrations. Any spurious change of state of the relay module output contacts did not exceed 2 milliseconds in duration for both energized and de-energized contact states.  
  
 The TUT chassis alarm relay contacts were not monitored for contact chatter during Seismic Testing. Therefore, the TUT chassis alarm relays were not seismically qualified as part of Seismic Testing.
  - (d) As reported by Triconex, the TUT met all acceptance criteria of Post-Seismic Operability Testing, as recorded in the completed Post-Seismic Test Run No. 3.6 of Triconex Procedure No. 9600164-503 (Reference 9.17).
3. The Seismic Test results demonstrate that the Triconex TRICON v10 PLC platform is suitable for qualification as a (seismic) Category 1 Safety System. 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 9.6).
4. The horizontal and vertical seismic withstand response spectrum of the TRICON v10 PLC as determined by testing is shown in Figure 8-1. The figure is based on a damping value of 5% used in the data analysis.

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5. Several procedural deviations were taken during Seismic Testing as described in Section 7.8 of this test report. In addition, several material condition anomalies were encountered during Seismic Testing as described in Section 7.6 of this test report. Review of the procedural deviations and material condition anomalies showed that they had no impact on the validity of the test results.



Frequency	OBE	SSE
1.0 Hz	0.3 g	0.3 g
4.5 Hz	10 g	10 g
6.3 Hz	10 g	14 g
35 Hz	10 g	14 g
40 Hz	4.9 g	7.0 g
100 Hz	4.9 g	7.0 g

**Figure 8-1:** Seismic Withstand Response Spectrum

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## 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 9.6) 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. 9600164-507 (Reference 9.8), Triconex Document No. 9600164-540, Rev. 6 was in effect at the start of Seismic Testing.*

- 9.1 Triconex Document No. 9600164-500, "Master Test Plan," Rev. 4
- 9.2 MPR Procedure No. 9600164-507, "Seismic Test Procedure," Rev. 0
- 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 Triconex Document No. 9600164-002, "Nuclear Qualification Quality Plan," Rev. 3
- 9.5 Triconex Drawing No. 9600164-100, "TRICON v10 Nuclear Qualification Project TRICON Under Test - General Arrangement," Rev. 1
- 9.6 Triconex Document No. 9600164-540, "Master Configuration List," Rev. 18
- 9.7 IEEE Standard 323-1974, "Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations"
- 9.8 Completed MPR Procedure No. 9600164-507, "Seismic Test Procedure," Rev. 0, MPR Review and Approval Dated April 16, 2007
- 9.9 Triconex Drawing No. 9600164-103, "TRICON v10 Nuclear Qualification Project System Block Diagram," Rev. 2
- 9.10 Triconex Document No. 9600164-541, "TRICON v10 Nuclear Qualification Project, System Description," Rev. 0
- 9.11 Triconex Document No. 9600164-517, "Test Specimen Application Program (TSAP) Software Requirements Specification (SRS)," Rev. 3

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- 9.12 National Technical Systems Test Procedure No. TP62987-07N-SEI, “Test Procedure for Seismic Qualification of the TRICON v10 Nuclear Qualification Project TRICON-Under-Test,” Rev. 0
- 9.13 Triconex Drawing No. 9600164-102, “TRICON v10 Nuclear Qualification Project, Seismic Test Equipment Configuration Details,” Rev. 2
- 9.14 National Technical Systems Test Report No. TR62987-07N-SEI, “Test Report for Seismic Qualification of TRICON v10 Nuclear Qualification Project TRICON-Under-Test,” Rev. 0
- 9.15 Completed TUT Chassis 1 and 2 Pre-Seismic Testing Run No. 3.4 of Triconex Procedure No. 9600164-502, “System Setup and Checkout Procedure,” Rev. 0
- 9.16 Completed TUT Chassis 3 and 4 Pre-Seismic Testing Run No. 3.5 of Triconex Procedure No. 9600164-502, “System Setup and Checkout Procedure,” Rev. 0
- 9.17 Completed Post-Seismic Testing Run No. 3.6 of Triconex Procedure No. 9600164-503, “Operability Test Procedure,” Rev. 2
- 9.18 IEEE Standard 344-1987, “Recommended Practices for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations”
- 9.19 IEEE Standard 381-1977, “Standard Criteria for Type Tests of Class 1E Modules Used in Nuclear Power Generating Stations”
- 9.20 Triconex Procedure No. 9600164-503, “Operability Test Procedure,” Rev. 3
- 9.21 Triconex Procedure No. 9600164-502, “System Setup and Checkout Procedure,” Rev. 4

## 10.0 ATTACHMENTS

**Attachment 1:** Example Plots of TUT Normal Operating Performance Data

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