Attachment to LTR-NRC-02-41

Changes to the Westinghouse Common Qualified Platform Post Accident Monitoring Systems, CENPD-396-P, Appendix 1, Revision 1

(Generic change)

The processor type will be changed from PM646 to PM646A at all locations in the document consistent with this design change in the Common Q platform and applications. See the changes to the Common Q Topical Report for a further description of this change.

(Section A1.1.2.2.9, Page 28, second paragraph, first and second bullets)

[ ]

(Section A1.2.1.4, Page 56, entire section)

[ ]

(Section A1.3.1.1, Page 59-61, changes as indicated)

[ ]

(Section A1.3.1.2.1, Page 62, second and third paragraphs)

[ ]

(Section A1.3.4, fourth paragraph, Page 72)

[ ]

(Section A1.3.5, first paragraph, Page 73)

[ ]

Attachment to LTR-NRC-02-41

Changes to the Westinghouse Common Qualified Platform Topical Report,

CENPD-396-P, Rev.01

(Section 3, Page 11, Insert new reference)

3.26 WCAP-8587, Revision 6-A (NP), "Methodology for Qualifying Westinghouse WRD Supplied NSSS Safety Related Equipment," 1983

(Page 35, Section 5, Insert new final paragraph)

[ ]

(Section 5, Page 36, replace existing Figure 5)

[ ]

ITP: Interface and Test Processor ~~WDT: Watchdog Timer~~ FOM: Fiber Optic Modem

Figure 5

(Section 5.1, Page 37, next to last paragraph)

~~Although T~~the processor module has a built in watchdog timer module~~,~~ that ~~an independent external watchdog timer~~ is to be used in the Common Q systems. Depending on the specific system application, the watchdog timer can be used to annunciate a failure, actuate a channel trip, or set output states to predefined conditions. For example, the watchdog timer may be used to control the power to the relays on the digital output module. Isolation is provided for those applications where the watchdog timer is connected to external systems. The Watchdog Timer ~~module~~ is discussed in Section 6.2.4.

(Note: All other references to the external watchdog timer in the report will be changed to the PM646A built in watchdog timer)

(Section 6.2.1.1.1, Page 45, last paragraph)

Missing modules are also signaled by the function supervising the configuration on the associated (DB) elements. The PC (process control/application) program can process the status signals on the DB elements in the same way as other signals. This feature provides the capability to include error-handling routines in application programs. Severe problems (e.g., component errors) in the processor module stop the processor module. These errors also switch an internal watchdog timer relay in the processor module. For Common Q applications, this relay is used to provide alarm, and in some applications, conservative failure responses of the affected channel. ~~stopping the processor will also cause an external and independent watchdog timer to timeout.~~

(Section 6.2.1.1.3, Page 49, Analog Input Module subsection, new last item)

[ ]

(Section 6.2.4, Page 73, revised paragraph)

The internal PM646A watchdog timer actuates a form C relay, whose contacts are accessible from the processor front panel.. ~~An external and independent watchdog timer module is used to monitor the activity of the processing system. The watchdog timer module has a separate timing circuit and detects the lack of activity~~. Depending on the specific system application, the watchdog timer can be used to annunciate a failure, actuate a channel trip, or set output states to predefined conditions. For example, the watchdog timer may be used to control the power to the relays on the digital output module. Isolation is provided for those applications where the watchdog timer is connected to external systems.

(Section 6.3.1.2, Page 77, first paragraph)

[ ]

(Section 6.4.1.4.1, Page 85, entire section)

6.4.1.4.1 ~~Redundant~~ AF100 Interface (CI631)

The AC160 ~~redundant~~ CI631 configuration provides on-line surveillance of this ~~ese~~ card~~s~~ to ensure that it is ~~they are~~ in operational condition. ~~in case a failover is required~~. The ~~primary and secondary~~ CI module~~s~~ contains self-diagnostics, and reports any errors to the application in the PM646A.

~~If the primary fails, there will be an automatic switchover to the secondary module. When this occurs the new primary module will report an error to the application that the original primary has failed.~~ This error report can be used for alarm or screen indication to direct technicians to the specific AC160 node that has the CI failure. Normally the failed module will be indicated by a red light on the front panel. However, if this was a transient error and the PM is able to reboot the CI, the CI will return to service ~~(as the standby)~~ and there will be no red light.

~~The automatic failover can be periodically tested as follows:~~

~~1 – The technician verifies that CI one and two are functioning (i.e., no error reports and no red lights are on the front panel)~~

~~2 – The technician removes the primary CI module (indicated by the LED light on front plate), and verifies the switchover of the other CI from backup to primary (same LED indication)~~

~~3 – The technician reinserts the CI module – this CI module now returns to service as the backup CI (there is no automatic switch back)~~

~~Upon detection of any error that would jeopardize the operation of the AC160 controller, the primary CI631 enters the passive state. [ ], and the processor modules will thus become aware of the situation. Using an engineering workstation to interrogate the error buffer, the diagnostics information can be obtained to find the cause of the problem.~~

~~In case of a forced switchover due to a CI631 failure, any ongoing service data (non-deterministic Message Transfer) communication will be aborted and restarted with the new primary CI631. If restarting from scratch is not possible, the communication with the originator of the service data message will be aborted, and the originator can then retry the transfer.~~

(Section 6.4.4, Page 86, first paragraph)

The design of the Common Q platform includes a software watchdog in each application program and ~~external~~ a hardware watchdog~~s~~ within the processor module to override the activation outputs of the safety system should the processor halt. Each program will update a counter or toggle a binary each execution cycle. A watchdog timer ~~hardware device (e.g., Watchdog Module)~~ will monitor the binary toggle. The binary toggle ~~The counter~~ will also be monitored by another application on another processor. When the monitoring application detects the counter not changing for a predefined period of time, it will assume the application has halted and will take appropriate error handling action. The Appendices will address the disposition of errors.

(Section 6.5, Pages 87 and 88, various changes)

CPC Processor

[ ]

(Section 6.5, Page 89, replace existing Figure 6.5-1)

[ ]

(Section 7.1, Pages 92-93, table and associated description)

[ ]

(Section 7.2.1, Page 94, first paragraph)

[ ]

(Section 8.2, Page 104, Revise entire section as indicated)

The Common Q equipment will be qualified based on the assumption that the equipment will be installed in a mild environment. The mild environment is an environment expected as a result of normal and abnormal in service conditions where seismic is the only design basis event (DBE) of consequence.

The Common Q equipment environmental qualification will be demonstrated by a combination of type testing and analysis. The environmental qualification will be performed to satisfy the technical requirements of IEEE 323 as supplemented by RG 1.89, CENPD-255-A (Reference 3.6) and WCAP 8587 (Reference 3.26).

The expected room abnormal temperature and humidity parameters, where the Common Q cabinets will be installed are tabulated in Table 8.2.1. These environmental parameters envelope the expected room abnormal environment identified in CENPD-255-A (Reference 3.6) and WCAP 8587 (Reference 3.26).

The environmental qualification parameters for Common Q equipment installed in a cabinet, corresponding to the room ambient environment identified in Table 8.2.1, are tabulated in Table 8.2.2 and shown in Figure 8-4. These temperature and humidity parameters envelope requirements specified in CENPD-396-P, Rev. 01 (Figure 8-3) and margin to satisfy the intent of IEEE 323-1983 (Reference 25).

As noted in IEEE 323-1983 Section 6.2.3 margin may be applied, if needed, in a number of ways, including increasing the test temperature range and repeating test cycles. The test margin is required to address reasonable uncertainties in demonstrating satisfactory performance and normal variations in commercial production to ensure that the equipment will perform under abnormal conditions specified. [ ]

The Common Q equipment will be subjected to abnormal environmental testing to meet the qualification requirements specified in Table 8.2.2 and shown in Figure 8-4. An evaluation will be performed for each application, if needed, to ensure that the design basis temperature of the Common Q equipment is not exceeded when installed in the cabinet. The evaluation, based on the data, will demonstrate that the equipment temperature specifications are not exceeded within the cabinet/enclosure when the cabinet/enclosure is subjected to the environmental conditions specified in Table 8.2.1.

~~[The Common Q Platform equipment is Class 1E and will be qualified to the applicable requirements of IEEE Std 323-1983, as augmented by RG 1.89 and CENPD-255-A, Reference 3.6. Since this equipment is located in mild environments (main control room and/or auxiliary electrical equipment rooms), the method of qualification will be by test and analysis.~~

~~The Common Q Platform equipment will be subjected to a temperature/humidity test to demonstrate its environmental qualification. The ambient outside cabinet environmental parameters are defined in Table 8.2-1. This table depicts the expected normal and abnormal environment where the cabinet containing the Common Q equipment is located.~~

~~The environmental design parameters for the Common Q Platform equipment mounted inside the cabinet is shown in Table 8.2-2. These requirements are derived from Table 8.2-1 assuming a maximum temperature rise of 18°F inside the cabinet.~~

~~The Common Q test fixture will be subjected to qualification testing to meet the environmental design requirements in Table 8.2-2. IEEE-323, for determining the qualification test profile, requires certain margins be applied to the environmental parameters to account for reasonable uncertainties in demonstrating satisfactory performance and normal variations in commercial production to assure the equipment can perform under the most adverse conditions specified. The environmental test program to achieve this goal will subject the test specimen to the expected ranges of temperature and humidity plus, margins to meet the intent of IEEE-323. The specimen will be held at each temperature (80°F, 137°F, & 40°F) for a minimum of eight hours. The environmental test profile is shown in Figure 8-3. Figure 8.2-3 shows the environmental test profile to which the Common Q equipment will be tested in order to insure operation at the environmental conditions defined in Table 8.2-2.~~

~~An analysis shall be performed for each application to insure that the design basis temperature (test temperature minus the IEEE-323 margin requirement) of the Common Q equipment is not exceeded when installed in the cabinet. The analysis will demonstrate, using extrapolated test data, that individual component and equipment temperature specifications are not exceeded within the cabinet/enclosure when the cabinet is exposed to the environmental conditions as specified in Table 8.2-1.~~

~~EMI testing will be successfully completed before the environmental tests are performed.~~

Table 8.2-1 Cabinet Environmental Design Requirements

[ ]

~~Notes:~~

~~(1) At or above 80°F, the moisture content is that which produces 90% RH at 80°F (dewpoint of 77°F).~~

~~(2) Outside normal range~~

Table 8.2-2 Common Q Equipment Environmental Design Requirements

[ ]

~~Notes:~~

~~(1) At or above 80°F, the moisture content is that which produces 90% RH at 80°F (dewpoint of 77°F).~~

~~(2) Outside normal range~~

[ ]

Figure 8-3 Original Environmental Test Profile

[ ]

Figure 8-4 Modified Environmental Test Profile

Attachment to LTR-NRC-02-41

Additional Information Regarding the Westinghouse Common Qualified Platform Core Protection Calculator System, CENPD-396-P, Appendix 2, Revision 1

Introduction:

The Common Qualified Platform-based Core Protection Calculator System (CPCS) has evolved from that presented in CENPD 396-P, Rev. 01, Appendix 2. The safety-related algorithms of the CPCS will remain the same as in the topical report submittal, as will the platform used to implement these algorithms. However, the configuration of the individual modules will be changed to enhance system performance. The following sections describe the configuration change and its rationale.

Revised CPCS Configuration

Figure 1.1 depicts the CPCS configuration as depicted in Figure 2.1-1 of the CPCS topical report appendix. Figure 1.2 depicts the revised configuration.

1.1 Physical Configuration Changes

The following changes to the CPCS configuration are depicted in Figures 1.1 and 1.2.

In the following description, the term "existing configuration" refers to the configuration as described in the topical report appendix. "Revised configuration" refers to the new CPCS configuration as it differs from that in the topical report appendix. "Legacy System" refers to the CPCS that is presently installed and operational at existing plants.

1.1.1. Number of Subracks and Disposition of Processors

[ ]

The revised configuration has several advantages over the existing CENPD 396P Appendix 2 configuration:

1.1.1.1 CEAC Redundancy

[ ]

1.1.1.2 Backplane Loading Considerations

[ ]

1.1.1.3 CPC Processor Allocation

[ ]

1.1.1.4 Analog Input Module Configuration

[ ]

1.1.1.5 CEAC to CPC Penalty Factor Transmission

[ ]

1.1.1.6 Channel Communications

[ ]

1.1.2 Power Supply Configuration

[ ]

1.1.3 OM and MTP ethernet connections

[ ]

1.1.4 Time Synchronization

[ ]

1.1.5 Processor Module Model

[ ]

1.1.6 Changes in Watchdog Timer Configuration.

The existing configuration employs a separate discrete watchdog timer module. The revised implementation employs a watchdog timer included within the PM646A processor. This WDT receives inputs from both the processor and communications sections of the PM646A such that if either fails to update the WDT within the prescribed time interval, the watchdog timer will time out, deenergizing an output relay which is accessed from the PM front panel. Relay contacts are configured to open (trip) the Low DNBR, High LPD trip and pretrip contacts, as well as the CWP signal to the PPS. This response is identical to the PPS.

2. Other Changes:

As the design has evolved, several additional changes have been made to the CPCS which are not apparent in an examination of Figures 1.1 and 1.2.

Appendix Section	Proposed
A2.1.1.3	[ ]
A2.1.1.3	[ ]
A2.1.1.3	[ ]
A2.1.1.3	[ ]
A2.1.2.1	[ ]
Table A2.1.2-2	Changed range of DNBR Margin meter output to 0 to 2 units rather than 0 to 10 units, at customer request. At full power, the DNBR margin is normally between 0 and 1.0, so the existing resolution is less than optimal. This affects meter display scaling only, and does not impact the safety related functions of the CPCS in any way. The resulting improved meter resolution will increase its usefulness during full power operation, when DNBR margins are the lowest, and DNBR margin monitoring is of the greatest concern.
A2.1.2.2.2	Refined conditions for annunciation. Additional annunciator digital outputs provided.
A2.1.2.2.2	[ ]
2.3	[ ]
A2.3.1.3	[ ]
A2.3.1.3	[ ]
A2.3.1.5	[ ].
A2.3.1.5	[ ]
A2.3.2.1	[ ]
A2.3.3.1	[ ]
A2.6	The FMEA is revised to reflect the new configuration and failure modes.
A2.8	Technical Specifications: Plant specific TS will be submitted, reflecting these changes.

Figure 1.1
(Existing Figure A2.1-1)

[ ]

Figure 1.2
(Revised Figure A2.1-1)

[ ]

REVISED CPC ARCHITECTURE
FAILURE MODE AND EFFECTS ANALYSIS

[ ]

SUMMARY QUALIFICATION REPORT

OF HARDWARE TESTING

FOR COMMON Q APPLICATIONS

00000-ICE-37764
Revision 02

Prepared by Westinghouse Electric Company LLC

Issued: August 2002

Total Pages 37

RECORD OF REVISIONS

REVISION	ISSUE DATE	PAGES INVOLVED
00	08/02	Initial issue
01	08/02	1,2,3,29,30,44,45
02	08/02	1,2,3,43

REVISION ABSTRACT

Revision 00

Initial Issue. This is the original issue of this document. All future revisions of this document shall be briefly described within this section, such that a historical record may be kept as to why the document changed.

Revision 01

This revision was issued to provide clarifications to the several test anomalies that occurred during EMC testing. The installation guidelines were also revised to provide more detail to the requirements.

Revision 02

This revision was issued to correct the notes to Table 6-1.

TABLE OF CONTENTS

TABLE OF FGIRUES

Executive Summary

This summary report provides an overview of the results of the Common Q supplemental hardware qualification program. This program was conducted to qualify a group of equipment for use in safety related applications in nuclear power plants. The equipment qualified consisted of digital processors, I/O modules, power supplies, display systems and miscellaneous support equipment. The qualification effort described in this report was a continuation of a previous Common Q qualification program. Based of the previous qualification effort the NRC had issued an SER (Reference 8.18) on the Common Q system. This SER contained several Generic Open Items which were related to the Common Q qualification effort. These Generic Open Items are addressed by this qualification report as follows:

Item 7.1 – Westinghouse has addressed this issue by developing and qualifying a new analog input module (AI685). This analog input module meets the requirements of EPRI TR-107330 as described in this report.

Item 7.2 – Westinghouse has addressed this issue by designing and qualifying a series of Common Q power supplies. Power supply qualification is addressed in this report. Commercial grade dedication of the Common Q power supplies is addressed elsewhere.

Item 7.3 – Westinghouse has addressed this requirement by dedicating and qualifying a hardware watch dog timer. The qualification of the hardware watch dog timer is addressed in this report. In addition Westinghouse has qualified the PM646A internal watchdog timer. This qualification is addressed in this qualification report.

Item 7.5 – Westinghouse has addressed this requirement by qualifying the PM646A to the requirements of EPRI TR-102323. The EMC qualification of the PM646A is addressed in this report and the referenced EMC qualification report.

Item 7.6 – Westinghouse has addressed this item by performing environmental, seismic and EMC testing on the complete complement of Common Q equipment. This qualification effort is described in this report.

1 Introduction

This report provides a summary of the hardware qualification testing which has been performed to certify various equipment as Class 1 for use in Common Q systems. The testing was conducted over the period from August, 2001 to April 2002. The bulk of the testing was performed at WYLE Laboratories in Huntsville, Alabama. Some follow-up EMI testing was conducted at Retlif Testing Laboratories in Ronkonkoma, New York.

Section 3.0 provides a description of the equipment, which was qualified for this project. The equipment qualified consisted of various Advant® AC160 modules including processors and I/O modules. Also included in the test program were power supplies, flat panel displays, modems, and other peripheral equipment such as relays and terminal blocks. Table 3-1 in Section 3.0 contains a list of the equipment qualified by this program for Common Q applications.

Section 4.0 lists the requirements of the qualification program. These requirements encompass both domestic and international standards such that the equipment will be qualified for nuclear applications.

Section 5.0 provides a summary of the testing performed and Section 6.0 provides an overview of the test results and a summary of the qualification status of the equipment.

In several instances during the test program equipment performance was inhibited by the test environment. In these cases special installation requirements are required in order to ensure proper equipment operation. These installation requirements are summarized in Section 7.0.

2 Definitions And Abbreviations

AC160	Advant Power Controller 160
AF100	Advant Field Bus 100
CEA	Control Element Assembly
CPC	Core Protection Calculator
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EUT	Equipment Under Test
FB	Front-to-Back
FOM	Fiber Optic Modem
FPD	Flat Panel Display
HJTC	Heated Junction Thermocouple
HSL	High Speed Link
I/O	Input/Output
LCD	Liquid Crystal Display
OBE	Operating Basis Earthquake
PAMS	Post Accident Monitoring System
RH	Relative Humidity
RMF	Random Multi-frequency
RS	Resonance Search
RRS	Required Response Spectra
RSPT	Reed Switch Position Transmitter
SER	Safety Evaluation Report
SS	Side-to-Side
SSE	Safe Shutdown Earthquake
TRI	Triaxial
TRS	Test Response Spectra
V	Vertical
ZPA	Zero Period Acceleration

3 Hardware Description

3.1 AC160 Modules

The Common Qualified platform is based on the Advant® AC160 line of processors and S600 I/O modules. The processor is the PM646A. The PM646A has high speed link multi-drop capability, which allows the processors to establish a fast unidirectional communication link between each other. The I/O modules qualified provide a wide range of analog and digital input and output capabilities for interfacing with the various process inputs and outputs found in safety systems.

The following AC160 modules were qualified during this program:

- PM646A
- CI631
- CI527W
- AI620
- AI635
- AI685
- DI620
- AO610
- AO650
- DO620
- DO625
- DO630
- DP620
- TC514 V2

3.2 Power Supplies

Three power supply variations were designed, built, and qualified for the Common Q project. The three variations are the CPC, PAMS and 230VAC versions. All three versions incorporate a modular building block design to allow the configuration flexibility required to meet the various system needs for which the Common Q is intended. The modular approach allows specific power supply functions to be added by using different plug in modules for the various system functions.

The CPC power supply includes dual auctioneered power supplies for powering the AC160 processor and I/O. A dual auctioneered power supply is provided for powering relays and modems. Also included is a dual auctioneered supply for powering the RSPT for CEA position input information.

The PAMS power supply, in addition to the AC160 station and relay module power, also provides the heater power supply outputs to the HJTC system. Each heater in the HJTC system is provided with its own adjustable power supply. The PAMS processor controls the power provided to each heater.

The 230VAC power supply is intended to be used in Common Q applications in European power plants where the input power is typically provided as 230VAC.

3.3 Flat Panel Displays

For the Common Q program a PC Node Box and three variations of the FPD have been qualified. The displays are designed to meet the requirements of providing a user interface and are located in the Operators module and the Maintenance and Test Panel. The three variations of FPD have different display sizes, 12.1 inch, 15 inch and 18 inch. All variations feature a color LCD screen and an embedded Single Board Computer. The PC Node Box can be programmed to provide the various information the displays require for each specific application.

3.4 Miscellaneous Equipment

The qualification program also included miscellaneous hardware that may be required in the implementation of a Common Q system. This includes such items as relays, terminal blocks, switches, keyboards, modems and other support equipment. A complete list of equipment tested and qualified by this program is provided in Table 3-1.

Table 3-1- Qualified Equipment List

Common-Q Power Supply Qualification Testing Configuration					
Chassis #1 CPC					
Slot	*Module ID*	*Description*	*Function*	*Model No.*	*Assembly*
1	C1	AC Line Filter Module	120 Vac Input Power	W12-FM	D-00000-435-020, Rev. 01
2	C2	Front-End Module	120 Vac Input Power	W1-FEM	D-00000-435-010, Rev. 02
3	C3	MAXI Module (24 Vdc)	Redundant 24 Vdc [AC160] (paralleled with Module C8)	W1-24	D-00000-435-035, Rev. 01
4	C4	Dual MINI Module (5 & 24 Vdc)	Redundant 5 and 24 Vdc [HSL 5 & Aux 24] (paralleled with Module C7)	W1-0524	D-00000-435-030, Rev. 01
5	C5	Dual MINI Module (15 Vdc Output only)	Redundant 15 Vdc [RSPT] (paralleled with Module C6)	W1-1500	D-00000-435-030, Rev. 01
6	C6	Dual MINI Module (15 Vdc Output only)	Redundant 15 Vdc [RSPT] (paralleled with Module C5)	W1-1500	D-00000-435-030, Rev. 01
7	C7	Dual MINI Module (5 & 24 Vdc)	Redundant 5 and 24 Vdc [HSL 5 & Aux 24] (paralleled with Module C4)	W1-0524	D-00000-435-030, Rev. 01
8	C8	MAXI Module (24 Vdc)	Redundant 24 Vdc [AC160] (paralleled with Module C3)	W1-24	D-00000-435-035, Rev. 01
9	C9	Front-End Module	120 Vac Input Power	W1-FEM	D-00000-435-010, Rev. 02
10	C10	AC Line Filter Module	120 Vac Input Power	W12-FM	D-00000-435-020, Rev. 01
	Fan	Fan Drawer	Fan Drawer Assembly	W12-FAN	D-00000-435-025, Rev. 01

Common-Q Power Supply Qualification Testing Configuration					
Chassis #2 PAMS					
Slot	*Module ID*	*Description*	*Function*	*Model No.*	*Assembly*
1	P1	AC Line Filter Module	120 Vac Input Power	W12-FM	D-00000-435-020, Rev. 01
2	P2	Front-End Module	120 Vac Input Power	W1-FEM	D-00000-435-010, Rev. 02
3	P3	Dual MINI Module (24 / 24 Vdc)	Dual redundant 24 Vdc [AC160] and 24 Vdc [Aux] (paralleled with Module P8)	W1-2424	D-00000-435-030, Rev. 01
4	P4	Triple MICRO Module (28 / 28 / 00 Vdc)	Two independent variable (5 - 30 Vdc) [PAMS Heaters]	W1-282824*	D-00000-435-040, Rev. 02
5	P5	Triple MICRO Module (28 / 28 / 5 Vdc)	Two independent variable (5 - 30 Vdc) [PAMS Heaters], The 5 Vdc output is redundant [HSL] (paralleled with P6)	W1-282824*	D-00000-435-040, Rev. 02
6	P6	Triple MICRO Module (28 / 28 / 5 Vdc)	Two independent variable (5 - 30 Vdc) [PAMS Heaters], The 5 Vdc output is redundant [HSL] (paralleled with P5)	W1-282824*	D-00000-435-040, Rev. 02
7	P7	Triple MICRO Module (28 / 28 / 00 Vdc)	Two independent variable (5 - 30 Vdc) [PAMS Heaters]	W1-282824*	D-00000-435-040, Rev. 02
8	P8	Dual MINI Module (24 / 24 Vdc)	Dual redundant 24 Vdc [AC160] and 24 Vdc [Aux] (paralleled with Module P3)	W1-2424	D-00000-435-030, Rev. 01
9	P9	Front-End Module	120 Vac Input Power	W1-FEM	D-00000-435-010, Rev. 02
10	P10	AC Line Filter Module	120 Vac Input Power	W12-FM	D-00000-435-020, Rev. 01
	Fan	Fan Drawer	Fan Drawer Assembly	W12-FAN	D-00000-435-025, Rev. 01

* A 24V converter has been substituted for the 5V HSL Converter in the final W1-282824 design

Common-Q Power Supply Qualification Testing Configuration					
Chassis #3 MISC					
Slot	*Module ID*	*Description*	*Function*	*Model No.*	*Assembly*
1	E1	AC Line Filter Module	230 Vac Input Power	W12-FM	D-00000-435-020, Rev. 01
2	E2	Front-End Module	230 Vac Input Power	W2-FEM	D-00000-435-010, Rev. 02
3	E3	MAXI Module (24 Vdc)	Redundant 24 Vdc [AC160] (paralleled with Module E8)	W2-24	D-00000-435-035, Rev. 01
4	E4	Dual MINI Module (5 / 24 Vdc)	Dual redundant 5 Vdc and 24 Vdc (paralleled with Module E7)	W2-0524	D-00000-435-030, Rev. 01
5	E5	Triple MICRO Module (48 / 48 / 48 Vdc)	Three independent 48 Vdc Outputs	N/A*	N/A
6	E6	Triple MICRO Module (48 / 48 / 48 Vdc)	Three independent 48 Vdc Outputs	N/A*	N/A
7	E7	Dual MINI Module (5 / 24 Vdc)	Dual redundant 5 Vdc and 24 Vdc (paralleled with Module E4)	W2-0524	D-00000-435-030, Rev. 01
8	E8	MAXI Module (24 Vdc)	Redundant 24 Vdc [AC160] (paralleled with Module E3)	W2-24	D-00000-435-035, Rev. 01
9	E9	Front-End Module	230 Vac Input Power	W2-FEM	D-00000-435-010, Rev. 02
10	E10	AC Line Filter Module	230 Vac Input Power	W12-FM	D-00000-435-020, Rev. 01
	Fan	Fan Drawer	Fan Drawer Assembly	W12-FAN	D-00000-435-025, Rev. 01

* 48 V Triple Micro Module is not used

Qualification Test Miscellaneous Equipment			
Description	*Manufacture*	*Model Number*	*Serial Number*
Relay	Phoenix	REL-MR-24DC/21-21AU	N/A
Relay	Phoenix	REL-MR-24DC/21	N/A
Relay	Phoenix	REL-MR-24DC/21-21	N/A
Relay	Phoenix	REL-MR-24DC/21AU	N/A
Relay Base Terminal	Phoenix	PLC-BSC-24DC/21	N/A
Relay Base Terminal	Phoenix	PLC-BSC-24DC/21-21	N/A
Keyboard	Trilogic	G81-1800HQU/04	G 016102 No. 3
Keyswitch (2)	Grayhill	03S603	N/A
Rotary Switch	Grayhill	44A30-02-1-07W	N/A
Terminal Block	Phoenix	UK2,5B	N/A
Terminal Block	Phoenix	UD MTK 5	N/A
Terminal Block	Phoenix	UKKB5	N/A
Relay-Watchdog Timer	Brentek	P8-WDT24/PLCA210	N/A
HSL F.O. Modem	Hirschmann	OZDV-114A	943703021000001248
HSL F.O. Modem	Hirschmann	OZDV-114A	943703021000001279
HSL F.O. Modem	Hirschmann	OZDV-114A	943703021000001241
HSL F.O. Modem	Hirschmann	OZDV-114A	943703021000001242
HSL F.O. Modem	Hirschmann	OZDV-114A	943703021000001226
HSL F.O. Modem	Hirschmann	OZDV-114A	943703021000001295
D-Sub 50 pin module	Phoenix	FLK-D50 SUB/S	N/A
D-Sub 50 pin module	Phoenix	FLK-D50 SUB/B	N/A
D-Sub 37 pin module	Phoenix	FLK-D37 SUB/S	N/A
D-Sub 37 pin module	Phoenix	FLK-D37 SUB/B	N/A
D-Sub 15 pin module	Phoenix	FLK-D15 SUB/B	N/A
D-Sub 15 pin module	Phoenix	FLK-D15 SUB/B	N/A
Circuit Breaker	ABB	S 282 UC	N/A

Qualification Test Miscellaneous Equipment			
Description	*Manufacture*	*Model Number*	*Serial Number*
Base Rack Seismic Bkt	Westinghouse	11930-50010-1	N/A
Sub Rack Seismic Bkt	Westinghouse	11930-50010-2	N/A

Qualification Test PC Node Boxes			
Description	*Manufacture*	*Model Number*	*Serial Number*
PC Node Box 1	Trilogic	TL-WEST-002A	TRI01290314
Single Board Comp	Teknor	T830E/502 2-100	1000262562
Digital I/O Board (2)	Trilogic	A01003-1 RA	N/A
IRIG B	True Time	560-5908	14301-DEG
F.O. Enet Modem	Milan	MIL-C2112US	N/A
CI527W	ABB	3BSE018190R1	SE012559RK
CI527W	ABB	3BSE018190R1	SE012559R5
PC Node Box 2	Trilogic	TL-WEST-002A	TRI01290315
Single Board Comp	Teknor	T830E/502 2-100	1000272710
CI527W	ABB	3BSE018190R1	SE012559RO

Qualification Test Flat Panel Displays			
Description	*Manufacture*	*Model Number*	*Serial Number*
FPD 12.1 inch	AVT	AVT-12 FPRM	200105002
FPD 15 inch	AVT	AVT-15 FPRM	200105002
FPD 18 inch	AVT	AVT-18 FPRM	200105001
FPD 18 inch	AVT	AVT-18 FPRM	200105002

Qualification Test AC160 Data

		Main Assembly			Main Board				Sub-Board			
Item/Slot	*Model No*	*Article No.*	*PR*	*Serial No.*	*Model No*	*Article No.*	*PR*	*Serial No.*	*Model No*	*Article No.*	*PR*	*Serial No.*
	PM646A	3BDS005619R1	C	SE01274141	SAC2001A	3BSE021901R1	B	SE012377EF	SAC001A	3BSE023237R1	B	SE012481E1
PM3/05	PM646A	3BDS005619R1	C	SE01274097	SAC2001A	3BSE021901R1	B	SE012377D2	SAC001A	3BSE023237R1	B	SE012481EA
PM2/04	PM646A	3BDS005619R1	C	SE01274152	SAC2001A	3BSE021901R1	B	SE012377DG	SAC001A	3BSE023237R1	B	SE012481CF
PM1/03	PM646A	3BDS005619R1	C	SE01274139	SAC2001A	3BSE021901R1	B	SE012377FM	SAC001A	3BSE023237R1	B	SE012481CT
PM4/06	PM646A	3BDS005619R1	C	SE01274096	SAC2001A	3BSE021901R1	B	SE012377H3	SAC001A	3BSE023237R1	B	SE012461H6
AI1/07	AI685	3BSE023684R1		01	AI685M	3BSE023694R1	P1	SE0119815H	AI685S	3BSE023695R1	P1	SE0126393V
AI2/08	AI685	3BSE023684R1		05	AI685M	3BSE023694R1	P1	SE012433GU	AI685S	3BSE023695R1	P1	SE0126393S
AI3/09	AI685	3BSE023684R1		04								
AI4/10	AI685	3BSE023684R1		02	AI685M	3BSE023694R1	P1	SE0119815I	AI685S	3BSE023695R1	P1	SE0126393X
AI1/07	AI685	3BSE023684R1		23								
AI2/08	AI685	3BSE023684R1		21								
AI3/09	AI685	3BSC390014	R0001	0051								
AI4/10	AI685	3BSE023684R1		24								
AI1/07	AI685	3BSE023684R1	A	SE02225124	AI685M	3BSE023694R1	A	SE0217278S	AI685S	3BSE023695R1	A	SE021727BU
AI2/08	AI685	3BSE023684R1	A	SE02225123	AI685M	3BSE023694R1	A	SE0217278M	AI685S	3BSE023695R1	A	SE021727A8
AI3/09	AI685	3BSE023684R1	A	SE02225130	AI685M	3BSE023694R1	A	SE02172794	AI685S	3BSE023695R1	A	SE021727AB
AI4/10	AI685	3BSE023684R1	A	SE02225113	AI685M	3BSE023694R1	A	SE0217278C	AI685S	3BSE023695R1	A	SE0217279U
DO3/20	DO630	3BHT300007R1	G	SE01215513								
DO2/19	DO625	3BHT300040R1	C	SE0034G546								
DO1/18	DO620	3BHT300009R1	J	SE01220228								
CI3/17	CI631	3BSE016347R1	C	SE01164001	CI631-1	3BSE018787R1	C	SE01122974	TC511	3BSE006381R1	B	SE01142LC
CI1/01	CI631	3BSE023544R1	A	SE01266816	CI631-1	3BSE023545R1	A	SE012560BY	TC511	3BSE023546R1	A	SE012556BN
CI2/02	CI631	3BSE023544R1	A	SE01266865	CI631-1	3BSE023545R1	A	SE012560BU	TC511	3BSE023546R1	A	SE012556CT
DI/16	DI620	3BHT300002R1	E	SE0112M679								
AI6/12	AI635	3BHT300032R1	D	SE01222CUE								
AO1/13	AO610	3BHT300008R1	F	SE0112N011								
DP1/15	DP620	3BHT300016R1	H	SE01179603	DP620S	3BHT300028R1	E	SE011558BW				
AO2/14	AO650	3BHT300051R1	F	SE9809Z221	AO650S	3BHT310454R1	1	SE9801C191				
AI5/11	AI620	3BHT300005R1	H	SE98027829								

		Main Assembly			Main Board				Sub-Board			
Item/Slot	*Model No*	*Article No.*	*PR*	*Serial No.*	*Model No*	*Article No.*	*PR*	*Serial No.*	*Model No*	*Article No.*	*PR*	*Serial No.*
L2-3	TC514V2	3BSE023541R1	A	SE01265617	TC514-1V3	3BSE023543R1	A	SE012655VQ	TC5142V2	3BSE023542R1	A	SE01265617
L3-4	TC514V2	3BSE023541R1	A	SE0126561L	TC514-1V3	3BSE023543R1	A	SE012655V0	TC5142V2	3BSE023542R1	A	SE0126561L
L3-3	TC514V2	3BSE023541R1	A	SE01265615	TC514-1V3	3BSE023543R1	A	SE012655VE	TC5142V2	3BSE023542R1	A	SE01265615
L3-2	TC514V2	3BSE013281R1	A	SE0013C075	TC514-1V3	3BSE013282R1	A	SE00141278	TC5142V2	3BSE013282R1	A	SE00144280
R01	RF616	3BSE010997R1		N/A								
R02	RF620	3BHT100011R1		N/A								
	CI527W	3BSE018190R1	A	SE012559RK								
	CI527W	3BSE018190R1	A	SE012559R5								
	CI527W	3BSE018190R1	A	SE012559RO								
Terminator	TC506	3BSC840074R1	N/A	N/A								
Terminator	TC501V150	3BSC550038R1	N/A	N/A								
Cable	TK612	3BHT200010R1	N/A	N/A								
Connector	TX620K01	3BSE009963R1	N/A	N/A								
Connector	TF620	3BHT100013R1	N/A	N/A								

ABB has recently revised the article numbers for their line of AC160 equipment. Table 3-2 below provides a cross reference between the article number for the AC160 equipment which was qualified by the Common Q program and the corresponding revised ABB article number for ordering the equipment.

4 Qualification Requirements

The qualification of the Common Q equipment is based on the standards listed in Table 4-1.

Table 4-1 - Qualification Standards

Standard Number
IEEE 323-1974
IEEE 344-1987
IEEE 603-1991
IEEE 381-1977
IEEE 384-1974
USNRC Regulatory Guide 1.89, June 1984
USNRC Regulatory Guide 1.180, January 2000
EPRI TR-107330, December 1996
EPRI TR-102323-R1, January 1997
MIL-STD-461D
MIL-STD-462D
IEC 801-2
IEC 801-4
IEC 801-5

The qualification of the Common Q equipment was carried out in several phases. The first phase consisted of the full suite of qualification tests including environmental, seismic and EMC. This testing was conducted at Wyle Laboratories in Huntsville, Alabama during August and September of 2001. Testing was performed in accordance with the guidelines and requirements listed in the above standards.

During EMC testing, several anomalies with the equipment performance were noted. As a result, modifications were made to the affected equipment and follow-up EMC testing was performed on the Common Q power supplies and AC160 equipment. This testing was performed at Retlif Laboratories in Ronkonoma, New York. Testing of the Common Q power supplies was conducted in October and November of 2001. Testing of the AC160 equipment was conducted in January and April of 2002. The anomalies noted during the first test phase were successfully addressed by this additional testing. Incorporation of temporary modifications which were made to the equipment and allowed testing to succeed have been factored into the final design of the equipment which was released for construction.

Section 5.0 provides a discussion of the qualification requirements and the method by which the equipment was tested to show compliance with the requirements of Table 4-1.

5 Qualification Program Testing

The qualification program for the Common Q equipment was established to meet the requirements listed in Section 4.0.

In accordance with Reference 8.1, an assessment of the Common Q equipment was performed to determine if aging effects (i.e. thermal, radiation, mechanical wear, etc.) would have a significant affect of operability. [Since the equipment is to be located in a mild (non-harsh) environment it was determined that aging related degradation due to temperature, radiation, in-plant vibration, pressure, humidity, chemical spray and submergence will be insignificant or non-existent. Therefore, thermal and radiation aging of the Common Q equipment is not required. The PM646A watch dog timer relays and the DO630 digital output module relays along with other electromechanical relays were determined to require electromechanical aging.

Prior to the qualification test the PM646A watchdog timer, DO630 output relays and other electromechanical relays were electromechanically aged by cycling the relays under load. The number of cycles performed were calculated to represent the number times that the relays could be reasonably expected to operate during the expected life of the equipment.]

5.1 EMC Testing

The objective of the EMC test program was to qualify the Common Q equipment to the requirements of EPRI documents TR-102323-R1, Reference 8.9, TR-107330, Reference 8.8 and Reg. Guide 1.180, Reference 8.7. The EPRI TR-102323-R1 guide defines recommended, generic EMI susceptibility and emission test levels to be used in establishing equipment electromagnetic compatibility sources in Nuclear Power Plant applications. Specifically, the guide identifies emission sources in nuclear power plants; recommends appropriate standards for equipment testing; defines plant and equipment emissions limits; and details proper grounding sources in the vicinity of EMI-sensitive equipment. Recommended tests are referenced in standards defined by the military and commercial sectors, and the levels are conservative based on analyzed data.

For the initial EMC testing, the test specimen consisted of a worst case configuration for the proposed Common Q applications. [The configuration consisted of four processor modules, a full complement of I/O modules, internal watchdog timers, Flat Panel Displays, PC Node Boxes, power supplies and other miscellaneous hardware. The power supplies were loaded with a nominal load. Application programs exercised all applicable functions and monitoring software tracked the performance of the equipment.]

For the follow up testing performed at Retlif Labs only a subset of the Common Q equipment was tested. This subset consisted of equipment that had exhibited susceptibilities during the initial EMC testing.

5.1.1 Description of EMC Test Performed

The following is an overview of the EMC testing which was performed to satisfy the requirements of the Common Q program. Table 5-1 provides a summary of the EMC requirements for the program. Table 6-1 documents the test performed as well as the results.

Table 5-1 - Applicable EMC Test

EPRI TR-102323-R1	Frequency Range/Levels	Test Points
Emissions Tests		
CE101 Conducted Emissions	30 Hz to 50 kHz	AC/DC input power
CE102 Conducted Emissions	50 kHz to 400 MHz	AC/DC input power
RE101 Radiated Emissions	30 Hz to 100 kHz	Cable & EUT
RE102 Radiated Emissions	10 kHz to 1 GHz	2 antenna positions, front & rear
Susceptibility Tests:		
CS101 Conducted Susceptibility, Audio Frequency	Frequency: 30 Hz to 50 kHz (DC lines) : 120 Hz to 50kHz (AC lines) Amplitude: 6.3 Vrms average, 142dBμA, 80W	AC/DC input Power
CS114 Conducted Susceptibility, High Frequency	Frequency: 50 KHz to 30 MHz Amplitude: 103dBμA average	AC/DC input power, interconnecting cables
RS103 Radiated Susceptibility, Electric Field	Frequency: 10 kHz to 1 GHz Amplitude: 10 V/M	2 antenna positions, front & rear
Other Tests:		
IEC 801-2 ESD	1p.p.s/±8kV air, ±15 contact	EUT surface
IEC 801-4 Fast Transient and Impulse Test	Amplitude: ±2kV/±3kV Burst Rep. Rate: 3Hz Burst consists of transients generated at a rate of 2.5 to 5kHz.	AC/DC input power, interconnecting cables
IEC 801-5 Surge Test	Level: ±2kV/±3.0 kV peak Repetition: 1 pulse per minute	AC/DC input power and ground plane

5.1.2 Emissions Tests

Test for radiated and conducted emissions were conducted on the Common Q equipment per the requirements of EPRI TR-102323 (Reference 8.9). The tests were conducted in accordance with the limits of MIL-STD-461D (Reference 8.10) utilizing the test methods defined in MIL-STD-462D (Reference 8.11).

5.1.3 Susceptibility Tests

Tests for radiated and conducted susceptibility were conducted on the Common Q equipment per the requirements of EPRI TR-102323 (Reference 8.9). The AC and DC input power cables as well as the interconnecting I/O cables were tested. The tests were conducted in accordance with the limits of MIL-STD-461D (Reference 8.10) utilizing the test methods defined in MIL-STD-462D (Reference 8.11).

5.1.4 Electrostatic Discharge Test

The test for susceptibility to electrostatic discharge was conducted on the Common Q equipment per the limits of IEC 801-2. Equipment tested was that which would normally be accessible to operating personnel such as AC160 modules, power supplies and Flat Panel Displays.

5.1.5 Surge Test

The test for susceptibility to electrical surges was conducted on the Common Q equipment per the limits of IEC 801-5. Tests were conducted on the AC and DC input power lines.

5.1.6 Fast Transient Test

The test for susceptibility to electrical fast transients was conducted on the Common Q equipment per the limits of IEC 801-4. Tests were conducted on the AC and DC input power lines and the I/O interconnecting cables.

5.2 Environmental Testing

The objective of the environmental test program was to qualify the Common Q equipment for use as safety grade equipment in nuclear power plants. The test program was based on the requirements of References 8.1, 8.3, 8.4, 8.6 and 8.8.

For the environmental testing, the test specimen consisted of a worst case configuration for the proposed Common Q applications. The configuration consisted of four processor modules, a full complement of I/O modules, internal watchdog timers, Flat Panel Displays, PC Node Boxes, power supplies and other miscellaneous hardware. The power supplies were loaded with a nominal load. Application programs exercised all applicable functions and monitoring software tracked the performance of the equipment.

5.2.1 Description of Environmental Test Performed

The environmental testing consisted of subjecting the test specimens to a series of temperature profiles while monitoring equipment performance. [ ] This testing profile conservatively enveloped the temperature profile requirements of CENPD 255 as well as the Westinghouse standard requirements. In addition to the temperature variations, the Common Q equipment was also subjected to variations in the input supply voltage. Table 5-2 provides a summary of the environmental conditions to which the equipment was tested. Figure 5-1 provides a graphical representation of the planned environmental test profile.

Table 5-2 - Common Q Equipment Environmental Design Requirements

[ ]

[ ]

Figure 5-1 - Common Q Environmental Test Profile

5.3 Seismic Testing

The objective of the seismic test program was to qualify the Common Q equipment for use as safety grade equipment in nuclear power plants. The testing involved mounting the test specimens to a Triaxial Seismic Simulator Table and subjecting the test specimens to a series of seismic simulation tests. The test series included resonance search tests and random multi-frequency tests. A total of five OBEs and one SSE were required to meet the qualification requirements. Testing was performed in accordance with the guidelines of Reference 8.2.

The seismic testing was conduced in two series. The first series, Test Series 1, included FPDs, power supplies, and some support equipment such as PC Node Boxes. The second series, Test Series 1A, consisted of a worst case configuration for the proposed Common Q applications. The configuration consisted of four processor modules, a full complement of I/O modules, internal watchdog timers, Flap Panel Displays, power supplies and other miscellaneous hardware. The power supplies were loaded with a nominal load. Application programs exercised all applicable functions and monitoring software tracked the performance of the equipment.

5.3.1 Description of Seismic Test Performed

5.3.1.1 Test Series 1

For Test Series One, the three variations of FPDs and the CPC power supply were mounted in a test stand, which was then welded to the seismic table. Two PC Node Boxes were also mounted to the seismic table. The PC Node Boxes were bolted to pieces of angle iron, which was in turn welded to the table. Off table test equipment provided signals to exercise the equipment under test as well as monitor its functionality during the seismic events.

A total of eleven test runs were conducted. The first three were resonance search runs conducted to detect any input amplifications due to resonance in the test fixtures and EUT. Following the resonance search a total of six OBEs and two SSEs were performed. Figure 5-2 provides the Required Response Spectra for the seismic test while Table 5-3 provides a summary of the test runs performed for series one.

[ ]

Figure 5-2 - Required Response Spectra (RRS),
Horizontal and Vertical, 1% Damping

Table 5-3 - Test Run Descriptions, Test Series 1

[ ]

5.3.1.2 Test Series 1A

For Test Series 1A, the test specimen consisted of two racks of AC160 modules, four panels containing modems, relays, and terminal blocks and two FPDs. Also included were the PAMS and 230VAC power supplies. The two AC160 racks consisted of a base rack and a subrack. The base rack was fully loaded with four PM646A processors, four analog input cards and two communication cards. The subrack was fully loaded with analog and digital input and output cards. The AC160 processors communicated with redundant off table AC160 processors and a computer for monitoring functionality. Communication was over the AF100 and high-speed links.

A total of thirteen test runs were performed. The first three were resonance search runs conducted to detect any input amplifications due to resonance in the test fixtures and EUT. Following the resonance search a total of seven OBEs and three SSEs were performed. Figure 5-2 provides the Required Response Spectra for the test. Table 5-4 provides a summary of the test runs performed for Test Series 1A.

Table 5-4 - Test Run Descriptions, Test Series 1A

[ ]

6 Qualification Test Results

6.1 EMC

6.1.1 EMC Test Results

The Common Q test specimen was subjected to EMC testing in accordance with the requirements of Reference 8.9. The details of this testing, including test setup, monitoring, and results are provided in Reference 8.15. The following is a summary of the testing and the results:

6.1.1.1 CE101 Test

The CE101 test was conducted to determine the conducted emissions of the Common Q equipment in the frequency range of 100 Hz to 50 KHz. The conducted emissions were measured on the AC and DC input power leads [ ].

6.1.1.2 CE102 Test

The CE102 test was conducted to determine the conducted emissions of the Common Q equipment in the frequency range of 10 KHz to 400 MHz. The conducted emissions were measured on the AC and DC input power leads [ ].

6.1.1.3 RE101 Test

The RE101 test was conducted to determine the magnetic-field radiated emissions from the Common Q equipment in the frequency range of 1 KHz to 100 KHz. The radiated emissions in this frequency range [ ].

6.1.1.4 RE102 Test

The RE102 test was conducted to determine the electric field emissions of the Common Q equipment in the frequency range of 10 KHz to 1 GHz. The radiated emissions in this frequency range [ ].

6.1.1.5 CS101 Test

The CS101 test was conducted to determine the susceptibility of the Common Q equipment to 2.0 Vrms or 80 watts into a 0.5 ohm load injected on the DC input power lines over the frequency range of 30 Hz to 50 Hz., and a level of 6.3 Vrms injected into the AC input power lines over the frequency range of 120 Hz to 50 KHz. The Common Q equipment [ ].

6.1.1.6 CS114 Test

The CS114 test was conducted to determine the susceptibility of the Common Q equipment to injected currents onto the AC and DC input and interconnecting cables over the frequency range of 50 KHz to 30 MHz. The Common Q equipment [ ].

6.1.1.7 RS103 Test

The RS103 test was conducted to determine the susceptibility of the Common Q equipment to radiated 10V/m electric fields in the frequency range of 10 KHz to 1 GHz. The Common Q equipment [ ].

6.1.1.8 IEC 801-2 Test

The IEC 801-2 test was conducted to determine the susceptibility of the Common Q equipment to electrostatic discharges of ±8kV on contact and ±15kV air. [ ].

6.1.1.9 IEC 801-4 Test

The IEC 801-4 test was conducted to determine the susceptibility of the Common Q equipment to electrical fast transients of $2kV_{pk}$ and $3kV_{pk}$, 5/50 nsec, 2.5 kHz to 5 kHz pulse repetition rate, and 3 Hz burst repetition rate onto the AC and DC input power leads. The system was also tested with $1kV_{pk}$ and $3kV_{pk}$ transients injected on to the I/O interconnecting cables. The Common Q equipment [ ].

6.1.1.10 IEC 801-5 Test

The IEC 801-5 test was conducted to determine the susceptibility of the Common Q equipment to surge pulses of ± 2 kV_{pk} and ± 3 kV_{pk}, 1.2/50 sec @ 0°, 90°, and 270° injected onto the AC and DC input power cables. The Common Q equipment [ ].

6.1.2 EMC Conclusion

The Common Q equipment, [ ], has successfully passed EMC qualification to the requirements of Reference 8.9. Several limitations on equipment installation are required in order for the Common Q equipment to maintain this qualification. These installation requirements are listed in Section 7.0 of this report.

Reference 8.15 provides a detailed report on the EMC test program. Included in the report are details on the test facilities, test sample and monitoring equipment including hardware and software used, and specifics on equipment performance during each of the test conducted.

Table 6-1 provides a list of the Common Q equipment that was tested and their status with respect to the qualification requirements.

6.2 Environmental Test Results

The Common Q test specimen was subjected to environmental testing in accordance with the requirements of Reference 8.1. The test was conducted in two series, Test Series 1 and Test Series 1A. For both test series the EUT was subjected to the environmental conditions of Table 5-2.

6.2.1 Test Series 1

For Test Series 1, the EUT consisted of three variations of FPDs, PC Node Boxes, a keyboard for interfacing with the PC Node Box and modems for communication with the out of chamber monitoring equipment. Also included was the CPC power supply. The FPDs and PC Node Boxes interfaced with out of chamber equipment that provided video inputs for the displays and monitored the EUT for proper operation during the test. The CPC power supply interfaced with an out of chamber load panel that provided loading for the supply as well as a convenient location for monitoring power supply operation during the test.

All of the EUT was mounted in one open frame rack. The environmental chamber wet bulb and dry bulb temperatures were continuously monitored and recorded on a circular chart recorder. In addition to the chamber temperature monitoring, 24 thermocouples were mounted at various locations on the EUT. These thermocouples monitored the surface temperature of various Common Q components, which may be used for future evaluations of the equipment.

The EUT was subjected to the environmental conditions of Table 5-2. The CPC power supply's AC input voltage and frequency was varied per the values in Table 5-2. During the test there were several problems associated with the chamber temperature control and some of the monitoring equipment. The EUT only suffered one failure. The 18 inch FPD lost its video output at elevated temperatures. A root cause analysis of this failure was conducted by the manufacture and concluded that the failure was due to a faulty chip

that did not meet the manufacture's specifications. This was not considered a generic issue. A second 18 inch FPD was included in Test Series 1A. All the other Common Q equipment operated within specification during the test.

6.2.2 Test Series 1A

For Test Series 1A the test specimen consisted of two open frame racks. One rack contained two racks of AC160 modules, four panels containing modems, relays, and terminal blocks, and two power supply assemblies. The power supply assemblies were the PAMS and the 230VAC versions. The two AC160 racks consisted of a base rack and a subrack. The base rack was fully loaded with four PM646A processors, four analog input cards and two communication cards. The subrack was fully loaded with analog and digital input and output cards. The AC160 processors communicated with redundant off table AC160 processors and a computer for monitoring functionality. Communication was over the AF100 and high-speed links.

The second test rack contained three FPDs, one 12.1", one 15", and one 18". Also located in this rack were one PC Node Box, a panel containing keyswitches and a keyboard.

As in Test Series 1, the environmental chamber wet bulb and dry bulb temperatures were continuously monitored and recorded on a circular chart recorder. In addition to the chamber temperature monitoring, 24 thermocouples were mounted at various locations on the EUT. These thermocouples monitored the surface temperature of various Common Q components that may be used for future evaluations of the equipment.

The EUT was subjected to the environmental conditions of Table 5-2. The AC input to the PAMS and 130VAC power supplies was varied per the values in Table 5-2. During the test several anomalies were noted. These test anomalies are summarized below.

Several anomalies were not related to the test environment. [ ].

Several anomalies associated with out of specification readings also occurred. These were all traced to problems with the test equipment supplying the inputs to the EUT. These problems were corrected and testing continued with no additional problems. Additional details on these anomalies can be found in Reference 8.16.

6.2.3 Environmental Conclusion

The Common Q equipment successfully completed the environmental test program and is qualified to the conditions specified in Figure 5-1 and Table 5-2. [ ].

6.3 Seismic Test Results

6.3.1 Test Series 1

After the test specimen was mounted to the seismic table a resonance search test was performed. The resonance search involved subjecting the test specimens to a low level, single axis sine sweep from 1 to 50 Hz in each of the three orthogonal axes to determine major resonances. A resonance condition was detected in the test stand housing the FPDs and CPC power supply. Additional bracing was added to this test fixture in an effort to stiffen it for the follow on testing.

Following the resonance search test a sequence of six OBEs followed by two SSEs was performed. [ ].

6.3.2 Test Series 1A

After the test specimen was mounted to the seismic table, a resonance search test was performed. Once again a resonance condition was detected in the test stand housing the FPDs and CPC power supply. After consulting with the test facility it was decided that additional stiffing of the test stand would not be possible. With no other options available it was decided to continue the test program with the existing test stand.

Following the resonance search a total of seven OBEs were performed. During the first OBE one of the accelerometer blocks mounted on the test frame became detached. This invalidated the test run. The seventh OBE was performed so that it could be counted as a SSE if the equipment failed to function during the following SSE runs. A total of four runs were attempted at the SSE level. During the first SSE run one of the accelerometer blocks became detached and the run was aborted. During the second SSE an accelerometer block again became detached but enough data was collected to validate the run. The third and forth SSE runs were performed without further test equipment problems.

During the OBE and SSE test for Test Series 1A, the following were observed:
[ ].

6.3.3 Seismic Conclusion

Common Q Flat Panel Displays and PC Node Box

All three versions of the Common Q Flat Panel Displays and PC Node Box functioned properly and are qualified to [ ].

Common Q Power Supplies

All three versions of the Common Q Power Supply Assemblies functioned properly and are qualified to [ ].

Advant AC160

[ ].

[ ]

Figure 6-1 – Test Series 1 SSE Test Response Spectra (TRS), 1% Damping

(Refer to Wyle Report in Reference 8.17, Attachment 1, Wyle Appendix VI, Test Run 22, pp. VI-67, 72, 77)
(Minimum values of seismic table control accelerometers, FBHCA, SSHCA, VCA)

[ ]

Figure 6-4 – Test Series 1A SSE Test Response Spectra (TRS), 1% Dampling

(Minimum values of seismic table control accelerometers, FBHCA, SSHCA, VCA)
(Refer to Wyle Report in Attachment 1, Wyle Appendix VI, Test Run 45, pp. VI-154, 157, 160)

[ ]

Figure 6-5 – Composite SSE TRS for Test Series 1 and 1A, 1% Dampling

This curve represents a composite of the TRS for Test Series 1 and 1A. It is composed of the minimum values of seismic table control accelerometers, FBHCA, SSHCA, VCA for these two test runs.

[ ]

Figure 6-6 – Composite SSE Test Series 1 and 1A, 5% Damping

This curve represents a composite of the TRS for Test Series 1 and 1A. It is composed of the minimum values of seismic table control accelerometers, FBHCA, SSHCA, VCA for these two test runs.

[ ]

Figure 6-7 – Test Series 1A OBE Test Response Spectra (TRS), 1% Damping

(Minimum values of seismic table control accelerometers, FBHCA, SSHCA, VCA)
(Refer to Wyle Report in Attachment 1, Wyle Appendix VI, Test Run 44, pp. VI-127, 128, 129)

Table 6-1
Summary of Common Q Qualification Test Results

	Conducted Emissions	Radiated Emissions	Conducted Susceptibility (Audio Freq)	Conducted Susceptibility (High Freq)	Radiated Susceptibility	ESD (Electro Static Discharge)	Fast Transient Burst	Surge	Environmental	Seismic
	EPRI TR-102323					IEC 801-2	IEC 801-4	IEC 801-5	IEEE-323	IEEE-344
PM646A	[									
AI685										
DO630										
DO625										
DO620										
CI631										
DI620										
AI635										
AI620										
AO650										
AO610										
DP620										
TC514V2										
RF616										
RF620										
CI627W										
TC506										
TC501V150										
TK612										
TF620										
CPC P/S										
PAMS P/S										
230VAC P/S										

	Conducted Emissions	Radiated Emissions	Conducted Susceptibility (Audio Freq)	Conducted Susceptibility (High Freq)	Radiated Susceptibility	ESD (Electro Static Discharge)	Fast Transient Burst	Surge	Environmental	Seismic
EPRI TR-102323						IEC 801-2	IEC 801-4	IEC 801-5	IEEE-323	IEEE-344
12.1" FPD										
15" FPD										
18" FPD										
PC Node Box										
Modem OZDV-114A										
Keyboard										
Rotary SW										
Relays										
Terminal Blocks										
WDT Brentek										
D-Sub 50 pin module										
D-Sub 37 pin module										
D-Sub 15 pin module										
ABB circuit breaker										]

Table Notation: X indicates passed test requirement
N/A – Requirement is not applicable to this piece of equipment

[ ]

7 Installation Limitations

The following limitations must be followed during installation of the Common Q equipment in order to maintain the EMI qualification of the system.

[ ]

8 References

8.1. IEEE Standard Criteria for Qualifying Class 1E Equipment for Nuclear Power Generating Stations, IEEE-323-1983.

8.2. Recommended Practices for Seismic Qualification of Class 1E Equipment for Nuclear Generating Stations, IEEE-344-1987.

8.3. IEEE Standard Criteria for Safety Systems for Nuclear Power Generating Stations, IEEE-603-1991.

8.4. IEEE Standard Criteria for Type Test of Class 1E Modules Used in Nuclear Power Generating Stations, IEEE-381-1977.

8.5. Standard for Type Test of Class 1E Electrical Cables, Field Splices, and Connectors for Nuclear Power Generating Stations, IEEE-383-1974.

8.6. "Environmental Qualification of Certain Electrical Equipment Important to Safety for Nuclear Power Plants," USNRC Regulatory Guide 1.89, June 1984.

8.7. U.S. Nuclear Regulatory Commission Regulatory Guide 1.180, January 2000, "Guidelines for Evaluating Electromagnetic and Radio-Frequency Interference in Safety-Related Instrumentation and Control Systems".

8.8. "Generic Requirements Specification for Qualifying a Commercially Available PLC for Safety-Related Applications in Nuclear Power Plants", EPRI TR-107330, issued December 1996.

8.9. "Guidelines for Electromagnetic Interference Testing in Power Plants", EPRI TR-102323-R1, final report, issued January 1997.

8.10. MIL-STD-461D, "Requirements for the Control of Electromagnetic Interference Emission and Susceptibility".

8.11. MIL-STD-462D, "Measurement of Electromagnetic Interference Characteristics".

8.12. IEC 801-2, "Electromagnetic compatibility for industrial process measurement and control equipment Part 2: Electrostatic discharge requirements".

8.13. IEC 801-4, "Electromagnetic compatibility for industrial process measurement and control equipment Part 4: Electrical fast transient/burst requirements"

8.14. IEC 801-5 , "Electromagnetic compatibility for electrical and electronic equipment Part 5: Surge immunity requirements"

8.15. EMI Qualification Test Report of Supplemental Testing for Common Q Applications, 00000-ICE-37738, Rev. 00.

8.16. Environmental Qualification Test Report For Supplemental Testing for Common Q Applications, 00000-ICE-37737, Rev. 00

8.17. Seismic Qualification Test Report for Supplemental Testing for Common Q Applications, 00000-ICE-37736, Rev. 00.

8.18. Safety Evaluation by the Office of Nuclear Reactor Regulation CE Nuclear Power Topical Report CENPD-396-P "Common Qualified Platform" Project NO. 692.

Attachment to LTR-NRC-02-41

Changes to the Westinghouse Software Program Manual for Common Q Systems, CE-CES-195, Revision 1

(Section 3.3.1, Page 20, last paragraph, item 4)

4. Support~~Participate with~~ the QA department on any audits within the purview of its responsibilities.

(Section 4.1.2, Page 37, first paragraph)

All software modules developed or used within a system shall be documented by class ~~and category~~ as shown in Exhibit 4-1 for DPPS, CPCS and PAMS. The documentation required depends on the category of software and shall be consistent with Exhibit 4-4. Common Q applications not listed in Exhibit 4-1 shall document the software classification using Exhibit 4-2 or its equivalent. The V&V team shall review the completed Exhibit 4-2 form. This shall be performed by the Common Q design team and may be included in the software requirements documents.

(Section 4.4.1, Page 47, first paragraph)

Te documentation required for each category of software is~~Document classes required by this SQAP are~~ listed in Exhibit 4-4. Section 8 of this SPM provides guidance for the development of documents. If required, documents listed shall be made lifetime quality records in accordance with Reference 1.6.4.

(Section 4.6, Page 51, section title)

4.6 REVIEWS~~ AND AUDITS~~

(Section 4.6.2, Pages 55 and 56, changes as indicated)

4.6.2.5 Functional Review~~Audit~~

The Functional Review~~Audit~~ is held prior to software delivery to verify that all requirements specified in the Software Requirements Specification have been met. The CEO Manager shall perform the Functional Review~~Audit~~. The review~~audit~~ shall include an overview of all documentation and a review of the

results of previous reviews, including Software Requirements Review, PDR, CDR, and V&V Report (for safety related software).

The results of functional audits shall be documented identifying all deficiencies found, and plans and schedule for their resolution.

4.6.2.6 Physical Review~~Audit~~

The Physical Review~~Audit~~ is held to verify that the software and its documentation are internally consistent and are ready for delivery. The audit shall include a review of the following deliverable items:

- Deliverable software media
- V&V Report and code certificate (for safety related software)
- User/Technical Manual
- Installation instructions (if required)

The results of physical reviews~~functional audits~~ shall be documented~~, and shall be a requirement for issuing the Certificate of Conformance for the Common Q System~~.

4.6.2.7 In-Process Audits

In-process audits of a sample of the design are held to verify consistency of the design. Software inspections may be included as part of the in-process audit activity. Nuclear Quality shall perform in-process audits for nuclear safety-related ~~protection~~ class systems. CEO Managers shall perform the in-process audits for all other systems. The audit shall review different items depending upon the software phase the audit is held and can include a review of the following items:

- Code versus design documentation (code walkthroughs or code inspections)
- Interface specifications
- Design implementations versus functional requirements
- Functional requirements versus test description
- Test descriptions versus test procedures
- Test procedures versus test reports

The results of in-process audits shall be documented identifying all deficiencies found. The CEO Manager then must evaluate the deficiencies and prepare plans and schedules for resolving the deficiencies.

4.6.2.8 Managerial Reviews

Managerial reviews are held periodically to assess the execution of all of the actions and the items identified in this SQA guideline. ~~These reviews shall be held as part of the CE Nuclear Power Project Management reviews.~~

The management review shall be documented by a report summarizing the review findings, exceptions to the process stated in the SQAP and recommended changes or improvements to the SQA process. The reviews result in statement as to the adequacy of the SQA process and its execution.

(Section 5.5.5, Page 85, "V&V Inputs")

V&V Inputs

1. Software/Hardware design documents.
2. Source code listings and executable code.
3. Interface design documentation.
4. User documentation.
5. Other standards and procedures.
6. Software Configuration Management Procedures.
~~7. Wire Lists and other drawings.~~
7~~8~~. Module Test Reports

(Section 5.5.6, Page 90, "V&V Outputs")

V&V Outputs

1. Test procedures.

2. Test Report and evaluation for acceptability.

3. Test Phase checklist #4 (Exhibit 5-5), as well as the appropriate checklist(s) in Reference 1.6.4 for Safety-Related software.

4. Produce a summary report on test phase V&V activity results, including identification of deficiencies and possible enhancements.

5. Code certificates certifying the software is acceptable for use.

(Section 5.5.7, Page 90, "V&V Inputs")

V&V Inputs

1. Installation procedures, system generation procedures, etc.
2. User documentation
3. ~~Training documentation~~

(Section 5.5.7, Page 92, "V&V Outputs")

V&V Outputs

1. Final V&V report with summary review of the system's acceptability.
2. ~~Code certificates certifying the software is acceptable for use.~~

(Section 5.6.1, Page 93, Item 1)

1. V&V phase summary reports: These reports are issued after each life cycle phase of the V&V task to summarize the V&V review. Phase reports may be consolidated into a single report if desired. These reports shall contain the following:

(Section 6.3.1, Page 106, Item 3.a)

a. Source and object files for software items must be identified by a unique name (which is also defined in the SDD) a unique number, and a revision. For example, o~~O~~bject files may be identified by a date time stamp.~~)~~ The CEO manager shall have the responsibility for defining the name/numbering system for a project. If the project specific SCM plan does not define software identification requirements, the following shall be utilized:

(Section 6.3.2, Page 110, last paragraph)

After approval of the SCR, the CEO will schedule the change and the personnel responsible for implementing the change. After implementation, the changed software and accompanying documentation will be submitted for inclusion in controlled system files and documentation.

(Exhibit 4-1, Page 144, Core Protection Calculator)

Core Protection Calculator	Safety Critical Kernel (FLOW, UPDATE, POWER, STATIC)	Protection
	CEAC Software	Protection
	MTP	Important To Safety
	Operators Module	Important To Safety
	Inter-System Communication Software	Important To Safety
	CEAPDS	Important to Availability
	All Other Software	General Purpose
	Development Tools	General Purpose

(Exhibit 5-1, Pages 150 and 151)

TASK	PROTECTION	IMPORTANT TO SAFETY	IMPORTANT TO AVAILABILITY	GENERAL
SOFTWARE REQUIREMENTS PHASE				
SYSTEM AND SOFTWARE REQUIREMENTS	DT/VT	DT/VT	DT~~A/T~~	DT~~A/T~~
REQUIREMENTS VERIFICATION	VT	VT	DT~~A/T~~	DT~~A/T~~
SOFTWARE DESIGN PHASE				
SDD	DT/VT	DT/VT	DT~~A/T~~	DT
PROTOTYPE CODING	DT	DT	DT	DT
DESIGN VERIFICATION	VT	VT	N/A~~V/T~~	N/A
SOFTWARE IMPLEMENTATION PHASE				
TEST PLAN (MAY BE PART OF SVVP)	VT/DT	VT/DT	~~V/T~~/DT	DT
MODULE CODING	DT	DT	DT	DT
MODULE TEST PROCEDURE	DT/VT	N/A	N/A	N/A
MODULE TEST EXECUTION	DT/VT	N/A	N/A	N/A
UNIT TEST PROCEDURE	VT/DT*	VT/DT*	N/A	N/A
UNIT TEST EXECUTION	DT/ VT	DT/VT	N/A~~D/T~~	N/A
IMPLEMENTATION VERIFICATION	VT	VT	DT~~A/T~~	DT~~A/T~~
TESTING/INSTALLATION & CHECKOUT PHASES				
SYSTEM TEST PROCEDURE	VT/DT*	VT/DT*	DT~~/DT~~	DT
SYSTEM TEST EXECUTION	VT*	VT*	DT~~A/T~~	DT
SYSTEM TEST REPORT	VT/DT*	VT/DT*	DT~~A/T~~	DT
INTEGRATION TEST PROCEDURE	VT/DT*	VT/DT*	~~V/T~~/DT	~~V/T~~/DT
INTEGRATION TEST EXECUTION	VT*	VT*	DT~~A/T~~	DT~~A/T~~

TASK	PROTECTION	IMPORTANT TO SAFETY	IMPORTANT TO AVAILABILITY	GENERAL
INTEGRATION TEST REPORT	VT/DT*	VT/DT*	DT~~/VT~~	DT~~/VT~~
USER DOCUMENTATION	DT/VT	DT/VT	DT~~/VT~~	DT~~/VT~~
SVVR	VT	VT	N/A~~/VT~~	N/A~~/VT~~
SAT PROCEDURE	DT/VT	DT/VT	DT~~/VT~~	DT~~/VT~~
SAT REPORT	DT/VT	DT/VT	DT~~/VT~~	DT~~/VT~~
KEY: ORIGINATOR/REVIEWER (E.G. DT/VT)	DT = DESIGN TEAM			VT = V&V TEAM

Exhibit 9-2
Corrective Action Process

Issue Report

Step 1: Identification of Issue - (required information)

Step 1: Identification of Issue

Created by:	Alan W Hill
Created on:	08/14/2002
Phone:	8-286-6592
Originator's Organization	
Originator's Business Unit:	NABU
Organizational Level 2:	Projects
Organizational Level 3:	Project Controls and Contract Administration
Originator's Group:	Projects - Controls & Contract Admin
Originator's Location:	Monroeville PA
Issue Title:	Example Title
Issue Description:	Exmaple desciption of the Issue is entered here
QA/QC Controlled?	○ Yes ◉ No **By choosing yes, this issue will become a CAR**
Issue raised by	◉ Employee ○ Supplier ○ Customer ○ Regulatory Agency

Step 2: Identification of Issue - (optional information)

Step 2: Identification of Issue - (optional information)

Suggested Significance Level:	○ High ○ Suggestion for Improvement ◉ Medium ○ Best Practice ○ Watch/Trend
Recommended Resolution:	
Background:	
Date Issue First Occured:	
Affected Customer(s):	Utility X
Affected Unit(s):	Units A & B
Affected Supplier(s):	
Immediate Actions Taken:	
Impacted Documents, Systems, Components, etc:	
Submitted on behalf of:	
Is this issue potentially reportable?	○ Yes ○ No ○ I don't know
Improvement Plan #:	
Audit #:	
Disposition of Material:	○ Accept as is ○ Repair ○ Rework ○ Scrap
Have non-conforming material or calculations been marked or "Hold Tagged"?	○ Yes ○ No ○ N/A

Step 3: Comments

Step 4: Prepare for Issue Review Meeting

Step 5: Issue Review Meeting Complete

Step 6: Event Codes

Step 7: Causal Analysis

Step 8: Root Cause Coding

Step 9: Summary Table of Commitments

Step 10: Effectiveness Evaluation

Step 11: WorkFlow Information

CAM Administration Section