invensys
Operations Management

TRICON TOPICAL REPORT

EPRI TR-107330 REQUIREMENTS COMPLIANCE AND TRACEABILITY MATRIX

Document No.: 7286-545-1

Revision 3

Appendix A

TRICON TOPICAL REPORT

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
1	Scope. Description of TR scope.	- - -	No requirements.
2	Definitions, Abbreviations, Acronyms. List of definitions, abbreviations, and acronyms used in the TR.	- - -	No requirements.
3	Reference Documents. List of documents referenced in the TR.	- - -	No requirements.
4	System Requirements. (section heading)	- - -	No requirements.
4.1	Overview of Performance Basis. Descriptive information.	- - -	No requirements.
4.2	Functional Requirements. (section heading)	- - -	No requirements.
4.2.1	General Functional Requirements. Descriptive information.	- - -	No requirements.

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SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.2.1.A	Response Time. The overall response time from an analog or discrete input exceeding its trip condition to the resulting discrete outputs being set shall be 100 milliseconds or less. Response time shall include time required for input filtering, input module signal conversion, main processor input data acquisition, two scan times of an application program containing 2000 simple logic elements, main processor output data transmission, digital output module signal conversion, and performance of self-diagnostics and redundancy implementation.	Comply	Ref 7, Section 4.0 gives a summary of calculated maximum response time. However, the as tested Maximum response times were 83.0 milliseconds (for a DI to DO loop), 119.0 milliseconds (for an AI to DO loop), and 126.0 milliseconds (for an AI to AO loop). See Ref. 53, Section 6. The test specimen application program included 3946 simple logic elements, and 175 simple and complex logic elements, almost twice that required by the TR. This effectively resulted in almost double the scan time associated with 2000 elements.
4.2.1.B	Discrete I/O. The PLC shall have the capability to provide a total of at least 400 discrete I/O points.	Comply	See Ref. 45, Chapter 3, Table 62
4.2.1.C	Analog I/O. The PLC shall have the capability to provide a total of 100 analog I/O points.	Comply	See Ref. 45, Chapter 3, Table 62
4.2.1.D	Combined I/O. The PLC shall have the capability to provide a total of 50 analog and 400 discrete I/O points.	Comply	See Ref. 45, Chapter 3, Table 62
4.2.2	Control Function Requirements. The PLC shall provide a high -level language designed for control algorithms.	Comply	See Ref. 46 and 47.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.2.3	Availability/Reliability and FMEA. (section heading)	- - -	No requirements.
4.2.3.1	Availability/Reliability Overview. Descriptive information.	- - -	No requirements.
4.2.3.2	Availability/Reliability and Basic Requirements. The overall availability goal of the PLC is 0.99.	Comply	See Ref. 11.
4.2.3.3	Availability/Reliability Calculation Requirements. An availability calculation shall be prepared which conforms to IEEE 352.	Comply	See Ref. 11.
4.2.3.3.1	Availability/Reliability Calculation Requirements Applicable to Redundant PLCs. For PLCs that include redundancy, the availability calculation shall address additional, redundancy-specific considerations.	Comply	See Ref. 11.
4.2.3.4	PLC Fault Tolerance Requirements. Fault tolerance capability shall be addressed in the availability calculation, and included as part of the qualification envelope definition.	Comply	See Ref. 11 and Appendix B of this report.
4.2.3.5	Failure State/FMEA Requirements. An FMEA analysis shall be performed in accordance with IEEE 352. The analysis shall evaluate the effects of failures of components in the PLC modules on the PLC performance.	Comply	See Ref. 10.

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4.2.3.6	Failure Detection Requirements. The PLC shall contain features to permit generating an alarm when the on-line fault detection detects a failure. Processor-to-processor communication for fault detection shall meet the given specific performance requirements.	Comply	See Ref. 45, Chapter 4, Table 74 to Table 86 and Ref. 10. The Tricon does not require loopback of output to input signals for fault detection.
4.2.3.7	Recovery Capability Requirements. The PLC shall include a watchdog timer and power bus monitoring features. Output modules shall initialize to a known state.	Comply	See Ref. 20, Sections 8.0 and 10.0.
4.2.3.8	Requirements for Use of Operating Experience. If operating experience is used as a basis for establishing module failure rates, the PLC manufacturer must have a problem reporting and tracking program.	Comply	See Table Section 7.8 for reference to manufacturer Problem Reporting and Tracking Program procedures.
4.2.4	Setpoint Analysis Support Requirements. An analysis shall be prepared to provide the information needed to support an application specific set point analysis per ISA RP 67.04.	Comply	See Ref. 9.
4.3	Hardware Requirements. (section heading)	- - -	No requirements.
4.3.1	General. (section heading)	- - -	No requirements.
4.3.1.1	Background. Descriptive information.	- - -	No requirements.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.3.1.2	Requirements Common to All Modules. All modules shall meet or support the general requirements given in Section 4.2.1, and shall meet the range of environmental conditions given in Section 4.3.6. Special requirements apply to single module assemblies that include both inputs and outputs.	Comply	See Table Sections 4.2.1 and 4.3.6. No Tricon modules include Input and Output points on the same assembly.
4.3.1.3	External Device Requirements. External devices used to meet I/O module requirements shall meet the given specific requirements.	Comply	Qualification testing did not include use of external devices.
4.3.1.4	General Redundancy Requirements. Redundant components may be included in the generic PLC platform.	Comply	Tricon test specimen included redundant main processors and chassis power supplies.
4.3.2	Input Requirements. (section heading)	- - -	No requirements.
4.3.2.1	Analog Input Requirements. The PLC shall include modules that provide analog inputs.	Comply	See Ref. 45, Chapter 2.0. See Ref. 56 for list of Tricon analog input modules included in the qualification program.
4.3.2.1.A	Monotonicity. The analog inputs shall be monotonic to ±1/2 LSB.	Comply	The DACs used by Triconex are monotonic by design.
4.3.2.1.B	Number of Channels. Each analog input module shall provide a minimum of four input channels.	Comply	See Ref. 45, Chapter 2.0.

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4.3.2.1.C	Over Range. The converted value of each analog input module shall remain at its maximum value for over range inputs up to twice rated.	Comply	See Ref. 45, Chapter 2.0. Analog input module A/D converters remain at their maximum value regardless of the input value once the input is ≥ the specified over range value.
4.3.2.1.D	Under Range. The converted value of each analog input module shall remain at its minimum value for low range inputs up to the negative of the rated input value.	Comply	See Ref. 45, Chapter 2.0. Analog input module A/D converters remain at their minimum value regardless of the input value once the input is ≤ the specified under range value.
4.3.2.1.E	Out of Range Indication. Over and under range conditions shall be indicated in a manner available to the application program.	Comply	See Ref. 45, Chapter 2.0.
4.3.2.1.1	Voltage Input Requirements. (section heading)	- - -	No requirements.
4.3.2.1.1.A	Analog Voltage Input Module Ranges. The PLC shall include analog voltage input modules with ranges of: 0 to 10 VDC, -10 to 10 VDC, and 0 to 5 VDC.	Partial Exception	See Ref. 45, Chapter 2.0. Tricon analog voltage input modules do not include a –10 to 10 VDC range.
4.3.2.1.1.B	Analog Voltage Input Module Accuracies. Overall accuracies shall be ≤ ± 0.32% of the specified range.	Comply	See Ref. 45, Chapter 2.0, and Ref. 9.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.3.2.1.1.C	Analog Voltage Input Module Resolution. The minimum resolution shall be 12 bits.	Comply	See Ref. 45, Chapter 2.0.
4.3.2.1.1.D	Analog Voltage Input Module Common Mode Voltage. The common mode voltage capability shall be at least 10 volts with a common mode rejection ratio of at least 90 dB.	Partial Exception	See Ref. 45, Chapter 2.0. Common mode rejection rating of Module 3701 is 80 dB, Module 3721 is 85dB, and Module 3703 is 90dB.
4.3.2.1.1.E	Analog Voltage Input Module Response Time. The overall response time of the analog voltage input modules must support the response time requirement given in Section 4.2.1.A.	Comply	See Ref. 20, Section 3.0 and Table Section 4.2.1.A.
4.3.2.1.1.F	Analog Voltage Input Module Group-to-Group Isolation. The group-to-group isolation shall be at least ± 30 volts peak.	N/A	See Ref. 45, Chapter 2.0. Tricon analog voltage input module points are not grouped.
4.3.2.1.1.G	Analog Voltage Input Module Class 1E to Non-1E Isolation. The Class 1E to Non-1E isolation capability shall meet the requirements of Section 4.6.4.	N/A	Analog input modules are not intended for use as a Class 1E to Non-1E isolation device.
4.3.2.1.1.H	Analog Voltage Input Module Surge Withstand. Surge withstand shall be as given in Section 4.6.2.	Comply	See Ref. 39 and 57. Surge withstand capability meets IEC 61000-4-5 (Ring Wave) and IEC 61000-4-12 (Combination Wave) basic immunity levels.

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4.3.2.1.1.I	Analog Voltage Input Module Input Impedance. The input impedance shall be at least 1 megohm.	Comply	See Ref. 45, Chapter 2.0.
4.3.2.1.2	Current Input Requirements. (section heading)	- - -	No requirements.
4.3.2.1.1.A	Analog Current Input Module Ranges. The PLC shall include analog current input modules with ranges of: 4 to 20 mA and 10 to 50 mA or 0 to 50 mA.	Partial Exception	See Ref. 45, Chapter 2.0. Tricon analog current input modules do not include a 10 to 50 mA or 0 to 50 mA range.
4.3.2.1.1.B	Analog Current Input Module Accuracies. Overall accuracies shall be ≤ ± 0.35% of the specified range.	Comply	See Ref. 45, Chapter 2.0, and Ref. 9.
4.3.2.1.1.C	Analog Current Input Module Resolution. The minimum resolution shall be 12 bits.	Comply	See Ref. 45, Chapter 2.0.
4.3.2.1.1.D	Analog Current Input Module Common Mode Voltage. The common mode voltage capability shall be at least 10 volts.	Comply	See Ref. 45, Chapter 2.0.
4.3.2.1.1.E	Analog Current Input Module Common Mode Rejection Ratio. The common mode rejection ratio shall be at least 90 dB.	Partial Exception	See Ref. 45, Chapter 2.0. Common mode rejection rating of Module 3701 is 80 dB, Module 3721 is 85dB, and Module 3703 is 90dB..

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4.3.2.1.1.F	Analog Current Input Module Response Time. The overall response time of the analog current input modules must support the response time requirement given in Section 4.2.1.A.	Comply	See Ref. 20, Section 2.0 and Table Section 4.2.1.A.
4.3.2.1.1.G	Analog Current Input Module Group-to-Group Isolation. The group-to-group isolation shall be at least ± 30 volts peak for 4 to 20 mA inputs.	N/A	See Ref. 45, Chapter 2.0. Tricon analog current input module points are not grouped.
4.3.2.1.1.H	Analog Current Input Module Class 1E to Non-1E Isolation. The Class 1E to Non-1E isolation capability shall meet the requirements of Section 4.6.4.	N/A	Analog input modules are not intended for use as a Class 1E to Non-1E isolation device.
4.3.2.1.1.I	Analog Current Input Module Surge Withstand. Surge withstand shall be as given in Section 4.6.2.	Comply	See Ref. 39 and Ref. 57. Surge withstand capability meets IEC 61000-4-5 (Ring Wave) and IEC 61000-4-12 (Combination Wave) basic immunity levels.
4.3.2.1.1.J	Analog Current Input Module Input Impedance. The input impedance shall be 250 ohms maximum.	Comply	See Ref. 48, Chapter 7.0. 0 to 5 VDC analog voltage input modules are used for 4 to 20 mA current inputs with a 250 ohm resistor supplied by Triconex.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.3.2.1.3	RTD Input Requirements. (section heading)	- - -	No requirements.
4.3.2.1.3.A	RTD Input Module Types. The PLC shall include RTD input modules for use with 2, 3 or 4 wire European (DIN 43 760) or US standard 100 ohm RTDs.	Partial Exception	See Ref. 48, Chapter 5, Table 135. Tricon RTD input signal conditioners are for use with 2 or 3 wire, 100 ohm platinum RTDs.
4.3.2.1.3.B	RTD Input Module Ranges. The PLC shall include RTD input modules with a range of at least 0 to 800°C (32 to 1472°F).	Exception	See Ref. 48, Chapter 5, Table 135. Tricon RTD input signal conditioners span the -100°C to 600°C (32 to 1112°F) range.
4.3.2.1.3.C	RTD Input Module Accuracies. Overall accuracies shall be ≤ ± 2°C.	Comply	See Ref. 45, Chapter 2.0 and Ref. 9. Tricon RTD input signal conditioners are interfaced with a 0 to 5 VDC analog input module. Combined accuracy is ≤ ± 2°C.
4.3.2.1.3.D	RTD Input Module Resolution. The minimum resolution shall be 0.1° or less for both °C or °F scaling.	Exception	See Ref. 45, Chapter 2.0, and Ref. 9. Tricon RTD input signal conditioners (32 to 1112°F max. span = 1 to 5 V output) are interfaced with a 12 bit, 0 to 5 V analog input module. The resulting minimum resolution is 0.33°F (0.19°C).

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4.3.2.1.3.E	RTD Input Module Common Mode Voltage. The common mode voltage capability shall be at least 10 volts.	Comply	See Ref. 45, Chapter 2.0.
4.3.2.1.3.F	RTD Input Module Common Mode Rejection Ratio. The common mode rejection ratio shall be at least 90 dB.	Comply	See Ref. 45, Chapter 2.0.
4.3.2.1.3.G	RTD Input Module Response Time. The overall response time of the RTD input modules must support the response time requirement given in Section 4.2.1.A.	Exception	See Ref. 20, Section 3.0 and Table Section 4.2.1.A. For large step changes (0 to 90% of full scale range), RTD's and input signal conditioners have a relatively long input update rate, and were not considered in qualification response time testing.
4.3.2.1.3.H	RTD Input Module Group-to-Group Isolation. The group-to-group isolation shall be at least ± 30 volts peak.	N/A	See Ref. 48, Chapter 5. Tricon RTD input signal conditioner points are not grouped.
4.3.2.1.3.I	RTD Input Module Class 1E to Non-1E Isolation. The Class 1E to Non-1E isolation capability shall meet the requirements of Section 4.6.4.	N/A	RTD input signal conditioners are not intended for use as a Class 1E to Non-1E isolation device.

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4.3.2.1.3.J	RTD Input Module Surge Withstand. Surge withstand shall be as given in Section 4.6.2.	Comply	See Ref. 39 and 57. Surge withstand capability meets IEC 61000-4-5 (Ring Wave) and IEC 61000-4-12 (Combination Wave) basic immunity levels.
4.3.2.1.3.K	RTD Input Module Input Impedance. The input impedance shall be 1 megohm minimum.	Comply	The Analog Devices signal conditioner has a two-pole output filter and subsequent buffer to ensure that a low noise, low impedance (<1Ω) signal is available at the output to drive loads to 2 kΩ minimum (Ref. 55). Input impedance of RTD signal conditioning modules is not relevant. Modules are compatible with specific RTD types via the Analog Devices signal conditioners.
4.3.2.1.4	Thermocouple Input Requirements. Thermocouple (T/C) input modules must meet performance requirements with 1000 feet of 20 AWG extension wire connected to input.	Comply	Comparison of the input impedance to load impedance indicates there is no effective maximum limit.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.3.2.1.4.A	T/C Input Module Types. The PLC shall include T/C input modules for use with type B, E, J, K, N, R, S and T thermocouples over the specified temperature ranges.	Partial Exception	See Ref. 45, Chapter 2.0. Tricon T/C input modules are for use with type E, J, K and T thermocouples. Type J input range is –250 to 2000°F (vs. TR requirement of 32 to 2192°F).
4.3.2.1.4.B	T/C Input Module Accuracies. Overall accuracies shall be: Type E: ≤ ± 4.5°F, Type J: ≤ ± 6.3°F, Type K: ≤ ± 7.2°F, Type T: ≤ ± 4.5°F.	Comply	See Ref. 45, Chapter 2.0.
4.3.2.1.4.C	T/C Input Module Accuracies. Cold junction compensation shall support Section 4.3.2.1.4.B accuracies for the environmental temperature range given in Section 4.3.6.	Comply	See Ref. 45, Chapter 2.0, for T/C termination module (cold junction) temperature in range of 32 to 140°F, and over TR temperature ranges for each T/C type.
4.3.2.1.4.D	T/C Input Module Resolution. The minimum resolution shall be 0.1° or less for both °C or °F scaling.	Exception	See Ref. 45, Chapter 2.0, minimum resolution is 0.125°F (0.07°C).
4.3.2.1.4.E	T/C Input Module Common Mode Voltage. The common mode voltage capability shall be at least 10 volts.	Comply	See Ref. 45, Chapter 2.0.

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4.3.2.1.4.F	T/C Input Module Common Mode Rejection Ratio. The common mode rejection ratio shall be at least 90 dB.	Comply	See Ref. 45, Chapter 2.0. T/C input module Model 3708E common mode rejection ratio is 90 dB (0 to 60 Hz) minimum.
4.3.2.1.4.G	T/C Input Module Open Detection. The module shall provide open thermocouple detection.	Comply	See Ref. 45, Chapter 2.0.
4.3.2.1.4.H	T/C Input Module Response Time. The overall response time of the T/C input modules must support the response time requirement given in Section 4.2.1.A.	Clarification	The input response time is the same as the analog input module 3708; they both use the same PCBA. This module was successfully tested during the SER testing and there have not been any design changes.
4.3.2.1.4.I	T/C Input Module Group-to-Group Isolation. The group-to-group isolation shall be at least ± 30 volts peak.	N/A	See Ref. 45, Chapter 2.0. Tricon T/C input module points are not grouped.
4.3.2.1.4.J	T/C Input Module Class 1E to Non-1E Isolation. The Class 1E to Non-1E isolation capability shall meet the requirements of Section 4.6.4.	N/A	T/C input modules are not intended for use as a Class 1E to Non-1E isolation device.

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4.3.2.1.4.K	T/C Input Module Surge Withstand. Surge withstand shall be as given in Section 4.6.2.	Comply	See Ref. 39 and 57. Surge withstand capability meets IEC 61000-4-5 (Ring Wave) and IEC 61000-4-12 (Combination Wave) basic immunity levels.
4.3.2.1.4.L	T/C Input Module Input Impedance. The input impedance shall be 1 megohm minimum.	Comply	See Ref. 45, Chapter 2.0.
4.3.2.2	Discrete Input Requirements. The PLC shall include modules that provide discrete inputs. Each module shall provide a minimum of 8 input channels and include indicators that show the ON/OFF status of each point.	Comply	See Ref. 45, Chapter 2.0. See Ref. 3 for list of Tricon discrete input modules included in the qualification program.
4.3.2.2.1	Discrete AC Input Requirements. (section heading)	- - -	No requirements.
4.3.2.2.1.A	Discrete AC Input Module Types. The PLC shall include discrete AC input modules for nominal inputs of 120 VAC and 24 VAC.	Comply	See Ref. 45, Chapter 2.
4.3.2.2.1.B	Discrete AC Input Module ON Transition. The input must transition to ON at 90 VAC max. (120 VAC input) or 20 VAC max. (24 VAC input).	Comply	See Ref. 45, Chapter 2.

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4.3.2.2.1.C	Discrete AC Input Module OFF Transition. The input must transition to OFF between 65 to 25 VAC (120 VAC input) or 15 to 6 VAC (24 VAC input).	Comply	See Ref. 45, Chapter 2.
4.3.2.2.1.D	Discrete AC Input Module Operating Range. The module must operate for inputs up to at least 150 VAC (120 VAC input) or 40 VAC (24 VAC input).	Comply	See Ref. 45, Chapter 2.
4.3.2.2.1.E	Discrete AC Input Module Response Time. The overall response time of the discrete AC input modules must support the response time requirement given in Section 4.2.1.A.	Comply	See Ref. 20, Section 3.0 and Table Section 4.2.1.A.
4.3.2.2.1.F	Discrete AC Input Module Group-to-Group Isolation. The group-to-group isolation shall be at least 600 volts peak for 120 VAC inputs or 100 volts peak for 24 VAC inputs.	Comply	The Triconex design utilizes point to point and ETP isolation at 1500Vac (Ref. 45)
4.3.2.2.1.G	Discrete AC Input Module Class 1E to Non-1E Isolation. The Class 1E to Non-1E isolation capability shall meet the requirements of Section 4.6.4.	N/A	Discrete AC input modules are not intended for use as a Class 1E to Non-1E isolation device.

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4.3.2.2.1.H	Discrete AC Input Module Surge Withstand. Surge withstand shall be as given in Section 4.6.2.	Comply	See Ref. 39 and 57. Surge withstand capability meets IEC 61000-4-5 (Ring Wave) and IEC 61000-4-12 (Combination Wave) basic immunity levels.
4.3.2.2.2	Discrete DC Input Requirements. (section heading)	- - -	No requirements.
4.3.2.2.2.A	Discrete DC Input Module Types. The PLC shall include discrete DC input modules for nominal inputs of 125, 24 , 15 and 12 Vdec.	Partial Exception	See Ref. 45, Chapter 2.0. Tricon discrete DC input modules are for nominal inputs of 115, 48 and 24 Vdc.
4.3.2.2.2.B	Discrete DC Input Module ON Transition. The input must transition to ON at 90 VDC max. (125 VDC input) or 20 VDC max. (24 VDC input).	Comply	See Ref. 45, Chapter 2.0.
4.3.2.2.2.C	Discrete DC Input Module OFF Transition. The input must transition to OFF between 65 to 25 VDC (125 VDC input) or 15 to 6 VDC (24 VDC input).	Comply	See Ref. 45, Chapter 2.0.
4.3.2.2.2.D	Discrete DC Input Module Operating Range. The module must operate for inputs up to at least 150 VDC (125 VDC input) or 40 VDC (24 VDC input).	Comply	See Ref. 45, Chapter 2.0.

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4.3.2.2.2.E	Discrete DC Input Module Response Time. The overall response time of the discrete DC input modules must support the response time requirement given in Section 4.2.1.A.	Comply	See Ref. 20, Section 3.0 and Table Section 4.2.1.A.
4.3.2.2.2.F	Discrete DC Input Module Group-to-Group Isolation. The group-to-group isolation shall be at least 600 volts peak for 125 VDC inputs or 40 volts peak for 24 VDC inputs.	Comply	The 120 Vdc DI module is the same as the 115 Vac module. They are commen in groups of 8 because of "stuck-on" diagnostics.
4.3.2.2.2.G	Discrete DC Input Module Class 1E to Non-1E Isolation. The Class 1E to Non-1E isolation capability shall meet the requirements of Section 4.6.4.	N/A	Discrete DC input modules are not intended for use as a Class 1E to Non-1E isolation device.
4.3.2.2.2.H	Discrete DC Input Module Surge Withstand. Surge withstand shall be as given in Section 4.6.2.	Comply	See Ref. 39 and 57. Surge withstand capability meets IEC 61000-4-5 (Ring Wave) and IEC 61000-4-12 (Combination Wave) basic immunity levels.
4.3.2.2.3	TTL Input Requirements. Requirements for TTL level input modules.	Exception	There is no TTL level input module available for use with the Tricon PLC.
4.3.2.3	Other Inputs. (section heading)	- - -	No requirements.

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4.3.2.3.1	Pulse Input Requirements. The PLC shall include modules that provide pulse inputs.	Comply	See Ref. 45, Chapter 2.0. See Ref. 9 for identification of Tricon pulse input module included in the qualification program.
4.3.2.3.1.A	Pulse Input Module Input Number. The module shall have at least two inputs.	Comply	See Ref. 45, Chapter 2.0.
4.3.2.3.1.B	Pulse Input Module Range. The module input count frequency range shall be at least 20 to 5000 Hz.	Comply	See Ref. 45, Chapter 2.0.
4.3.2.3.1.C	Pulse Input Module Operation. The input must operate for a pulse range of at least 3 to 28 VDC and a duty cycle of at least 20 microseconds at 90%.	Comply	The PI Module clocks on a falling edge and does not care about duty cycle.
4.3.2.3.1.D	Pulse Input Module Count Accuracy. The module shall have up and down count modes with a range of at least 9999. The accuracy of the count shall be ≤ 0.1%.	Exception	See Ref. 45, Chapter 2.0. The Tricon pulse input module provides speed or RPM measurement only.
4.3.2.3.1.E	Pulse Input Module Frequency Accuracy. The module shall have a frequency mode with a range of at least 20 to 5000 Hz. The accuracy of the frequency measurement shall be ≤ 0.1%.	Partial Exception	See Ref. 45, Chapter 2.0. Accuracy is ± 1.0% of reading from 20 to 99 Hz. Accuracy is ± 0.1% of reading from 100 to 999 Hz. Accuracy is ±0.01% from 1000 to 20,000 Hz

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4.3.2.3.1.F	Pulse Input Module Response Time. The overall response time of the pulse input module must support the response time requirement given in Section 4.2.1.A.	Comply	See Ref. 20, Section 3.0. Pulse Input Modules were not used for Response Time Analyses. Module selection was based on update rates; the selection of digital and analog output modules to include in the test is not significant.
4.3.2.3.1.G	Pulse Input Module Group-to-Group Isolation. The group-to-group isolation shall be at least 40 VDC.	N/A	See Ref. 45, Chapter 2.0. Tricon pulse input module points are not grouped.
4.3.2.3.1.H	Pulse Input Module Class 1E to Non-1E Isolation. The Class 1E to Non-1E isolation capability shall meet the requirements of Section 4.6.4.	N/A	Pulse input modules are not intended for use as a Class 1E to Non-1E isolation device.
4.3.2.3.1.I	Pulse Input Module Surge Withstand. Surge withstand shall be as given in Section 4.6.2.	Comply	See Ref. 39 and 57. Surge withstand capability meets IEC 61000-4-5 (Ring Wave) and IEC 61000-4-12 (Combination Wave) basic immunity levels.
4.3.3	Output Requirements. (section heading)	- - -	No requirements.
4.3.3.1	Analog Output Requirements. The PLC shall include modules that provide analog outputs.	Comply	See Ref. 45, Chapter 2. See Ref. 3 for identification of Tricon analog output module included in the qualification program.

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SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.3.3.1.A	Monotonicity. The analog outputs shall be monotonic to ±1/2 LSB.	Comply	The DACs used by Triconex are monotonic by design.
4.3.3.1.B	Number of Channels. Each analog output module shall provide a minimum of four output channels.	Comply	See Ref. 45, Chapter 2.0.
4.3.3.1.1	Analog Voltage Output Requirements. Requirements for analog voltage output modules.	Exception	There is no analog voltage output module available for use with the Tricon PLC.
4.3.3.1.2	Current Output Requirements. (section heading)	- - -	No requirements.
4.3.3.1.2.A	Analog Current Output Module Ranges. The PLC shall include analog current output modules with ranges of: 4 to 20 mA or 0 to 20 mA, and 10 to 50 mA or 0 to 50 mA.	Partial Exception	See Ref. 45, Chapter 2.0. Tricon analog current output module output range is 4 to 20 mA.
4.3.3.1.2.B	Analog Current Output Module Accuracy. Overall accuracy shall be ≤ ± 0.32% of full range.	Comply	See Ref. 45, Chapter 2.0, and Ref. 9.
4.3.3.1.2.C	Analog Current Output Module Resolution. The minimum resolution shall be 12 bits.	Comply	See Ref. 45, Chapter 2.0.
4.3.3.1.2.D	Analog Current Output Module Load Impedance. The 4 to 20 mA outputs shall support a load impedance of 1 Kohm or less.	Comply	See Ref. 45, Chapter 2.0.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.3.3.1.2.E	Analog Current Output Module Response Time. The overall response time of the analog current output modules must support the response time requirement given in Section 4.2.1.A.	Comply	Section 4.2.1.A bases response time on AI to DO or DI to DO configurations. Analog outputs are not addressed.
4.3.3.1.2.F	Analog Current Output Module Isolation. The group-to-group, module-to-module and module to backplane isolation shall meet the requirements of Section 4.6.4.	N/A	Section 4.6.4 provides requirements for Class 1E to Non-1E isolation capability. Tricon analog current output modules are not intended for use as a Class 1E to Non-1E isolation device.
4.3.3.1.2.G	Analog Current Output Module Surge Withstand. Surge withstand shall be as given in Section 4.6.2.	Comply	See Ref. 39 and 57. Surge withstand capability meets IEC 61000-4-5 (Ring Wave) and IEC 61000-4-12 (Combination Wave) basic immunity levels.
4.3.3.2	Discrete Output Requirements. The PLC shall include modules that provide discrete outputs.	Comply	See Ref. 45, Chapter 2.0. See Ref. 9 for list of Tricon discrete output modules included in the qualification program.
4.3.3.2.A	Number of Channels. Each module shall provide a minimum of 8 output channels.	Comply	See Ref. 45, Chapter 2.0.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.3.3.2.B	Leakage Current. Leakage current in the OFF state of non-supervised (no internal ringback) modules shall be less than 80% of the minimum current needed to turn ON any digital input module.	Comply	See Ref. 45, Section 2.0. Minimum digital input module turn ON current is 3 mA. Maximum non-supervised digital output module leakage current is 2 mA which is < 0.8 x 3 mA.
4.3.3.2.C	Output Circuit Interrupter. Outputs must include a circuit interrupter.	Comply	See Ref. 48, Chapter 4.
4.3.3.2.D	Status Indication. Modules must include indicators that show the ON/OFF status of each point.	Comply	See Ref. 45, Chapter 2.0.
4.3.3.2.1	Discrete AC Output Requirements. (section heading)	- - -	No requirements.
4.3.3.2.1.A	Discrete AC Output Module Types. The PLC shall include discrete AC output modules for nominal outputs of 120 and 24 Vac.	Partial Exception	See Ref. 45, Chapter 2.0. Tricon discrete AC output modules do not include 24 Vac nominal outputs.
4.3.3.2.1.B	Discrete AC Output Module Output Current. The output must operate with an output current between 50 mA and 0.5 amps with an inrush capability of at least 2 amps.	Comply	See Ref. 45, Chapter 2.0
4.3.3.2.1.C	Discrete AC Output Module ON State Voltage Drop. The ON state voltage drop shall not exceed 2 VAC at 0.5 amps.	Comply	See Ref. 45, Chapter 2.0, Table 31.
4.3.3.2.1.D	Discrete AC Output Module OFF State Leakage. The OFF state leakage current shall not exceed 2 mA.	Comply	See Ref. 45, Chapter 2.0. Based on load leakage specifications.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.3.3.2.1.E	Discrete AC Output Module Operating Range. The modules must operate for point source inputs at 47 Hz to 63 Hz over the range 90 to 130 VAC min. (120 VAC output).	Comply	See Ref. 45, Chapter 2.0
4.3.3.2.1.F	Discrete AC Output Module Response Time. The overall response time of the discrete AC output modules must support the response time requirement given in Section 4.2.1.A.	Comply	See Ref. 20, Section 3.0 and Table Section 4.2.1.A.
4.3.3.2.1.G	Discrete AC Output Module Group-to-Group Isolation. The group-to-group isolation shall be at least 600 volts peak for 120 VAC outputs.	N/A	See Ref. 45, Chapter 2.0. Tricon discrete AC output module points are not grouped.
4.3.3.2.1.H	Discrete AC Output Module Class 1E to Non-1E Isolation. The Class 1E to Non-1E isolation capability shall meet the requirements of Section 4.6.4.	N/A	Discrete AC output modules are not intended for use as a Class 1E to Non-1E isolation device.
4.3.3.2.1.I	Discrete AC Output Module Surge Withstand. Surge withstand shall be as given in Section 4.6.2.	Comply	See Ref. 39 and 57. Surge withstand capability meets IEC 61000-4-5 (Ring Wave) and IEC 61000-4-12 (Combination Wave) basic immunity levels.
4.3.3.2.2	Discrete DC Output Requirements. (section heading)	- - -	No requirements.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.3.3.2.2.A	Discrete DC Output Module Types. The PLC shall include discrete DC output modules for nominal outputs of 125, 48, 24, 15 and 12 Vdc.	Partial Exception	See Ref. 45, Chapter 2.0. Tricon discrete DC output modules include 120, 48 and 24 Vdc nominal outputs.
4.3.3.2.2.B	Discrete DC Output Module Output Current. The outputs must operate with an output current between 50 mA and 0.5 amps with an inrush capability of at least 2 amps.	Comply	See Ref. 45, Chapter 2.0.
4.3.3.2.2.C	Discrete DC Output Module ON State Voltage Drop. The ON state voltage drop shall not exceed 2 Vdc at 0.5 amps.	Exception	See Ref. 45, Chapter 2.0. Module Model 3607E ON state voltage drop is < 3 V.
4.3.3.2.2.D	Discrete DC Output Module OFF State Leakage. The OFF state leakage current shall not exceed 2 mA.	Exception	See Ref. 45, Chapter 2.0. Module Models 3625 OFF state load leakage is 4 mA maximum.
4.3.3.2.2.E	Discrete DC Output Module Operating Range. The module points must operate for source inputs of 90 to 140 Vdc min. (125 Vdc output), 35 to 60 VDC min. (48 Vdc output), and 20 to 28 Vdc min. (24 Vdc output).	Exception	See Ref. 45, Section 2.0. Module Model 3607E (48 Vdc output) operates from 44 to 80 Vdc. Module Model 3625 (24 Vdc output) operates from 22 to 45 Vdc.
4.3.3.2.2.F	Discrete DC Output Module Response Time. The overall response time of the discrete DC output modules must support the response time requirement given in Section 4.2.1.A.	Comply	See Ref. 20, Section 3.0 and Table Section 4.2.1.A.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.3.3.2.2.G	Discrete DC Output Module Group-to-Group Isolation. The group-to-group isolation shall be at least twice nominal output.	N/A	See Ref. 45, Chapter 2.0. Tricon discrete DC output module points are not grouped.
4.3.3.2.2.H	Discrete DC Output Module Class 1E to Non-1E Isolation. The Class 1E to Non-1E isolation capability shall meet the requirements of Section 4.6.4.	N/A	Discrete DC output modules are not intended for use as a Class 1E to Non-1E isolation device.
4.3.3.2.2.I	Discrete DC Output Module Surge Withstand. Surge withstand shall be as given in Section 4.6.2.	Comply	See Ref. 39 and 57. Surge withstand capability meets IEC 61000-4-5 (Ring Wave) and IEC 61000-4-12 (Combination Wave) basic immunity levels.
4.3.3.2.3	Relay Output Requirements. (section heading)	- - -	No requirements.
4.3.3.2.3.A	Relay Output Module Types. The PLC shall include relay output modules that provide normally open and normally closed contacts.	Partial Exception	See Ref. 45, Chapter 2.0. Tricon relay output module contacts are normally open.
4.3.3.2.3.B	Relay Output Module Output Current. The continuous current carrying capacity must be at least 2 amps with make and break switching capability of at least 750 VA for AC and 150 watts for DC.	Comply	See Ref. 45, Chapter 2.0

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.3.3.2.3.C	Relay Output Module Contact Resistance. The contact resistance shall not exceed 2 ohms.	Comply	Per the vendor published catalog information, the contacts have a maximum resistance of 30 milli-ohms.
4.3.3.2.3.D	Relay Module Operating Range. The contacts must operate from a source of up to 30 VDC or 150 VAC.	Comply	See Ref. 45, Chapter 2.0
4.3.3.2.3.E	Relay Output Module Response Time. The overall response time of the relay output module must support the response time requirement given in Section 4.2.1.A.	Comply	See Ref. 20, Section 3.0 and Table Section 4.2.1.A.
4.3.3.2.3.F	Relay Output Module Group-to-Group Isolation. The group-to-group isolation shall be at least 600 volts peak.	N/A	See Ref. 45, Section 2. Tricon relay output module points are not grouped.
4.3.3.2.3.G	Relay Output Module Class 1E to Non-1E Isolation. The Class 1E to Non-1E isolation capability shall meet the requirements of Section 4.6.4.	Comply	See Ref. 41. Isolation test voltage levels selected per IEEE-384, Section 7.2.2.1.
4.3.3.2.3.H	Relay Output Module Surge Withstand. Surge withstand shall be as given in Section 4.6.2.	Comply	See Ref. 39 and 57 and 57. Surge withstand capability meets IEC 61000-4-5 (Ring Wave) and IEC 61000-4-12 (Combination Wave) basic immunity levels.
4.3.3.2.4	TTL Output Requirements. Requirements for TTL level output modules.	Exception	There is no TTL level output module available for use with the Tricon PLC.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.3.4	Processor/Other System Component Requirements. (section heading)	- - -	No requirements.
4.3.4.1	Processor Loop Time Requirements. Processor loop time shall support the response time requirement given in Section 4.2.1.A. Also, processor loop time shall be faster than the longer of the analog input conversion time or the period associated with 2.5 times the analog filter cutoff frequency.	Comply	See Ref. 20, Section 3.0 and Reference 52, Section 4. The processor loop time is included in the overall application program scan time, which is set by the user. For each nuclear plant application, the actual set scan time must be evaluated and demonstrated acceptable based on the data acquisition rates and response time requirements of the plant application.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.3.4.2	Memory Capacity and Data Retention Capability Requirements. The memory capacity of the main processor shall provide sufficient memory to execute a single application program with the number of program elements given.	Comply	See Ref. 45. A four chassis, 24 module Tricon system programmed as described in TR Section 4.3.4.2 has over 90% remaining free memory. See Ref. 46 for number of supported program elements.
	The memory used to contain the program shall be capable of retaining the information for a minimum of 6 months with no power applied.	Comply	See Ref. 45, Chapter 2, Page 28.
	Any memory used for field modifiable constants shall be capable of at least 100,000 write cycles.	Comply	Memory used for field modified constants is battery backed up ram on the 3008 main processors. There is no limit on the number of write cycles on this memory.
4.3.4.3	Data Acquisition Requirements. The PLC shall be capable of transferring information between the main processor and I/O modules mounted in the same or expansion chassis. The data transfer rate shall support the response time requirement given in Section 4.2.1.A, and 4.3.4.1.	Comply	See Ref. 45, Chapter 2, page 38-41.See Ref. 7, Section 4.0 and Table Section 4.2.1.A.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.3.4.3.A	Main Chassis Interconnect Device Operation. Devices used to interface remote or expansion chassis to the main chassis shall meet the range of environmental conditions given in Section 4.3.6. Failures of the chassis interconnect devices shall not defeat the ability to transfer data on the main chassis.	Comply Comply	See Ref. 35. Remote and expansion chassis interface devices were included in environmental testing. See Ref. 20, Section 7. Fault simulations of interconnect hardware performed during Operability tests showed that main chassis data transfer is not interrupted.
4.3.4.3.B	Main Chassis Interconnect Device Failure. Failures of the chassis interconnect devices shall not affect memory capacity or main processor data retention.	Comply	This attribute is inherent in the design of the Tricon. Local & Remote I/O operate independent of the MP memory.
4.3.4.3.C	Main Chassis Interconnect Device Loss of Power. Loss of power to chassis interconnect devices shall not defeat the ability to transfer data on the main chassis or I/O on any other chassis.	Comply	See Ref. 20, Section 7. Fault simulation of chassis power supplies performed during Operability tests showed that main chassis data transfer is not interrupted to local I/O or any other chassis.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.3.4.3.D	Main Chassis Interconnect Device Class 1E to Non-1E Isolation. The Class 1E to Non-1E isolation capability shall meet the requirements of Section 4.6.4.	N/A	See Ref. 41, Section 3. Multi-pin cable connectors in-between Tricon Chassis are not intended for use as a Class 1E to Non-1E isolation device. Fiber optic cable and interface (RXM) module connectors inherently provide Class 1E to Non-1E isolation through non-conducting fiber optic cables.
4.3.4.3.E	Main Chassis Interconnect Device Surge Withstand. Surge withstand shall be as given in Section 4.6.2.	N/A	See Ref. 27, Section 3.2. No interposing devices are used on multi-pin cable connectors and therefore surge testing is not required. Fiber optic cable and interface (RXM) module connectors inherently provide surge protection through non-conducting fiber optic cables.
4.3.4.3.F	Main Chassis Interconnect Device Data Acquisition Time. Data acquisition time shall be deterministic or manufacturer shall provide information to establish timing effect.	Comply	See Ref. 45, Chapter 2, Page 31 and 44. All expansion or remote chassis communication is at same rate as main chassis communication.
4.3.4.3.G	Redundant Inter-Processor Data Acquisition Backplane Busses. Descriptive information.	- - -	No requirements.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.3.4.3.G.1	Redundant Inter-Processor Data Acquisition Backplane Busses. Busses shall be at least dual redundant.	Comply	See Ref. 42.
4.3.4.3.G.2	Redundant Inter-Processor Data Acquisition Backplane Busses. Loss of one bus shall not cause misoperation.	Comply	See Ref. 42.
4.3.4.3.G.3	Redundant Inter-Processor Data Acquisition Backplane Busses. Loss of all busses shall not result in an indeterminate operation.	Comply	See Ref. 42.
4.3.4.3.G.4	Redundant Inter-Processor Data Acquisition Backplane Busses. External alarm shall be activated on loss of one bus.	Comply	See Ref. 42.
4.3.4.3.G.5	Redundant Inter-Processor Data Acquisition Backplane Busses. Data acquisition time shall be deterministic.	Comply	See Ref. 42.
4.3.4.3.G.6	Redundant Inter-Processor Data Acquisition Backplane Busses. Operation of busses shall support the response time requirement given in Section 4.2.1.A.	Comply	See Ref. 20, Section 3.0. Redundant busses are always operational. Therefore, response time determination and qualification testing was performed with redundant busses operational.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.3.4.4	Communication Port Requirements. The main processor shall provide at least one communication port.	Comply	See Ref. 45, Chapter 2, Page 148. TCM Module.
4.3.4.4.A	Communication Port Data Rate. The port shall support data rates up to 9600 baud.	Comply	See Ref. 45, Table 60
4.3.4.4.B	Communication Port Interface. The port shall support RS-232, RS-422, RS-485 or other widely used protocol.	Comply	See Ref. 45, Table 61.
4.3.4.4.C	Communication Port Connector. The port shall provide positive hold down of connectors.	Comply	See Ref. 50, Appendix A. Standard DB-9 connectors provided on TCM ports.
4.3.4.4.D	Communication Port Isolation. For multiple ports, the port-to-port isolation shall be at least 300 volts peak.	Comply	See Ref. 50, Appendix A
4.3.4.4.E	Communication Port Class 1E to Non-1E Isolation. The Class 1E to Non-1E isolation capability shall meet the requirements of Section 4.6.4.	Exception	See Ref. 41, Section 7.0. Tricon TCM serial communication ports tested for Class 1E to Non-1E isolation capability at 250 Vac (vs. 600 Vac required by TR) and 250 Vdc. Test level is based on maximum credible voltage (see Ref. 41).

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.3.4.4.F	Communication Port Surge Withstand. Surge withstand shall be as given in Section 4.6.2.	Comply	See Ref. 39 and 57. Surge withstand capability meets IEC 61000-4-5 (Ring Wave) and IEC 61000-4-12 (Combination Wave) basic immunity levels.
4.3.4.5	Coprocessor Module Requirements. Detailed requirements for coprocessors that may be installed in I/O slots but contain local processing capability independent of the main processor.	N/A	See Ref. 20. Section 3.0. Operation of Tricon coprocessors is invoked automatically during application program execution. Coprocessor performance is evaluated during all qualification tests.
4.3.4.6	Chassis Requirements. Chassis must be suitable for mounting in a standard 19 inch rack, and must have adequate strength and provide positive hold down of modules sufficient to meet seismic withstand requirements.	Comply	See Ref. 45, Chapter 3, Page 169. See Ref. 13, Drawing No. 9600164-102 for seismic mounting details. See Ref. 36, Section 7.0 for summary of seismic test results.
4.3.4.7	Backup Devices/Redundancy Requirements. Descriptive information.	- - -	No requirements.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.3.4.7.A	Redundant Device Requirements. Transfer to a redundant device shall occur within the larger of the main processor scan cycle or three data conversion cycles of the failed module.	N/A	See Ref. 20, Section 7, Subsection 1.0. Because redundant components are always online, component faults do not result in transfers to a redundant component.
4.3.4.7.B	Redundant Device Requirements. Undetected failures in redundant components shall be detectable during periodic surveillance.	N/A	See Ref. 20, Section 7, Subsection 1.0. Because redundant components are always online, failures can be immediately indicated through redundant alarm circuits.
4.3.4.7.C	Redundant Device Requirements. Diagnostics shall not result in indeterminate failure states and repetitive switching between redundant components.	N/A	See Ref. 20, Section 7, Subsection 1.0. Because redundant components are always online, switching between failed components does not occur.
4.3.4.7.D	Redundant Device Requirements. Requirements for affect of transfer mechanism operation on input/output module operation.	N/A	See Ref. 20, Section 7, Subsection 4.0. Because redundant components are always online, “transfers” to redundant components are bumpless.
4.3.5	Programming Terminal Requirements. Special programming terminal hardware or software shall meet the requirements of Sections 4.4.4, 7.7.2 and 7.5.2.	Comply	See Table Sections 4.4.4, 7.7.2, and 7.5.2. No special programming terminal hardware is required.
4.3.6	Environmental Requirements. (section heading)	- - -	No requirements.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.3.6.1	Normal Environmental Basic Requirements. The normal PLC operating environment is: Temperature Range: 16 to 40ºC (60 to 104ºF). Humidity Range: 40 to 95% (non-condensing)	Comply	See Ref. 49. Tricon is rated for 0 to 60ºC (32 to 140ºF), 5% to 95% humidity (non-condensing).
	Power Source Range: As given in Section 4.6.1.1	Exception	See Table Section 4.6.1.1 for exceptions to power source range.
	Radiation Exposure: Up to 1000 Rads	Comply	See Ref. 34. Tricon has been tested to a 1000 Rad dose of Co60 gamma radiation.
4.3.6.2	Abnormal Environmental Basic Requirements. The abnormal PLC operating environment is: Temperature Range: 4 to 50ºC (40 to 120ºF). Humidity Range: 10 to 95% (non-condensing)	Comply	See Ref. 49. Tricon is rated for 0 to 60ºC (32 to 140ºF), 5% to 95% humidity (non-condensing).
	Power Source Range: As given in Section 4.6.1.1	Exception	See Table Section 4.6.1.1 for exceptions to power source range.
	Radiation Exposure: Up to 1000 Rads	Comply	See Ref. 34. Tricon has been tested to a 1000 Rad dose of Co60 gamma radiation.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.3.6.3	Environmental Withstand Specific Requirements. PLC shall operate for the temperature/humidity profile given in TR Figure 4-4 with operability as given in Section 5.3. Evaluations may be used to establish radiation withstand capability.	Comply	See Ref. 35, Section 7.0 & Ref. 34 for tested radiation capability.
4.3.7	EMI/RFI Withstand Requirements. The PLC shall withstand EMI/RFI levels given in EPRI TR-102323. When exposed to the radiated and conducted test levels, the PLC processors shall continue to function, I/O data transfer shall not be interrupted, discrete I/O shall not change state, analog I/O shall not vary more than 3%.	Exception	Tricon showed some susceptibilities to NRC RG 1.1.80 Rev. 1 (CE101). See Ref. 37 for results.
4.3.8	Electrostatic Discharge (ESD) Withstand Requirements. The PLC shall withstand ESD levels given in EPRI TR-102323.	Comply	See Ref. 40.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.3.9	Seismic Withstand Requirements. PLC shall be suitable for qualification as a Category 1 Seismic device. The PLC shall meet performance requirements during and after exposure to OBE and SSE levels shown in TR Figure 4-5.Relay contacts of relay output modules shall not chatter.	Comply	See Ref. 36. Seismic testing demonstrates that the TRICON is qualified as a Category I seismic device within the test limits shown in Figure 4-5. Due to limitations of the seismic test table, the five OBE tests and the SSE test of the TRICON were performed using a test response spectrum (TRS) that did not envelope the required response spectrum (RRS) below 4.5 Hz for the OBE and 6.3 Hz for the SSE
4.4	Software/Firmware. (section heading)	- - -	No requirements.
4.4.1	Executive. (section heading)	- - -	No requirements.
4.4.1.1	Background. Descriptive information.	- - -	No requirements.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.4.1.2	Main Processor Executive Capability Requirements. The main processor executive shall: A. Acquire inputs from the modules. B. Implement the application program in a continuous loop. C. Load outputs to the modules. D. Perform power-up and run time diagnostics. E. Manage communications. F. Upload application programs. G. Support on-line diagnostics, maint. and troubleshooting. H. Implement the application program functions. I. Perform power-up initialize functions. J. Implement redundancy functions.	Comply	See Ref. 42.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.4.1.3	Program Flow Control Requirements. Requirements for PLCs where scanning of the inputs and application program execution are performed in parallel.	Comply	See Ref. 42. Tricon is a scan based system execution of each application program scan is preceded by an input module data request. While program is being executed for a given scan, the input modules continue to collect inputs from the field devices for the next scan.
	The use of application program interrupts shall be restricted. The use of interrupts that result in non-deterministic application program execution should not be permitted.	Comply	See above.
	Requirements for PLCs that implement interrupts that could result in non-deterministic application program execution.	N/A	Tricon is a scanned based system. See Ref. 42
4.4.1.4	Unintended/Unused Function Isolation Requirements. Descriptive information.	- - -	No requirements.
4.4.1.5	Coprocessor Executive Capability. (section heading)	- - -	No requirements.
4.4.1.5.1	Coprocessor Executive Capability Background. Descriptive information.	- - -	No requirements.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.4.1.5.2	Coprocessor Executive Capability Requirements. Requirements for coprocessor resident executives or invoked utilities.	N/A	Tricon coprocessors are not user programmable. Tricon executive software includes coding for control and operation of embedded coprocessors.
4.4.2	Media Requirements. Software media provided by the manufacturer shall be high quality and new. CD-ROMS or 3-1/2 inch floppy disks are acceptable. Packaging shall preclude damage during shipping. Media shall be clearly labeled including revision and serial number. Media shall include electronic identification.	Comply	See Ref. 46, Project Administration section. See Ref. 54, Section QAM 15.0, Handling, Storage, Packaging Preservation, and Delivery.
4.4.3	Ladder Logic Requirements. Descriptive information.	- - -	No requirements.
4.4.3.A	Standard Functions. Simple normally inactive and normally active paths.	Comply	See Ref. 46, Table 39.
4.4.3.B	Standard Functions. Transition ON/OFF (one-shot) paths.	Comply	See Ref. 46, Table 39.
4.4.3.C	Standard Functions. Simulate break before make and make before break contact actions.	Comply	See Ref. 46, Table 39. Requires two program scans.
4.4.3.D	Standard Functions. Coils that change paths from normal to alternate states when energized.	Comply	See Ref. 46, Table 37.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.4.3.E	Standard Functions. Coils that change paths from normal to alternate states when energized and remain there until the coils are de-energized and a reset signal is applied.	Comply	See Ref. 46, Table 37.
4.4.3.F	Standard Functions. Timing functions that can be set from 0.1 seconds to 2 hours.	Comply	See Ref. 47, TMR function. Must be set to multiples of the application program scan time.
4.4.3.G	Standard Functions. Counters that perform up or down counting from at least 1 to 9999.	Comply	See Ref. 47, CTD and CTU functions.
4.4.3.H	Standard Functions. Methods to perform less than, equal to and greater than numeric comparisons.	Comply	See Ref. 47, LT, GT and EQ conditional statements.
4.4.3.I	Standard Functions. Addition, subtraction, multiplication, and division functions for integer and floating point numbers. Out of range and error on division by zero.	Comply	See Ref. 47, ADD, SUB, MUL and DIV operators, DINT and REAL point types. CHK_ERR function block.
4.4.3.J	Standard Functions. Square root, exponentiation and logarithm functions. Out of range indications.	Comply	See Ref. 47, SQRT, EXPT and LOG functions. CHK_ERR function block.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.4.3.K	Standard Functions. A PID algorithm with 5 to 500% proportional band, 1% resolution, 0 to 100 repeats per minute integral action, 1 repeat per second resolution, anti-reset windup, 0 to 100 minutes rate action, 1 second resolution, output limiting, out of range indication, bumpless transfer to external switch activated manual control, cascade control.	Comply	See Ref. 47, PID and CHK_ERR function blocks. See Ref. 15.
4.4.3.L	Standard Functions. A dynamic compensation function. Lead/lag ratio of 0 to 10, minimum resolution of 0.05, 0.01 to 100 minute lag time, minimum 1 second resolution, lead action filter.	Comply	See Ref. 47, LEADLAG and EXPFLTR function blocks. See Ref. 15.
4.4.3.M	Standard Functions. Capability to put limits on values.	Comply	See Ref. 47, LIMIT function.
4.4.3.N	Standard Functions. Implement a function generator with at least five slopes.	Comply	See Ref. 15.
4.4.3.O	Standard Functions. Support Section 4.9.1 communications requirements.	Comply	See Table Section 4.9.1.
4.4.3.P	Standard Functions. Functions to capture results of self-tests.	Comply	See Ref. 47.
4.4.3.Q	Standard Functions. Functions to implement sequence of events requirements in Section 4.4.9.	Comply	See Ref. 59.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.4.3.R	Standard Functions. AND, OR and XOR bit manipulation functions.	Comply	See 47, AND, OR and XOR library functions.
4.4.3.S	Standard Functions. Functions to store results in buffer type memory, 10 instances of 50 values. Facilities to transmit this data over a serial port.	Comply	See Ref. 15.
4.4.3.T	Standard Functions. Functions to implement requirements of Section 4.4.7.2.	Comply	See Table Section 4.4.7.2.
4.4.3.U	Standard Functions. Capability to attach comments to ladder logic rungs.	Comply	See Ref. 47.
4.4.4	Software Tools Requirements. A tool shall be provided for programming, debugging and documentation.	Comply	See Ref. 46 and 47. The tool is Tristation 1131.
4.4.4.A	Software Tools Requirements. Ability to use a host device to enter a program in the PLC.	Comply	See Ref. 46, Introduction.
4.4.4.A.1	Software Tools Requirements. Ability to attach explanatory comments to program steps.	Comply	See Ref. 47.
4.4.4.A.2	Software Tools Requirements. Ability to store programs on removable magnetic media.	Comply	See Ref. 46 and 47Appendix A.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.4.4.A.3	Software Tools Requirements. Ability to perform bit by bit comparison of program contained in PLC and program contained in programming device.	Comply	See Ref. 46Appendix A.
4.4.4.A.4	Software Tools Requirements. Ability to print the program contained in the PLC or programming device in a fashion similar in appearance to programming device display. Include supplemental prints of programming values.	Comply	See Ref. 46 and 47, .
4.4.4.A.5	Software Tools Requirements. Features to aid in I/O mapping and memory management of the PLC.	Comply	See Ref. 47 and 49
4.4.4.A.6	Software Tools Requirements. System security requirements similar to Section 4.9.2.	Comply	See Table Section 4.9.2.
4.4.4.B	Debugging Aids. Descriptive information.	- - -	No requirements.
4.4.4.B.1	Debugging Aids. Ability to highlight all discrete elements not in their normal state.	Comply	See Ref. 46.
4.4.4.B.2	Debugging Aids. Ability to display input, output and intermediate program values.	Comply	See Ref. 46.
4.4.4.B.3	Debugging Aids. Ability to set constants and variables to arbitrary values, including values outside normal range.	Comply	See Ref. 46.
4.4.4.B.4	Debugging Aids. Ability to force outputs.	Comply	See Ref. 46.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.4.4.B.5	Debugging Aids. Ability to single step through a program.	Comply	See Ref. 46.
4.4.4.B.6	Debugging Aids. Ability to view the status of memory where error codes and other status information is stored.	Comply	See Ref. 60.
4.4.4.C	Software Tools Requirements. Apply Configuration management requirements per Section 7.7.3.	Comply	See Table Section 7.7.3.
4.4.4.D	Software Tools Requirements. Meet requirements of Sections 4.4.5.2 and 4.4.7.2.	Comply	See Table Sections 4.4.5.2 and 4.4.7.2.
4.4.4.E	Software Tools Requirements. Software Verification and Validation requirements of Section 7.4 shall be applied to the software tools.	Comply	See Ref. 52.
4.4.4.F	Software Tools Requirements. Provide features to aid in detecting faults in redundant components which are not detectable by self-diagnostics.	N/A	All faults in redundant components are detectable through self-diagnostics.
4.4.5	Configuration Identification. (section heading)	- - -	No requirements.
4.4.5.1	Configuration Identification Background. Descriptive information.	- - -	No requirements.
4.4.5.2	Configuration Management Aids Requirements. Descriptive information.	- - -	No requirements.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.4.5.2.A	Configuration Management. The PLC executive shall include a retrievable, embedded electronic revision level.	Comply	See Ref. 60.
4.4.5.2.B	Configuration Management. Configuration information of configurable modules shall be retrievable in the field.	Comply	See Ref. 47.
4.4.5.2.C	Configuration Management. Software tools for modifying device configurations shall provide measures to prevent unauthorized access.	Comply	See Ref. 47.
4.4.5.2.D	Configuration Management. PLC and support tools shall provide capability to extract and record database information, including program constants.	Comply	See Ref. 47.
4.4.5.2.E	Configuration Management. All PLC devices that include firmware shall be marked with an identifier that includes revision level.	Comply	See Ref. 45, Appendix A.
4.4.5.2.F	Configuration Management. For PLCs with redundancy, tools shall provide capability to confirm that configurations are consistent.	Comply	See items 4.4.5.2.A and 4.4.5.2.B above.
4.4.6	Diagnostics Requirements. (section heading)	- - -	No requirements.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.4.6.1	General Diagnostic Requirements. PLC must have sufficient diagnostics and test capability to detect all failures that could prevent the PLC from performing its intended safety function.	Comply	See Table Sections 4.4.6.1.1 through 4.4.6.1.14.
	Items 4.4.6.1.1 through 4.4.6.1.6 must be covered by on-line self test.	Comply	See Table Section 4.4.6.2.
	Items 4.4.6.1.7 and 4.4.6.1.8 must be covered in power-up tests.	Comply	See Table Section 4.4.6.3.
	Short term diagnostics changes in module outputs shall be 2 msec or less for DC outputs and 1/2 cycle or less for AC outputs. Capability to disable these diagnostics shall be provided.	Comply	See Ref. 45, Chapter 2 Page 83.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.4.6.1.1	Processor Stall. For PLCs with redundant processors, the PLC shall detect processor stall and halt operation of the failed processor.	Comply	Failure Detect: See Ref. 42, Section 8.13. Failure Alarm: See Ref. 45, Tables 74 and 75, MP Active LED. Application Program Interface: See Ref. 47, TR-MP-STATUS function.
4.4.6.1.2	Executive Program Error. Check of executive firmware integrity using a checksum or similar test.	Comply	Failure Detect: See Ref. 42, Section 8.13. Failure Alarm: See Ref. 45, Chapter 4, Table 75, MP Fault LED. Application Program Interface: See Ref. 47, TR-MP-STATUS function.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.4.6.1.3	Application Program Error. Check of application program integrity using a checksum or similar test.	Comply	Failure Detect: See Ref. 42, Section 8.13. Failure Alarm: See Ref. 45, Chapter 4, Table 74, MP Active LED. Application Program Interface: See Ref. 47, TR-MP-STATUS function.
4.4.6.1.4	Variable Memory Error. Read/Write memory test by writing and reading back bit patterns that test both states of all bits, or similar test.	Comply	Failure Detect: See Ref. 42, Section 8.13. Failure Alarm: See Ref. 45 Chapter 4, Table 75, MP Fault LED. Application Program Interface: See Ref. 47, TR-MP-STATUS function.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.4.6.1.5	Module Communication Error. Check of communication data integrity.	Comply	Failure Detect: See Ref. 42, Section 8.13. Failure Alarm: See Ref. 45, Chapter 4, Table 76, MP COM RX and TX LEDs. Application Program Interface: See Ref. 47, TR-MP-STATUS and TR-PORT-STATUS functions.
4.4.6.1.6	Memory Battery Low. Check of memory battery capacity.	Comply	Failure Detect: See Ref. 45, Chapter 4, Table 75, Bat Low. Failure Alarm: See Ref. 45, Chapter 4, Table 75, Bat Low LED.
4.4.6.1.7	Module Loss of Configuration. For software configurable modules, validate configuration.	Comply	Failure Detect and Alarm: See Ref. 45, Chapter 4, Table 77, Main Chassis Power Module. Application Program Interface: See Ref. 47, TR-CHASSIS-STATUS function.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.4.6.1.8	Failure of Watchdog Timer. Check of operation of watchdog timer.	Comply	Failure Detect: See Ref. 43, Section 8.13. Failure Alarm: See Ref. 45, Chapter 4, Table 75, MP Fault LED. Application Program Interface: See Ref. 47, TR-MP-STATUS function.
4.4.6.1.9	Application not Executing. Failure to complete application program scan.	Comply	Failure Detect: See Ref. 42, Section 8.13. Failure Alarm: See Ref. 45, Chapter 4, Table 75, MP Active LED. Application Program Interface: See Ref. 47, TR-MP-STATUS function.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.4.6.1.10	Analog Output not Following. Failure of analog output to following commanded value.	Comply	Failure Detect: See Ref. 45, Chapter 4, Table 80. Failure Alarm: See Ref. 45, Chapter 4, Table 80, Analog Output Module Fault LED. Application Program Interface: See Ref. 47, TR-SLOT-STATUS function.
4.4.6.1.11	Analog Input not Responding. Failure of analog input to respond to input signal.	Comply	Failure Detect: See Ref. 45, Chapter 4, Table 80 and Table 81. Failure Alarm: See Ref. 45, Chapter 4, Table 80 and Table 81, Module Fault LEDs. Application Program Interface: See Ref. 47, TR-SLOT-STATUS function.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.4.6.1.12	Discrete Input/Ouput not Responding. Failure of discrete input/output to operate correctly.	Comply	Failure Detect: See Ref. 45, Chapter 4, Table 79 & Table 80. Failure Alarm: See Ref. 45, Chapter 4, Table 79 & Table 80, Module Fault LEDs. Application Program Interface: See Ref. 47, TR-SLOT-STATUS, TR-POINT-STATUS and TR-MP-STATUS functions.
4.4.6.1.13	Analog I/O out of Calibration. Analog input or output point out of calibration.	Comply	Failure Detect: See Ref. 45, Chapter 4, Table 80 and Table 81. Failure Alarm: See Ref. 45, Chapter 4, Table 80 and Table 81, Module Fault LEDs. Application Program Interface: See Ref. 47, TR-SLOT-STATUS function.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.4.6.1.14	Power Supply out of Tolerance. Power supply to PLC is interrupted or a chassis power supply module fails.	Comply	Failure Detect: See Ref. 45, Chapter 4, Table 77 & Table 78. Failure Alarm: See Ref. 45, Chapter 4, Table 77 & Table 78, Module Fault LEDs. Application Program Interface: See Ref. 47, TR-CHASSIS-STATUS function.
4.4.6.2	On-Line Self-Test Requirements. On-line self-tests shall cover at least items 4.4.6.1.1 through 4.4.6.1.6 above. Results shall be made available to the application program.	Comply	See Ref. 42, Section 8.1.3. See Table sections 4.4.6.1.1 through 4.4.6.1.6 above.
4.4.6.3	Power Up Diagnostics Requirements. Power up diagnostics shall include all on-line self tests, configuration verification, and test of failure to complete a scan. Application program execution shall be inhibited if power up diagnostics detect a failure.	Comply	See Ref. 42, Sections 8.1.3. The Power Up diagnostics and initializations are followed by execution of the background runtime diagnostics and fault analysis functions, which include the on-line self tests identified in Table Section 4.4.6.2.
4.4.7	Data and Data Base. (section heading)	- - -	No requirements.
4.4.7.1	Data and Data Base Overview. Descriptive information.	- - -	No requirements.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.4.7.2	Data and Data Base Requirements. Descriptive information.	- - -	No requirements.
4.4.7.2.A	Data and Data Base Requirements. PLC shall support use of user-defined program constants that are contained in non-volatile memory. Features shall confirm that constants in redundant processors are the same.	Comply	See Ref. 46, Application Development. See Ref. 45, Table 8, memory is battery backed. See Ref. 42, Section 8.1.3, constants in memory are continuously verified.
4.4.7.2.B	Data and Data Base Requirements. PLC shall provide functions to read and modify data base constants. Features shall confirm that modified constants are consistent between redundant processors.	Comply	See Ref. 46, Application Development. See Ref. 42, Section 8.1.3, constants in memory are continuously verified.
4.4.7.2.C	Data and Data Base Requirements. PLC shall provide features to prevent modifications to data base constants over connected communication paths.	Comply	See Ref. 46, Project Administration.
4.4.7.2.D	Data and Data Base Requirements. PLC shall provide features to permit transmitting input, outputs and calculated values to other devices over a serial port.	Comply	See Ref. 15.
4.4.8	Other Non-Ladder Logic Programming Languages. (section heading)	- - -	No requirements.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.4.8.1	Requirements for Sequential Logic Languages. Sequential logic language other than ladder logic may be used. Language shall provide capabilities given in Section 4.4.3. Language must support tools with features given in Section 4.4.4.	Comply	See Ref. 46, Application Development. Tristation 1131 also provides Function Block Diagram and Structured Text languages for application development. All discussions in Table Sections 4.4.3 and 4.4.4 apply to these languages as well.
4.4.8.2	Standard High Level Languages. (section heading)	- - -	No requirements.
4.4.8.2.1	Overview of Standard High Level Languages. Descriptive information.	- - -	No requirements.
4.4.8.2.2	Requirements for Standard High Level Languages. Required capabilities of supported standard high level programming languages.	N/A	Tricon does not support use of standard high level programming languages.
4.4.9	Sequence of Events Processing Requirements. Descriptive information.	- - -	No requirements.
4.4.9.A	Sequence of Events. Shall permit application program to capture, store and time tag up to 20 transitions of up to 50 different discrete events of inputs or application objects.	Comply	See Ref. 48, Chapter 3. A single SOE block (or list of discrete variables) will support recording of 100,000 events.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.4.9.B	Sequence of Events. Shall permit starting and stopping the event recording.	Comply	See Ref. 48, Chapter 2,. SOESTRT and SOESTOP commands.
4.4.9.C	Sequence of Events. Shall permit transmitting the data to an external device using a PLC communication port.	Comply	See Ref. 46, Introduction. Supports transmission of data through TCM.
4.4.9.D	Sequence of Events. Relative accuracy of time tags shall be one scan cycle ± 50 msecs.	Comply	See Ref. 46, , Using Time Synchronization. Accuracy of time tags is one scan cycle ± 25 msecs
4.4.10	System Integration Requirements. An appropriate level of system integration and integration testing shall be applied to the test specimen and TSAP.	Comply	See Table Section 5.2.C.
4.5	Human/Machine Interface (HMI). (section heading)	- - -	No requirements.
4.5.1	Human/Machine Interface (HMI) Background. Descriptive information.	- - -	No requirements.
4.5.2	Requirements for Human/Machine Interface Functions. Descriptive information.	- - -	No requirements.
4.5.2.A	HMI Functions. PLC shall support switching a loop controller between manual and automatic via switch inputs. For control loops with integral action, auto/manual tracking shall be provided.	Comply	See Ref. 47, LEADLAG and PID function descriptions. See Ref. 15.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.5.2.B	HMI Functions. PLC shall support setpoint adjustments via switch inputs. Adjustments shall include increase, decrease, and rate of change of setpoint.	Comply	See Ref. 15.
4.5.2.C	HMI Functions. PLC shall support manual initiation of equipment via switch inputs. PLC shall support detection of manually initiated equipment.	Comply	See Ref. 15.
4.5.2.D	HMI Functions. PLC shall support display of status of discrete and continuous value parameters via connected devices.	Comply	See Ref. 15.
4.5.2.E	HMI Functions. PLC shall support sending information to a serial port device. Information sent shall include input, output and internal variable values, on-line diagnostics, sequence of events (SOE) data, and results of calculations, comparisons and bit manipulations.	Comply	See Ref. 15.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.5.3	Requirements for Interactive Features. The PLC shall provide mechanisms to prevent unauthorized access to or inadvertent use of on-line functions.	Comply	See Ref. 13, Chassis Options.
	Interactive features shall be available through a programming, maintenance and debugging port. PLC shall operate with no connection to this port.	Comply	See Ref. 46.
	PLC shall mask interactive commands during run mode.	Comply	See Ref. 13, Chassis Options.
4.5.4	Requirements for Operator Action System Response Times. For any operator action that requires PLC confirmation, the PLC shall include features to enable confirmation within 0.5 seconds.	Comply	See Ref. 47. As an example, a discrete input to discrete output sequence with intervening internal timer function would meet this requirement.
4.5.5	Display Requirements. LEDs are acceptable for any status displays.	Comply	See Ref. 45, Chapter 4.
4.5.6	Alarm Processing Requirements. Descriptive information.	- - -	No requirements.
4.5.6.A	Alarm Processing. PLC shall have ability to compare inputs or derived parameters to setpoints.	Comply	See Ref. 15.
4.5.6.B	Alarm Processing. PLC shall have ability to latch an alarm condition and reset based on alarm reset condition.	Comply	See Ref. 15.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.5.6.C	Alarm Processing. PLC shall have ability to blink an output indicator.	Comply	See Ref. 47, BLINK function. As an example, a discrete output driven by a BLINK coil would meet this requirement.
4.5.6.D	Alarm Processing. PLC shall have ability to acknowledge an alarm.	Comply	See Ref. 46, LATCH coil function. As an example, a discrete input connected to a LATCH coil would meet this requirement.
4.5.6.E	Alarm Processing. Application program shall have ability to capture results of self-diagnostics.	Comply	See Ref. 46. As an example, TR_xxx_STATUS functions return diagnostic status of system hardware to application program.
4.5.6.F	Alarm Processing. Application program shall have ability to store results of items A through E in a buffer and transmit the data via a communication port.	Comply	See Ref. 45, Chapter 2, Page 38, As an example, Sequence of Events utility can store and transmit alarm information.
4.5.7	Hard Manual Backup. Descriptive information.	- - -	No requirements.
4.6	Electrical. (section header)	- - -	No requirements.
4.6.1	Power Supply Requirements. (section heading)	- - -	No requirements.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.6.1.1	PLC Power Sources and Power Supply Requirements. Descriptive information.	- - -	No requirements.
4.6.1.1.A	Power Sources. AC sources shall operate from at least 90 Vac to 150 Vac and 57 to 63 Hz.	Exception	See Ref. 45 and 49. Model 8310 AC power supply modules are rated for 85 to 140 Vac input.
	AC sources shall operate at the temperature and humidity range given in Section 4.3.6.	Comply	See Ref. 35. Model 8310 AC power supply modules were tested as per required temperature and humidity range (see Table Section 4.3.6.3).

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.6.1.1.B	Power Sources. DC sources shall operate from at least 20.4 to 27.6 Vdc.	Exception	See Ref. 45 and 49. Model 8311 DC power supply modules are rated for 22 to 31 Vdc input.
	DC sources shall operate at the temperature and humidity range given in Section 4.3.6.	Comply	See Ref. 35. Model 8311 DC power supply modules were tested as per required temperature and humidity range (see Table Section 4.3.6.3).
4.6.1.1.C	Power Sources. DC sources shall operate for seven days from a 30 VDC source.	Comply	See Ref. 19 Section 10.18.
4.6.1.1.D	Power Sources. Sources shall be capable of supplying 1.2 times bus loading for a fully loaded main chassis.	Comply	See Ref. 49, Page 24.
4.6.1.1.E	Power Sources. Sources shall be capable of supplying 1.2 times bus loading for a fully loaded expansion chassis.	Comply	See Ref. 49 Page 24.
4.6.1.1.F	Power Sources. Hold up time for AC supplied power sources shall be 40 msec.	Comply	Ref. 53, Section 7.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.6.1.1.G	Power Sources. Sources shall meet the EMI/RFI, surge withstand and ESD requirements of Sections 4.3.7, 4.6.2 and 4.3.8.	Comply	See Ref. 37, Ref. 39 and Ref. 40.
	Sources shall meet the grounding requirements of Section 4.6.8.	Comply	See Table Section 4.6.8.
4.6.1.1.H	Power Sources. Requirements for fan cooled power sources.	N/A	See Ref. 45, Chapter 3, Page 170. Tricon power supplies are convection cooled.
4.6.1.1.I	Power Sources. Faults in redundant power sources shall not prevent operation of the alternate supply.	Comply	See Ref. 45, Page 32. Redundant power sources are independently fused.
4.6.1.2	Loop Power Supply Requirements. Power supply modules shall be provided for external devices. Modules shall provide at least 500 mA at 24 VDC. The modules shall meet requirements A, B, C, F. G and H above.	N/A	No third party power supplies were included in the qualification program.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.6.2	Surge Withstand Capability Requirements. PLC platform shall withstand IEEE Standard C62.41 ring wave and combination wave, 3000 volt peak surges.	Comply	See Ref. 39 and 57. Power sources meet surge withstand criteria- Circuits were tested to IEC 61000-4-5 and IEC 61000-4-12 using 1 kV Ring wave, and combination waves at 1kV open circuit/0.5kA short circuit per R.G. 1.180, Rev. 1, Level 2. All circuits met TR Section 4.6.2 acceptance criteria.
	Withstand capability applies to power sources, analog and discrete I/O interfaces, and communication port interfaces. Per Section 6.3.5, surge testing shall be conducted per IEEE Standard C62.45.	Partial Exception	Power Sources were tested per Reg Guide 1.180 Rev. 1 for category B low exposure installations to 2KV. IEEE Standards 62.41 and 62.45 do not address testing of I/O and communication circuits; these circuits were tested per Reg. Guide 1.180 Rev. 1 for low exposure level 2 installations at 1KV. Tests were performed to IEC61000-4-5 for Combination Wave and 61000-4-12 for Ring Wave.
4.6.3	Separation. Descriptive information.	- - -	No requirements.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.6.4	Class 1E/Non-1E Isolation Requirements. The PLC modules shall provide isolation of at least 600 Vac and 250 Vdc applied for 30 seconds. Isolation features shall conform to IEEE 384. Isolation testing shall be performed on the modules.	Exception	See Ref. 41. Only relay output modules, communication ports, and fiber optic chassis inter- connections are intended to provide Class 1E to Non-1E isolation. Isolation tests were performed on relay output module and communication ports. Relay output module meets TR Section 4.6.4 isolation requirements. Communication ports provide isolation to 250 Vac and 250 Vdc for 30 seconds. Fiber optic chassis connections inherently provide isolation through non-conducting fiber optic cables.
4.6.5	Cable/Wiring Requirements. Manufacturer shall supply all PLC hardware interconnecting cabling. All cabling shall be suitable for UL Class 2 service. Specifically, withstand rating shall be larger of 3 times the signal level voltage or 150 volts. Temperature rating shall be 60ºC or greater. Vendor shall identify the quantities of PVC type wire and cable used in the system.	Comply	See Ref. 49 and 61 Chassis-to-chassis and chassis-to-termination panel interconnect cables are rated for 300 VAC and a minimum of 80ºC. Cable jackets are made of PVC or XLPE.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.6.6	Termination Requirements. Modules shall be able to be removed without disconnecting field wiring.	Comply	See Ref. 48..
	Features shall be provided to substitute test signals or monitoring instruments for field connections. Connectors to the PLC shall have positive hold down mechanisms.	Comply	See Ref. 45 and 48
	Connectors and terminations to the PLC shall be qualified with the generic PLC.	Comply	See Ref. 3. Field termination panels were included in the qualification test specimen.
4.6.7	Backup Power. Descriptive information.	- - -	No requirements.
4.6.8	Grounding/Shielding Requirements. The PLC equipment shall meet IEEE 1050 and EPRI TR-102323 grounding requirements. This includes supporting connection to single point, multi-point and floating ground systems, and providing separate ground connection points on each chassis for AC ground, DC ground, and signal ground.	Comply	See Ref. 45, Chapter 3.
	The PLC equipment shall meet IEEE 1050 and EPRI TR-102323 shielding requirements. This includes providing shielding connection points for the I/O module field terminations.	Comply	See Ref. 45, Chapter 3.
4.7	Maintenance. (section heading)	- - -	No requirements.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.7.1	Maintenance Background. Descriptive information.	- - -	No requirements.
4.7.2	Diagnosis/Built-in Testability Requirements. Descriptive information.	- - -	No requirements.
4.7.3	Module Replacement Requirements. The PLC shall contain features to aid in module replacement.	Comply	See Ref. 45, Chapter 3.
	The maintenance manual shall contain a description of any hardware configuration item for each module.	Comply	See Ref. 45, Chapter 3.
	The module hold downs shall be easily accessible and provide ease of removal and reinstallation.	Comply	See Ref. 45, Chapter 3.
4.7.4	Preventive Maintenance Requirements. Equipment manuals shall contain preventive maintenance information. Preventive maintenance shall also include components identified in Section 4.7.8.2.	Comply	See Ref. 45, Chapter 3. See Table Section 4.7.8.2.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.7.5	Surveillance Testing Requirements. The PLC shall support IEEE 338 surveillance testing through: - Ability to read input, intermediate and output values. - Ability to force output values. - Ability to make connections to all I/O signals. - Ability to program I/O operations.	Comply	See Ref. 49, Page 59. Tristation 1131 connection permits required access to application program variables. Also, screw terminals used on field termination panels can be loosened for connection to all I/O signals.
	Features and procedures shall be provided that permit detection of failures of all redundant components if those failures are not detectable by self-diagnostics or are masked by redundant channel behavior.	N/A	See Ref. 45, Chapter 4. All failures of redundant devices are indicated by module fault LEDs.
4.7.6	Output Bypass/Control Devices. Descriptive information.	- - -	No requirements.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.7.7	Hot Repair Capability. The PLC shall support installing I/O modules with backplane power applied.	Comply	See Ref. 45, Chapter 3
	Low power modules shall support removal with field power applied.	Comply	See Ref. 45, Chapter 3. Modules can be "hot-swapped" with field power applied. Active modules shall not be removed from a chassis. An active module can be replaced on-line through insertion of a similar module in the adjoining spare slot and after bumpless transfer of control to the spare module.
	When output modules are removed from the backplane, the state of the outputs should be known.	N/A	Removal of an output module from the chassis results in disconnection of all field wiring from the module.
4.7.8	Manufacturer System Life Cycle Maintenance. (section heading)	- - -	No requirement.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.7.8.1	Parts Replacement Life Cycle Requirements. The baseline configuration of the qualified PLC shall be established.	Comply	See Ref. 3.
	Records shall be maintained for revision history and changes.	Comply	See Ref. 62, QAM 4.0, Design Control.
	Records shall be maintained for tracking failures.	Comply	See Table Section 7.8.
	Testing shall be performed as necessary to maintain a qualified platform based on future revisions or replacements.	Comply	See Ref. 63.
4.7.8.2	Component Aging Analysis Requirements. A periodic surveillance and maintenance interval shall be determined per IEEE 323 to account for any significant aging mechanisms.	Comply	See this report, Section 4.15.
4.7.9	Maintenance Human Factors. Descriptive information.	- - -	No requirements.
4.7.9.A	Special PLC Manufacturer Equipment. The manufacturer shall provide documentation for PLC support equipment.	N/A	See Ref. 45, Chapter 3. No special tools required for routine maintenance.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.7.9.B	Test Equipment Connections. Test equipment connections shall be supported by documentation and hardware, including interconnection devices. The manufacturer shall provide any special instruction for use of test equipment connections.	Comply	See Ref. 45, Chapter 3. This section provides instruction and precautions for connection and use of Tristation 1131 to perform recommended routine maintenance activities.
4.7.9.C	Job Aids. Aids for operating the PLC equipment shall be provided.	Comply	See various sections of Ref. 45 for equipment pictures, and operational recommendations and warnings. See Ref. 45, Chapter 3 for description of module installation keying.
4.7.9.D	Help Screens. Help screens for software used to support maintenance shall be provided.	Comply	See Ref. 45. Tristation 1131 software may be used during maintenance.
4.8	Requirements for Third Party/Sub-Vendor Items. All items provided by sub-vendors or third parties shall be subjected to all applicable requirements and tests. Compatibility of operation with the PLC shall be demonstrated through tests.	Comply	See Ref. 56. Third party signal conditioners were included in the qualification program.
4.9	Other. (section heading)	- - -	No requirements.
4.9.1	Data Handling and Communication Interface Overview. Descriptive information.	- - -	No requirements.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.9.1.1	Peripheral Communication Requirements. The PLC executive and/or application software tools shall provide features to prevent loss of serial communication from degrading the application program.	Comply	See Ref. 53. Communication port failure tests performed throughout qualification testing showed no effect on application program or PLC scan cycle.
	Communication overhead time shall be deterministic.	Comply	See Ref. 7.
	Peripheral communications shall support at least 1000 character communication buffers. (Note: 1 character = 1 byte. A real variable uses 8 bytes or eight characters).	Comply	See Ref. 46, Aliases for Tricon Points. Aliased variables (points) are automatically buffered each scan for use by external hosts. Over 2000 real memory variables can be aliased (= 16000 characters).
	Serial communications shall support checksum (or equivalent) data quality checks.	Comply	Tricon serial communications implement Cyclic Redundancy Checks (CRC) for compatibility with standard industry communication protocols.
	Requirements for redundant communication hardware.	N/A	No redundant communication hardware.
4.9.1.1.1	Software Isolation Requirements. Descriptive information.	- - -	No requirements.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.9.1.1.1.A	Software Isolation. Features shall be provided to permit sending serial port data with no hardware or software handshaking.	Comply	See Ref. 46, Configurable Modules (TCM), and Peer-to-Peer Communication.
4.9.1.1.1.B	Software Isolation. Features shall be provided to permit the application program to ignore communication port incoming data.	Comply	See Ref. 46, Configurable Modules (TCM), and Peer-to-Peer Communication.
4.9.1.1.1.C	Software Isolation. Software shall permit use of the send data functions with the receive data functions disabled.	Comply	See Ref. 46, Configurable Modules (TCM), and Peer-to-Peer Communication.
4.9.1.1.1.D	Software Isolation. Features shall be provided to disable interrupts caused by full serial port receive buffers.	Comply	See Ref. 58. No interrupts to main processors are generated based on communication buffer full interrupts.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.9.1.	PLC Peer-to-Peer Communication Requirements. Peer-to-peer link shall meet requirements of Section 4.3.4.4, except item B.	Comply	See Ref. 45, Section 3.8, TCM Module, Net 1 port. Tricon Peer-to-Peer protocol is proprietary. See Ref. 8. Net 1 port surge withstand capability meets IEC 801-5 "basic immunity" levels.
	Communication time shall be deterministic.	Comply	See Ref. 46, Peer-to-Peer Communication Data Transfer Time.
	Communication errors shall not affect other portions of the application program or inhibit the PLC scan cycle. Queues for communicated data shall be supported and queue status shall be available to the communication program. Loss of communication shall be detected and made available to the application program.	Comply	See Ref. 64. TCM Module Net 1 port failure tests showed no effect on application program or PLC scan cycle. See Ref. 46, Peer-to-Peer Communication.
	Use of the peer-to-peer communication link shall support the response time requirement given in Section 4.2.1.A.	Comply	See Ref. 20, Section 3 and Table Section 4.2.1.A. Peer-to-Peer communication link was implemented during all qualification testing.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.9.2	Overall System Security Requirements. Switching the main processor from RUN mode to other modes shall be by keylock switch.	Comply	See Ref. 45, Chapter 2.
	Features shall ensure that redundant components operate in the same mode, and that program changes are loaded into all redundant processors.	Comply	See Ref. 45, Chapter 2, Main Processor Modules. See Ref. 46, Chapter 5.
	Provisions shall prevent modification of the application program and operating system while the PLC in on-line.	Comply	See Ref. 45, Chapter 2, Page 28 and Ref. 46, System Administration, Elements of a Security System.
4.9.3	Heartbeat Requirements. The PLC shall provide capability to activate a "heartbeat" external to the PLC.	Comply	See Ref. 15.
4.9.4	Hazardous Materials Requirements. Material data sheets shall be provided for all hazardous materials associated with the PLC.	N/A	No hazardous materials associated with the Tricon PLC.
4.10	Shipping and Handling Requirements. Packaging and shipping shall be in accordance with ANSI N45.2.2.	Comply	See Ref. 54, Section QAM 15.0, Handling, Storage, Packaging Preservation, and Delivery.
4.10.1	Packaging Requirements. Descriptive information.	- - -	No requirements.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.10.1.A	Items Shipped. Shall be packaged to avoid damage or degradation due to various environmental and handling factors which may be encountered during shipping and storage.	Comply	See Ref. 54, Section QAM 15.0, Handling, Storage, Packaging Preservation, and Delivery.
4.10.1.B	Items Shipped. Packaging shall include desiccant materials as required.	Comply	See Ref. 54, Section QAM 15.0, Handling, Storage, Packaging Preservation, and Delivery.
4.10.1.C	Items Shipped. Items shall be inspected for cleanliness prior to packaging. Items not immediately packaged shall be protected from contamination.	Comply	See Ref. 54, Section QAM 15.0, Handling, Storage, Packaging Preservation, and Delivery. See Ref. 54, Section QAM 10.0, Inspection and Testing.
4.10.1.D	Items Shipped. Cushioning shall be provided to protect against shock and vibration.	Comply	See Ref. 54, Section QAM 15.0, Handling, Storage, Packaging Preservation, and Delivery.
4.10.1.E	Items Shipped. Items and containers shall be marked with appropriate identification.	Comply	See Ref. 54, Section QAM 15.0, Handling, Storage, Packaging Preservation, and Delivery. See Ref. 54, Section QAM 8.0, Product, Parts, and Material Identification and Traceability.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.10.1.F	Items Shipped. Copies of packing lists shall be included with each carton shipped.	Comply	See Ref. 54, Section QAM 15.0, Handling, Storage, Packaging Preservation, and Delivery.
4.10.1.G	Items Shipped. ESD sensitive items shall be appropriately packaged, handled and marked.	Comply	See Ref. 54, Section QAM 15.0, Handling, Storage, Packaging Preservation, and Delivery.
4.10.1.H	Items Shipped. Packaging shall be suitable for movement using hand trucks.	Comply	See Ref. 54, Section QAM 15.0, Handling, Storage, Packaging Preservation, and Delivery.
4.10.1.I	Items Shipped. Special handling or storage requirements shall be marked on the containers.	Comply	See Ref. 54, Section QAM 15.0, Handling, Storage, Packaging Preservation, and Delivery.
4.10.1.J	Items Shipped. See Section 4.4.2 for requirements for software storage media.	Comply	See Table Section 4.4.2.
4.10.2	Shipping Requirements. Requirements for mode of shipping, use of fully enclosed vehicles, special handling and stacking instructions as necessary, and container markings and protective covers.	Comply	See Ref. 54, Section QAM 15.0, Handling, Storage, Packaging Preservation, and Delivery.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
4.10.3	Storage Requirements. Storage and shelf life requirements shall be provided for all PLC items.	Comply	See Ref. 54, Section QAM 15.0, Handling, Storage, Packaging Preservation, and Delivery.
5	Acceptance/Operability Testing. Descriptive information.	- - -	No requirements.
5.1	Acceptance/Operability Testing Overview. The development, design and performance of acceptance testing shall use the documentation requirements of Section 8.14.	Comply	See Table Section 8.14.
5.2	Pre-Qualification Acceptance Test Requirements. Descriptive information.	- - -	No requirements.
5.2.A	Application Objects Testing. Testing of the software objects in the PLC library shall be performed. This testing shall be in addition to any testing performed by the manufacturer.	Exception	See Ref. 2, Section 5. Triconex and TUV Rheinland have performed extensive testing of the Tricon PLC application software. Results of this testing are documented in Ref. 58. Accordingly, this testing was not performed.
5.2.B	Initial PLC Calibration. The generic qualification sample PLC shall be calibrated to NIST traceable sources.	Comply	See Ref. 19, Section 9.0.
5.2.C	System Integration. System integration testing portion of TSAP V&V shall be performed during acceptance testing.	Comply	See Ref. 65.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
5.2.D	Operability Tests. The Operability Test shall be performed during acceptance testing.	Comply	See Ref. 53.
5.2.E	Prudency Tests. The Prudency Test shall be performed during acceptance testing.	Comply	See Ref. 66.
5.2.F	Burn-In Test. A minimum 352 hour burn-in test shall be performed during acceptance testing.	Exception	See Ref. 2, Appendix 3. Triconex routinely conducts burn-in tests on all Tricon hardware as part of manufacturing process. This testing meets TR requirements for burn-in testing. Accordingly, this testing was not performed.
5.3	Operability Test Requirements. Descriptive information.	- - -	No requirements.
5.3.A	Accuracy. Accuracy checks shall be performed on the analog input/output modules.	Comply	See Ref. 20, Section 2.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
5.3.B	Response Time. Response time of analog input to digital output and digital input to digital output sequences shall be measured. For baseline (acceptance) testing, the acceptance criteria is that the measured response time shall not vary more than 20% from the value calculated from manufacturer's data. For all subsequent testing, the measured value shall not vary more than 10% from the baseline.	Exception	See Ref. 20, Section 3. Based on Tricon design, it is not practicable to perform a test that provides consistent (within ±20%) measured response times. Instead, manufacturer's data is used to calculate maximum expected AI to DO and DI to DO response times. The acceptance criteria for all tests is that the calculated response times are not exceeded.
5.3.C	Discrete Input Operability. Discrete inputs shall be tested for capability to detect changes in the inputs.	Comply	See Ref. 20, Section 4.
5.3.D	Discrete Output Operability. Discrete outputs shall be tested for ability to operate within rated voltages and currents.	Comply	See Ref. 20, Section 5.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
5.3.E	Communication Operability. If any communication functions are included in the qualification envelope, then operability of the ports shall be tested. Tests shall look for degradation in bit rates, signal levels and pulse shapes of communication protocol.	Partial Exception	See Ref. 20, Section 1. The TCM Module NET1 and NET2 ports are included in the qualification envelope. Test equipment to measure degradation of bit rates, pulse shapes, and signal levels was not available at the time testing was performed. The port protocol is proprietary and not amenable to TR specified tests-. Port operation is monitored for correct performance throughout all qualification tests.
5.3.F	Coprocessor Operability. If any coprocessors are included in the qualification envelope, then tests shall be performed specifically on these coprocessors.	Comply	See Ref. 20. Section 1. Operation of Tricon coprocessors is invoked automatically during application program execution. Separate coprocessor tests are not required.
5.3.G	Timer Tests. Accuracy of timer functions shall be tested.	Comply	See Ref. 20, Section 6.
5.3.H	Test of Failure to Complete Scan Detection. The function of the mechanism to detect failure to complete a scan shall be tested. The power up testing of this feature may be used to establish its operability.	Comply	See Ref. 20, Section 8.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
5.3.I	Failover Operability Tests. If redundancy with automatic transfer to a redundant device is used, tests shall be performed to establish operability of the failover hardware.	Comply	See Ref. 20, Section 7.
5.3.J	Loss of Power Test. The AC and DC power sources shall be shut off for at least 30 seconds and reapplied.	Comply	See Ref. 20, Section 8.
5.3.K	Power Interrupt Test. The AC power sources shall be interrupted for a 40 millisecond hold-up time.	Comply	See Ref. 20, Section 9.
5.4	Prudency Testing Requirements. The Prudency tests shall be performed with the power supply sources at the minimum values specified in Section 4.6.1.1.	Partial Exception	See Ref. 21, Section 2, Subsection 3.1. To accommodate power frequency changes, external power to the 230Vac chassis power supplies was provided through a step-up transformer which was fed by the same external power supply for the 115Vac chassis power supplies. This limited the voltage to the 115Vac chassis power supplies to 97Vac.
5.4.A	Burst of Events Test. Tests shall be performed to verify operation of the PLC under highly dynamic input/output variation conditions.	Comply	See Ref. 21, Section 2.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
5.4.B	Failure of Serial Port Receiver Test. The receiving device connected to the main processor serial communication port shall be simulated to fail in various modes. PLC response time shall be verified to not degrade unacceptably.	Comply	See Ref. 21, Section 3.
5.4.C	Serial Port Noise Test. The transmit line to the main processor serial communication port shall be subjected to white noise. PLC response time shall be verified to not degrade unacceptably.	Comply	See Ref. 21, Section 3.
5.4.D	Fault Simulation. For PLC's that include redundancy, failures in redundant elements shall be simulated.	Comply	See Ref. 20, Section 1, Subsection 3.0, and Ref. 6, Section 7. Fault simulation in redundant elements is performed during the Failover portion of Operability testing, in lieu of during Prudency Testing..

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
5.5	Operability/Prudency Testing Applicability Requirements. As a minimum, Operability and Prudency tests shall be performed: - During acceptance testing: Operability – All, Prudency – All - During environmental testing: Operability – All, Prudency – All - During seismic testing: Operability – All, Prudency – All - After seismic testing: Operability – All, Prudency – None - During EMI/RFI testing: Operability – All except analog I/O checks, Prudency – Only burst of events test - After ESD testing: Operability – All, Prudency - None	Partial Exception	Due to short duration of seismic SSE tests, and special set-up required for EMI/RFI tests, it is not practicable to perform Operability and Prudency tests at those times. The testing complied with the other requirements of Section 5.5. See Ref. 2 for detailed qualification test plan.
5.6	Application Software Objects Acceptance (ASOA) Testing. Requirements for ASOA testing.	Exception	See Ref. 2, Section 5, and Table Section 5.2.A
6	Qualification Testing and Analysis. Descriptive information.	- - -	No requirements.
6.1	Qualification Process Overview. Descriptive information.	- - -	No requirements.
6.1.1	PLC System Qualification Overview. Descriptive information.	- - -	No requirements.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
6.2	PLC System Test Configuration Requirements. Descriptive information.	- - -	No requirements.
6.2.1	Test Specimen Hardware Configuration Requirements. Hardware configuration shall be developed and documented consistent with the requirements of Sections 6.5 and 8.2.	Comply	See Table Sections 6.5 and 8.2
6.2.1.A	Module Types. The test specimen shall include at least one type of module needed to encompass the requirements of Section 4.3. Multiple samples of configurable modules shall be included to cover the different configurations. For T/C modules, only one T/C type needs to be tested unless different types use different signal conditioning.	Comply	See Ref. 3 for identification of module types included in test specimen. One of each available module type was included. Configurable modules (analog inputs, T/C inputs, pulse inputs) use only software to invoke different configurations and therefore do not require multiple installed samples.
6.2.1.B	Module Types. The test specimen shall include modules needed to support Operability testing.	Comply	See Ref. 20 for identification of module tests performed during Operability testing.
6.2.1.C	Ancillary Devices. The test specimen shall include at least one of each type of ancillary device needed to meet the TR requirements.	Comply	No ancillary devices used in test specimen.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
6.2.1.D	Chassis Types. The test specimen shall include at least one of each type of chassis needed to meet the TR requirements. Connections between chassis shall use maximum permissible cable lengths.	Comply	See Ref. 3 for identification of chassis types and interconnecting cable lengths used in test specimen.
6.2.1.E	Power Supplies. The test specimen shall include the power supplies needed to meet the TR requirements. Additional resistive loads shall be placed on each power supply output so that the power supply operates at rated conditions.	Exception	See Ref. 3 for identification of power supplies included in test specimen. The Tricon design does not allow for adding resistive load on the power supplies without altering design and operation. To demonstrate significant power supply loading, one chassis of the test specimen was fully populated with one module in each slot.
6.2.1.F	Dummy Modules. Dummy modules shall be used to fill all remaining slots in the main chassis and at least one expansion chassis. The dummy modules shall provide a power supply and weight load approximately equal to an eight point discrete input module.	Exception	See Ref. 24. Seismic Balance Modules (SBMs) were installed in two test specimen chassis to increase the weight loading to that representative of a fully module populated chassis. Dummy modules did not provide a load on the power supplies.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
6.2.1.G	Termination Devices. The test specimen shall include at least one of each type of termination device and associated cabling used to provide field connections.	Comply	See Ref. 3 for identification of external termination panels and interconnecting cables used in the test specimen.
6.2.1.H	Redundant Devices. The test specimen shall include any devices needed to implement any redundancy included in the qualification envelope.	Comply	See Ref. 3 for identification of redundant devices used in test specimen. These devices include redundant main processor modules, chassis power supplies, chassis interconnect cabling, and chassis fiber optic interconnect modules and cables.
6.2.1.I	Additional Modules. The test specimen shall include any additional modules needed to support Operability and Prudency testing and to support module arrangement variations.	Comply	See Ref. 20 and 21 for identification of module tests performed during Operability and Prudency testing. No module arrangement variations required in test specimen.
6.2.1.1	Test Specimen Hardware Arrangement Requirements. Descriptive information.	- - -	No requirements.
6.2.1.1.A	Seismic Testing. Hardware shall be arranged to maximize stress on the chassis and mountings.	Comply	See Ref. 24, Section 3.3.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
6.2.1.1.B	Environmental Testing. Modules shall be arranged to simulate maximum expected temperature rise across the chassis.	Comply	See Ref. 22, Section 3.4
6.2.2.	Test Specimen Application Program (TSAP) Configuration Requirements. Descriptive information.	- - -	No requirements.
6.2.2.A	TSAP Communication Commands. TSAP shall include a serial communication output sequence.	Comply	See Ref. 17, Section 34.
6.2.2.B	TSAP Programming. TSAP shall include program sequences to support Operability and Prudency testing.	Comply	See Ref. 20, 21 and 17.
6.2.2.C	TSAP Programming. TSAP shall include a program sequence to change the state of an output once each cycle.	Comply	See Ref. 17.
6.2.2.D	TSAP Programming. TSAP shall include any functions needed to support redundancy, and fault detection and failover.	Comply	No special TSAP functions required.
6.2.2.1	Coprocessor TSAP Requirements. If a coprocessor uses a high-level language, then it shall have its own TSAP which implements the given functions.	N/A	See Ref. 20. Section 1. Operation of Tricon coprocessors is invoked automatically during application program execution.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
6.2.3	Test Support Equipment Requirements. Test equipment to support Acceptance and Operability testing shall be provided.	Comply	See Ref. 14 and 42.
6.2.3.A	Test Support Equipment. Equipment shall include panels for connecting and simulating inputs and outputs.	Comply	See Ref. 14 and 42.
6.2.3.B	Test Support Equipment. Equipment shall include test and measurement equipment with required accuracy.	Comply	See Ref. 14 and 42.
6.2.3.C	Test Support Equipment. Equipment shall include special tools and devices needed to support testing.	Comply	See Ref. 14 and 42.
6.2.3.D	Test Support Equipment. All test equipment shall be controlled per IEEE 498.	Comply	Intent of IEEE 498 requirements for test equipment calibration control was met by following the requirements of QAM 11.0. Ref. 4 includes requirements for identification and control of calibrated test equipment during qualification testing.
6.3	Qualification Tests and Analysis Requirements. All PLC testing shall be performed on a calibrated system with all user setpoint values adjusted to default values.	Comply	See Ref. 19, Section 9.0. No user setpoints.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
6.3.1	Aging Requirements. Testing shall include environmental, electrostatic discharge (ESD), seismic, EMI/RFI and surge withstand testing. Environmental testing shall be performed first.	Comply	See Ref. 2, Section 5.
6.3.2	EMI/RFI Test Requirements. EMI/RFI testing to be performed as described in Section 4.3.7. Susceptibility tests to be performed at 25%, 50% and 75% of specified levels in addition to the specified levels.	Exception	See Ref. 25, Section 3.2 and Ref. 57. EMI/RFI testing performed per R.G. 1.180, R1. Testing performed at levels lower than specified levels only as needed to establish susceptibility threshold.
6.3.2.1	EMI/RFI Mounting Requirements. Test specimen shall be mounted on a non-metallic surface six feet above floor with no secondary enclosure. PLC shall be grounded per manufacturer's recommendations.	Exception	See Ref. 25, Section 3.3. Due to space limitations of NTS Labs EMI/RFI chamber, the test specimen was mounted less than six feet above the floor. The test specimen was mounted in a Rittal cabinet with sides and doors removed. Cabinets provided no significant shielding.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
6.3.3	Environmental Testing Requirements. Testing shall be performed using the temperature and relative humidity profile given in TR Figure 4-4. Margin shall be applied to maximum and minimum specified temperatures and humidities. Power sources shall be set to maximize heat dissipation. PLC shall be energized with TSAP operating. One-half of all discrete and relay outputs shall be on and energized to rated current. All analog outputs shall be set to one-half to two-thirds full scale output.	Comply	See Ref. 22, Sections 3.2, 3.4 and 3.5.
6.3.3.1	Environmental Test Mounting Requirements. PLC shall be mounted on a simple structure. Air temperature at bottom of chassis shall be monitored. No additional cooling fans shall be included.	Comply	See Ref. 22, Sections 3.3, 3.4 and 3.6.
6.3.4	Seismic Test Requirements. PLC shall be vibration aged using five OBEs with the RRS as shown in TR Figure 4-5 followed by an SSE with the RRS shown in TR Figure 4-5. Testing shall conform to IEEE 344. Tri-axial, random, multi-frequency tests shall be used. Repairs during testing shall conform to IEEE 344.	Comply	See Ref. 24, Sections 3.1, 3.2 and Step 10.2.10.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
6.3.4.1	Seismic Test Mounting Requirements. Test specimen shall be mounted per manufacturer's recommendations. Mounting structure shall have no resonances below 100 Hz. Most susceptible mounting configuration shall be tested. All mounting screws shall be torqued to known values.	Comply	See Ref. 24, Section 3.3.
6.3.4.2	Seismic Test Measurement Requirements. Relay contacts shall be monitored for chatter. One half of the relays shall be energized and on half de-energized. One quarter of the relays shall transition from ON to OFF and one quarter from OFF to ON during the tests. The PLC shall be powered with the TSAP operating. One half of the digital outputs shall be ON and loaded to their rated current. Power sources shall be at lower voltage and frequency limits. One or more response accelerometers shall be mounted on each chassis.	Clarification	See Ref. 24, Sections 3.4, 3.5, 3.6 and 3.7.
6.3.4.3	Seismic Test Performance Requirements. Seismic test shall include a resonance search, five OBE's, one SSE and an Operability test.	Comply	See Ref. 24, Sections 3.1, 3.3 and 4.4.
6.3.4.4	Seismic Test Spectrum Analysis Requirements. The test response spectrum from the control and specimen response accelerometers shall be reported at 1/2, 1, 2, 3 and 5% damping.	Comply	See Ref. 32.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
6.3.5	Surge Withstand Capability Testing. Surge testing shall be conducted per Section 4.6.2 and IEEE C62.45.	Comply	See Table Section 4.6.2.
6.3.5.1	Surge Withstand Test Mounting Requirements. Test specimen shall be mounted on a non-metallic surface six feet above floor with no secondary enclosure. PLC shall be grounded per manufacturer's recommendations.	Exception	See Ref. 27. Due to space limitations of NTS Labs EMI/RFI chamber, the test test specimen was mounted less than six feet above floor. Test specimen was mounted in a Rittal cabinet with the sides and doors removed.
6.3.6	Class 1E to Non-1E Isolation Testing. Test specimen shall be mounted on a non-metallic surface six feet above floor with no secondary enclosure. PLC shall be grounded per manufacturer's recommendations.	Exception	See Ref. 29. Due to space limitations of NTS Labs EMI/RFI chamber, the test specimen was mounted less than six feet above floor. Test specimen was mounted in a Rittal cabinet with the sides and doors removed.
6.4	Other Tests and Analysis. (section heading)	- - -	No requirements.
6.4.1	FMEA. An FMEA analysis of the PLC shall be performed.	Comply	See Ref. 10.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
6.4.2	Electrostatic Discharge (ESD) Testing Requirements. ESD testing of the PLC shall be performed per EPRI TR-102323.	Comply	See Ref 40, Section 7.0.
6.4.3	Power Quality Tolerance Requirements. Power quality tolerance testing shall be performed during acceptance testing, at the end of the elevated temperature test while still at high temperature and following seismic tests. The same AC source shall be connected to redundant power supplies during testing.	Comply	See Ref. 20, Section 10.
6.4.4	Requirements for Compliance to Specifications. Test instrumentation measurement accuracy shall be considered. Compliance to specifications shall be considered for each module or grouping of modules.	Comply	Where required, data analyses have been performed to provide for correction of the measured test data prior to comparison to acceptance criteria to account for the accuracies of the instruments used during testing. See Ref. 53
6.4.4.A	Environmental Test Compliance. Environmental Operability test results shall be evaluated for compliance to specifications.	Comply	See Ref. 35 and 52.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
6.4.4.B	Seismic Test Compliance. The seismic levels achieved during testing shall be used as the seismic withstand response spectrum.	Comply	See Ref. 36 and 52
6.4.4.C	Class 1E to Non-1E Test Compliance. Test levels shall be checked for compliance to Section 4.6.4 specifications.	Comply	See Ref. 41 and 52
6.4.4.D	Surge Withstand Test Compliance. Test levels shall be checked for compliance to Section 4.6.2 specifications.	Comply	See Ref. 39 and 52
6.4.4.E	EMI/RFI Test Compliance. PLC performance shall be checked for compliance to Section 4.3.7 specifications.	Comply	See Ref. 37 and 52
6.4.4.F	Power Quality Test Compliance. Results shall be evaluated for compliance to Sections 4.6.1 and 4.2.3.7 specifications.	Comply	See Ref. 52.
6.4.4.G	ASOA Test Compliance. Results shall be evaluated for compliance to Section 5.6 requirements.	Exception	See Ref. 2, Section 5. ASOA testing not performed.
6.4.4.H	Quality Assurance Program Compliance. Results of audits of manufacturer's QA Program shall be checked for compliance to Section 7 requirements.	Comply	Triconex is a 10CFR50, Appendix B supplier. The manufacturing and qualification processes are owned and controlled by Triconex. MPR was contracted by Triconex to perform some of the qualification tests. An audit of MPR was performed by Triconex. See Audit Report V0510.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
6.4.5	Human Factors. Descriptive Information.	- - -	No requirements.
6.5	Quality Assurance Measures Applied to Qualification Testing. Test program TSAP development, hardware procurement, test specimen chain of custody, and tests and data analysis shall meet the requirements of 10CFR50, Appendix B.	Comply	See Ref. 2, 4 and 5.
7	Quality Assurance. Descriptive information.	- - -	No requirements.
7.1	QA Overview. Descriptive information.	- - -	No requirements.
7.2	10CFR50 Appendix B Requirements for Safety-Related Systems. Descriptive information.	- - -	No requirements.
7.2.A	10CFR50 Applicability. Regulations apply to all qualification activities.	Comply	See Ref. 4, Section 3.
7.2.B	10CFR50 Applicability. Regulations apply to application specific activities.	N/A	Requirement applies to safety-related application of a PLC.

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SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
7.2.C	10CFR50 Applicability. Regulations apply to PLC dedication activities.	N/A	Tricon PLC is manufactured under a 10CFR50 Appendix B program. Requirement applies to dedication of a commercial PLC.
7.2.D	10CFR50 Compliance. Quality processes other than 10CFR50 shall be shown to be commensurate with 10CFR50.	N/A	Tricon PLC is manufactured under a 10CFR50 Appendix B program.
7.2.E	10CFR50 Compliance. Qualifier shall perform audits to confirm that manufacturer's quality process has been applied to the PLC product.	Comply	Triconex is a 10CFR50, Appendix B supplier. The manufacturing and qualification processes are owned and controlled by Triconex. MPR was contracted by Triconex to perform some of the qualification tests. An audit of MPR was performed by Triconex. See Audit Report V0510.
7.2.F	10CFR50 Compliance. Audits performed against programs other than 10CFR50 shall demonstrate that the program process is commensurate with 10CFR50.	N/A	Tricon PLC is manufactured under a 10CFR50 program.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
7.2.G	V&V Program Evaluation. Qualifier shall evaluate the manufacturer's V&V program to the criteria in Section 7.4.	Comply	Triconex is a 10CFR50, Appendix B supplier. The manufacturing and qualification processes are owned and controlled by Triconex. V&V activities are performed by Triconex Engineering.
7.2.H	Qualification Test Witnessing. The qualifier shall have the right to witness qualification tests.	Comply	See Ref. 4 and 2. A Triconex Project Quality Assurance Engineer was permanently assigned to the qualification project. See the NQQP and Master Test Plan for PQAE responsibilities.
7.3	10CFR21 Compliance Requirements. Section lists 10CFR21 compliance requirements of a utility which applies the PLC in a safety-related application.	N/A	Requirement applies to safety-related application of a PLC.
	PLC manufacturer shall support problem reporting and tracking.	Comply	See Table Section 7.8.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
7.4	Verification and Validation Requirements. Qualifier shall evaluate the manufacturer's V&V process for software, firmware and software tools against IEEE 7-4.3.2 and IEEE 1012.	Comply	Triconex is a 10CFR50, Appendix B supplier. Triconex procedures ensure compliance with the applicable portions of IEEE 7-4.3.2 and IEEE 1012. See Ref. 4, 5 and 44
	If the manufacturer V&V processes do not meet requirements applicable to Nuclear Power Plants, then compensatory measures shall be implemented.	N/A	See above. Manufacturer V&V processes meet requirements applicable to Nuclear Power Plants.
7.5	Manufacturer Qualification Maintenance Throughout Product Life Cycle. (section heading)	- - -	No requirements.
7.5.1	Overview of Manufacturer Qualification Maintenance Throughout Product Life Cycle. Descriptive information.	- - -	No requirements.
7.5.2	Requirements for Manufacturer Qualification Maintenance Throughout Product Life Cycle. The qualifier shall obtain documentation confirming that the PLC manufacturer will ensure upward compatibility, maintain rigor of processes, commit to at least five year support for the qualified PLC configuration, and commit to six months notice before withdrawing product support.	Comply	Triconex is a 10CFR50, Appendix B supplier. The manufacturing and qualification processes are owned and controlled by Triconex.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
7.5.3	Life Cycle Support for Tools Requirement. PLC manufacturer shall ensure continued access to the same versions of application software development tools, or capability to reconstruct functionality with using revised tools.	Comply	See Ref. 5.
7.6	Compensatory Quality Activities for Legacy Software. (section heading)	- - -	No requirements.
7.6.1	Overview of Compensatory Quality Activities for Legacy Software. Descriptive information.	- - -	No requirements.
7.6.2	Requirements for Compensatory Quality Activities for Legacy Software. The qualifier may compensate for shortcomings in legacy software by evaluating documented operating experience in applications similar to nuclear safety related applications, and by performing tests of legacy software to confirm conformance to requirements. The manufacturer shall place legacy software under configuration control once baselined.	N/A	See Ref. 58. No legacy software is included in the qualification project scope.
7.7	Configuration Management. (section heading)	- - -	No requirements.
7.7.1	Configuration Management Overview. Descriptive information.	- - -	No requirements.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
7.7.2	Hardware Configuration Management Requirements. The scope shall include revisions to module design, module component configuration, compatibility of revised modules with existing hardware, and manufacturer documentation.	Comply	See Ref. 5.
7.7.2.A	Hardware Configuration Management Review. Utility (and Qualifier) shall evaluate the manufacturer configuration management process for design revisions to NQA-1.	Comply	See Ref. 58. Configuration management reviews considered both hardware and software.
7.7.2.B	Hardware Configuration Management Review. Utility (and Qualifier) shall evaluate the manufacturer configuration management process for methods of identification of each constituent component within the PLC modules to NQA-1.	Comply	See Ref. 58. Configuration management reviews considered both hardware and software.
7.7.2.C	Hardware Configuration Management Review. Utility (and Qualifier) shall evaluate the manufacturer configuration management process for methods of document control to NQA-1.	Comply	See Ref. 58. Configuration management reviews considered both hardware and software.
7.7.3	Software Configuration Management Requirements. The scope of software configuration management includes creation and revision of firmware, runtime software libraries, software engineering tools, and documentation.	Comply	See Ref. 5.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
7.7.3.A	Software Configuration Management Review. Utility (and Qualifier) shall evaluate the manufacturer software configuration management process for definition of organization and responsibilities to Reg. Guide 1.169, Section C.	Comply	See Ref. 58.
7.7.3.B	Software Configuration Management Review. Utility (and Qualifier) shall evaluate the manufacturer software configuration management process for methods of configuration identification, control, status and audits to Reg. Guide 1.169, Section C.	Comply	See Ref. 52.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
7.7.3.C	Software Configuration Management Review. Utility (and Qualifier) shall evaluate the manufacturer configuration management process to ensure sub-tier suppliers maintain comparable levels of configuration management per Reg. Guide 1.169, Section C.	Comply	See Ref. 58.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
7.8	Problem Reporting/Tracking Requirements. PLC manufacturer shall maintain a problem reporting and tracking system that includes classification of problems, description of problems, identification of affected hardware, type of application, description of configuration, name of reporting site and means to contact site, type of site, and cumulative operating time of PLC when problem occurred. Manufacturer shall provide a mechanism for making this information available to all nuclear utility users.	Comply	Key Procedures: - QAM 14.0: Corrective Action - QAM 19.0: Servicing - QAM 13.3: 10CFR21 Reporting - QPM 14.0: QA Review Board - QPM 14.1: Customer Contacts - QPM 13.2: Product Discrepancies. - QPM 19.1 to 6: RMA Process Key Documents: - Product Discrepancy Reports - Customer Service Database - Customer System Config. Files - Product Alert Notices
8	Documentation. Descriptive information.	- - -	No requirements.
8.1	Equipment General Overview Document Requirements. Descriptive information.	- - -	No requirements.
8.1.A	Manufacturer Documentation. Documentation shall include a description of the PLC.	Comply	See Ref. 45, Chapter 1, 2, 3 and 4, Ref. 48, 49, and 50.
8.1.B	Manufacturer Documentation. Documentation shall include a description of the chassis interconnections.	Comply	See Ref. 45, Chapter 3.
8.1.C	Manufacturer Documentation. Documentation shall include a module overview and selection guide.	Comply	See Ref. 45, Chapter 2.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
8.1.D	Manufacturer Documentation. Documentation shall include a description of the overall I/O capacity and processing speeds.	Comply	See Ref. 45, Chapter 2.
8.1.E	Manufacturer Documentation. Documentation shall include installation information.	Comply	See Ref. 45, Chapter 3, Ref. 48 and 14.
8.1.F	Manufacturer Documentation. Documentation shall include handling and storage requirements.	Comply	See Ref. 45, Chapter 3.
8.1.G	Manufacturer Documentation. Documentation shall include a description of the self-diagnostics and redundancy features.	Comply	See Ref. 45, Chapter 2.
8.2	Equipment General Specifications Requirements. Manufacturer documentation shall provide general specifications for the PLC.	Comply	See Ref. 45 and 49.
8.3	Operator's Manual Requirements. Manufacturer documentation shall include information on operation of the PLC.	Comply	See Ref. 45 and 49.
8.4	Programmer's Manual Requirements. Manufacturer shall provide detailed information on the use of the functions available in the PLC processors.	Comply	See Ref. 46 and 47.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
8.4.A	Programmer's Manual Requirements. Manual shall include a summary and brief description of available functions.	Comply	See Ref. 46 and 47
8.4.B	Programmer's Manual Requirements. Manual shall include a detailed description of each function.	Comply	See Ref. 46 and 47
8.4.C	Programmer's Manual Requirements. Manual shall include examples of complex functions.	Comply	See Ref. 46, Section 2.
8.4.D	Programmer's Manual Requirements. Manual shall include limitations on use of functions.	Comply	See Ref. 46 and 47
8.4.E	Programmer's Manual Requirements. Manual shall include methods for resource management.	Comply	See Ref. 46 and 47
8.4.F	Programmer's Manual Requirements. Manual shall include a user manual for programming and debugging tools, and for any programming terminal.	Comply	See Ref. 46 and 47
8.4.G	Programmer's Manual Requirements. Manual shall include detailed information for creating user defined functions.	Comply	See Ref. 46 and 47
8.4.H	Programmer's Manual Requirements. Manual shall include a detailed description of operation of conditional statements.	Comply	See Ref. 46 and 47

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
8.4.I	Programmer's Manual Requirements. Manual shall include a description of limitations of PID and lead/lag functions.	Comply	See Ref. 46 and 47
8.4.J	Programmer's Manual Requirements. Manual shall include a description of interaction between main processor and I/O modules.	Comply	See Ref. 46 and 47
8.4.K	Programmer's Manual Requirements. Manual shall include a detailed description of interaction between the application program and redundancy features.	Comply	See Ref. 47.
8.4.L	Programmer's Manual Requirements. Manual shall include any software build procedures and software tools.	Comply	See Ref. 46 and 47
8.4.M	Programmer's Manual Requirements. Manual shall include a description of the operation of the executive.	Comply	See Ref. 46 and 47
8.4.N	Programmer's Manual Requirements. Manual shall include a description of data, data base and configuration management.	Comply	See Ref. 46 and 47
8.4.O	Programmer's Manual Requirements. Manual shall include a description of operation and use of self-diagnostics.	Comply	See Ref. 47.
8.4.P	Programmer's Manual Requirements. Manual shall include a manual for coprocessor programming.	N/A	Coprocessor operation is invoked automatically.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
8.5	Equipment Maintenance Manual Requirements. Manufacturer documentation shall contain information for calibration, trouble shooting, maintenance, required special tools or software, and communication protocols.	Comply	See Ref. 45, Chapter 4, and Ref. 50
	Manufacturer documentation shall include results of component aging analysis.	Comply	See this report, Section 4.12.
8.6	Qualification Documentation Requirements. Qualifier shall provide and submit all qualification documentation to customer utility for review and approval.	Comply	See Ref. 3.
8.6.1	Programmatic Documentation Requirements. Descriptive information.	- - -	No requirements.
8.6.1.A	Programmatic Documentation. A test plan shall be prepared which includes test plans for environmental, seismic, surge, Class 1E to Non-1E, EMI/RFI, availability/reliability, FMEA and ASOA qualification activities.	Comply	See Ref. 1 and 2.

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SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
8.6.1.B	Programmatic Documentation. Test specifications shall be prepared which include equipment identifications, interfaces and service conditions.	Comply	See Ref. 2 and 3.
8.6.1.C	Programmatic Documentation. Procedures shall be prepared for qualification testing.	Comply	See Ref. 2, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28 29, and 65.
8.6.1.D	Programmatic Documentation. Test reports shall be prepared for each qualification test performed.	Comply	See Ref., 34, 35, 36, 37, 38, 39, 40 41, 53, 64, 66, 67 and 68.
8.6.1.E	Programmatic Documentation. Reports on audits performed on the manufacturer shall be prepared.	Comply	Triconex is a 10CFR50, Appendix B supplier. The manufacturing and qualification processes are owned and controlled by Triconex. MPR was contracted by Triconex to perform some of the qualification tests. An audit of MPR was performed by Triconex. See Audit Report V0510.
8.6.1.F	Programmatic Documentation. Reports on design evaluations shall be prepared.	Comply	See Ref. 8. Design evaluations include interface cable similarity analysis.
8.6.2	Technical Items and Acceptance Criteria Documentation Requirements. Descriptive information.	- - -	No requirements.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
8.6.2.A	Technical Items Documentation. Documentation shall include test specimen requirements.	Comply	See Ref. 1.
8.6.2.B	Technical Items Documentation. Documentation shall include test specimen purchasing records.	N/A	See Ref. 3 .
8.6.2.C	Technical Items Documentation. Documentation shall include TSAP development documentation.	Comply	See Ref., 17, 18, 4344, 64, 66, 67, and 68.
8.6.2.D	Technical Items Documentation. See Sections 8.8, 8.9, 8.10, 8.12 and 8.13.	- - -	No requirements.
8.6.2.E	Technical Items Documentation. See Section 8.14.	- - -	No requirements.
8.6.3	Application Guide Documentation Requirements. A qualification summary document shall be provided.	Comply	See Appendix B of this report.
8.6.3.A	Application Guide. Guide shall include results of environmental Operability testing to support each specific safety related application.	Comply	See Ref. 35, 52, and 53, and Appendix B of this report.
8.6.3.B	Application Guide. Guide shall include results of seismic testing including seismic withstand capability for all damping values used in test data analysis.	Comply	See Ref. 36 and Appendix B of this report.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
8.6.3.C	Application Guide. Guide shall include results of Class 1E to Non-1E isolation testing.	Comply	See Ref. 41 and Appendix B of this report.
8.6.3.D	Application Guide. Guide shall include results of surge withstand testing.	Comply	See Ref. 39 and 57, and Appendix B of this report.
8.6.3.E	Application Guide. Guide shall include results of EMI/RFI testing.	Comply	See Ref. 37 and 57, and Appendix B of this report.
8.6.3.F	Application Guide. Guide shall include results of power quality testing.	Comply	See Ref. 52 and Appendix B of this report.
8.6.3.G	Application Guide. Guide shall describe any combination of software objects or special purpose objects created to support testing.	N/A	No software objects or special purpose objects were used in testing.
8.6.3.H	Application Guide. Guide shall include a description of the as-tested PLC configuration.	Comply	Appendix B of this report.
8.6.3.I	Application Guide. Guide shall include a description of the executive software and software tools revision levels included in qualification.	Comply	See Ref. 3 and Appendix B of this report.
8.6.3.J	Application Guide. Guide shall include a description of the as-tested PLC configuration.	Comply	See Ref. 42 and Appendix B of this report.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
8.6.3.K	Application Guide. Guide shall include a summary of the FMEA and availability analysis.	Comply	See Ref. 9, 10 and Appendix B of this report.
8.6.3.L	Application Guide. Guide shall include the setpoint analysis support document.	Comply	See Ref. 9 and Appendix B of this report.
8.6.3.M	Application Guide. Guide shall include information from manufacturer audits and surveys applicable to future purchasing.	Comply	See Appendix B of this report.
8.6.3.N	Application Guide. Guide shall include a description of the redundancy features include in qualification.	Comply	See Appendix B of this report.
8.6.3.O	Application Guide. Guide shall include a description of external devices included in qualification.	Comply	See Appendix B of this report.
8.6.3.P	Application Guide. Guide shall include a description of the PLC configuration management methods.	Comply	See Appendix B of this report.
8.6.3.Q	Application Guide. Guide shall include a summary of the component aging analysis.	Comply	See Appendix B of this report.
8.6.3.R	Application Guide. Guide shall include a description of seismic mounting methods.	Comply	See Ref. 14 and Appendix B of this report.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
8.6.3.S	Application Guide. Guide shall include a description of qualification envelopes for specific modules if different from the overall envelope.	Comply	Appendix B of this report.
8.6.3.T	Application Guide. Guide shall include a description of any application hardware or software features that are assumed in order to meet qualification requirements.	Comply	See Appendix B of this report.
8.6.4	Supporting Analyses Documentation Requirements. Documentation shall be provided of the FMEA and Availability/Reliability Analyses.	Comply	See Ref. 10 and 11.
8.6.5	Class 1E to Non-1E Isolation Test Plan. A Class 1E to Non-1E Isolation test plan and report shall be provided. The test plan shall be reviewed and approved by the utility.	Comply	See Ref. 2, 29 and 41.
8.7	V&V Documentation Requirements. Descriptive information.	- - -	No requirements.
8.7.A	V&V Documentation. Documentation shall include a software quality assurance plan.	Comply	See Ref. 5.
8.7.B	V&V Documentation. Documentation shall include a software requirements specification.	Comply	See Ref. 17.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
8.7.C	V&V Documentation. Documentation shall include a software design description.	Comply	See Ref. 18.
8.7.D	V&V Documentation. Documentation shall include a software V&V plan.	Comply	See Ref. 5.
8.7.E	V&V Documentation. Documentation shall include a software V&V report.	Comply	See Ref. 44.
8.7.F	V&V Documentation. Documentation shall include software user documentation.	Comply	See Ref. 46.
8.7.G	V&V Documentation. Documentation shall include a software configuration management plan.	Comply	See Ref. 5.
8.8	System Description Requirements. A test specimen hardware and software description document shall be provided.	Comply	See Ref. 42.
8.9	Critical Characteristics Listing Requirement. A critical characteristics listing document shall be provided.	N/A	Triconex is a 10CFR50, Appendix B supplier. Commercial dedication of Tricon PLC is not required.
8.10	System Drawing Requirements. A set of test specimen hardware, software and configuration drawings shall be provided.	Comply	See Ref. 14.

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SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
8.10.A	System Drawing Requirements. Drawings shall include a functional description of the test specimen.	Comply	See Ref. 15, Functional Drawings.
8.10.B	System Drawing Requirements. Drawings shall include a schematic of the test specimen.	Comply	See Ref. 12 and 14, Wiring Schedule and System Drawings.
8.10.C	System Drawing Requirements. Drawings shall include diagrams that define the TSAP.	Comply	See Ref. 15, Functional Diagrams.
8.10.D	System Drawing Requirements. Drawings shall show test specimen wiring, power distribution and grounding.	Comply	See Ref. 12 and 14, Wiring Schedule and System Drawings.
8.10.E	System Drawing Requirements. Drawings shall show layout of test specimen chassis, modules and qualification test fixtures.	Comply	See Ref. 12 and 14, Wiring Schedule and System Drawings.
8.10.F	System Drawing Requirements. Drawings shall show test specimen mounting and mounting fixtures, including special installation requirements.	Comply	See Ref. 12 and 14, Wiring Schedule and System Drawings.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
8.11	System Software/Hardware Configuration Document Requirements. Software and hardware configuration used for qualification testing shall be documented, including identification and revision of executive software, module firmware, software tools, downloadable PLC executive packages, and the TSAP (including printout). The identification, revision level and serial number of hardware shall be documented.	Comply	See Ref. 3.
8.12	System Database Documentation Requirements. The TSAP database used for qualification testing shall be documented.	Comply	See Ref. 15, and 18.
8.13	System Setup/Calibration/Checkout Procedure Requirements. All setup, calibration and checkout procedures used during qualification shall be documented.	Comply	See Ref. 19.
8.14	System Test Documentation Requirements. A test plan and test report shall be provided covering qualification Operability testing. The documents shall include test requirements, acceptance criteria, sequence of testing, data recording methods, test equipment requirements and a test data summary.	Comply	See Ref. 2, 20 and 53.
8.15	Manufacturer's Quality Documentation Requirements. The manufacturer shall provide its Quality Assurance Plan.	Comply	See Ref. 4 and 5.

SECTION	SUMMARY OF EPRI TR-107330 REQUIREMENTS [1]	COMPLIANCE [2]	COMMENTS [3]
8.16	Manufacturer's Certifications Requirements. Manufacturer shall provide certificates of conformance for all test specimen hardware.	Comply	See Ref. 56.

Table Notes:

1. The requirement summaries are intended to paraphrase the basic hardware, software or programmatic requirements, and may not include all of the detailed requirement text given in the corresponding section of TR-107330. The statement of compliance for each requirement given in the table pertains to the detailed requirements as given in the corresponding section of EPRI TR-107330.

2. Definition of Compliance Terms:

- - -	The referenced TR-107330 section does not include any specific PLC requirements. No statement of compliance is necessary.
N/A	The TR-107330 requirement is not applicable to the specific design of the Tricon PLC. No statement of compliance is necessary. The Comments column provides a basis for the requirement being not applicable.
Comply	The Tricon PLC design fully complies with the corresponding requirement as given in the applicable section of EPRI TR-107330.
Exception	The Tricon PLC design does not fully comply with the corresponding requirement as given in the applicable section of EPRI TR-107330. The Comments column provides a disposition of the compliance exception.

3. Comments provide traceability of compliance to requirements through identified references. See the List of References following these Table Notes.

List of References:

Note: Unless indicated, applicable revision levels of all Triconex documents, reports, procedures and drawings were per the current revision of Triconex Document No. 9600164-540, Master Configuration List upon completion of the Nuclear Qualification Project. Subsequent revisions are maintained in the Triconex R&D Engineering database (Agile).

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

2. Triconex Document No. 9600164-500, Tricon Nuclear Qualification Program Master Test Plan (MTP).

3. Triconex Document No. 9600164-540, Tricon Nuclear Qualification Program Master Configuration List (MCL).

4. Triconex Document No. 9600164-002, Tricon Nuclear Qualification Quality Plan (NQQP)

5. Triconex Document No. 9600164-537, Tricon Nuclear Qualification Program Software Quality Assurance Plan (SQAP).

6. Triconex Document No. 9600164-730, Analog Input/Output Machine Count Calculations.

7. Triconex Document No. 9600164-731, Maximum Response Time Calculations.

8. Triconex Document No. 9600164-538, External Termination Panel Interface Cable Similarity Analysis.

9. Triconex Document No. 9600164-534, Tricon System Accuracy Specifications.

10. Triconex Document No. 9600164-531, Failure Modes and Effects Analysis.

11. Triconex Document No. 9600164-532, Reliability/Availability Study.

12. Triconex Document No. 9600164-700, Wiring Schedule.

13. Triconex Drawing No. 9600164-100 to 103 & 9600164-105, System Drawings.

14. Triconex Drawing No. 9600164-200 to 207, System Drawings.

15. Triconex Drawing No. 9600164-600 to 614, Function Diagrams.

16. Triconex Document No. 9600121-001, Tricon System Test Requirements Specification.

17. Triconex Document No. 9600164-517, TSAP Software Requirements Specification.

18. Triconex Document No. 9600164-518, TSAP Software Design Description.

19. Triconex Document No. 9600164-502, System Setup & Checkout Procedure.

20. Triconex Document No. 9600164-503, Operability Test Procedure.

21. Triconex Document No. 9600164-504, Prudency Test Procedure.

22. Triconex Document No. 9600164-506, Environmental Test Procedure.

23. Triconex Document No. 9600164-511, Radiation Exposure Test Procedure.

24. Triconex Document No. 9600164-507, Seismic Test Procedure.

25. Triconex Document No. 9600164-510, EMI/RFI Test Procedure.

26. Triconex Document No. 9600164-514, EFT Test Procedure.

27. Triconex Document No. 9600164-508, Surge Withstand Test Procedure.

28. Triconex Document No. 9600164-512, ESD Test Procedure.

29. Triconex Document No. 9600164-509, Class 1E Isolation Test Procedure.

30. NTS Document No. TP62987-07N-ENV, Procedure for Environmental Qualification.

31. NTS Document No. TP62987-07N-RAD, Procedure for Radiation Testing.

32. NTS Document No. TP62987-07N-SEI, Procedure for Seismic Qualification.

33. NTS Document No. TP62987-07N-EMI, Procedure for EMI Qualification.

34. Triconex Document No. 9600164-512, Tricon Nuclear Qualification Program Radiation Exposure Test Report.

35. Triconex Document No. 9600164-525, Tricon Nuclear Qualification Program Environmental Test Report.

36. Triconex Document No. 9600164-526, Tricon Nuclear Qualification Program Seismic Test Report.

37. Triconex Document No. 9600164-527, Tricon Nuclear Qualification Program EMI/RFI Test Report.

38. Triconex Document No. 9600164-521, Tricon Nuclear Qualification Program EFT Test Report.

39. Triconex Document No. 9600164-528, Tricon Nuclear Qualification Program Surge Withstand Test Report.

40. Triconex Document No. 9600164-522, Tricon Nuclear Qualification Program ESD Test Report.

41. Triconex Document No. 9600164-529, Tricon Nuclear Qualification Program Class 1E to Non 1E Isolation Test Report.

42. Triconex Document No. 9600164-541, Tricon Nuclear Qualification Program System Description.

43. Triconex Document No. 9600164-513, TSAP Software Verification and Validation Plan.

44. Triconex Document No. 9600164-536, TSAP Final V&V Report.

45. Planning and Installation Guide for Tricon v9-v10 Systems, Part No. 9700077-002.

46. Tristation 1131 Developer's Workbench, Document No. 9700100-003.

47. Tristation 1131 Developer's Workbench Libraries Reference, TS 1131 Version 4.1, Document No. 9700098-003.

48. Tricon Version 9-10 Systems Field Termination Guide, Part No. 9700052-012.

49. Tricon Version 9-10 System Technical Product Guide, Part No. 9791007-013.

50. Tricon Version 9-10 System Communication Guide, Part No. 9700088-001.

51. Tricon V9-10 System, Safety Consideration Guide, Part No. 9700097-001.

52. Triconex Document No. 9600164-545, Equipment Qualification Summary Report.

53. Triconex Document No. 9600164-566, Performance Proof Operability Test Report.

54. Triconex Corporation, Quality Assurance Manual Date 06/07/2007.

55. . Triconex Part No. 1600083-200 document attachment, 7B34_analog.pdf.

56. Triconex Document No. 9600164-540, Master Configuration List.

57. USNRC Regulatory Guide 1.180, Revision 1 - Guidelines for Evaluating Electromagnetic and Radio-Frequency Interference in Safety-Related Instrumentation and Control Systems.

58. Triconex Document No. 9600164-535, Software Qualification Report.

59. SOE Recorder User's Guide, v4.0, Document Number 9720081-003.

60. Enhanced Diagnostics Monitor v2.0 User's Guide, Document Number 9720107-002.

61. Triconex Document Number 9600164-538, External Termination Panel Interface Cable Assembly Similarity Analysis.

62. Triconex Corporation Quality Assurance Manual.

63. Triconex Engineering Procedure EDM 75.00, Nuclear Product Qualification.

64. Triconex Document No. 9600164-573, Performance Proof Prudency Test Report.

65. Triconex Document No. 9600164-716, TSAP Software Validation Test Procedure.

66. Triconex Document No. 9600164-570, Pre-Qualification Prudency Test Report.

67. Triconex Document No. 9600164-713, V&V Test Phase Summary Report.

68. Triconex Document No. 9600164-717, Software Validation Test Report.