



HF Controls

**FPGA Modules of HFC-6000 Safety Platform
EPRI TR 107330 Requirement Compliance Traceability Matrix**

RR901-107-03

Rev. B

Effective Date 6 / 6 / 2017

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Revision History

Date	Revision	Author	Changes
6/19/2014	A0	I. Chow	Initial Draft
6/19/2015	A	Y. Lu	Initial Release
3/28/17	B	E. O'Donnell	Updated to include VV0115 results

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1.0 INTRODUCTION

This document presents a traceability matrix for the compliance of the FPGA Controllers of HFC-6000 Safety Platform with EPRI TR-107330, Generic Requirements Specification for Qualifying a Commercially Available PLC for Safety-Related Applications in Nuclear Power Plants. NRC Safety Evaluation of HFC-6000 Safety Platform has already validated majority of the compliance with respect to the process and procedures used in product development. Refer to NRC document ML110831014. The matrix presented here covers FPGA I/O Modules and Controllers with digital and analog input and output channels. The FPGA controllers continue to use HFC-6000 safety platform as the basis for the design architecture. Complimentary equipment/devices in the HFC-6000 platform have already been covered by previous submittal, ML11297A039 to 042. The modules listed in Section 4.0 of this document are the new modules that have not been addressed in previous NRC reviews.

2.0 TRACEABILITY MATRIX

The traceability matrix consists of a multi column table. The purpose and content of the material in each column is as follows:

EPRI TR-107330 Reference	Contains the section and paragraph number reference for each line of text in the specification.
Summary of Requirement	Contains either the paragraph heading or the summary of the content in the indicated paragraph.
Compliance	Indicates level of compliance achieved. (Refer to paragraph 2.1)
HFC Document Reference	Identifies the HFC document that either accomplishes the specific requirement or provides the evidence for compliance. Refer to ML110831014, HFC-6000 Product Line Document Map for a list of document references.
Comments	Provides explanatory information about the level of compliance or the way in which compliance is accomplished.

2.1 Traceability Matrix Compliance

Comply	The intent of the stated requirement was met in full by the indicated document.
Exception	The intent of the stated requirement was not met in some respect. The entry in the comments column indicates the nature of the deviations.

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N/A Not Applicable. Either the EPRI reference did not include any requirement, or the stated requirement is not applicable to the test specimen covered by this report.

2.2 Abbreviations

ADC	Analog/Digital Converter
AI	Analog Input
AIC	Analog Input Conversion
AO	Analog Output
C	Centigrade
CD	Compact Disk
C-Link	Communication Link
CPC	Communication Protocol Controller
CPLD	Complex Programmable Logic device
CR	Condition Report
CRC	Cyclic Redundancy Check
DAC	Digital/Analog Converter
dB	deci Bell
DI	Digital (Discrete) Input
DIP	Dual In-Line Package
DO	Digital (Discrete) Output
EMI	Electromagnetic Interference
EWS	Engineering Workstation
FMEA	Failure Modes and Effects Analysis
FPGA	Field Programmable Gated Array
FOT	Fiber-Optics Transmitter
FPC	Flat Panel Controller
FPD	Flat Panel Display
g	acceleration of gravity
HAS	Historical Archiving System
HFC	HF Controls
HIFR	Host Interface Remote (HFC software utility)
HMI	Human-Machine Interface
HPAT	HFC Plant Automated Tester
hr	hour
iaw	in accordance with
ICL	Intercommunications Link
I/O	Input/Output
MCRT	Microsoft/Windows CRT (HFC software utility for operator workstations)
KHz	Kilo Hertz
LED	Light Emitting diode
min	minute
ms	millisecond
NMI	Non-Maskable Interrupt
OBE	Operating Basis Event
PC	Personal Computer

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PCB	Printed circuit Board
PLC	Programmable Logic Controller
PROM	Programmable Read-Only Memory
PVC	Poly Vinyl Chloride
QA	Quality Assurance
QAPM	QA Program Manual
RAM	Random Access Memory
RFI	Radio Frequency Interference
RH	Relative Humidity
RQ	Designation for a remote data routing table
RTD	Resistance Thermal Detector
ROM	Read Only Memory
sec	second
SLC	Single Loop Controller
SOE	Sequence of Events
SSE	Safety Shutdown Event
TC	Thermocouple
TSAP	Test Specimen Application (synthetic application program for test specimen)
TTL	Transistor-Transistor Logic
v	volt
V&V	Verification and Validation
vac	volt alternating current
vdc	volt direct current
w	watt

3.0 REFERENCE

3.1 References of Components in the Test Specimen

40117306	HFC-FPUD01 Schematic
40117541	HFC-FPUD02 Schematic
40124341	HFC-FPUA Schematic
40127101	HFC-FPUL Schematic
40127541	HFC-FPUM Schematic
40127481	HFC-FPUAO Schematic
40129901	HFC-TBDO16T4 Schematic
40155542	HFC-FPUM2 Schematic
50067304	VV0115 Tie Bar Weldment TB Front Panel
50067420	VV0115 Front Panel Fabrication, Terminal Board
71005901	D/G Load Sequence – FPGA I/O Interface Schematic
71005902	D/G Load Sequence Logic – FPGA Control Logic
71006001	VV0115 Seismic Rack Assembly
71006101	VV0115 Power Distribution Panel Assembly

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71006301	VV0115 Loop Layout FPGA EQ
71006401	VV0115 Wire List
71006501	VV0115 Cable Connection FPGA EQ
71006601	VV0115 Power Distribution Test Equipment Assembly
71006701	VV0115 Front/Rear Terminal Board Assembly
71006801	VV0115 Inside Center Right Terminal Board Assembly
71006901	VV0115 Inside Center Left Terminal Board Assembly
DS001-007-01	FPGA System Module Design Description
DS001-007-02	FPGA System IP Core Design Description.
DS001-007-03	FPGA Logic Library Component Design Description
DS001-007-04	HFC-FCPU FPGA Software Design Description
DS901-000-25	HFC-FPC08 FPGA Gateway Hardware Design Spec
DS901-001-20	HFC-HSIM Design Specification
DS901-001-25	HFC-HSIM FPGA Design Specification
DS901-001-54	HFC-FPUD_Design_Specification
DS901-001-70	HFC-FPUA 16 Channel (4~20 ma/0~10V) AI Hardware Design Desc.
DS901-001-71	HFC-FPUAL 8 Channel (TC) AI Hardware Design Description
DS901-001-72	HFC-FPUAO 8 Channel (4-20ma) AO Hardware Design Description
DS901-001-73	HFC-FPUM 8 Channel (RTD) AI Hardware Design Description
DS901-001-74	HFC-FCPU Hardware Design Specification
DS901-000-81	HFC-6000 FPGA Platform Diagnostic Design Specification
DS901-001-99	FPC08 G-Link Gateway Software Design Specification
DS901-002-14	HFC-FPC08 G-Link Gateway Firmware Design Specification
DS901-002-18	HFC-FCPUX Hardware Design Specification
DS901-002-19	HFC-FPUM2 Hardware Design Specification
DS901-003-01	HFC-FPUD01/D02 FPGA DI/DO Software Design Description
DS901-003-02	HFC-FPUA 16 Channel AI FPGA Software Design Description
DS901-003-03	HFC-FPUL 8 Channel (TC) AI FPGA Software Design Description
DS901-003-04	HFC-FPUAO 8 Channel AO FPGA Software Design Description
DS901-003-05	HFC-FPUAM 8 Channel (RTD) FPGA Software Design Description

**EPRI TR 107330 Requirement Compliance Traceability Matrix for
HFC-6000 FPGA Modules**

DS901-201-07	Application Design Descriptions for TSAP for FPGA Controllers
MS901-000-08	HFC-6000 FPGA System Design Description
RR901-107-01	FMEA for HFC-6000 FPGA Controllers
RR901-107-02	Reliability and Availability Report for HFC-6000 FPGA Controllers
RR901-107-04	Radiation Exposure Evaluation for FPGA Controllers
RR901-107-05	Performance Envelope for HFC-6000 FPGA Controllers
RR901-107-06	NRC DI&C ISG-06 Compliance Matrix
RR901-107-07	Analyses report on FPGA component testing
RR901-107-10	Amendment for HFC-FPGA System to HFC-6000 Safety Platform
RS901-000-01	HFC-6000 Product Line
RR901-000-10	
RS901-001-15	HFC-HSIM F-Link FPGA Software Requirements Specification
RS901-001-43	HFC-FPUD 32 Channel DI/DO Hardware Requirement Specification
RS901-001-48	HFC-FPUA 16 Channel (4~20 ma/0~10V) AI Hardware Req. Spec
RS901-001-71	HFC-FPUL 8 channel (TC) AI Hardware Requirement Specification
RS901-001-64	HFC-FPUD FPGA Software Requirement Specification
RS901-001-65	HFC-FPUA FPGA 16 Channel (4~20 ma/0~10V) AI Software Req. Spec.
RS901-001-66	HFC-FPUAL FPGA 8 channel (TC) AI Software Requirement Specification
RS901-001-67	HFC-FPUAO FPGA 8 channel AO Software Requirement Specification
RS901-001-68	HFC-FPUM FPGA 8 channel (RTD) AI Software Requirement Spec.
RS901-001-69	HFC-FPUAO 8 channel AO Hardware Requirement Spec.
RS901-001-70	HFC-FPUM 8 channel RTD AI Hardware Requirement Specification
RS901-001-71	HFC-FPUL 8 channel (TC) AI Hardware Requirement Specification
RS901-002-04	HFC-FPC08 FPGA Gateway Software Requirement Specification
RS901-003-02	HFC-FCPU SW Requirement Specification
RS901-201-07	FPGA Controllers TSAP Requirement Specification
UG004-001-01	FPGA Controller EWS User's Guide
RR901-107-03	

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UG004-001-02	FPGA Controller Onestep Software User's Guide
UG004-001-03	FPGA Controller Maintenance & Troubleshooting Guide
UG004-001-04	FPGA Controller Site Planning and Installation Guide
3.2 References for Qualification Tests of the Test Specimen	
PP901-000-01	Topical Report of HFC-6000 Platform, Rev. C
QAPM	Quality Assurance Program Manual
QPP 2.3	Lead Auditor Qualification
QPP 2.4	Auditor Qualification
QPP 3.2	Product Lifecycle and Verification Validation Program
QPP 12.1	Control of Measurement and Test Equipment
QPP 16.1	Corrective Action Program
QPP 16.2	Customer Feedback
QPP 16.3	10 CFR Part21 Reporting
QPP 18.1	Audits
QPP 12.1	Control of Measurement and Test Equipment
TP901-200-00	EPRI TR 107330 Pre-Qualification Test Procedures
TP901-200-01	EPRI TR 107330 Burn-in Test Procedures
TP901-302-02	VV0115 Environmental Stress Test Procedure
TP901-302-03	VV0115 EMI RFI Test Procedure
TP901-302-04	VV0115 Surge Withstand Test Procedure
TP901-302-05	VV0115 Electrostatic Discharge Withstand Test Procedure
TP901-115-01	VV0115 Qualification Operability Test Procedure
TP901-115-02	VV0115 Qualification Prudency Test Procedure
TP901-115-04	VV0115 Qualification Application Software Object Test Procedure
TP901-115-05	VV0115 Integration Test Plan
TP901-115-06	VV0115 TSAP Validation Test Procedure
TR901-201-01	HFC-6000 FPGA Controller System Qualification Test Report
TR901-302-01	HFC-FPGA Control System of HFC-6000 Safety Platform Qualification Test Report
TS001-000-09	Isolation Test Specification
TS901-002-31	HFC-FPUD01 Prototype Test Procedure
TS901-002-32	HFC-FPUD02 Prototype Test Procedure
TS901-002-33	HFC-FPUA Prototype Test Procedure

**EPRI TR 107330 Requirement Compliance Traceability Matrix for
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VV901-117-01	VVP for FPGA Controllers (FCPU included)
VV901-117-16	Final V&V Report FPGA Controllers
VV901-300-09	VV0115 Qualification Master Test Plan
VV901-300-10	HFC-6000 FPGA Test Specimen Design Description
VV901-308-01	FPGA Controllers Test Specimen Design Description (FCPU)
VV901-308-02	FPGA Controller Master Configuration List
WI-DOC-001	Document Distribution
WI-ENG-003	Configuration Management
WI-ENG-020	Software Security
WI-ENG-100	Engineering Processes
WI-ENG-815	Red-Line Procedure

3.3 NRC Published Documents

ML110831014	NRC Safety Evaluation of HFC-6000 Safety Platform
ML11297A039 to 042	Amendment of Enhanced Equipment for NRC Safety Evaluation of HFC-6000 Safety Platform

4.0 FPGA MODULES

Table 1 – List of FPGA I/O Modules and Controllers

Part Number (With Bezel)	Model	Description
40117421	HFC-FPUD01	Configurable 16 channels DI/16 channels DO
40117422	HFC-FPUD02	32 channel DI
40124221	HFC-FPUA	16 channel AI (4~20 ma)
40129421	HFC-FPUAO	8 channel AO board
40127021	HFC-FPUL	8 channel TC board
40127421	HFC-FPUM	8 channel RTD board
40145621	HFC-FPUM2	8 channel RTD board (High Accuracy)
40132221	HFC-FCPU	Control Processing Unit
40145221	HFC-FCPUX	Control Processing Unit (Increased FPGA size)
40108621	HFC-HSIM	F-Link High Speed Interface Module
40103834	HFC-FPC08	Communication Gateway Controller

EPRI TR 107330 Requirement Compliance Traceability Matrix for
HFC-6000 FPGA Modules

Table 2 – EPRI TR 107330 Requirement Compliance Traceability Matrix Table

EPRI TR-107330 Reference	Summary of Requirement	Compliance	HFC Document Reference	Comments
1	Scope. Background information only.	N/A		[]
2	Definitions, Abbreviations, Acronyms. Reference information only.	N/A		[]
3	Reference Documents List of reference standards only.	N/A		[]
4	System Requirements. Section Heading	N/A		[]
4.1	Overview of Performance Basis. Descriptive Information	N/A		[]
4.2.1	Functional Requirements. Section Heading	N/A		[]
4.2.1.A	Response Time. Overall response time from input exceeding trip condition to the resulting output shall be 100 ms or less. This duration includes the effects of input filtering, internal processing and two processing cycles for an application having the equivalent of 2000 simple logic elements.	Comply	TR901-302-01 TP901-115-01	[]
4.2.1.B	Discrete I/O. Provide capability for a total of at least 400 discrete I/O	Comply	RR901-107-10-PI VV901-300-10	[]
4.2.1.C	Analog I/O. Provide capability for a total of at least 100 analog I/O	Comply	RR901-107-10-PI VV901-300-10	[]
4.2.1.D	Combined I/O. Provide capability for a combined total of at least 50 analog and 400 discrete I/O points.	Comply	RR901-107-10-PI VV901-300-10	[]

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EPRI TR-107330 Reference	Summary of Requirement	Compliance	HFC Document Reference	Comments
				[]
4.2.2	Control Functional Requirements. The PLC shall provide a high level language for implementing applications.	Comply	UG004-000-01 UG004-000-04	[]
4.2.3	Availability/Reliability and FEMA. Section Heading	N/A		
4.2.3.1	Availability/Reliability Overview. Descriptive Information	N/A		
4.2.3.2	Availability/Reliability and Basic Requirements. Overall availability shall be 0.99. The analysis shall be based on the following combination of modules: A. 3 discrete input modules B. 2 analog input modules C. 1 analog output module D. 3 discrete output modules and 1 relay output module E. 1 high-level language module (N/A) F. Any other module required to support performance G. Any required ancillary devices H. Main processor I. Power supplies J. Chassis/backplane K. Interconnect devices L. Modules required to implement redundancy M. Ringback (N/A)	Comply	RR901-107-02	[]
4.2.3.3	Availability/Reliability Calculation Requirements. Method of analysis shall comply with IEEE 352. A. Fault detection by online diagnostics instantaneous B. Analysis includes surveillance interval C. Module replacement requires 24 hours D. Fault detection by surveillance requires 24 hours E. Normal environmental conditions assumed F. Probability of normal operation for 2 wks under environmental stress G. Definition of module availability 4.2.3.3.1.A Single point failure rates 4.2.3.3.1.B Faults not detected by diagnostics 4.2.3.3.1.C Triple redundant systems (N/A)	Comply	RR901-107-02	[]

EPRI TR 107330 Requirement Compliance Traceability Matrix for
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EPRI TR-107330 Reference	Summary of Requirement	Compliance	HFC Document Reference	Comments
	4.2.3.3.1.D PLC failure definition			
4.2.3.4	PLC Fault Tolerance Requirements. Fault tolerance shall be included as part of the reliability/availability analysis and included as part of the qualification envelope definition.	Comply	RR901-107-02	[]
4.2.3.5	Failure State/FMEA Requirements. FMEA shall be conducted in accordance with IEEE 352.	Comply	RR901-107-01	[]
4.2.3.6	Failure Detection Requirements. PLC provides features to permit generating an alarm when fault detected during online operation. Redundant systems provide: A. Significant level of coverage and status transfer B. Processor-processor communication (N/A) C. Processor firmware requirements of 4.4.5.2 and section 7.	Comply	RR901-107-01	[]
4.2.3.7	Recovery Capability Requirements. PLC shall include watchdog timer and power bus monitor. Output modules shall initialize to a known state following powerup.	Comply	DS901-001-25 DS901-003-01 DS901-003-02 DS901-003-03 DS901-003-04 DS901-003-05 DS001-007-04	[]
4.2.3.7.A	The PLC shall have a watchdog timer or equivalent capable of detecting failure to complete a scan. <ul style="list-style-type: none"> • On failure to complete a scan the PLC shall halt. • The mechanism shall not depend on the same clock source as the processor. • No communication feature of the executive shall defeat the operation of the mechanism. • No interrupt service routine shall defeat the mechanism. 	Comply	DS901-001-25 DS901-003-01 DS901-003-02 DS901-003-03 DS901-003-04 DS901-003-05 DS001-007-04	[]
4.2.3.7.B	The PLC shall provide a power bus monitor.	Comply	DS901-001-25 DS901-003-01 DS901-003-02 DS901-003-03 DS901-003-04 DS901-003-05 DS001-007-04	[]

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EPRI TR-107330 Reference	Summary of Requirement	Compliance	HFC Document Reference	Comments
4.2.3.7.C	All output modules shall initialize to a known state.	Comply	DS901-003-01 DS901-003-04	[]
4.2.3.8	Requirements for Use of Operating Experience. A. Non-proprietary problem reporting and tracking B. Provide justification for claimed operating history C. System under configuration management	Comply	RR901-107-10-PI	[]
4.2.4	Setpoint Analysis Support Requirements. Analysis report iaw ISA RP 67.04 shall include: A. Calibrated accuracy, hysteresis, and nonlinearity B. Repeatability C. Temperature sensitivity D. Drift with time E. Variations caused by power supply voltage levels F. Error contribution of arithmetic operations G. Components that could be affected by vibration H. Components that could be affected by radiation I. Components that could be affected by humidity	Exception	TR901-302-01	[]
4.3	Hardware Requirements. Section Heading	N/A		[]
4.3.1	General. Section Heading	N/A		[]
4.3.1.1	Background. General Information	N/A		[]
4.3.1.2	Requirements Common to all Modules. A. Shall meet or support requirements of section 4.2.1. B. A square root of the sum of squares may be used to combine independent random factors. C. Environmental requirements defined in section 4.3.6. Single assemblies with both inputs and outputs shall meet isolation and surge withstand requirements.	Comply	TS001-000-09 TP901-302-02 TR901-302-01	[]
4.3.1.3	External Device Requirements. External devices used to meet I/O requirements shall meet listed overall requirements.	Exception		[]
4.3.1.4	General Redundancy Requirements. Test specimen may include redundant modules.	Comply	VV901-300-10	[]
4.3.2	Input Requirements. Section Heading	N/A		[]
4.3.2.1	Analog Input Requirements. Test specimen shall include analog input modules.	Comply	VV901-300-10	[]
4.3.2.1.A	Monotonic within $\pm 1/2$ LSB (equivalent to ± 0.00122 v)	Comply	DS901-003-02	

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EPRI TR-107330 Reference	Summary of Requirement	Compliance	HFC Document Reference	Comments
			40124341	
4.3.2.1.B	Each module shall provide a minimum of 4 channels.	Comply	DS901-003-02 40124341	[]
4.3.2.1.C	The converted value shall remain at its maximum value for inputs up to twice the rated input.	Comply	DS901-003-02 40124341	[]
4.3.2.1.D	The converted value shall remain at its minimum for up to twice the rated value for unipolar inputs.	Comply	DS901-003-02 40124341	[]
4.3.2.1.E	Under range and over range conditions shall be indicated with a flag that is available to the application program.	Comply	DS901-003-02 40124341	[]
4.3.2.1.1	<u>Voltage Input Requirements.</u> Section Heading	Exception		[]
4.3.2.1.2	<u>Current Input Requirements.</u> Section Heading	N/A		[]
4.3.2.1.2.A	Current input shall be 4 to 20 mA, 0 to 20 mA, 10 to 50 mA, or 0 to 50 mA	Comply	DS901-003-02 40124341	[]
4.3.2.1.2.B	Overall accuracy shall be $\leq \pm 0.35\%$, including drift and hystereses.	Comply	DS901-003-02 40124341	[]
4.3.2.1.2.C	Minimum resolution shall be 12 bits.	Comply	DS901-003-02 40124341	[]
4.3.2.1.2.D	The common mode voltage capability shall be at least 10 volts.	Exception		[]
4.3.2.1.2.E	Common mode rejection shall be at least 90 dB.	Comply	TS901-002-33	[]
4.3.2.1.2.F	Overall response for AI modules shall support the response time requirement of Section 4.2.1.A.	Comply	TR901-302-01 TP901-115-01	[]

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EPRI TR-107330 Reference	Summary of Requirement	Compliance	HFC Document Reference	Comments
4.3.2.1.2.G	Group-to-group isolation shall be ± 30 volts peak for 4- to 20 mA channels	Comply	TS001-000-09	[]
4.3.2.1.2.H	Module Isolation shall meet requirements of Section 4.6.4.	Comply	TS001-000-09	[]
4.3.2.1.2.I	Surge withstand shall meet requirements of Section 4.6.2.	Comply	TR901-302-01	[]
4.3.2.1.2.J	Input impedance shall be at least 250 ohms maximum.	Comply	40124341	[]
4.3.2.1.3	<u>RTD Input Requirements.</u> Section Title	N/A		[]
4.3.2.1.3.A	The input module shall be suitable for 2, 3, and 4 wire elements using both European and US standard 100 ohm RTDs.	Exception	DS901-001-73, DS901-002-19	[]
4.3.2.1.3.B	The range shall be at least 0° to 800° C.	Exception	DS901-001-73, DS901-002-19	[]
4.3.2.1.3.C	Overall accuracy shall be $\pm 2^{\circ}$ C or better.	Comply	DS901-001-73, DS901-002-19	[]
4.3.2.1.3.D	Minimum resolution shall be 0.1° or less for both be $^{\circ}$ C and be $^{\circ}$ F scales.	Comply	DS901-001-73, DS901-002-19	[]
4.3.2.1.3.E	Common mode voltage capability shall be at least 10 vdc.	Comply	DS901-001-73, DS901-002-19	[]
4.3.2.1.3.F	Common mode rejection shall be at least 90 dB.	Comply	DS901-001-73, DS901-002-19	[]
4.3.2.1.3.G	Overall response time shall support requirements of Section 4.2.1.	Comply	TR901-302-01	[]
4.3.2.1.3.H	Group to group isolation shall be at least ± 30 volts peak.	Comply	TS001-000-09	[]
4.3.2.1.3.I	Module isolation shall meet the requirements of Section 4.6.4.	Comply	TS001-000-09	[]
4.3.2.1.3.J	Surge withstand shall meet requirements of Section 4.6.2.	Comply	TR901-302-01	[]
4.3.2.1.3.K	Input impedance shall be 1 megohm minimum.	Comply	DS901-001-73,	[]

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EPRI TR-107330 Reference	Summary of Requirement	Compliance	HFC Document Reference	Comments
			DS901-002-19 40127541 40155542	[]
4.3.2.1.4	Thermocouple Input Requirements. Section Heading	N/A		[]
4.3.2.1.4.A	TC input module shall be provided for types B, E, J, K, N, R, S, and T over specified input ranges.	Exception	DS901-001-71	[]
4.3.2.1.4.B	Overall accuracy shall be: B type $\leq \pm 2.5^\circ \text{C}$; E type $\leq \pm 3.0^\circ \text{C}$; J type $\leq \pm 3.5^\circ \text{C}$; K type $\leq \pm 4.0^\circ \text{C}$; N type $\leq \pm 2.0^\circ \text{C}$; R type $\leq \pm 2.5^\circ \text{C}$; S type $\leq \pm 2.5^\circ \text{C}$; T type $\leq \pm 2.5^\circ \text{C}$;	Comply	DS901-001-71, TP901-115-01	[]
4.3.2.1.4.C	Cold junction compensation shall support required accuracy	Comply	DS901-001-71	[]
4.3.2.1.4.D	Minimum resolution shall be 0.1° or less for both be $^\circ \text{C}$ and be $^\circ \text{F}$ scales.	Comply	DS901-001-71	[]
4.3.2.1.4.E	Common mode voltage capability shall be at least 10 vdc.	Comply	DS901-001-71	[]
4.3.2.1.4.F	Common mode rejection ratio shall be at least 90dB.	Comply	DS901-001-71	[]
4.3.2.1.4.G	The module shall provide open thermocouple detection.	Comply	DS901-001-71	[]
4.3.2.1.4.H	Overall response shall support requirements of Section 4.2.1.	Comply		[]
4.3.2.1.4.I	Group to group isolation shall be at least ± 30 volts peak.	Comply	TS001-000-09	[]
4.3.2.1.4.J	Module isolation shall meet the requirements of Section 4.6.4.	Comply	TS001-000-09	[]
4.3.2.1.4.K	Surge withstand shall meet requirements of Section 4.6.2.	Comply	TR901-302-01	[]
4.3.2.1.4.L	Input impedance shall be 1 megohm minimum.	Comply	40127101	[]
4.3.2.2	Discrete Input Requirements. Each module shall provide a minimum of 8 channels with an ON/OFF status indicator for each.	Comply	DS901-001-54	[]
4.3.2.2.1	Discrete AC Input Requirements. Section Heading	Exception		[]
4.3.2.2.2	Discrete DC Input Requirements. Section Heading	N/A		[]
4.3.2.2.2.A	Input module voltage levels shall be 1) 125 vdc, 2) 24	Exception	DS901-001-54	[]

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EPRI TR-107330 Reference	Summary of Requirement	Compliance	HFC Document Reference	Comments
	vdc		40117306	[]
4.3.2.2.2.B	Input transition to ON state shall occur at: 90 vdc max (125 vdc input); 20 vdc max (24 vdc input), 12 vdc max (15 vdc input); 10 vdc max (12 vdc input)	Comply	DS901-001-54 40117306	[]
4.3.2.2.2.C	Input transition to OFF state shall occur at: 65 to 25 vdc (125 vdc input); 15 to 6 vdc (24 vdc input), 9 to 4 vdc (15 vdc input); 7.5 to 3 vdc (12 vdc input)	Comply	TS901-002-32 DS901-001-54 401173-06	[]
4.3.2.2.2.D	Must operate up to at least: 150 vdc min (125 vdc input); 40 vdc min (24 vdc input), 25 vdc min (15 vdc input); 10 vdc max (12 vdc input)	Comply	DS901-001-54 401173-06	[]
4.3.2.2.2.E	Overall response time must support requirements of Section 4.2.1.	Comply	TR901-302-01	[]
4.3.2.2.2.F	Group to group isolation shall be at least: 600 v peak (125 vdc input); 40 vdc peak (24, 15, 12 vdc input).	Comply	TS001-000-09	[]
4.3.2.2.2.G	Module isolation shall meet the requirements of Section 4.6.4.	Comply	TS001-000-09	[]
4.3.2.2.2.H	Surge withstand shall comply with Section 4.6.2.	Comply	TR901-302-01	[]
4.3.2.2.3	<u>TTL Input Requirements.</u> Section Heading	Exception		[]
4.3.2.3	<u>Pulse Input Requirements.</u> Section Heading	Exception		[]
4.3.3	<u>Output Requirements.</u> Section Heading	N/A		[]
4.3.3.1	<u>Analog Output Requirements.</u> AO channels shall be monotonic within $\pm 1/2$ LSB, and each AO module shall have at least four channels.	Comply	40129481	[]
4.3.3.1.1	<u>Voltage Output Requirements.</u>	Exception		[]
4.3.3.1.2	<u>Current Output Requirements.</u> Section Heading	N/A		[]
4.3.3.1.2.A	AO channel ranges shall be: 1) 4 to 20 mA or 4 to 20 mA; and 2) 10 to 50 mA or 0 to 50 mA.	Comply	40129481	[]

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EPRI TR-107330 Reference	Summary of Requirement	Compliance	HFC Document Reference	Comments
4.3.3.1.2.B	AO channels shall provide an overall accuracy of $\pm 0.32\%$ accuracy.	Comply	TR901-302-01 DS901-001-72	[]
4.3.3.1.2.C	The minimum resolution shall be 12 bits.	Comply	DS901-001-72	[]
4.3.3.1.2.D	The output signal will meet requirements for a load impedance of 1Kohm or less.	Comply	40129481	[]
4.3.3.1.2.E	Overall response shall support requirements of Section 4.2.1.	Comply	TR901-302-01	[]
4.3.3.1.2.F	Group to group, module to module, and module to backplane isolation shall meet requirements of Section 4.6.4.	Comply	TS001-000-09	[]
4.3.3.1.2.G	Surge withstand shall meet requirements of Section 4.6.2.	Comply	TR901-302-01	[]
4.3.3.2	<u>Discrete Output Requirements.</u> Section Heading	N/A		[]
4.3.3.2.A	Each module shall provide a minimum of 8 output channels.	Comply	DS901-001-54	[]
4.3.3.2.B	Leakage in the off state shall be as specified in the following section or 80% of the minimum current needed to turn on any input module whose range includes the range of the output.	Comply	DS901-001-54 40117541	[]
4.3.3.2.C	Output channels must include circuit interrupter.	Comply	40117541 40129901	[]
4.3.3.2.D	Modules must provide onboard indicators to display ON/OFF status of each channel.	Comply	DS901-001-54 40117541	[]
4.3.3.2.1	<u>Solid State Discrete AC Output Requirements.</u> Section Heading	Exception		[]
4.3.3.2.2	<u>Solid State Discrete DC Output Requirements.</u> Section Heading	Exception		[]
4.3.3.2.3	<u>Relay Output Requirements.</u> Section Heading	N/A		[]
4.3.3.2.3.A	Relay output channels shall provide both normally open and normally closed contacts.	Comply	DS901-001-54	[]
4.3.3.2.3.B	Minimum contact rating shall be for 2 A continuous current with switching capacity of at least 750 VA (ac) or 150 watts (dc).	Comply	DS901-001-54 RR901-107-05	[]

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EPRI TR-107330 Reference	Summary of Requirement	Compliance	HFC Document Reference	Comments
4.3.3.2.3.C	Contact resistance shall not exceed 0.2 ohm.	Comply	DS901-001-54 TP901-115-01 TR901-302-01 RR901-107-05	[]
4.3.3.2.3.D	Contact must operate from source up to 30 vdc or 150 vac.	Comply	DS901-001-54 RR901-107-05	[]
4.3.3.2.3.E	Overall response must support requirements of Section 4.2.1.	Comply	TP901-307-02 TR901-115-01 RR901-107-05	[]
4.3.3.2.3.F	Group to group isolation shall be at least 600 v peak.	Comply	TS001-000-09	[]
4.3.3.2.3.G	Module isolation shall meet requirements of Section 4.6.4.	Comply	TS001-000-09	[]
4.3.3.2.3.H	Surge withstand requirements shall meet Section 4.6.2.	Comply	TR901-302-01	[]
4.3.3.2.4	<u>TTL Output Requirements.</u> Section Heading	Exception		[]
4.3.4	<u>Processor/Other System Component Requirements.</u> Section Heading	N/A		[]
4.3.4.1	<u>Processor Loop Time Requirements.</u> Processor loop time shall support response time requirement of Section 4.2.1. Also the loop time shall be faster than the greater of the analog conversion time or of 2.5 times the analog input filter cutoff frequency.	Comply	TR901-302-01	[]
4.3.4.2	<u>Memory Capacity and Data Retention Capacity Requirements</u> Controller shall provide sufficient memory capacity to execute a single application with the indicated number of program elements. Memory used for application program shall be capable of retaining information for a minimum of 6 months without power applied.	Comply	DS001-007-01 DS001-007-02	[]
4.3.4.3	<u>Data Acquisition Requirements.</u> Controller shall be capable of transferring information between main processor and I/O modules in the same chassis or an	Comply	DS001-007-01 DS001-007-02 VV901-300-10	[]

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EPRI TR-107330 Reference	Summary of Requirement	Compliance	HFC Document Reference	Comments
	extension chassis. Data transfer rates shall support requirements of Section 4.2.1.			[]
4.3.4.3.A	Interfacing devices shall meet environmental requirements of Section 4.3.6. Failure of interconnecting devices shall not defeat ability to transfer information between main processor and expansion chassis.	Comply	TR901-302-01	[]
4.3.4.3.B	Failure of interconnect modules shall not defeat ability to transfer data between main processor and local I/O or data capacity and data retention capability.	Comply	TR901-302-01 TP901-115-01 TP901-115-02	[]
4.3.4.3.C	Loss of power in interconnect modules shall not defeat capability to transfer power between main processor and local I/O.	Comply	TR901-302-01 TP901-115-01 TP901-115-02	[]
4.3.4.3.D	Main chassis interconnect module shall meet requirements of Section 4.6.4 for Class 1E to Non Class 1E isolation.	Comply	TS001-000-09	[]
4.3.4.3.E	Surge withstand shall be as indicated in Section 4.6.2.	Comply	TR901-302-01 TP901-302-04	[]
4.3.4.3.F	Data acquisition time shall be deterministic or manufacturer shall provide information necessary to determine maximum possible acquisition time.	Comply	DS001-007-01 DS001-007-02 VV901-300-10	[]
4.3.4.3.G	Inter-processor data acquisition buses on backplane. Descriptive Information.	N/A		[]
4.3.4.3.G.1	Buses shall be dual redundant at least.	N/A		[]
4.3.4.3.G.2	Loss of one buss shall not cause any processor to stall, result in an indeterminate state, or create conflicting fault indications.	Comply	DS001-007-01 DS001-007-02 VV901-300-10	[]
4.3.4.3.G.3	Loss of all busses shall not result in indeterminate operation.	Comply	DS001-007-01 DS001-007-02 VV901-300-10	[]

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EPRI TR-107330 Reference	Summary of Requirement	Compliance	HFC Document Reference	Comments
4.3.4.3.G.4	Provide capability to generate alarm on loss of one or more buses.	Comply	DS001-007-01 DS001-007-02 VV901-300-10	[]
4.3.4.3.G.5	Data acquisition time shall be deterministic.	Comply	DS001-007-01 DS001-007-02 VV901-300-10	[]
4.3.4.3.G.6	Operation of buses shall support response time requirement of Section 4.2.1.A.	Comply	TR901-302-01 TP901-115-01	[]
4.3.4.4	Communication Port Requirements. Main processor shall provide at least one communication port.	Comply	VV901-300-10 DS901-001-74 DS901-002-18	[]
4.3.4.4.A	Port shall support data rates up to at least 9600 baud.	Comply	VV901-300-10 DS901-001-74 DS901-002-18 DS001-007-01 DS001-007-02	[]
4.3.4.4.B	The ports shall support a widely used standard physical layer protocol.	Comply	DS001-007-01 DS001-007-02	[]
4.3.4.4.C	The ports shall provide positive hold down connectors.	Comply	DS001-007-01 DS001-007-02	[]
4.3.4.4.D	Port to port isolation shall be at least ±300 volts peak for 30 seconds.	N/A		[]
4.3.4.4.E	Port to processor isolation shall meet requirements of Section 4.6.4.	N/A		[]
4.3.4.4.F	Surge withstand shall meet requirements of Section 4.6.2.	N/A		[]
4.3.4.5	Coprocessor Module Requirements. Section Heading	Exception		[]
4.3.4.6	Chassis Requirements. Section Heading	N/A		[]
4.3.4.6.A	Suitable for installation in standard 19-in. equipment cabinets.	Comply	PP901-000-01 VV901-300-10	[]
4.3.4.6.B	Provide positive hold down for modules.	Comply	VV901-300-10	[]
4.3.4.6.C	Provide adequate structural integrity to meet seismic requirements of Section 4.3.9.	Comply	VV901-300-10 TR901-302-01	[]

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EPRI TR-107330 Reference	Summary of Requirement	Compliance	HFC Document Reference	Comments
4.3.4.7	<u>Backup Devices/Redundancy Requirements.</u> Section Heading	N/A		[]
4.3.4.7.A	Automatic transfer to a backup device shall occur within the greater of two main processor scan cycles or three conversion cycles of the main processor.	Comply	TP901-115-01 TR901-302-01	[]
4.3.4.7.B	Features or procedures shall be provided to assure that undetected failures are detected during periodic surveillance testing.	Comply	VV901-300-10 DS001-007-01 DS001-007-02	[]
4.3.4.7.C	Diagnostics shall not result in repetitive failover between redundant modules.	Comply	VV901-300-10 DS001-007-01 DS001-007-02	[]
4.3.4.7.D	Mechanism for transferring between redundant modules:	N/A		[]
4.3.4.7.D.1	Analog I/O modules	Comply	VV901-300-10	[]
4.3.4.7.D.2	Discrete I/O modules	Comply	VV901-300-10	[]
4.3.4.7.D.3	Pulse input modules	Exception		[]
4.3.4.7.D.4	Failover between redundant main processors shall be bumpless and result in an alarm.	Comply	TR901-302-01 TP901-115-01	[]
4.3.4.7.D.5	Transfer between redundant power supplies	Comply	TR901-302-01 TP901-115-01	[]
4.3.5	<u>Programming Terminal Requirements.</u> If a special programming terminal is required, its software shall meet requirements of Section 4.4.4, 7.5.2, and 7.7.2.	Exception		[]
4.3.6	<u>Environmental Requirements.</u> Section Heading	N/A		[]
4.3.6.1	<u>Normal Environmental Basic Requirements.</u> Ranges for normal environmental conditions: Temperature: 16° to 40° C (60° to 104° F) Humidity: 40 to 95% noncondensing Powersource range per Section 4.6.1.1 A and B Radiation Exposure: Up to 10 ³ RADS	Exception	TR901-302-01 TP901-302-02	[]

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4.3.6.2	<p><u>Abnormal Environmental Basic Requirements.</u> Ranges for normal environmental conditions:</p> <p>Temperature: 4° to 50° C (40° to 120° F) Humidity: 10 to 95% noncondensing Power source range per Section 4.6.1.1 A and B Radiation Exposure: Up to 103 RADS</p>	Exception	TR901-302-01 TP901-302-02	[]
4.3.6.3	<p><u>Environmental Withstand Specific Requirements.</u> The test specimen shall be subjected to the temperature profile shown in Figure 4-4 and tested in accordance with Section 5.3. Evaluations for paragraphs 4.3.6.1 and 4.3.6.2 provide adequate confidence for radiation harness.</p>	Comply	TR901-302-01 TP901-302-02	[]
4.3.7	<p><u>EMI/RFI Withstand Requirements.</u> The test specimen shall withstand EMI/RFI levels defined by specified sections of EPRI TR-102323.</p>	Comply	TR901-302-01 TP901-302-03	[]
4.3.8	<p><u>Electrostatic Discharge (ESD) withstand Requirements.</u> Test specimen shall withstand ESD levels as defined by EPRI TR-102323, Appendix B Section 3.5.</p>	Comply	TR901-302-01 TP901-302-05	[]
4.3.9	<p><u>Seismic Withstand Requirements.</u> Test specimen shall be subjected to the Required Response Spectrum shown in Figure 4-5. Relay output modules shall not chatter.</p>	Comply	TR901-302-01 TP901-302-06	[]
4.4	<u>Software/Firmware.</u> Section Heading	N/A		[]
4.4.1	<u>Executive.</u> Section Heading	N/A		[]
4.4.1.1	<u>Background.</u> Descriptive Information	N/A		[]
4.4.1.2	<p><u>Main Processor Executive Capability Requirements.</u> Main processor shall:</p> <p>A. Acquire inputs from modules. B. Implement the application in a continuous loop. C. Load outputs to modules. D. Perform powerup and runtime diagnostics per Section 4.4.6. E. Manage communications functions. F. Provide features to permit uploading application program while in program mode. G. Provide features to support online diagnostics per Section 4.4.6 and troubleshooting per Section 4.7.</p>	Comply	VV901-300-10 DS001-007-01 DS001-007-02	[]

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	<p>H. Provide at least the minimum set of application program functions per Section 4.4.3.</p> <p>I. Perform powerup initialization functions required for graceful startup.</p> <p>For systems with redundant I/O, the I/O section shall be transparent to the application program.</p>			
4.4.1.3	<p><u>Program Flow Control Requirements.</u> PLCs that perform I/O scan and execute the application in parallel shall assure that both input scan and execution of the application are completed each cycle.</p> <p>Use of interrupts shall be restricted to prevent non deterministic operation of the application program.</p> <p>Requirements for PLCs that use non deterministic operation of the application program.</p>	Comply	VV901-300-10 DS001-007-01 DS001-007-02	[]
4.4.1.4	<p><u>Unintended/Unused Function Isolation Requirements.</u> Descriptive Information</p>	N/A		[]
4.4.1.5	<p><u>Coprocessor Executive Capability.</u></p>	N/A		[]
4.4.2	<p><u>Media Requirements.</u> Software media used for shipping and storing software shall be high quality and new. CD ROMs or 3.5-in. floppy disks are acceptable. Packaging shall prevent damage in transit. The media shall be clearly labeled with the contents of the media, including revision level and serial numbers.</p>	Comply	UG004-001-01	[]
4.4.3	<p><u>Ladder Requirements.</u> Descriptive Information</p>	N/A		[]

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EPRI TR-107330 Reference	Summary of Requirement	Compliance	HFC Document Reference	Comments
4.4.3.A	Normally open/normally closed elements	Comply	UG004-001-01	[]
4.4.3.B	Single-shot for transition on or transition off functions.	Comply	UG004-001-01	[]
4.4.3.C	Ability to simulate make before break and break before make contact actions.	Comply	UG004-001-01	[]
4.4.3.D	Simulate standard coil that causes paths associated with it to change from normal to alternate state when energized.	Comply	UG004-001-01	[]
4.4.3.E	Simulate latching coil that causes paths associated with it to change from normal to alternate state when coil is energized and to remain in that state until coil is de-energized and reset signal is applied.	Comply	UG004-001-01	[]
4.4.3.F	Timers that can be adjusted from 0.1 second to 2 hours with a timing accuracy of 0.1% or better.	Comply	UG004-001-01	[]
4.4.3.G	Count up and count down functions with a range from 1 up to at least 9999.	Comply	UG004-001-01	[]
4.4.3.H	Comparison function between two numeric values.	Comply	UG004-001-01	[]
4.4.3.I	Basic math functions (+, -, *, ÷) shall be provided for both floating-point and integer values.	Comply	UG004-001-01	[]
4.4.3.J	Advanced math functions (exp, square root, log) shall be provided.	Comply	UG004-001-01	[]
4.4.3.K	PID algorithm shall provide the following capabilities: <ul style="list-style-type: none"> • Proportional band in range of 5% to 500% with minimum 1% resolution. • Integral action in range of 0 to 100 repeats per minute with a minimum resolution of 1 repeat per second. • Anti-reset windup • Rate action in range of 0 to 100 minutes with minimum resolution of 1 second. • Output limiting • Out of range status indications 	Comply	UG004-001-01	[]

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EPRI TR-107330 Reference	Summary of Requirement	Compliance	HFC Document Reference	Comments
	<ul style="list-style-type: none"> • Internal exception monitoring • Mechanism for external manual control with bumpless transfer between manual and auto. • PLC shall include the minimum number of analog loops indicated in Section 4.3.4.2.I. 			
4.4.3.L	Lead/lag algorithm with the following minimum characteristics: <ul style="list-style-type: none"> • Lead lag ratio range of 0 to 10 with minimum resolution of 0.05. • Lag time with minimum range of 0.01 to 100 minutes and minimum resolution of 1 second. • Lead action filter. 	Comply	UG004-001-01	[]
4.4.3.M	The capability to limit values	Comply	UG004-001-01	[]
4.4.3.N	Function generator with a minimum of five slopes.	Comply	UG004-001-01	[]
4.4.3.O	PLC shall include functions necessary to support communication requirements of Section 4.9.1.	Comply	DS901-004-03 UG004-001-01	[]
4.4.3.P	PLC shall include functions necessary for application to capture results of self-tests. (Refer to Section 4.4.6)	Comply	DS901-004-03 UG004-001-01	[]
4.4.3.Q	Functions necessary to implement sequence of events	Comply	DS901-003-01	[]
4.4.3.R	Bit manipulation functions of AND, OR, and XOR shall be provided.	Comply	UG004-001-01	[]
4.4.3.S	Ability to store results of calculations of at least 10 instances of at least 50 values in a ring buffer for transfer over a serial port.	Comply	DS901-003-01, -02, -03, -04, -05 DS901-002-19	[]
4.4.3.T	PLC shall include functions to implement database requirements per Section 4.4.7.2.	Comply	UG004-001-01	[]
4.4.3.U	PLC application software and programming utilities shall permit insertion of explanatory comments. (Refer to Section 4.4.4.)	Comply	UG004-001-01 UG004-001-02	[]
4.4.4	Software Tools Requirements. Tool shall be provided for programming, debugging, and documentation of	Comply	UG004-001-01 UG004-001-02	[]

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EPRI TR-107330 Reference	Summary of Requirement	Compliance	HFC Document Reference	Comments
	application code.			[]
4.4.4.A	Ability to use host device to enter a program into the PLC.	Comply	UG004-001-01 UG004-001-02	[]
4.4.4.A.1	Ability to attach explanatory comments to the program steps.	Comply	UG004-001-01 UG004-001-02	[]
4.4.4.A.2	Ability to store the program on removable magnetic media or some other type of offline storage device.	Comply	UG004-001-01 UG004-001-02	[]
4.4.4.A.3	Ability to perform bit-by-bit comparison between program in the PLC and a program contained in the programming device.	Comply	UG004-001-01	[]
4.4.4.A.4	Ability to print program that is contained in PLC and in programming device in a fashion similar to the appearance of the program steps in the programming device. Programming device shall provide the ability to print programming values that do not appear on screen.	Comply	UG004-001-01	[]
4.4.4.A.5	Features to aid in I/O mapping and memory management	Comply	UG004-001-01	[]
4.4.4.A.6	Provide a method to prevent modification of the application program or the operating system while the PLC is online performing its safety function.	Comply	UG004-001-01 RS901-000-01	[]
4.4.4.B	Debugging aids	N/A		[]
4.4.4.B.1	Ability to highlight all discrete elements that are not in their normal mode.	Comply	UG004-001-01	[]
4.4.4.B.2	Ability to display values of all inputs, outputs, and intermediate points.	Comply	UG004-001-01	[]
4.4.4.B.3	Ability to set constants and variables	Comply	UG004-001-01	[]
4.4.4.B.4	Ability to force outputs	Comply	UG004-001-01	[]
4.4.4.B.5	Ability to single step through the program.	Comply	UG004-001-01	[]
4.4.4.B.6	Ability to view the status of any memory location where error codes and other status information is stored.	Comply	UG004-001-01	[]
4.4.4.C	Application configuration management requirements of Section 7.7.3 shall be applied to the software tools.	Comply	PP901-000-01	[]

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EPRI TR-107330 Reference	Summary of Requirement	Compliance	HFC Document Reference	Comments
4.4.4.D	The tools shall meet support requirements of Sections 4.4.5.2 and 4.4.7.2.	Comply	PP901-000-01	[]
4.4.4.E	Software V&V shall be applied to the tools in accordance with requirements of Section 7.4.	Comply	PP901-000-01	[]
4.4.4.F	The tools shall provide features to aid in detecting any faults not detectable by the self-diagnostics.	Comply	UG004-001-01 UG004-001-02	[]
4.4.5	<u>Configuration Identification.</u> Section Heading	N/A		[]
4.4.5.1	<u>Configuration Identification Background.</u> Descriptive Information	N/A		[]
4.4.5.2	<u>Configuration Management Aids Requirements.</u> Descriptive Information	N/A		[]
4.4.5.2.A	An electronic revision level embedded in the PLC executive.	Comply	UG004-001-01	[]
4.4.5.2.B	Configuration data for configurable modules shall be retrievable in the field.	Comply	UG004-001-01	[]
4.4.5.2.C	Any software tool capable of altering a configuration item shall have positive mechanisms to prevent unauthorized access.	Comply	UG004-001-01	[]
4.4.5.2.D	PLC or support tools shall provide capability to extract and record any database information contained in the application.	Comply	UG004-001-01	[]
4.4.5.2.E	Any device in a PLC assembly or any external device that contains firmware or other programmed information shall be marked with an identifier that includes the revision level of the information programmed into it.	Comply	UG004-001-01 UG004-001-02	[]
4.4.5.2.F	Tools provide the capability to confirm that the configuration of hardware, software, and firmware is consistent between redundant devices.	Comply	UG004-001-01	[]

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EPRI TR-107330 Reference	Summary of Requirement	Compliance	HFC Document Reference	Comments
4.4.6	Diagnostic Requirements. Section Heading	N/A		[]
4.4.6.1	<p>General Diagnostic Requirements. The PLC must provide sufficient diagnostics and test capability to permit detection of any failure that could prevent the system from performing its safety function.</p> <p>Items 4.4.6.1.1 through 4.4.6.1.6 must be covered by online self tests.</p> <p>Item 4.4.6.1.7 must be covered by powerup or online self tests.</p> <p>Item 4.4.6.1.8 must be covered by powerup self tests.</p> <p>The remaining items are covered by maintenance and operator surveillance (Section 4.7).</p> <p>If any diagnostics uses short term changes in outputs to detect failures, the change shall be 2 ms or less for dc outputs and ½ cycle or less for ac outputs</p>	<p>Comply</p> <p>Comply</p> <p>Comply</p> <p>Comply</p> <p>N/A</p>	<p>DS901-003-01,-02.-03,-04,-05 DS901-002-19 TP901-115-01 TP901-115-02 TR901-302-01</p>	[]
4.4.6.1.1	Processor Stall. Watchdog function shall detect processor stall.	Comply	DS901-003-01,-02.-03,-04,-05 DS901-002-19 DS001-007-04	[]
4.4.6.1.2	Executive Program Error. Check of executive program using checksum or equivalent test.	Comply.	DS901-003-01,-02.-03,-04,-05 DS901-002-19 DS001-007-04	[]
4.4.6.1.3	Application Program Error. Check of application program using checksum or equivalent test.	Comply	DS901-003-01,-02.-03,-04,-05 DS901-002-19	[]
4.4.6.1.4	Variable Memory Error. Read/write test of specific bit patterns to test both states of each bit or equivalent test.	Comply	DS901-001-54,-70.-71,-72,-73, -74 DS901-002-18	[]
4.4.6.1.5	Module Communication Error. Processor monitors communication data integrity.	Comply	DS901-003-01,-02.-03,-04,-05 DS901-002-19 DS001-007-04	[]

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EPRI TR-107330 Reference	Summary of Requirement	Compliance	HFC Document Reference	Comments
4.4.6.1.6	<u>Memory Battery Low.</u>	N/A		[]
4.4.6.1.7	<u>Module Loss of Configuration.</u> Validate configuration of module with software set configuration, and set indication if not valid.	Comply	DS901-003-01,-02.-03,-04,-05 DS901-002-19 DS001-007-04	[]
4.4.6.1.8	<u>Failure of Watchdog Mechanism.</u> Surveillance of watchdog and failover function.	Comply	DS901-003-01,-02.-03,-04,-05 DS901-002-19 DS001-007-04 UG004-001-03	[]
4.4.6.1.9	<u>Application Not Executing.</u> Application program fails to complete a processing cycle.	Comply	DS901-003-01,-02.-03,-04,-05 DS901-002-19 DS001-007-04 UG004-001-03	[]
4.4.6.1.10	<u>Analog Output not Following.</u> AO signal fails to follow commanded output signal.	Comply	UG004-001-03	[]
4.4.6.1.11	<u>Analog Input not Responding.</u> AI channel fails to respond to input signal.	Comply	UG004-001-03	[]
4.4.6.1.12	<u>Discrete I/O not Responding.</u> Discrete I/O channel fails to respond to operate correctly.	Comply	UG004-001-03	[]
4.4.6.1.13	<u>Analog I/O Out of Calibration.</u> Analog I/O channel out of calibration.	Comply	UG004-001-03	[]

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EPRI TR-107330 Reference	Summary of Requirement	Compliance	HFC Document Reference	Comments
				[]
4.4.6.1.14	Power Supply Out of Tolerance. Power supply fails or produces an incorrect output voltage.	Comply	UG004-001-03	[]
4.4.6.2	OnLine Self Test Requirements. As a minimum, online self test for the main processor shall cover Sections 4.4.6.1.1 through 4.4.6.1.6. The results of the self test shall be made available to the application unless the fault causes the processor to halt.	Comply	DS901-003-01,-02.-03,-04,-05 DS901-002-19 DS001-007-04	[]
4.4.6.3	Powerup Diagnostics Requirements. As a minimum, powerup diagnostics shall include: A. All of the online self tests B. Configuration verification for modules with software set configurations. C. Test of failure to complete scan detection feature. (Refer to Section 4.2.3.7.)	Comply	DS901-003-01,-02.-03,-04,-05 DS901-002-19 DS001-007-04	[]
4.4.7	Data and Database. Section Heading	N/A		[]
4.4.7.1	Data and Database Overflow. Descriptive Information	N/A		[]
4.4.7.2	Data and Database Requirements. Refer to Sections 4.4.4 and 4.4.5.2.	N/A		[]
4.4.7.2.A	Support user-defined program constants that are contained in non-volatile memory. Redundant systems shall provide a mechanism to confirm that the constants are the same for both processors.	Comply Comply	UG004-001-01 UG004-001-02	[]
4.4.7.2.B	PLC shall provide function to read and modify constants in the application program.	Comply	UG004-001-01 UG004-001-02	[]

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EPRI TR-107330 Reference	Summary of Requirement	Compliance	HFC Document Reference	Comments
				[].
4.4.7.2.C	PLC shall provide features to prevent modifications to configuration constants over peer-to-peer communication paths.	Comply	DS901-003-01,-02.-03,-04,-05 DS901-002-19 DS001-007-04 UG004-001-01	[]
4.4.7.2.D	PLC shall provide features to enable transmitting inputs, outputs, and calculated values to other devices via serial port.	Comply	DS901-003-01,-02.-03,-04,-05 DS901-002-19 DS001-007-04 UG004-001-01	[]
4.4.8	<u>Other Non-Ladder Logic Programming Language.</u> Section Heading	N/A		[]
4.4.8.1	<u>Requirements for Sequential Logic Languages.</u> Sequential language may be used for the application program instead of ladder logic. Sequential language shall provide the minimum capabilities of Section 4.4.3 and be supported by tools as described in Section 4.4.4.	Comply	UG004-001-01 UG004-001-02	[]
4.4.8.2	<u>Standard High Level Languages.</u> Section Heading	N/A		[]
4.4.8.2.1	<u>Overview of Standard High Level Languages.</u> Descriptive Information	N/A		[]
4.4.8.2.2	<u>Requirements for Standard High Level Languages</u>	N/A		[]
4.4.9	<u>Sequence of Events Processing Requirements</u>	N/A		[]
4.4.10	<u>System Integration Requirements.</u> An appropriate level of integration and the testing shall be applied to the test specimen and TSAP.	Comply	TP901-115-01 TP901-115-02	[]
4.5	<u>Human/Machine Interface (HMI).</u> Section Heading	N/A		[]
4.5.1	<u>HMI Background.</u> Descriptive Information	N/A		[]
4.5.2	<u>Requirements for HMI Functions.</u> Section Heading	N/A		[]
4.5.2.A	Provides method for switching control mode between manual and auto modes. (Refer to Section 4.4.3.K.)	Comply	UG004-001-01	[]
4.5.2.B	Methods and features will be provided to permit adjustment of setpoint values via HMI.	Comply	UG004-001-01	[]

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EPRI TR-107330 Reference	Summary of Requirement	Compliance	HFC Document Reference	Comments
				[]
4.5.2.C	PLC shall permit manual initiation and detection of manual initiation of equipment that is normally automatically initiated.	Comply	UG004-001-01	[]
4.5.2.D	PLC must provide features for displaying status of discrete elements and analog values via any of the specified output modules specified in Sections 4.3.3.1 and 4.3.3.2.	Comply	UG004-001-01	[]
4.5.2.E	The PLC shall support transfer of data via a serial port that meets the requirements of Sections 4.3.4.4 and 4.9.1.1. Available information shall be inputs, outputs, calculated values, SOE data, and data from ring buffer. (Refer to Sections 4.4.9 and 4.4.3.S.)	Comply	UG004-001-01	[]
4.5.3	<u>Requirements for Interactive Features.</u> The PLC shall provide interactive features to support programming and maintenance. The PLC shall provide mechanism to prevent unauthorized access to interactive features and to prevent inadvertent change of internal parameters.	Comply Comply	UG004-001-01 UG004-001-02	[]
4.5.4	<u>Requirements for Operator Action System Response Times.</u> If an operator action requires confirmation from the PLC, the PLC shall supply that confirmation within 0.5 second.	Comply	UG004-001-01	[]
4.5.5	<u>Display Requirements.</u> Any status displays included with PLC shall be easily readable in normal to low room lighting within a $\pm 30^\circ$ angle.	Comply	DS901-001-54,-70,-71,-72,-73,-74 DS901-002-18	[]
4.5.6	<u>Alarm Processing Requirements.</u> Descriptive Information	N/A		[]
4.5.6.A	Ability to compare input or derived value to setpoints (equivalent to Section 4.4.3.H).	Comply	UG004-001-01 UG004-001-02	[]

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4.5.6.B	Ability to latch alarm condition and reset it based on an alarm reset condition (equivalent to Section 4.4.3.E).	Comply	UG004-001-01 UG004-001-02	[]
4.5.6.C	Ability to produce a flashing display indication (equivalent to 4.4.3.B and F).	Comply	UG004-001-01 UG004-001-02	[]
4.5.6.D	Capability to acknowledge an alarm (equivalent to Section 4.4.3.A, D, and E).	Comply	UG004-001-01 UG004-001-02	[]
4.5.6.E	Capability for the application program to access the results of self diagnostics.	Comply	UG004-001-01 UG004-001-02	[]
4.5.6.F	Capability of the application program to store the results of alarm processing in a ring buffer for transmission over via a serial port (equivalent to Section 4.4.3.S).	Comply	UG004-001-01 UG004-001-02	[]
4.5.7	<u>Hard Manual Backup.</u> Descriptive Information	N/A		[]
4.6	<u>Electrical.</u> Section Heading	N/A		[]
4.6.1	<u>Power Supply Requirements.</u> Section Heading	N/A		[]
4.6.1.1	<u>PLC Power Sources and Power Supply Requirements.</u> Section Heading	N/A		[]
4.6.1.1.A	Power supplies for an ac power source shall operate over the following ranges of supply characteristics: <ul style="list-style-type: none"> • 90 to 150 vac • 57 to 63 Hz • Environmental conditions specified by Section 4.3.6. 	Comply	RR901-107-05 TP901-115-01 TR901-207-01 VV901-300-10	[]
4.6.1.1.B	Power supplies for connection to a DC source shall operate with a DC source of 24 VDC ± 15%	Exception		[]
4.6.1.1.C	In Addition to Item B, the DC source power shall be capable of operating for seven days with the DC source set at 30 VDC	Exception		[]

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4.6.1.1.D	Power supplies shall be capable of supplying 1.2 times bus loading for controller chassis.	Comply	PP901-000-01	[]
4.6.1.1.E	Power supplies shall be capable of supplying 1.2 times bus loading for expansion chassis.	Comply	PP901-000-01	[]
4.6.1.1.F	Holdup time shall be 40 ms on loss of ac power source when chassis loading is as described above.	Comply	PP901-000-01	[]
4.6.1.1.G	The power supply shall meet EMI/RFI, surge withstand, and ESD requirements of sections 4.3.7, 4.6.2, and 4.3.8.	Comply	TP901-115-01 TP901-115-02 TR901-302-01	[]
4.6.1.1.H	For power supplies with fan cooling, a fan failure detection or over temperature status alarm shall be provided.	Comply	PP901-000-01	[]
4.6.1.1.I	If redundant power supplies are provided, power faults for one supply shall not affect the other.	Comply	PP901-000-01 TP901-115-01	[]
4.6.1.2	Loop Power Supply Requirements. The PLC manufacturer shall provide power supply modules for external transmitters and other devices. These power supplies shall provide at least 500 mA at 24 vdc and meet items A, B, C, G, and H above.	Comply	PP901-000-01	[]
4.6.2	Surge Withstand Capability Requirements. The PLC shall withstand surges of both ring wave and combination wave with 3000-v peak voltage. The waveform shall be applied to power sources, I/O interfaces, and communication port interfaces per IEEE C62.41.	Comply	TR901-302-01	[]
4.6.3	Separation. Descriptive Information	N/A		[]
4.6.4	1E/non-1E Isolation Requirement. PLC modules shall provide isolation of at least 600 vac and 250 vac applied for 30 seconds.	Comply	TS901-000-09	[]
4.6.5	Cabling/Wiring Requirements. Manufacturer shall supply cabling and wiring used for connecting to terminations. Cable shall be suitable for UL class 2 service, withstand levels shall be for 3 times the signal levels of 150 v, and temperature rating shall be 60° C or greater. The manufacturer shall identify quantity of PVC used.	Comply	PP901-000-01	[]

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4.6.6	Termination Requirements. Method of connection to field terminations shall permit swapping of PLC modules without disturbing field cables. Field terminations and communication modules shall be qualified with generic PLC.	Comply	TR901-302-01 VV901-300-10	[]
4.6.7	Backup Power.	N/A		[]
4.6.8	Grounding/Shielding Requirements. Grounding and shielding shall conform with guidelines of IEEE 1050 and EPRI TR-102323. PLC chassis and power supply shall have grounding connection points.	Comply	VV901-300-10 71006601Q	[]
4.7	Maintenance. Section Heading	N/A		[]
4.7.1	Maintenance Background. Descriptive Information	N/A		[]
4.7.2	Diagnosis/Built-in Testability Requirements. Descriptive Information	N/A		[]
4.7.3	Module Replacement Requirements. PLC shall provide features to aid in module replacement. Maintenance manual shall describe any module configuration required. Method for securing module to assembly shall be easily accessible and permit easy removal and reinstallation.	Comply	PP901-000-01 UG004-001-03	[]
4.7.4	Preventive Maintenance Requirements. Manuals shall provide information required for preventive maintenance.	Comply	UG004-001-03	[]
4.7.5	Surveillance Testing Requirements. PLC shall support IEEE 338 surveillance testing through: <ul style="list-style-type: none"> • Ability to read inputs, intermediate, and output values. • Ability to force output values. • Ability to make connections to all I/O signals. • Ability to program I/O operations. For PLCs that include redundancy, features and procedures shall be provided to detect failures that could be masked by redundancy.	Comply	UG004-001-03	[]
4.7.6	Output Bypass/Control Devices.	N/A		[]
4.7.7	“Hot” Repair Capability. PLC shall support removal	Comply	DS901-001-54,-70.-	[]

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	<p>and replacement of modules except for main controller with power applied to the backplane.</p> <p>When output module is removed from backplane, the state of the output channels should be known and repeatable.</p>	N/A	71,-72,-73, -74 DS901-002-18	[]
4.7.8	<u>Manufacturer System Life Cycle Maintenance.</u> Section Heading	N/A		[]
4.7.8.1	<p><u>Parts Replacement Life Cycle Requirements.</u> Manufacturer shall establish baseline configuration of the qualified PLC hardware and software.</p> <p>Maintain records of revision history, failures, and changes.</p> <p>Identify and accomplish any testing needed to maintain a qualified PLC due to revision or replacement of modules.</p>	Comply	PP901-000-01	[]
4.7.8.2	<p><u>Component Aging Analysis.</u> Perform an aging analysis based on normal and abnormal environmental conditions per Section 4.3.6.</p> <p>An acceptable alternative is based on in-service surveillance and type testing in accordance with IEEE 323-1983.</p>	N/A		[]
4.7.9	<u>Maintenance Human Factors.</u> Section Heading	N/A		[]
4.7.9.A	The manufacturer shall provide unambiguous documentation and job aids for any equipment supplied to support the PLC platform.	Comply	UG004-001-01 UG004-001-02 UG004-001-03 UG004-001-04	[]
4.7.9.B	Test equipment connections to the PLC shall be supported by appropriate equipment, manuals, and	Comply	UG004-001-03 UG004-001-04	[]

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	special test leads.			[]
4.7.9.C	Job aids, keyed connectors, warning signs shall be provided.	Comply	UG004-001-03	[]
4.7.9.D	Help screens shall be provided for software used to support maintenance.	Comply	UG004-001-01	[]
4.8	Requirements for Third Party/Sub-Vendor Items. All third party items used with the PLC shall be subjected to all of the requirements and tests that are applicable to that item's function and design. The hardware and software compatibility of these items shall be subjected to suitable tests and analysis.	Comply	PP901-000-01	[]
4.9	<u>Other.</u> Section Heading	N/A		[]
4.9.1	<u>Data Handling and Communication Interfacing Overview.</u> Descriptive Information	N/A		[]
4.9.1.1	<p><u>Peripheral Communication Requirements.</u> The PLC executive shall prevent loss of serial communication from degrading the application program.</p> <p>The communication protocol shall assure deterministic overhead time or permit easy determination of the upper bound on the scan time interval.</p> <p>Peripheral communication shall support a buffer of the size specified in Section 4.3.4.2.K.</p> <p>All serial communication shall include data quality checks at least as robust as checksum.</p> <p>For redundant PLCs, the peripheral communication shall</p>	<p>Comply</p> <p>Comply</p> <p>Comply</p> <p>Comply</p> <p>Comply</p>	<p>DS901-001-54,-70.-71,-72,-73, -74</p> <p>DS901-002-18</p> <p>DS901-003-01,-02.-03,-04,-05</p> <p>DS901-002-19</p> <p>DS001-007-04</p>	[]

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	use data that is validated between redundant processor. The redundancy shall be transparent to the communication path, the PLC, and peripheral communication program			
4.9.1.1.1	<u>Software Isolation Requirements</u> Heading	N/A		[]
4.9.1.1.1.A	Serial communication shall require no hardware or software handshaking.	Comply	DS901-001-54,-70.-71,-72,-73, -74 DS901-002-18 DS901-003-01,-02.-03,-04,-05 DS901-002-19 DS001-007-03 DS001-007-04	[]
4.9.1.1.1.B	Features shall permit application to ignore any incoming data on the port.	Comply	DS901-001-54,-70.-71,-72,-73, -74 DS901-002-18 DS901-003-01,-02.-03,-04,-05 DS901-002-19 DS001-007-03 DS001-007-04	[]
4.9.1.1.1.C	Application object shall permit use of the send data function with the receive data function effectively disabled.	N/A	DS901-001-54,-70.-71,-72,-73, -74 DS901-002-18 DS901-003-01,-02.-03,-04,-05 DS901-002-19 DS001-007-03 DS001-007-04	[]
4.9.1.1.1.D	The application program shall be capable of disable interrupts based on receive buffer full status.	N/A	DS901-001-54,-70.-71,-72,-73, -74 DS901-002-18 DS901-003-01,-02.-03,-04,-05 DS901-002-19 DS001-007-03 DS001-007-04	[]
4.9.1.2	<u>PLC Peer-to-Peer Communication Requirements.</u>	Comply	DS901-001-54,-70.-	[]

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	<p>Peer-to-peer communication shall be accomplished over a dedicated link. If the PLC includes redundancy, this link shall also be redundant.</p> <p>Communication on this link shall be deterministic.</p> <p>No communication error on this link shall stop the application program from functioning or inhibit the PLC scan cycle.</p> <p>The response time requirement shall be met with any latency time needed to provide synchronization.</p> <p>Data quality check shall be at least as robust as checksum.</p> <p>Program shall detect loss of peer-to-peer communication and make that status available to the application.</p>	<p>Comply</p> <p>Comply</p> <p>Comply</p> <p>Comply</p> <p>Comply</p>	<p>71,-72,-73, -74 DS901-002-18 DS901-003-01,-02.- 03,-04,-05 DS901-002-19 DS001-007-03 DS001-007-04</p>	<p>[</p> <p style="text-align: right;">]</p>
4.9.2	<p><u>Overall System Security Requirements.</u> Switching the main controller from RUN mode to any other mode shall be by keylock switch.</p> <p>PLCs having redundancy shall include features to aid in assuring that the mode of the processors is the same.</p> <p>System security should include provide to prevent modification of either the application or the operating system while online performing its safety function.</p> <p>Redundant systems shall include features to ensure that program changes are loaded into all redundant processors.</p>	<p>Exception</p> <p>Comply</p> <p>Comply</p> <p>Comply</p>	<p>DS901-001-54,-70.- 71,-72,-73, -74 DS901-002-18 DS901-001-20 DS901-003-01,-02.- 03,-04,-05 DS901-002-19 DS001-007-03 DS001-007-04 DS901-001-25</p>	<p>[</p> <p style="text-align: right;">]</p>
4.9.3	<p><u>Heartbeat Requirement.</u> PLC shall include capability to activate a heartbeat indication that is external to the controller. This requirement does not apply to redundant PLCs.</p>	<p>Comply</p>	<p>UG004-001-01</p>	<p>[</p> <p style="text-align: right;">]</p>

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4.9.4	Hazardous Materials Requirements. Material Safety Datasheets shall be provided for any hazardous materials included with the PLC.	N/A		[]
4.10	Shipping and Handling Requirements. Packaging and shipping shall conform with requirements of ANSI N45.2.2.	Comply	PP901-000-01	[]
4.10.1	Packaging Requirements. Section Heading	N/A		[]
4.10.2	Shipping Requirements. Section Heading	N/A		[]
4.10.2.A	Shall be shipped in a sealed container designed to prevent deterioration of PLC components during shipment.	Comply	PP901-000-01	[]
4.10.2.B	Packaging shall include desiccant material when required iaw ANSI N45.2.2.	Comply	PP901-000-01	[]
4.10.2.C	Items shall be inspected for cleanliness prior to packaging and cleaned as required.	Comply	PP901-000-01	[]
4.10.2.D	Appropriate cushioning material shall be used as required.	Comply	PP901-000-01	[]
4.10.3	Storage Requirements. Manufacturer shall provide storage requirements and shelf life limits for all devices required for qualification.	Comply	PP901-000-01	[]

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5	Acceptance Operability Testing. Descriptive Information	N/A		[]
5.1	Acceptance Operability Testing Overview. The development design, and performance of the acceptance test program shall use the documentation defined by Section 8.14.	Comply		[]
5.2	Pre-Qualification Acceptance Test Requirements. Descriptive Information	N/A		[]
5.2.A	Application Objects Testing. Testing of the software objects in the PLC library. This testing shall be in addition to any testing conducted by the manufacturer.	Comply	TP901-115-04 UG004-000-01 UG004-000-04	[]
5.2.B	Initial PLC Calibration. Test specimen modules shall be calibrated to NIST traceable sources.	Comply	TP901-115-01 TP901-115-02 TP901-200-00	[]
5.2.C	System Integration. System setup and checkout and TSAP validation should be accomplished in conjunction with acceptance testing.	Comply	TP901-115-05 TP901-115-06	[]
5.2.D	Operability Tests. Initial execution of operability tests accomplished as part of acceptance testing.	Comply	TP901-115-01	[]
5.2.E	Prudency Tests. Initial execution of prudency tests accomplished as part of acceptance testing.	Comply	TP901-115-02	[]
5.2.F	Burn-in Test. Minimum 352-hour burn-in test to be performed to eliminate any early life failures. Acceptance criteria are that test specimen pass operability after completion of burn-in.	Comply	TP901-200-01	[]
5.3	Operability Test Requirement. Descriptive Information	N/A		[]
5.3.A	Accuracy. This test will verify that analog I/O modules meet the accuracy and linearity requirements.	Comply	TP901-115-01	[]
5.3.B	Response Time. This test will measure the response time for discrete and analog inputs from the leading edge	Comply	TP901-115-01	[]

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	of the input to the leading edge of the resulting output.			[]
5.3.C	Discrete Input Operability. This test will verify the capability of discrete input channels to respond to simulated input signals.	Comply	TP901-115-01	[]
5.3.D	Discrete Output Operability. This test will verify the capability of discrete output channels to produce output signals having specified voltages and currents.	Comply	TP901-115-01	[]
5.3.E	Communication Operability. This test will verify reliable data transfer over the F-Link. An acceptance criterion is that the bit rates, signal levels, and pulse shapes be within the specifications for the protocol used.	Comply	TP901-115-01	[]
5.3.F	Coprocessor Operability.	N/A		[]
5.3.G	Timer Tests. This test will verify the accuracy of the timer function accessible to the TSAP.	Comply	TP901-115-01	[]
5.3.H	Test of Failure to Complete Scan. This test will verify the ability of the system for detecting incomplete scan of the main processor.	Comply	TP901-115-01	[]
5.3.I	Failover Operability. This test will demonstrate correct operation of the failover function.	Comply	TP901-115-01	[]
5.3.J	Loss of Power Test. This test will demonstrate correct response of all I/O channels to loss of source power followed by reapplication of power to the system.	Comply	TP901-115-01	[]
5.3.K	Power Interruption Test. This test will demonstrate the capability of the power modules to sustain system operation during a temporary (transient) power interruption.	Exception	PP901-000-01	[]
5.4	Prudency Test Requirements. Descriptive information	N/A		[]
5.4.A	Burst of Events Test. This test will consist of the simultaneous activation of a significant proportion of input and output channels.	Comply	TP901-115-02	[]
5.4.B	Failure of Serial Port Receiver Test. The Test Specimen has two redundant serial communication links. This test will impose three simulated failures on one cable at a time: link open, transmit line shorted to ground,	Comply	TP901-115-02	[]

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	and transmit line shorted to receive line.			
5.4.C	Serial Port Noise Test. This test will introduce a white noise signal on each of the serial links one port at a time.	Comply	TP901-115-02	[]
5.4.D	Fault Simulation Test. This test covers introduction of a simulated failure condition to trigger failover from the primary to the secondary controller.	Comply	TP901-115-02	[]
5.5	Operability/Prudency Testing Applicability Requirements. Specified portions of the operability and prudency tests are to be repeated before, during and after specific qualification tests.	Comply	TP901-115-01 TP901-115-02 VV901-300-09	[]
5.6	Application Software Objects Acceptance Testing. Descriptive Information	N/A		[]
5.6.1	Failure Detection. Refer to Sections 4.2.3.6.B items 2 and 3.	N/A		[]
5.6.2	Ladder Logic. Refer to Section 4.4.3.	Comply	TP901-115-04	[]
5.6.3	Software Tools. Refer to Section 4.4.4	N/A		[]
5.6.4	Configuration Management Aids. Section 4.4.5.2	N/A		[]
5.6.5	Sequence of Events Processing	N/a		[]
5.6.7	Alarm Processing. Refer to Section 4.5.6.	Comply	TP901-115-04	[]
5.6.8	Software Isolation. Refer to Section 4.9.1.1.1.	N/A		[]
5.6.9	Peer-to-Peer Communications. Refer to Section 4.9.1.2.	N/A		[]
6.0	Qualification Testing and Analysis. Section Heading	N/A		[]

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EPRI TR-107330 Reference	Summary of Requirement	Compliance	HFC Document Reference	Comments
6.1	<u>Qualification Process Overview.</u> Descriptive Information	N/A		[]
6.1.1	<u>PLC System Qualification Overview.</u> Descriptive Information	N/A		[]
6.2	<u>PLC System Test Configuration.</u> Requirements. Descriptive Information	N/A		[]
6.2.1.	<u>Test Specimen Hardware Configuration Requirements.</u> Descriptive Information	N/A		[]
6.2.1.A	Includes at least one of each module of each type to be qualified. (Refer to Sections 4.3, 4.4, 4.5, 4.9.)	Comply	DS901-001-54,-70,-71,-72,-73, -74 DS901-002-18 DS901-001-20	[]
6.2.1.B	Includes any additional modules that are needed to support operability testing.	Comply	Section 4.0 of VV901-300-10	[]
6.2.1.C	At least one of each ancillary device needed to meet requirements of Section 4.3.	N/A		[]
6.2.1.D	At least one of each chassis needed to meet requirements of 4.2.1.	Comply	VV901-300-10	[]
6.2.1.E	Power supplies to meet requirements of Section 4.6.1 loaded to their power rating.	Comply	VV901-300-10	[]
6.2.1.F	If necessary, dummy modules shall be used so that at least one chassis is fully loaded.	N/A		[]
6.2.1.G	At least one of each type of termination device used to meet requirements of Section 4.6.6.	Comply	VV901-300-10	[]
6.2.1.H	Any modules required to implement redundancy to be included in the qualification envelope.	Comply	TP901-115-01 TP901-115-02	[]
6.2.1.I	Any additional modules required to support operability and prudency testing or to support module variations.	Comply	TP901-115-01 TP901-115-02	[]
6.2.1.1	<u>Test Specimen Hardware Arrangement Requirements.</u> Section Heading	N/A		[]

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EPRI TR-107330 Reference	Summary of Requirement	Compliance	HFC Document Reference	Comments
6.2.1.1.A	For seismic testing, modules and their cables shall be arranged to maximize stress on chassis and its mounting hardware.	Comply	TR901-302-01 VV901-300-10	[]
6.2.1.1.B	For environmental testing, modules shall be arranged to maximize temperature rise across chassis.	Comply	TR901-302-01 VV901-300-10	[]
6.2.2	<u>TSAP Configuration Requirements.</u> TSAP shall be developed in accordance with applicable sections of 7 and 8.6.	Comply	TP901-115-06 71005901 71005902	[]
6.2.2.A	If providing serial output data is to be included in the qualification envelop, then a serial output sequence shall be included.	Comply	DS901-003-01,-02.- 03,-04,-05 DS901-002-19 DS001-007-04 DS901-001-25	[]
6.2.2.B	Suggested programming sequence for operability and prudency support.	N/A		[]
6.2.2.B.1	The lead/lag function may be used to simulate a simple analog process.	Comply	71005901 71005902	[]
6.2.2.B.2	Mapping of a set of discrete inputs to aid in linearity testing.	Comply	71005901 71005902	[]
6.2.2.B.3	Initiating a timer on a discrete input and loading a discrete output on time out.	Comply	71005901 71005902	[]
6.2.2.B.4	If serial output is required to support requirements of Section 5.3.E, the TSAP shall include bit pattern.	N/A		[]
6.2.2.B.5	Discrete round-robin sequence of DI and DO channels to facilitate response time testing.	Comply	71005901 71005902 TP901-115-01	[]
6.2.2.B.6	Include a serial output message triggered by discrete input to facilitate analog output linearity testing.	Comply	71005901 71005902 TP901-115-01	[]

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EPRI TR-107330 Reference	Summary of Requirement	Compliance	HFC Document Reference	Comments
6.2.2.B.7	One-second timer that triggers 8 discrete outputs on each time out.	Comply	71005901 71005902 TP901-115-01 TP901-115-02	[]
6.2.2.B.8	Function that drives four analog output channels from 10% to 90% of full scale on 1 second period.	Comply	71005901 71005902 TP901-115-01 TP901-115-02	[]
6.2.2.C	A program sequence to change state of an output once each processing cycle.	Comply	71005901 71005902	[]
6.2.2.D	Any application functions required to support redundancy and failover functions	Comply	71005901 71005902 VV901-300-10	[]
6.2.2.1	<u>Coprocessor TSAP Requirements</u>	N/A		[]
6.2.3	<u>Test Support Equipment Requirements.</u> Descriptive Information	N/A		[]
6.2.3.A	Panel or other device for connecting inputs and outputs, for stimulating inputs, and for monitoring outputs	Comply	71006001Q 71006201Q TP901-115-01 TP901-115-02	[]
6.2.3.B	Test and measuring equipment with accuracy needed to support acceptance criteria.	Comply	TP901-115-01 TP901-115-02	[]
6.2.3.C	Any special tools and devices needed to support testing	Comply	TP901-115-01 TP901-115-02 QPP 12.1	[]
6.2.3.D	All test equipment shall be controlled per IEEE 498	Comply	QAPM QPP 12.1	[]
6.3	<u>Qualification Test and Analysis Requirements.</u>	N/A		[]

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EPRI TR-107330 Reference	Summary of Requirement	Compliance	HFC Document Reference	Comments
	Descriptive Information			
6.3.1	Aging Requirements. The test specimen shall be exposed to five different aging factors with the environmental stress test performed first. No specific order is imposed for the other tests.	Comply	TP901-302-01 to -06 TP901-115-01 TP901-115-02 VV901-300-09 TR901-302-01	[]
6.3.2	EMI/RFI Test Requirements. Testing shall be conducted in accordance with Section 4.3.7. Testing shall be conducted at 25%, 50%, 75%, and 100% of the specified levels. For redundant components, only the selected value from among the selected redundant signals must meet acceptance criteria.	Comply	TP901-302-05 TR901-302-01	[]
6.3.3	Environmental Test Requirements. Test will be conducted in accordance with Section 4.3.6. Tolerance margins for the environmental test shall be $\pm 2.8^{\circ}$ C and $\pm 5\%$ RH. Power sources shall be set to values to maximize heat dissipation in test specimen; $\frac{1}{2}$ of relay outputs shall be energized and loaded to their rated value; analog outputs shall be set between $\frac{1}{2}$ and $\frac{2}{3}$ of full scale.	Comply	TP901-302-02 TR901-302-01	[]
6.3.3.1	Environmental Test Mounting Requirements. The test specimen shall be mounted in the environmental chamber on a simple structure that does not enclose the chassis. The environmental air shall be monitored at the power supply fan inlet.	Comply	TP901-302-02 TR901-302-01	[]
6.3.4	Seismic Test Requirements. The test specimen shall be subjected to 5 OBEs and one SSE in accordance with the spectrum shown in Figure 4-5.	Comply	TP901-302-04 TR901-302-01	[]
6.3.4.1	Seismic Test Mounting Requirements. Test specimen shall be mounted in accordance with mounting requirements on a structure having no resonances below 100 Hz.	Exception	TP901-302-04 TR901-302-01	[]
6.3.4.2	Seismic Test Measurement Requirements. Relay contact monitor shall be used to detect contact chatter. Half of the relays shall be energized and half deenergized on a given module. The test specimen shall be energized with TASP running and $\frac{1}{2}$ of solid state outputs	Exception	TP901-302-04 TP901-115-01 TP901-115-02 TR901-302-01	[]

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EPRI TR-107330 Reference	Summary of Requirement	Compliance	HFC Document Reference	Comments
	energized. Power source shall be at lower end of specified range. In addition to control accelerometer, additional accelerometers shall be mounted on each chassis.			[]
6.3.4.3	Seismic Test Performance Requirements. The following test sequence shall be conducted: <ul style="list-style-type: none"> • Resonance search in accordance with IEEE 344 • Five tri-axial OBEs • One tri-axial SSE • Complete operability test 	Comply	TP901-302-04 TR901-302-01 TP901-115-01 TP901-115-02	[]
6.3.4.4	Seismic Test Spectrum Analysis Requirements. Test spectrum shall be reported for ½, 1, 2, 3, and 5% damping.	Exception	TP901-302-04 TR901-302-01	[]
6.3.5	Surge Withstand Capability Testing. Surge withstand testing shall be conducted in accordance with Section 4.6.2. The test only needs to be applied to a representative of points.	Comply	TP901-302-06 TR901-302-01	[]
6.3.5.1	Surge Withstand Test Mounting Requirements. Test specimen shall be mounted on non-metallic vertical surface at a vertical height of 6 feet.	N/A	TP901-302-06 TR901-302-01	[]
6.3.6	Class 1E to Non-Class 1E Isolation Testing. Isolation shall be conducted in accordance with Sections 4.3.2, 4.3.3, 4.3.4.3, 4.3.4.4, and 4.6.4. Failure of one of a redundant component will be considered acceptable if the other component continues normal operation.	Comply	TS001-000-09	[]
6.4	Other Tests and Analyses. Section Heading	N/A		[]
6.4.1	FMEA. Analysis shall be conducted in accordance with requirements of Sections 4.2.3.3 through 4.2.3.6 and IEEE 352 Sections 4.1, 4.5, and 4.6.	Comply	RR901-107-01	[]
6.4.2	Electrostatic Discharge (ESD) Testing Requirements. Testing shall be accomplished in accordance with Section 4.3.8 and EPRI TR-102323.	Comply	TP901-302-03 TR901-302-01	[]
6.4.3	Power Quality Tolerance Requirements. Testing shall be	Comply	TP901-302-02	[]

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EPRI TR-107330 Reference	Summary of Requirement	Compliance	HFC Document Reference	Comments
	accomplished to the voltage range of Section 4.6.1.1 items A and B. Testing shall be done during acceptance testing, at the end of the high temperature phase of the environmental test, and after completion of seismic testing.		TP901-115-01 TP901-115-02 TR901-302-01	[]
6.4.4	<u>Requirements for Compliance to Specifications.</u> Descriptive Information	N/A		[]
6.4.4.A	Performance of operability and prudency tests during qualification tests shall be compared with performance during acceptance.	Comply	TR901-302-01 VV901-300-09	[]
6.4.4.B	Applied seismic spectrum where test specimen meets requirements shall be compared with required response spectrum. If the test spectrum is less than the required response spectrum, then this will level determine the seismic withstand level for the system.	Comply	TP901-302-04 TR901-302-01	[]
6.4.4.C	Isolation level shall be compared with requirements of Section 4.6.4. Actual level met shall be recorded in application guide in accordance with Section 8.6.3.	Comply	TS001-000-09	[]
6.4.4.D	Surge withstand levels shall compared with requirements of Section 4.3.7. Actual level met shall be recorded in application guide in accordance with Section 8.6.3.	Comply	TP901-302-06 TR901-302-01	[]
6.4.4.E	Performance of EMI/RFI testing shall be compared with requirements of Section 4.3.7. Actual level met shall be recorded in application guide in accordance with Section 8.6.3.	Comply	TP901-302-05 TR901-302-01	[]
6.4.4.F	Results of power quality testing shall be compared with requirements of Section 4.6.1 and 4.2.3.7.B.	Comply	TP901-302-02 TP901-115-01 TP901-115-02 TR901-302-01	[]
6.4.4.G	Results of application object testing shall be compared with requirements of Section 5.6.	Comply	TP901-115-04	[]

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EPRI TR-107330 Reference	Summary of Requirement	Compliance	HFC Document Reference	Comments
6.4.4.H	Results of surveys and audits shall be compared with requirements of Section 7.	N/A		[]
6.4.5	<u>Human Factors</u>	N/A		[]
6.5	<u>QA Measures Applied to Qualification Testing.</u> Activities for qualification testing shall meet requirements of 10CFR50 Appendix B.	Comply	PP901-000-01	[]
6.5.A	QA program shall apply to development of TSAP.	Comply	PP901-000-01	[]
6.5.B	QA program shall apply to procurement of all items included in the test specimen.	Comply		[]
6.5.C	Chain of custody shall be maintained from initial receipt until all test reports and all other documentation is complete.	Comply		[]
6.5.D	The QA program shall apply to all tests and analyses that are conducted under Section 6 of EPRI TR-107330.	Comply		[]
7	<u>Quality Assurance.</u> Section Heading	N/A		[]
7.1	<u>QA Overview.</u> Descriptive Information	N/A		[]
7.2	<u>10CFR50 Appendix B Requirements for Safety-Related Equipment.</u> Section Heading	N/A		[]
7.2.A	All activities to provide generic qualification for the HFC-6000 platform.	Comply	PP901-000-01	[]
7.2.B	Application specific design and development, including integration.	Comply	PP901-000-01	[]

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7.2C	Any supplementary application specific activities for dedication of the product line.	Comply	QAPM	[]
7.2.D	If processes other than those specified by 10CFR50 Appendix B, the manufacturer shall demonstrate that those processes provide equivalent confidence.	Comply	QAPM	[]
7.2.E	The qualifier shall perform audits to confirm their quality program.	Comply	QAPM QPP 2.3 QPP 2.4 QPP 18.1	[]
7.2.F	If the audits are performed against ISO 9001 or other standards, qualifier shall provide supplementary activities to meet 10CFR50, App B requirements.	Comply	QAPM QPP 2.3 QPP 2.4 QPP 18.1 PP901-000-01	[]
7.2.G	Qualifier shall evaluate manufacturer's V&V program according to criteria of Section 7.4.	Comply	PP901-000-01 QPP 3.2	[]
7.2.H	The qualifier shall have the right to witness some or all of the qualification tests being performed.	Comply	TR901-302-01	[]
7.3	<u>10CFR21 Compliance Requirements.</u> Descriptive Information	N/A		[]
7.3.A	Identify, document, and communicate problems and errors with the PLC and PLC manufacturer.	N/A	QAPM PP901-000-01 RR901-000-10	[]

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EPRI TR-107330 Reference	Summary of Requirement	Compliance	HFC Document Reference	Comments
				[]
7.3.B	Evaluate problem reports received from PLC manufacturer and other users of the PLC and the NRC.	N/A	QAPM PP901-000-01 RR901-000-10	[]
7.3.C	Screen relevance of all problem reports regardless of origin with respect to the application and environment.	N/A	QAPM PP901-000-01 RR901-000-10	[]
7.3.D	Submit reportable items to the NRC as per requirements of the Part 21 program.	N/A	QAPM PP901-000-01 RR901-000-10	[]
7.4	<u>Verification and Validation Requirements.</u> V&V program shall conform with requirements of IEEE 1012 and 7-4.3.2	Comply	QAPM PP901-000-01 QPP 3.2	[]
7.4.a	Shall have a V&V plan	Comply	QAPM PP901-000-01 QPP 3.2	[]
7.4.b	Shall take a life cycle approach	Comply	QAPM PP901-000-01 QPP 3.2	[]
7.4.c	Software requirements document shall be reviewed for completeness, correctness, and consistency	Comply	PP901-000-01 QPP 3.2	[]
7.4.d	Provide traceability of requirements through lifecycle.	Comply	PP901-000-01 QPP 3.2	[]
7.4.e	Shall be both structural and functional testing of software.	Comply	PP901-000-01 QPP 3.2	[]
7.5	<u>Manufacturer Qualification Maintenance Throughout Product Life Cycle. Section Heading</u>	N/A		[]
7.5.1	<u>Overview of Manufacturer Qualification Maintenance Throughout Product Life Cycle.</u> Descriptive Information	N/A		[]
7.5.2	Requirements for Manufacturer Qualification Maintenance Throughout Product Life Cycle.	N/A		[]

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EPRI TR-107330 Reference	Summary of Requirement	Compliance	HFC Document Reference	Comments
				[]
7.5.2.A	Provide documentation that manufacturer will ensure upward compatibility for revisions	Comply	PP901-000-01	[]
7.5.2.B	Maintain or enhance rigor of process	Comply	PP901-000-01	[]
7.5.2.C	Commit to supporting the qualified platform for a minimum of 5 years	Comply	PP901-000-01	[]
7.5.2.D	Provide a minimum of 6 months' notice before withdrawing product support.	Comply	PP901-000-01	[]
7.5.3	<u>Life Cycle Support Tools Requirements.</u> Ensure either continued access to the same version of the engineering tools and environment used to generate the software for the qualified PLC or the capability of reconstructing the functionality with revised tools and environment.	Comply	PP901-000-01	[]
7.6	<u>Compensatory Quality Activities for Legacy Software.</u> Section Heading	N/A		[]
7.6.1	<u>Overview of Compensatory Quality Activities for Legacy Software.</u> Descriptive Information.	N/A		[]
7.6.2	<u>Requirements for Compensatory Quality Activities for Legacy Software.</u> Guidance of EPRI TR-106439 shall be used to compensate for short comings in the development of legacy software based on documented operating history and black bock testing. Configuration control shall be imposed as soon as a baseline is established.	Comply	PP901-000-01	[]
7.7	<u>Configuration Management.</u> Section Heading	N/A		[]
7.7.1	<u>Configuration Management Overview.</u> Descriptive Information	N/A		[]
7.7.2	<u>Hardware Configuration Management.</u> Scope shall include revisions to module design, hardware configuration of the modules, compatibility of revised modules with existing architecture, and manufacturer documentation.	Comply	PP901-000-01 WI-ENG-003	[]
7.7.2.A	Utility shall use Section 5 of Supplement 3S-1	N/A	PP901-000-01	[]

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EPRI TR-107330 Reference	Summary of Requirement	Compliance	HFC Document Reference	Comments
	(Supplementary Requirements for Design Control) to evaluate the configuration management process.		WI-ENG-100	[]
7.7.2.B.	The manufacturer's configuration management plan shall include a method for identification of each component of the PLC modules so that changes to configuration can be tracked in accordance with Supplement S8-1 (Supplementary Requirements for Identification and Control of Items).	Comply	WI-ENG-003 PP901-000-01	[]
7.7.2.C	The manufacturer's method of document control shall be evaluated against Supplementary Requirements for Document Control.	Comply	WI-DOC-001 PP901-000-01	[]
7.7.3	Software Configuration Management. Scope shall include PLC firmware, run-time software libraries and modules, software tools, documentation.	Comply	PP901-000-01 WI-ENG-003 WI-ENG-020	[]
7.7.3.A	Define the organization and responsibilities for performing software configuration management.	Comply	WI_ENG_003 PP901-000-01	[]
7.7.3.B.	Provide four basic functions: <ul style="list-style-type: none"> • Configuration ID • Configuration Control • Configuration Status Accounting & Reporting • Configuration Audits and Reviews 	Comply	PP901-000-01 WI-ENG-003 WI-ENG-020	[]
7.7.3.C	Ensure that sub-tier suppliers to the PLC manufacturer.	N/A		[]
7.8	Problem Reporting/Tracking Requirements. Qualifier shall maintain problem reporting and tracking information needed by the utility to evaluate potential PLC problem impacts on safety. Essential information includes: <ul style="list-style-type: none"> • Classification of problem or error • Description of problem or error • Affected OLC model, part, and revision Nos. • Type of application • Description of application configuration • Name of reporting site • Type of site • Cumulative operating time of PLC when error detected. An effective mechanism shall be provided to report problems, and a timely mechanism shall exist for making	Comply	QAPM PP901-000-01 QPP 16.1 QPP 16.2 QPP 16.3	[]

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EPRI TR-107330 Reference	Summary of Requirement	Compliance	HFC Document Reference	Comments
	this information available to all nuclear utility customers.			
8	<u>Documentation</u> . Descriptive Information	N/A		[]
8.1	<u>Equipment General Overview Document Requirements</u> . Descriptive Information	N/A		[]
8.1.A	Description of generic platform structure	Comply	VV901-300-10	[]
8.1.B	Description of types of interconnections between main and expansion I/O or other chassis	Comply	71006501Q	[]
8.1.C	Overview and selection guide of the modules available	Comply	VV901-300-10	[]
8.1.D	Overall capacity in terms of I/O and processing speeds	Comply	VV901-300-10	[]
8.1.E	Installation information: <ul style="list-style-type: none"> • Any variation in mounting available • Torque requirement for mounting screws • Requirements or limitations on structure it can be mounted on • Limitation on separation between main and expansion chassis • Requirements for user-supplied hardware required for mounting and connection to the PLC • Any special handling requirements • Grounding and shielding requirements 	Comply	71006501Q 71006001Q 71006101Q 71006701Q 71006801Q 71006901Q	[]
8.1.F	Handling and storage requirements	Comply	PP901-000-01	[]
8.1.G	Description of the self-diagnostic and redundancy features in the PLC platform	Comply	DS901-003-01,-02,-03,-04,-05 DS901-002-19 DS001-007-04 DS901-001-25 PP901-000-01	[]

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EPRI TR-107330 Reference	Summary of Requirement	Compliance	HFC Document Reference	Comments
8.2	<u>Equipment General Specifications Requirements.</u> Manufacturer documentation shall include: <ul style="list-style-type: none"> • General specifications for the PLC and its modules • Establish overall speed, accuracy and I/O capacity • Environmental, EMI/RFI, surge, isolation, and shock withstand capabilities. 	Comply	DS901-003-01,-02,-03,-04,-05 DS901-002-19 DS001-007-04 DS901-001-25 TR901-302-01 MS901-000-08	[]
8.3	<u>Operator Manual Requirements.</u> Manufacturer's documentation shall describe operation: <ul style="list-style-type: none"> • Purpose of status indicators • Special operating procedures • Purpose and use of any switches or controls that are part of the PLC • Description of operation and any redundancy features. 	Comply	PP901-000-01 UG004-001-01 UG004-001-02 UG004-001-03 UG004-001-04	[]
8.4	<u>Programmer's Manual Requirements.</u> Descriptive Information	N/A		[]
8.4.A	Summary of available functions with brief description for each	Comply	UG004-001-01 UG004-001-02	[]
8.4.B	Detailed description of the usage for each function	Comply	UG004-001-01 UG004-001-02	[]
8.4.C	Examples of the use for complex blocks	Comply	UG004-001-02	[]
8.4.D	Limitations on any of the functions	Comply	UG004-001-02	[]
8.4.E	Methods for managing resource utilization	Comply	UG004-001-01	[]
8.4.F	User manual for programming and debugging tools	Comply	UG004-001-01 UG004-001-02	[]
8.4.G	Detailed information for the creation and testing of user-defined functions, if applicable.	N/A	UG004-001-01 UG004-001-02	[]

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EPRI TR-107330 Reference	Summary of Requirement	Compliance	HFC Document Reference	Comments
8.4.H	Detailed description for the use of conditional branching statements	Comply	UG004-001-02	[]
8.4.I	Detailed description of limitations on application of dynamic functions and the relation of their operation to scan time	Comply	UG004-001-01	[]
8.4.J	Detailed description of interaction between main processor and coprocessor modules.	N/A		[]
8.4.K	Detailed description of interaction between application program and any redundancy features.	N/A		[]
8.4.L	Any software build procedures and software tools that are needed to apply the PLC to a safety system configuration.	Comply	UG004-001-01 UG004-001-02	[]
8.4.M	Description of the executive, including flow control information.	N/A		[]
8.4.N	Description of data, database management, data handling, data definition, and configuration management.	Comply	UG004-001-01 WI-ENG-003	[]
8.4.O	Description of self-diagnostic features, including the interface between the self-diagnostics and the application program.	Comply	DS901-001-81	[]
8.4.P	Programming manual for any coprocessor	N/A		[]
8.5	<u>Equipment Maintenance Manual General Requirements.</u> Manufacturer's manuals shall contain information needed for calibration, troubleshooting, and maintenance, including preventive maintenance procedures. Documentation shall include results of aging analysis..	Comply	UG004-001-03 RR901-107-02	[]
8.6	<u>Qualification Documentation Requirements.</u> Qualifier shall submit all documentation supporting qualification of PLC to customer utility for review and approval.	N/A		[]
8.6.1	<u>Programmatic Documentation Requirements.</u>	N/A		[]
8.6.1.A	Test plan shall be prepared covering environmental, seismic, surge and isolation, EMI/RFI, application objects tests, and FMEA and availability/reliability	Comply	VV901-300-09 RR901-107-01 RR901-107-02	[]

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EPRI TR-107330 Reference	Summary of Requirement	Compliance	HFC Document Reference	Comments
	analyses.			[]
8.6.1.B	Test specification that includes equipment identification, interfaces, and service conditions.	Comply	VV901-300-10	
8.6.1.C	Procedure shall include test procedures and data recording requirements. Procedure shall include requirements for identifying, handling, and documenting any test deviations and equipment modifications during tests.	Comply	TP901-115-01 to -06 TP901-302-02 to -06 WI-ENG-815	[]
8.6.1.D	Test reports shall be prepared for each of the test plans listed above.	Comply	TR901-302-01	[]
8.6.1.E	Reports on all audits performed on the manufacturer or the manufacturer's suppliers and subcontractors.	Comply	QA records	[]
8.6.1.F	Reports on all design evaluations performed to address requirements that cannot reasonably be addressed by testing.	Comply	RR901-107-07	[]
8.6.2	<u>Technical Items and Acceptance Criteria Documentation Requirements.</u> Descriptive Information	N/A		[]
8.6.2.A	Provides requirements and specifications to be covered by the qualification for a specific PLC.	Comply	RS901-000-01 VV901-300-10	[]
8.6.2.B	Test specimen purchasing records	Comply	QA records	[]
8.6.2.C	TSAP development documentation	Comply	RS901-201-07 DS901-201-07 TP901-115-06 71005901 71005902	[]
8.6.2.D	Test specimen documentation per Sections 8.8, 8.9, 8.10, 8.12, and 8.13.	N/A		[]
8.6.2.E	Test documentation per Section 8.14.	N/A		[]
8.6.3	<u>Application Guide Documentation Requirements.</u>	N/A		[]
8.6.3.A	Results of the environmental operability test shall be evaluated to establish the qualification envelope. Performance characteristics shall be described in sufficient detail to permit comparison with system requirements.	Comply	TP901-115-01 TP901-115-02 TP901-302-02	[]

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HFC-6000 FPGA Modules

EPRI TR-107330 Reference	Summary of Requirement	Compliance	HFC Document Reference	Comments
				[]
8.6.3.B	The applied levels of the seismic test and the test response spectrum where test specimen met acceptance criteria shall be reported as the seismic withstand capability. Withstand capability shall be reported for all clamping values used.	Comply	TP901-115-01 TP901-115-02 TP901-302-06	[]
8.6.3.C	The 1E to non-1E isolation level used in testing shall be reported as the qualification value for this parameter.	Comply	TP901-115-01 TP901-115-02 TS001-000-09	[]
8.6.3.D	The surge withstand level used in testing shall be reported as the qualification value for this parameter/	Comply	TP901-115-01 TP901-115-02 TP901-302-04	[]
8.6.3.E	Performance during EMI/RFI testing shall report for all test levels, including the performance of each individual module type.	Comply	TP901-115-01 TP901-115-02 TP901-302-03	[]
8.6.3.F	Actual variation of PLC performance during power quality testing shall be reported.	Comply	RR901-107-05 TP901-115-01 TP901-115-02	[]
8.6.3.G	Any combinations of software objects or special purpose objects created to implement requirements shall be described completely.	Comply	UG004-001-02	[]

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EPRI TR-107330 Reference	Summary of Requirement	Compliance	HFC Document Reference	Comments
8.6.3.H	Complete description of the as tested PLC configuration shall be included.	Comply	VV901-300-10 TR901-302-01	[]
8.6.3.I	A complete description of the executive software and software tools revision levels and any optional features that were included.	Comply	VV901-300-10	[]
8.6.3.J	A complete as tested configuration shall be included for each module, including mounting, grounding, and shielding methods used during test.	Comply	VV901-300-10 TR901-302-01	[]
8.6.3.K	A summary of the FMEA and availability analyses shall be included.	Comply	RR901-107-01 RR901-107-02	[]
8.6.3.L	The document shall include the setpoint analysis support in accordance with Section 4.2.4.	N/A		[]
8.6.3.M	Any information from surveys and audits of the manufacturer's processes that are applicable to future purchasing shall be included.	N/A	PP901-000-01	[]
8.6.3.N	Description of the redundancy features included in the qualification	Comply	VV901-300-10	[]
8.6.3.O	Description of external devices covered by qualification	N/A		[]
8.6.3.P	Description of the configuration management methods and features needed to support application of the platform	Comply	PP901-000-01 WI-ENG-003	[]
8.6.3.Q	Summary of the aging analysis performed in accordance with Section 4.7.8.2.	Comply	RR901-107-02	[]
8.6.3.R	Any special mounting methods or practices used to meet seismic requirements	Comply	TR901-302-01	[]
8.6.3.S	A definition of the qualification envelope for any module that is different for that from the whole PLC.	N/A		[]

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EPRI TR-107330 Reference	Summary of Requirement	Compliance	HFC Document Reference	Comments
8.6.3.T	Description of any application-level hardware or software features that are assumed in order to meet any of the requirements covered by the qualification.	N/A		[]
8.6.4	<u>Supporting Analyses Documentation Requirements.</u> Descriptive Information	N/A		[]
8.6.4.A	FMEA Report that is specific to the PLC platform being qualified.	Comply	RR901-107-01	[]
8.6.4.B	Availability/reliability analysis report that is specific to the PLC platform being qualified. The analysis shall include the basis for the values used in the analysis, including the use of operating experience. The impact of any self-diagnostics and recovery capability features assumed in the analysis shall be described.	Comply	RR901-107-02	[]
8.6.5	<u>Class 1E to non-1E Isolation Test Plan.</u> The Isolation test plan and reports shall conform with requirements of IEEE 384 and Reg. Guide 1.75.	Comply	TS001-000-09	[]
8.7	<u>V&V documentation Requirements.</u> Descriptive Information	N/A		[]
8.7.A	Software QA plan	Comply	QAPM PP901-000-03	[]
8.7.B	Software Requirements Specification	Comply	RS901-201-07 RS901-001-65 RS901-001-67 RS901-001-64 RS901-001-66 RS901-001-68 RS901-003-02 RS901-001-15 RS901-002-04	[]
8.7.C	Software Design Description	Comply	DS901-201-07 DS901-003-02 DS901-003-04 DS901-003-01 DS901-003-05 DS901-003-03 DS001-007-04 DS901-001-25 DS901-001-99	[]

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EPRI TR-107330 Reference	Summary of Requirement	Compliance	HFC Document Reference	Comments
8.7.D	Software V&V plan	Comply	QPP 3.2 VV901-117-01	[]
8.7.E	Software V&V Report	Comply	VV901-117-16	[]
8.7.F	User documentation	Comply	PP901-000-01 WI-ENG-003	[]
8.7.G	Software Configuration Management Plan	Comply	PP901-000-01 WI-ENG-003	[]
8.8	System Description Requirements. Design description covering the hardware and software, including the TSAP, configuration covered by the qualification.	Comply	RR901-107-06 VV901-308-01	[]
8.9	Critical Characteristics Listing Requirements. Definition of the critical characteristics covered by the qualification	Comply	QA records	[]
8.10	System Drawing Requirements. Descriptive Information	N/A		[]
8.10.A	Functional description of the test specimen	Comply	VV901-300-10	[]
8.10.B	Schematic of the test specimen, including devices external to the PLC used to create inputs and capture outputs.	Comply	710060-01 710061-01 710063-01 710064-01 710065-01 710066-01 710067-01 710068-01 710069-01 500673-04 500674-20	[]
8.10.C	Ladder diagram or equivalent for the TSAP.	Comply	710063-01	[]
8.10.D	Diagram that shows power distribution, wiring, and grounding	Comply	710066-01	[]
8.10.E	Layout drawing of chassis, modules, and any ancillary	Comply	710060-01	[]

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EPRI TR-107330 Reference	Summary of Requirement	Compliance	HFC Document Reference	Comments
	devices		710061-01 710064-01 710065-01 710067-01 710068-01 710069-01 500673-04 500674-20	[]
8.10.F	Documents to describe test specimen mounting and any test fixtures used during qualification.	Comply	710060-01 710061-01 710064-01 710065-01 710067-01 710068-01 710069-01 500673-04 500674-20 TR901-302-01	[]
8.11	<u>System Software/Hardware Configuration Document Requirements.</u> Descriptive Information	N/A		[]
8.11.A	The identification and revision level of the executive software in the PLC main processor and any coprocessors.	Comply	VV901-308-02	[]
8.11.B	The revision level of firmware used in tested modules.	Comply	VV901-308-02	[]
8.11.C	Identification and revision of tools used to create the TSAP.	Comply	UG004-001-02	[]
8.11.D	Identification and revision of any downloadable PLC executive packages.	N/A		[]
8.11.E	Identification and revision of the TSAP. A printout of the TSAP shall be included.	Comply	710063-01	[]
8.11.F	Identification, revision level, and serial number of any hardware module shall be documented.	Comply	VV901-308-02	[]

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EPRI TR-107330 Reference	Summary of Requirement	Compliance	HFC Document Reference	Comments
				[]
8.12	System Database Documentation Requirements. The TSAP database, including range of values, shall be documented.	Comply	VV901-308-02	[]
8.13	System Setup/Calibration/Checkout Procedure Requirements. Setup, calibration, and checkout procedures used for the test specimens shall be documented.	Comply	VV901-300-09	[]
8.14	System Test Documentation Requirements. Descriptive Information	N/A		[]
8.14.A	Test requirements	Comply	TP901-115-01,-02,-03,-04,-05 VV901-300-09 TP901-302-02,-03,-04,-05,-06	[]
8.14.B	Acceptance criteria for all tests	Comply	TP901-115-01,-02,-03,-04,-05 TP901-302-02,-03,-04,-05,-06	[]
8.14.C	Sequence of testing	Comply	VV901-300-09	[]
8.14.D	Vehicles for recording the results of tests	Comply	VV901-300-10	[]
8.14.E	Requirements for test equipment	Comply	QAPM	[]
8.14.F	Test report summarizing results of tests	Comply	TS001-000-09 TR901-302-01	[]
8.15	Manufacturer's Quality Documentation Requirements. Provide a QA Plan	Comply	QAPM	[]
8.16	Manufacturer's Certifications Requirements. Provide certifications of conformance to specifications and requirements for all items used in the test specimen.	Comply	QAPM	[]