

Enclosure 13 – RAI Response**RAI Letter Dated August 16, 2017****Documents to be Docketed****NRC QUESTION 1:**

1. Please docket the documents identified below:
 - FPG-DRT-C51-0005, “NICSD [Nuclear Instrumentation and Control Systems Department Critical] Digital Report”
 - FC51-3702-1000, “Oscillation Power Range Monitor (OPRM) unit detail design specification”
 - FA32-3709-0001, “Nuclear Energy Systems and Services Division FPGA [Field Programmable Gate Array]-based Safety-Related Systems Verification and Validation Plan, Rev.4”
 - FPG-PLN-C51-0006, “Verification and Validation Plan, Rev.5”
 - FA32-3709-1000, “Nuclear Instrumentation & Control Systems Department Verification and Validation Plan for FPGA-based Safety-Related Systems, Rev.8”
 - FA32-3701-1001, “Nuclear Instrumentation & Control Systems Department Software Quality Assurance Plan for FPGA-based Safety-Related Systems, Rev.3”
 - FC51-3704-0004, “NED [Nuclear Energy Systems and Services Division Software Safety] Analysis Report for OPRM, Rev.5”

RESPONSE:

Toshiba will docket above requested documents by the end of September, 2017.

System Description and Configuration**NRC QUESTION 2:**

2. (Open Item 80) The licensing topical report (LTR) Section II-2.2.2.3 describes the system configuration. However this section does not describe the configuration for a boiling water reactor (BWR)-5. Instead, the configuration for the BWR-5 is provided in Section II-A-7.1 of the LTR. Also, Section 4.2 of the Equipment Design Specification (EDS) (document No. FC51-3002-1000) identifies the configuration of the Power Range Neutron Monitoring (PRNM) system for one division.

It is the NRC staff's understanding that the description provided in the EDS is for the PRNM system for the Advanced BWR (ABWR), and thus this information can't be used as the configuration for the BWR-5 PRM system. Please address the following:

- Describe the PRM system configuration for each division (i.e., number of local power range monitors (LPRM), units, and modules in each division).
- Provide a figure/diagram showing the PRM system architecture, including the configuration for all divisions. Note that Figures 4-1 in the equipment requirement specification (ERS) and II-A-7-1 in the LTR show the PRM system configuration, but these figures do not identify the separation for each division.

RESPONSE:

- The BWR-5 PRM system configuration for one channel is shown in Figure II-2-14 in Topical Report (TR) Section II-2.2.2.4. Figure 1 below illustrates the relationship of the electrical divisions, FLOW channels, and the APRM channels described in Section 4.3.1 of the BWR-5 Equipment Requirement Specification (ERS) (FPG-RQS-C51-0001, Rev.7). Each of the BWR-5 electrical divisions has two FLOW units, an LRPM unit, and three LPRM/APRM units. The three LPRM/APRM units are considered three channels.

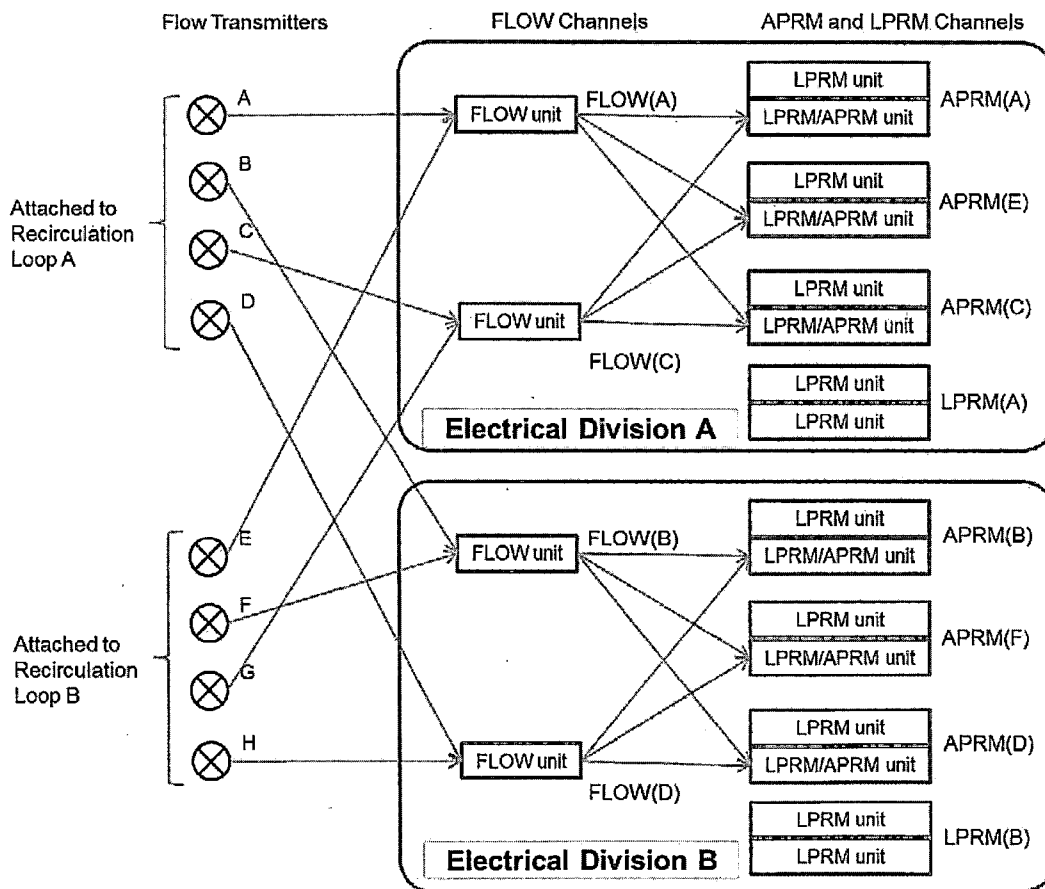


Figure 1 Relationship of Electrical Divisions, FLOW channels, and APRM channels

Figure II-2-14 of TR Part II shows “LPRM Det 1” through “LPRM Det 10” to illustrate the 10 LPRM detectors that provide signals to the LPRM/APRM unit (shown as an “APRM/LPRM unit” in the figure), and “LPRM Det 11” through “LPRM Det 21” for the

additional 11 LPRM detectors that provide signals to the LPRM unit. APRM(A), APRM(E), APRM(C), and LPRM(A) channels have 21 LPRM detectors, with one less LPRM than APRM(B), APRM(D), APRM(F) and LPRM(B) channels that have 22 LPRM detectors. Each LPRM detector requires an LPRM module. The number of other modules can be identified in this figure. Figure II-A-7-1 of LTR Part II provides more detailed information for the typical PRM system configuration for BWR-5 with 172 LPRM signals.

Note that the existing Figure II-2-14 of LTR Part II does not show the data communication paths precisely and has a few errors. Figure 2 in this document is a more precisely revised version of Figure II-2-14 of LTR Part II. The existing Figure II-2-14 of LTR Part II will be replaced with Figure 2 in future revision.

- b. Figure 1 provides a simple BWR-5 PRM system architecture showing the electrical divisions. As described in LTR Section II-A-7.1, the APRM channels, LPRM channels, and FLOW channels are divided into two electrical divisions in a BWR-5.

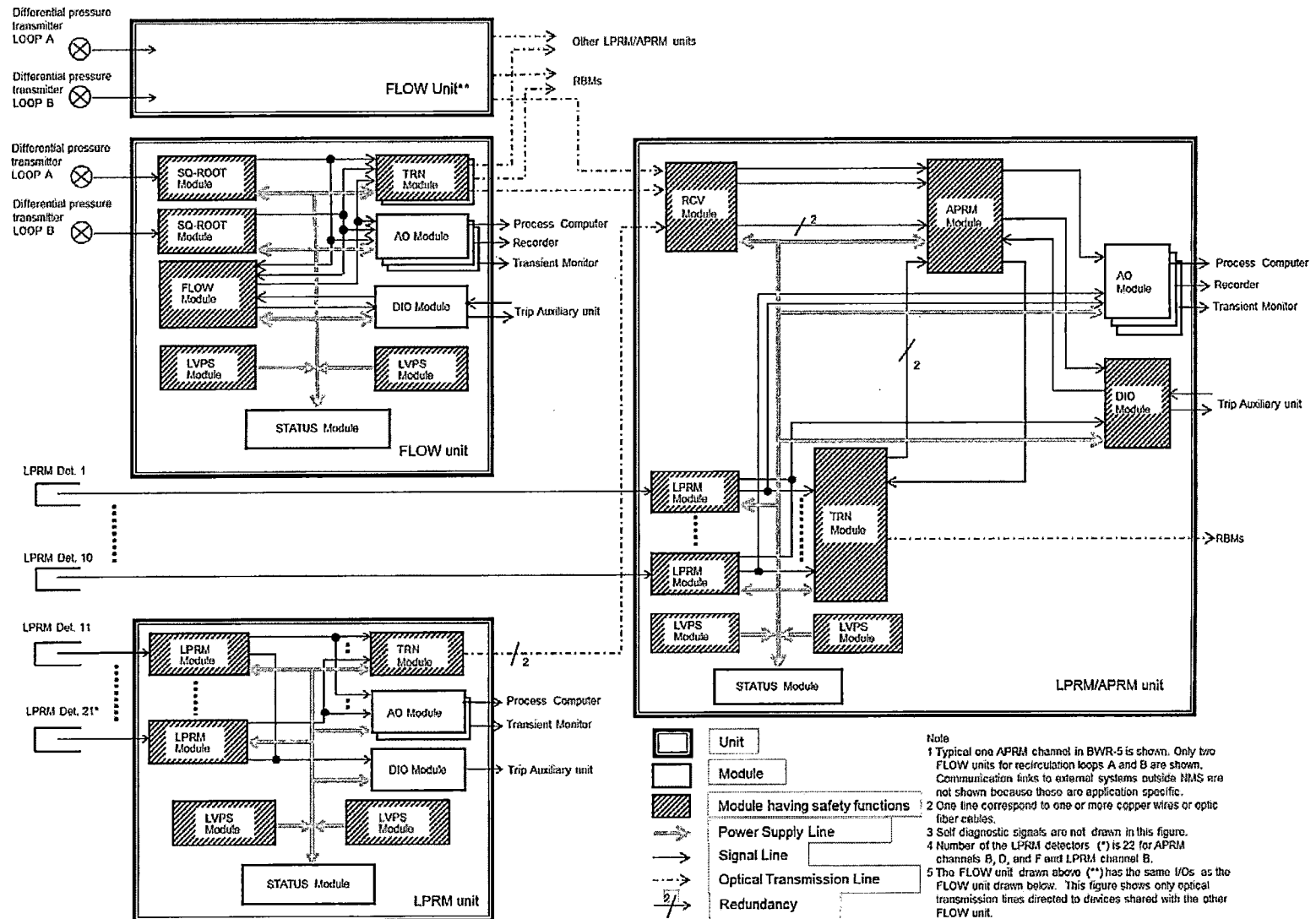


Figure 2 Module and Unit Configuration of PRM for BWR-5 (OPRM Not Shown)

NRC QUESTION 3:

3. (Open Item 82) In the LTR, Section II-2.2.3.1 describes system redundancy. This section refers to its subsection for specific details. Section II-2.2.3.1.2 describes redundancy for the PRM and OPRM. This section does not indicate the number of APRM, LPRM, and flow channels for the BWR-5 PRM. The information provided is very vague and furthermore states the APRM channels and groups are application specific. Please describe how the redundancy criteria is met by providing detailed information for the BWR-5 PRM and OPRM system configuration.

RESPONSE:

For the BWR-5 PRM, Figure 1 in this document shows how each of two electrical divisions (or electrical groups) has the same set of FLOW channels and APRM channels performing the same functions. This configuration meets the redundancy criteria between the divisions and is the digital equivalent of the systems currently installed in the BWRs.

When attaching OPRMs to a large core BWR-5 PRM, Toshiba will use the same design philosophy though the actual configuration is plant specific and will not require or include communicating LPRM data across divisional boundaries. A typical BWR-5 would have six APRM, two LPRM, and four FLOW channels. The BWR-5 would have four OPRM units, each of which would be assigned to a couple of APRM channels or a pair of APRM and LPRM channels. Section II-A-7.7 of LTR Part II provides the interface configuration between PRM and OPRM for Large Core BWR. When attaching OPRMs to a small core BWR PRM (as is currently required in the existing installed implementations), the design will require communicating LPRM data uni-directionally across electrical division boundaries, to provide sufficient LPRM cells for the algorithm.

NRC QUESTION 4:

4. (Open Item 88) Section II-2.2.2.2 in the LTR describes the requirement for the PRM system and OPRM unit response time. Section II-2.2.3.3 states that Toshiba “generates a report to document the timing analysis.” Further, Table IV-6, item 1.19 states the unit design specification specifies the performance for response time. Therefore, it is not clear if Toshiba prepared a timing analysis for the PRM system. Please clarify if Toshiba performed the system response time analysis.

RESPONSE:

For the PRM system response time, as described in the ERS Section 5.1.3.1, the Toshiba design assigns an individual response time to each unit and module to meet the overall system response time. The units and modules are designed so that they meet the assigned response time as stated in Table IV-6-1 of LTR Part IV, Item 1.19.

Section II-2.2.3.3 of LTR Part II discusses signal timing inside FPGAs to achieve the deterministic system response time. The software tool produced internal FPGA timing analysis reports. For example, the Implementation and Integration Phase V&V Report (included in LTR Part V) Section 3.1.1 describes how these timing analyses were performed and the timing analysis reports were produced.

Since unit response time is a unit and module requirement, verification and validation activities and reports include response time tests. A separate response time report was not required or generated. Response time will be provided to utilities in the Application Guide (Section II-A-5.1).

NRC QUESTION 5:

5. (Open Item 89) Section II-2.2.3.2 in the LTR briefly describes independence for each division. However, since it is not clear how many divisions are considered for the PRM system for a BWR-5 and whether inter-divisional communication is performed (see open items 80, 81, and 87), it is not clear how the system maintains independence.

Therefore, please provide detailed information on how the system maintains independence based on the system configuration for each division (for a BWR-5).

RESPONSE:

Figure 1 illustrates the configuration of the BWR-5 PRM system. The BWR-5 PRM system is divided into two electrical divisions, each of which has an independent power source. The FLOW and APRM channels in one electrical division operate independently, without receiving any data from the other division. The OPRM channels in a large core BWR use only the data from the division where the OPRM is installed. The OPRM channels in a small core BWR use LPRM data from both divisions (see Toshiba response to NRC Question 6).

System Communication

NRC QUESTION 6:

6. (Open Item 81) In the LTR, Toshiba stated that there is no inter-divisional communication in the PRM system. However, the information provided in the LTR for interim staff guidance (ISG)-04, "Task Working Group #4: Highly-Integrated Control Rooms–Communications Issues (HICR)," Staff Position 1, Point 2 states "the PRM and OPRM use unidirectional fiber optic links for interdivisional communication to protect the safety function of each safety channel from adverse influence from outside the division of which that channel is a member."

However, the LTR description in Point 1 states: "The PRM or OPRM does not require data from any other safety systems residing outside its own safety division or external to its own safety division." Based on these statements, it is not clear if inter-divisional communication is allowed. Please clarify if inter-divisional communication is performed in the PRM system. (When responding to this item, please consider the questions in open items 80 and 87).

RESPONSE:

The PRM system does not require inter-divisional communication to implement the APRM function for large core BWR-4, 5, and 6 units. However, for small core BWR units, LPRM data crosses divisional boundaries to the OPRM to provide sufficient cells to detect neutron flux

oscillations in the same way that data crosses divisions in the existing BWRs. Additionally, data is communicated in one-way fiber optic links to non-safety related external equipment.

Each LPRM/APRM unit provides signals to the non-safety Rod Block Monitors (RBMs) external to the PRM system as shown in Figure II-A-7.1. In addition, analog signals are provided to the non-safety process computer, transient monitor, and the recorder through AO modules that provide isolation capability.

NRC QUESTION 7:

7. (Open Item 83) Toshiba document No. 5G8HC108, "TRN [Transmit] Module Design Specification," Figure 3.21 shows the buffers for the TRN module. Section 6.1.2 describes the buffers for the TRN module, but this document does not describe how the buffers for the other FPGAs in the module work. Please describe how the buffers in the TRN module work.

RESPONSE:

Section 6.1.2 of the TRN Module Design Specification (5G8HC108) describes [] of I/O buffers in the [] FPGA. The I/O buffers in the [] FPGA are implemented as []
At any time, [] stores the data coming through the middle plane with its clock signal, and the [] transmits the previously received message data to the [] FPGA, which operates with the module clock signal. These [] is received during receipt of one data frame, for each of the [] channels of data. The [] are counted after the frame pulse signal is received.

NRC QUESTION 8:

8. (Open Item 84) Toshiba Document No. 5G8HC109, "RCV [Receive] Design Module Specification," states the RCV module decodes low-voltage power supply (LVPS) diagnostic alarms from the middle plane (Section 6). But then Section 3.3.10 states the faults and failure of the LVPS are hardwired to the STATUS module for indication. This module also monitors transmission errors and provides input to error signal to the middle plane. Please describe how the LVPS diagnostic alarms are generated, processed, and transmitted.

RESPONSE:

The power supply error monitoring circuit of the LVPS module monitors the []
[] If the monitoring circuit detects a [] the monitoring circuit activates the alarm signal line to the STATUS module.

Section 3.3.10 of NICSD's CDR (FPG-DRT-C51-0005) states faults and failures of the LVPS are hardwired to the STATUS module for indication. That is true in the LPRM, FLOW, and

LPRM/APRM units, each of which has its own STATUS module. As described above, if the monitoring circuit detects a voltage that exceeds its limits, the monitoring circuit activates the alarm signal line in the middle plane to the STATUS module.

It is true the RCV module decodes LVPS failure signals from the receiving data and provides them to middle plane but these are not used. In the LPRM/APRM unit, the STATUS module monitors the data transmission from the LPRM unit to the LPRM/APRM unit, data transmission from the FLOW unit to the LPRM/APRM unit, and data transmission inside the LPRM/APRM unit. The diagnostic information data is provided to the STATUS module by other modules through discrete hardwired connections or data communication in the LPRM/APRM unit.

NRC QUESTION 9:

9. (Open Item 85) Toshiba Document No. 5G8HC109, "RCV Design Module Specification," states the TRN module can provide safety to non-safety communication. In this case the TRN module would be broadcast only. Does this require any modification?

In addition, Section II-2.2.3.2.2 in the LTR states each division of the PRM system communicates data and status to non-safety related systems through dedicated communication interfaces in each's division module. Please clarify:

- a. How data is transmitted to the non-safety system;
- b. What module is dedicated for this data transmission; and
- c. How the communication interface is designed to prevent any data transfer from the non-safety to the safety-related division.

RESPONSE:

The TRN module transmits data without handshaking to the RCV module in other units. TRN Module Summary Description in LTR Part II provides a brief description of the TRN module. The correct connection between TRN module and RCV module is confirmed by UNIT TYPE and UNIT ID codes sent by the TRN module and checked by the RCV module. The UNIT TYPE and UNIT ID codes are hardwired. The RCV module checks if the sender's codes (set in the TRN module) and the receiver's codes (set in the RCV module) match. If those do not match, an error signal is generated.

- a. To transmit data to the non-safety system, the other end of the fiber optic cable is connected to the non-safety system. The non-safety system is responsible for decoding the standard message packet sent by the TRN. The TRN protocol is defined, and is a non-handshaking protocol. The non-safety system is responsible for catching and decoding the TRN messages.
- b. The TRN module in the LPRM/APRM unit transmits data to the non-safety Rod Block Monitor (RBM) as stated in Table 5-6 of the ERS (FPG-RQS-C51-0001).

- c. Since the TRN module is used with a fiber optic transmitter only and does not have an optical receiver, the hardware ensures that only one-way communication occurs. Thus, any non-safety equipment connected to the TRN module cannot transfer data to the module. Separate RCV modules have optical receivers. The only use of fiber optic receivers will be for receipt of data from an external process computer, which occurs only to the PRM through a tightly controlled process. This capability is not included in the BWR-5 PRM described in this LTR.

NRC QUESTION 10:

10. (Open Item 86) ISG-04, Staff Position 1, Point 4, states that the communication process itself should be carried out by a communications processor separate from the processor that executes the safety function. Toshiba provided a response to this item in Table IV-5 of the LTR. This response explained the use of the TRN and RCV modules for communication. However, if the TRN module or RCV module in the unit fails, the unit will not receive data to perform its safety function. In this case, please explain what will happen to the unit, besides identifying an alarm in the module.

RESPONSE:

For the PRM, the TRN and RCV modules are used in (1) data communication from the LPRM unit to the LPRM/APRM unit, and (2) data communication from two FLOW units to the LPRM/APRM unit.

For (1), one TRN module in the LPRM unit and one RCV module in the LPRM/APRM implement dual communication links (see Figure 2). If the TRN or the RCV module fails, the number of the LPRM levels is less than its limit, and the LPRM/APRM becomes inoperable. The redundant channels are not affected.

For (2), each of the two FLOW units has a TRN module to transmit data to one shared RCV module in the LPRM/APRM module. If the TRN module in one FLOW unit fails, the LPRM/APRM unit uses the healthy communication link from the other FLOW unit (as described in the response to NRC Question 11 and shown in Figure 1, the APRM channel still receives flow data of recirculation Loop A and B through this healthy communication from the other FLOW unit). If the RCV module fails, i.e., both independent data paths in the RCV module fail, the Flow value is set to zero, and this lowers the flow biased APRM setpoints. An alarm will be generated. The redundant PRM is not affected.

For the PRM system, the Requirements Definition Phase Preliminary Hazard Analysis Report (FPG-DRT-C51-0018) provides further information, including an FMEA evaluating failures of the TRN and RCV modules.

For the ABWR OPRM, the Software Safety Analysis Report for Safety-Related Oscillation Power Range Monitor (OPRM) (FC51-3704-0004) provides further information including an evaluation of RCV failures

Section 3.14 of IM-2015-000152 Rev.1 (ML15085A149) 2015 discusses diagnosis of communication.

NRC QUESTION 11:

11. (Open Item 87) Toshiba ERS (Document No. FPG-RQS-C51-0001), Section 4.3.1, states each APRM channel receives signals from two flow channels. If there is one flow unit per division, how can the APRMs in one division receive two flow channels without requiring communication from a flow unit in another division?

Also, the ERS states the system consists of 6 APRM channels, which will require signals be shared among the units. Please clarify if inter-divisional communication is required in the PRM system for BWR-5.

RESPONSE:

The APRM modules in one electrical division receive two FLOW channels in the same electrical division, as illustrated in Figure 1. Each FLOW channel receives flow values from both of the recirculation loops. Even if one FLOW unit fails, the APRM channel still receives flow data of recirculation Loop A and B from the other FLOW unit. For inter-divisional communication, see the response to NRC Question 6.

NRC QUESTION 12:

12. (Open Item 90) Section II-2.2.3.2 in the LTR briefly describes communication independence. This section states the communication links provide safety to non-safety related electrical and isolation, and therefore data transfer from non-safety can't occur. Please describe how this isolation is implemented (i.e., logic or hardware based).

RESPONSE:

PRM data is provided to external non-safety related equipment through the TRN module, which only has fiber optic transmitters. No provision is made in the existing design to support receipt of non-safety data from external equipment. In a future enhancement, the ability to receive gain adjustment factors from an external non-safety related fuel computer may be added to the PRM, which is not included in this LTR.

Regulatory Audit**NRC QUESTION 13:**

13. (Open Item 96) During the audit, Toshiba prepared several documents to assist NRC staff review traceability of system requirements. Please docket this information.

RESPONSE:

Toshiba will docket the following documents prepared during the audit by the end of September 2017:

- MEM-JHS-000757 Mapping of design criteria in EDS

- MEM-JHS-000758 V&V team activity and action for anomaly
- MEM-JHS-000759 CGD Flow Outline
- MEM-JHS-000761 RTM Table
- MEM-JHS-000762 OPRM CGD Trace Map
- MEM-JHS-000763 Document Map

NRC QUESTION 14:

14. (Open Item 114) Please describe the difference between Toshiba Design Verification Report (DVR) and the “IM” report used during the development of the system.

RESPONSE:

The Design Verification Report (DVR) is a project document. The DVR is used for design verification of the project document. The content of the DVR is defined in AS-200A002 “Design Verification Procedure.”

In addition to the project document, Toshiba uses IM report for general communication in such cases when a document does not fall into the categories used in the Project Control Document List (PCDL).

Note that “IM” stands for the abbreviation of a group name in the Toshiba organization that is responsible for the Toshiba FPGA system.

PRM Equipment Qualification

NRC QUESTION 15:

15. (Open Items 98-1, 98-1a, and 98-1b) Table #98-1, Revision 1 included in Document E2-2016-000749, Revision 0 shows specific scope (or limited scope) operability and prudency tests which are further clarified in Notes 1, 2, and 3. These notes specify test items that Toshiba performed during pre-qualification and post-qualification but did not perform when it conducted operability and prudency testing during environmental qualification. Table IV-4-1 of the LTR states “Comply” in the column “Compliance with EPRI [Electrical Power Research Institute] technical report (TR)-107330 Requirements” for several of these test items although some of them were not performed during environmental qualification. Please provide a revised and complete Table IV-4-1, with all modifications discussed and identified in the open items list.

RESPONSE:

Toshiba revised Table IV-4-1 to be consistent with the conducted Operability and Prudency tests. Attachment A includes the revised Table IV-4-1 and Tables IV-4-2 through IV-4-10 that are newly prepared to supplement the revised Table IV-4-1.

NRC QUESTION 16:

16. (Open Item 98-2) Item 5.3.I in Table IV-4-1 of the LTR identifies that the failover operability test item was performed with prudency testing. However, Notes 10, 11, and 12 in E2-2016-000749 appear to show that it was conducted during operability testing. Please clarify when the EPRI TR-107330 Failover Operability Test Item (Item I in Section 5.3 of EPRI TR-107330) was performed.

RESPONSE:

Table IV-4-3 and Table IV-4-8 in Attachment A show when the failover operability test item was performed for the PRM and the OPRM operability tests. To be consistent with Table #98-1, Table IV-4-1 was revised to agree with the correct data in Attachment A,

NRC QUESTION 17:

17. (Open Item 99) Please clarify the following for the temperature and humidity qualification envelope:
- a. Explain how you included margin in your atmospheric (i.e., temperature/humidity) qualification.
 - b. State your atmospheric qualification envelope.
 - c. Clarify how Table IV-4-1 in Part IV of the LTR can be labeled "Comply" for Line Item 6.3.3 given testing to low humidity was down to 10 percent relative humidity (See Section 6.2.2.2 of the Qualification Test Summary Report).

RESPONSE:

- a. The requirement for PRM in Table 5-1 of ERS (FPG-RQS-C51-0001) Rev.7 is 40 to 122 °F temperature and 10 to 95% relative humidity.

The actual testing profile was 35 to 140 °F temperature and below 10% to 95% relative humidity. So the temperature has 5 °F margin for lower side and 18 °F for higher side. The reason we tested up to 140 °F beyond 5 °F margin is that we would like to see the extended capability of the test specimen to the higher temperature.

Regarding humidity, we could not test the test specimen with 5% margin for both lower and higher side for the following reasons.

If we added 5% margin to the higher side humidity requirement of 95%, then the specimen would have to be tested at 100% RH. 100% relative humidity with no condensation cannot be reliably achieved.

On the lower side, our goal was to have a minimum humidity of 10% with 5% margin for a test minimum humidity of 5%. However, the 5% margin was not achievable for the minimum humidity at low temperatures (35 °F). Toshiba judges that this is acceptable. EPRI TR-107330 states that if the specified relative humidity cannot be achieved at the specified temperature, then the test can be performed for the specified time at the lowest relative humidity that can be achieved at the specified temperature followed by performing the test at the lowest temperature where the specified relative humidity can be achieved.

- b. The PRM and the OPRM systems were qualified as follows, based on EPRI TR-107330 Figure 4-4 and Section 4.3.6:

PRM:

- (i) High Temperature and Humidity: 140 °F and 95% relative humidity, which meets EPRI TR-107330 Section 4.3.6 and Figure 4-4 requirements (Toshiba notes that adding 5% margin to the relative humidity would most likely induce condensation, which is not included in Toshiba's qualification envelope).
- (ii) Low Temperature and Humidity: 35 °F and 10% relative humidity, which meets EPRI TR-107330 Section 4.3.6 requirements (Figure 4-4 requirements for humidity could not be met in this chamber, even with relaxation for non-simultaneous temperature and humidity, and Toshiba notes that the OPRM is constructed of similar components and had no issues at 40 °F and 5% relative humidity which could be achieved in the environmental test chamber used for testing the OPRM).

OPRM:

- (i) High Temperature and Humidity: 140 °F and 90% relative humidity, which meets EPRI TR-107330 Figure 4-4 requirements (Section 4.3.6 requirements for humidity were met in separate testing at Toshiba, see Note below).
- (ii) Low Temperature and Humidity: 40 °F and 5% relative humidity, which meets EPRI TR-107330 Section 4.3.6 and Figure 4-4 requirements.

Note: OPRM testing with 140 °F and 95% relative humidity profile was successfully met in the factory test which was performed under Toshiba's ISO 9001 program separately from the EQ test.

- c. Toshiba revised Table IV-4-1 (Attachment A) to add the description provided in a and b above to Table IV-4-1.

NRC QUESTION 18:

18. (Open Item 100) Please clarify the acceptance criteria stated in Section 7.2.3A of the ERS for the Burst of Events Test. The acceptance criteria in this section states that the response time for safety-related functions complies with the requirements shown in Section 4.1.2 during the Burst of Events Test. Section 4.1.2 states the safety-related functions only. Section 5.4A of EPRI TR-107330 states for acceptance criteria that all change of states of the discrete inputs shall be detected, all change of states of the discrete outputs shall occur, the analog input/output (I/O) meets the accuracy specifications after adjustment for loop time effects, and the response time requirement is met. Please clarify if the EPRI TR-107330, Section 5.4A criteria are being met and where this is stated.

RESPONSE:

The Burst of Events test is designed to ensure that a programmable logic controller (PLC) can cope with a burst of discrete input (DI) changes occurring simultaneously without causing increased scan processing time. This effect does not happen in FPGAs with parallel logic. For the PRM and OPRM, there are no general purpose DIs. However, Toshiba did demonstrate that the special purpose DIs operate correctly within the requirements.

Each logic element can work in parallel with synchronization of the clock signals, which are far shorter than the response time. The timeout of the signal processing is monitored by the watchdog timer. For DI toggling, all DIs in use (Reactor Operational Mode, APRM Bypass, and FLOW Bypass) are toggled. The acceptance criterion is that APRM High-High Trip occurs within 40 milliseconds after the Reactor Operational Mode DI is changed to OFF. In this DI toggling, the APRM High-High Trip is the only safety-related output which changes its status with DI toggling. Accordingly, Toshiba considers that this test satisfies the requirements in Section 5.4.A of EPRI TR-107330.

For Analog Input (AI) toggling, all AIs (LPRM inputs and Flow inputs) are toggled. The acceptance criterion is that APRM High-High Trip occurs within 28 milliseconds after the APRM AO outputs exceed 120.0% level. In this AI toggling, the APRM High-High Trip is the only safety-related output that changes its status with AI toggling. The accuracy was verified in the operability test. Toshiba considers that this test satisfies the requirements of Section 5.4.A of EPRI TR-107330.

NRC QUESTION 19:

19. (Open Items 98, 99, and 100) In the open items list, Toshiba identified many modifications to the LTR, Table IV-4-1. Please submit an updated Table IV-4-1.

RESPONSE:

Attachment A is the revised (updated) Table IV-4-1 with other associated tables from Tables IV-4-2 through IV-4-10.

NRC QUESTION 20:

20. (Open Item 100-2) Regarding operability and prudence, in Table IV-4-1 of the LTR, Toshiba shows compliance with EPRI TR-107330 requirements. However, in many cases (e.g., Item D in Section 7.2.2 of the ERS) NRC staff found that the acceptance criteria used for these tests are different than those in EPRI TR-107330. Toshiba specifies acceptance criteria in the ERS. Please explain why the acceptance criteria were modified and how Toshiba demonstrates compliance with EPRI TR-107330.

RESPONSE:

Toshiba revised Table IV-4-1 and added Tables IV-4-2 through IV-4-10 in Attachment A to address the differences regarding the acceptance criteria of operability and prudence testing.

NRC QUESTION 21:

21. (Open Item 101) It is NRC staff's understanding that the PRM system did not experience anomalies during the radiation and seismic testing, and only one anomaly occurred during atmospheric testing. Please state if any other anomalies occurred during the performance of radiation, atmospheric or seismic testing, either during the performance of operability and prudence testing or at any other time. If any anomalies occurred, then please clarify how they were evaluated to determine they had no effect on qualification.

RESPONSE:

The NRC understanding is correct. No anomalies occurred during radiation and seismic testing. One anomaly occurred during temperature and humidity testing.

NRC QUESTION 22:

22. (Open Item 103) Please explain if the Test Specimen Units were mounted consistent with the intended service mounting or if there are any differences.

RESPONSE:

Consistent with the most likely service mounting in US plants, Toshiba mounted the Test Unit Specimen Units in the test fixture with M5 screws in the front and M4 screws in the rear of the unit with the specified torque. There is no difference between the mounting on the test fixture and the intended service mounting.

NRC QUESTION 23:

23. (Open Item 104) For resonance searches during the seismic testing, please describe the criteria for identifying a resonance.

RESPONSE:

The test report Toshiba received from the test laboratory refers to IEEE Std. 344-1987. Toshiba understands that resonance searches and seismic tests based on the RRS supplied by Toshiba have been performed based on IEEE Std. 344-1987 by the US test facility. Toshiba also understands that the seismic tests based on IEEE Std. 344-1987 also satisfy IEEE Std. 344-2004 because the requirements for seismic tests in these versions are essentially the same. The US test laboratory has extensive experience in satisfying the requirements of both IEEE standards.

To identify a resonance, Toshiba used the phase relationships between the sinusoidal input signal and the Equipment Under Test (EUT) response, such as Figures A.1.1 through A.1.14 of the Qualification Test Summary Report (FPG-TRT-C51-0101). These figures will be improved to have the enhanced logarithmic scale gridlines in the new revision of the Qualification Test Summary Report to be docketed by the end of September 2017.

Section 6.3.4.3 of EPRI TR 107330 requires resonance search as described in Section 7.1.4.1 of IEEE Std. 344-1987 and Section 8.1.4.1 of IEEE Std. 344-2004 which recommends: "It is recommended that the resonance search be carried beyond 33 Hz, for example, to 50 Hz, or to the RRS cutoff frequency, whichever is higher, to obtain data on equipment dynamic characteristics that may be valuable to justify qualification for other dynamic loads." Based on this recommendation, the sweep was performed from 1Hz to 50Hz while the gathered resonance search data was up to 100Hz based on the test facility standard practice and equipment capabilities. Resonances above the 50 Hz cutoff frequency are not considered consequential. The acceptable seismic test results confirm this conclusion.

NRC QUESTION 24:

24. (Open Item 105) The Random Multi-Frequency Test results in Appendix A.2 of the Qualification Test Summary Report are hard to read because the gridlines are faint. In addition, the Test Response Spectrum (TRS) fell below the Control Spectrum or Required Response Spectrum (RRS) for at least one point in Figure A.2.6.1. Please provide the following information:
- a. Updated plots in Appendix A.2 of the new version of the Qualification Test Summary Report to show the gridlines or tabulate the breakpoints at one-sixth octave intervals over the frequency range from 1 to 100 Hz for at least Figure A.2.6.1 and one of the operating basis earthquakes (OBEs).
 - b. Information on whether Figure A.2.6.1 meets the requirements of Clause 8.6.3.1n of IEEE 344-2004. One point may fall below the RRS by 10 percent provided adjacent 1/6 octave points are at least equal to the RRS and adjacent 1/3 octave points are at least 10 percent above.
 - c. An explanation of how the control spectra shown in Appendix A.2 of the Qualification Test Summary Report are consistent with the RRS in Figure II-A-4-5 of the LTR. Additional breakpoints appear to have been added to the EPRI TR-107330 spectrum.

RESPONSE:

- a. Toshiba will revise and docket the Qualification Test Summary Report (FPG-TRT-C51-0101) by the end of September 2017. The revised Qualification Test Summary Report will include updated plots of Appendix A.2, which shows the gridlines or tabulates the breakpoints at one-sixth octave intervals over the frequency range from 1 to 100 Hz for at least Figure A.2.6.1 and one of the operating basis earthquakes (OBEs).
- b. Toshiba planned to conduct the seismic test with the RRS provided in Figure 4-5 of EPRI TR-107330 dated October 1997. The TRS listed in figures in Appendix A.2 of the Qualification Test Summary Report were achievable. Toshiba considers that exceedances below about 3.5 Hz are generally acceptable based on IEEE Std. 344 2004 Section 8.6.3.1(j) since there are clearly no resonances below 5 Hz. Toshiba evaluated the higher frequency area. Toshiba found that Figure 4-5 of a later version of EPRI TR-107330 is slightly different from Figure 4-5 in the original October 1997 version which is the basis for the current Toshiba RRS. Toshiba evaluated the difference. The later version (available from the EPRI website) provides Figure 4-5 with a narrow peak spectral band. Specifically, the 5% damped SSE response spectrum control points of Figure 4-5 of the later version of EPRI TR-107330 are (1 Hz, 0.42 g); (4.5 Hz, 14 g); (16 Hz, 14 g); (33 Hz, 6.13 g); and (100 Hz, 6.13 g). The original version of Figure 4-5 includes a broader frequency. Specifically, the 5 % damped SSE response spectrum break points of this version of Figure 4-5 are (0.5 Hz, 0.1 g); (1 Hz, 0.8 g); (3 Hz, 14 g); (33 Hz, 14 g); (40 Hz, 7 g); and (100Hz, 7 g). The discussion here refers to the version of EPRI TR-107330 Figure 4-5 of the later version of EPRI TR-107330 as the “narrow” spectrum, and the other version of EPRI TR-107330 Figure 4-5 as the “broad” spectrum.

Because of test table limitation of 9.8 g, Toshiba has had to take exception to the EPRI TR-107330 requirement of 14 g in the PRM testing. The PRM testing was conducted at a laboratory where the table could not satisfy the EPRI TR-107330 peak spectral limits. Specifically, the table could only satisfy a peak spectral demand of 9.8 g. PRM test results show that the “narrow” spectrum demand is satisfied with the following exceptions.

- The 14 g peak in the narrow spectrum was above the table capacity. The table capacity produced a peak that exceeded 9.8 g.
- Exceedances in the frequency lower than 3.5 Hz are acceptable based on Clause 8.6.3.1(j) of IEEE Std. 344-2004 since there are clearly no resonances below 5 Hz.
- An additional exception to the “broad” EPRI TR-107330 spectrum demand would have to be taken for the exceedance at the peak above 30 Hz.

Seismic testing for OPRM was conducted at a different facility several years after the PRM testing. The OPRM testing was conducted with the RRS in Figure II-A-4-5 that is based on the “broad” EPRI TR-107330 spectrum to ensure the test table could meet the seismic demand. The test results exceeded the requirements of the broad spectrum with the exception that exceedances in the frequency lower than 3.5 Hz are acceptable based on Clause 8.6.3.1(j) of IEEE Std. 344-2004 since there are clearly no resonances below 5 Hz.

Accordingly, Toshiba believes that the OPRM system satisfies EPRI TR-107330 requirements

for the "broad" spectrum with the noted exception.

- c. The control spectrum identified in the Appendix A.2 of the Qualification Test Summary Report is based on Figure 4-5 of EPRI TR-107330 dated October 1997. The seismic shake table at the test laboratory was considered. As mentioned above, EPRI Figure 4-5 is slightly different in the later version of EPRI TR-107330. Toshiba will replace Figure II-A-4-5 in the LTR with Figure 3 below adding the explanation that summarizes the discussions in Item b. above, and also replace the corresponding figures in the Qualification Test Summary Report and ERS with the additional explanations so that they will be consistent each other.

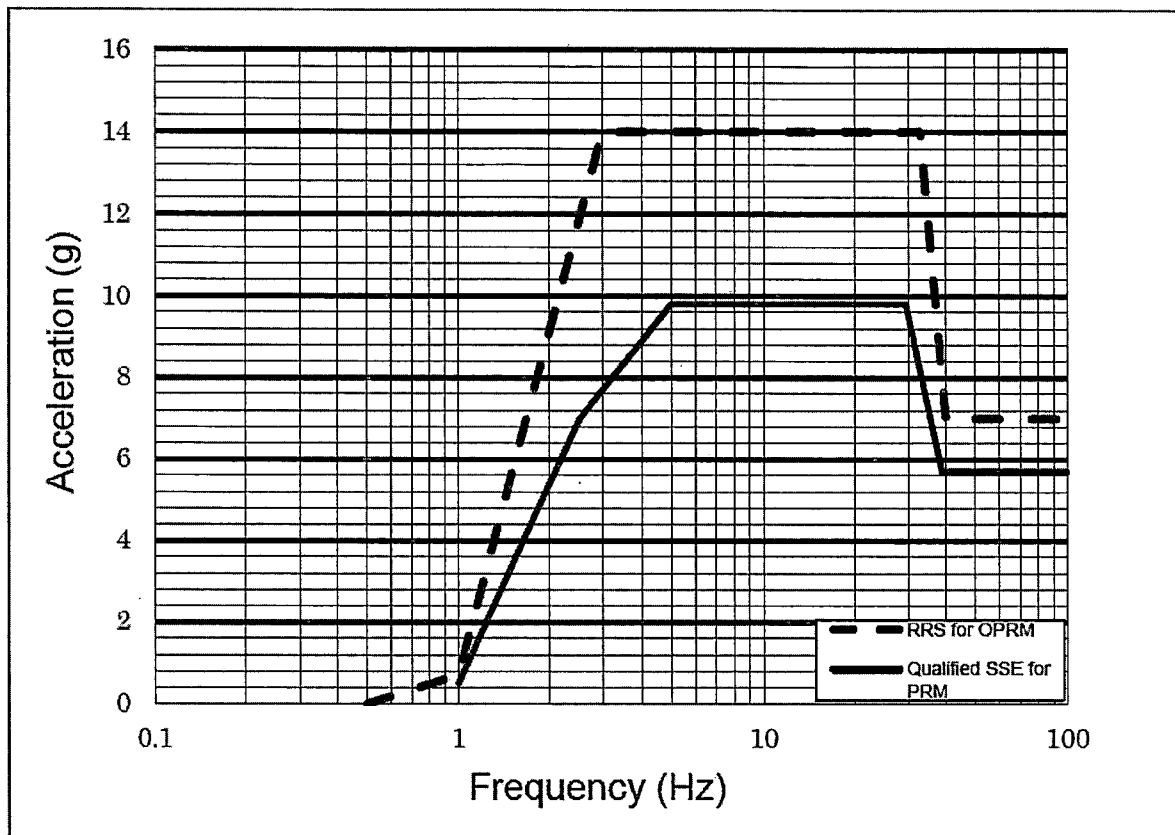


Figure 3 Required Response Spectrum

NRC QUESTION 25:

- 25. (Open Item 109) The Master Configuration List identifies the modules, units, and documents created for the PRM System. However, it is not clear for the entry on February 20, 2008, why there are two Flow Unit Configurations. Each block of Flow Unit Configuration shows different serial numbers. For example, the first block shows 00360017. The second block shows 00360018. Please clarify these two different Flow Unit Configurations and different serial numbers.

RESPONSE:

The test specimen qualified in the qualification test consists of one LPRM/APRM unit, one LPRM unit, and one FLOW unit. In addition to the FLOW unit (S/N 00360017) as a test specimen, another FLOW unit (S/N 00360018) is used as test equipment, because the LPRM/APRM unit needs to receive Flow signals from two FLOW units as described in Figure 1 and Figure 2 of this Response. The second FLOW unit (S/N 00360018) is not included in the test specimen as shown in the Figure 4-1 of the Preliminary Technical Evaluation Report (PTER) (FPG-DRT-C51-0001, Rev.10). Toshiba will revise the Master Configuration List (FPG-CFM-C51-0001) by the end of September, 2017 to show the second FLOW unit (S/N 00360018) as test equipment, not as part of the test specimen.

NRC QUESTION 26:

26. (Open Item 110) The NRC staff requests clarification regarding the following items associated with operability testing:

- a. For the Accuracy Test Item under Operability Testing in Section 7.2.2 of the ERS (FPG-RQS-C51-0001), it is not clear if the accuracy requirements in Sections 5.3A, 4.3.2.1, and 4.3.3.1 of EPRI TR-107330 are being addressed for operability testing performed as part of qualification testing. Section 5.1.4 of the ERS specifies input-to-output linearity and trip accuracies that range from ± 2 percent to ± 3 percent of full scale. As an example, Section 4.3.3.1.1 of EPRI TR-107330 specifies an overall accuracy with regard to voltage output requirements of equal to or less than ± 0.3 percent.
- b. Please state your response time requirements for operability testing following baseline testing.
- c. Section 5.3.K of EPRI TR-107330 refers to Item F in Section 4.6.1.1. This item requires analog input/output (I/O) to not change by more than 5 percent; however, Section 7.2.2.G of the ERS (FPG-RQS-C51-0001) does not include this requirement. Please clarify if this requirement was met.

RESPONSE:

- a. The value of the accuracy requirement described in EPRI TR-107330 is specific to analog inputs, processing, and outputs on a generic PLC, and not a neutron monitoring application. The application specific accuracy requirement for the PRM will be authorized in the plant application and compared to the PRM capabilities. Toshiba defines the accuracy requirement in Section 5.1.4 of the ERS (FPG-RQS-C51-0001) consistent with typical BWR requirements. Toshiba has confirmed that the accuracy satisfies the requirement in the operability test. Toshiba understands the accuracies provided in the EPRI TR are for analog inputs from a pressure transmitter or other devices being provided as 4-20 mA outputs. The Toshiba PRM equipment being qualified makes in-core neutron measurements, for which $\pm 2\%$ to $\pm 3\%$ FS (Full Scale) accuracy is acceptable.

- b. The response time required of the PRM is that the response time shall be less than or equal to the response time requirement in Section 5.1.3.1 of the ERS. By confirming that the PRM satisfies the acceptance criteria in the operability test, Toshiba confirmed that the defined, required response time had not changed from the test results of the Pre-Qualification Test, which Toshiba treats as baseline testing. Toshiba understands that the response time requirements in the EPRI TR are requirements for a generic PLC qualification, and are thus not applicable to the PRM or OPRM. Rather, specific response time requirements are provided for these dedicated purpose devices.
- c. The PRM does not have safety-related analog outputs. The PRM unit power supply rides through a short duration power interruption described in Section 7.2.2 G of the ERS (FPG-RQS-C51-0001). Since the internal DC power never drops, the system is unaffected by short duration power outages. By confirming the safety-related discrete output does not change through the power outage, Toshiba confirmed that safety-related system function did not change during the power interruption.

NRC QUESTION 27:

27. (Open Item 110-4) The safety-related signals in Item 1 of Section 4.1.2 of the ERS are the digital optical data transmission signals. It is not clear where Toshiba included these safety-related signals in its operability and prudency testing. It appears that Toshiba included the non-safety related analog outputs that correspond to these digital signals in its operability testing. But, the relevance of this testing performed on non-safety related signals is not clear in terms of its application to the safety-related signals. Also, note that digital optical data transmission signals are included under the heading "Analog Output" in Sections 5.2.2.1, 5.2.2.2, and 5.2.2.3 of the ERS.

RESPONSE:

The signals in Section 4.1.2 of ERS are generated by safety-related functions that are provided by modules other than the analog output (AO) module. In the operability and prudency tests, it is difficult to hook up instruments to these modules to look at the signals in these modules directly, since Toshiba would require pulling the module out of the chassis and put it on an extension board, restoring the module to the chassis after testing is complete. This takes time, and requires Toshiba to handle modules with ESD protection.

Toshiba concluded that the AO module can be used to observe the signals. Each D/A converter on the AO module is connected by individual hardwired connection to the register that holds the signal generated by the safety function in the responsible module. The same digital data as are used by the safety functions are fed to the D/A converter through the isolator on the AO module. The D/A converter has the same resolution (bit length) as the digital signal. The converted analog signal is monitored by non-safety-related equipment. Although the D/A conversion and isolation functions are not defined as safety functions, the AO module was designed, manufactured, and tested as a Class 1E module.

So Toshiba concluded that the analog signal that is directly converted from the digital signal generated by the safety functions in other module has sufficient quality to rely upon the analog

signals to observe and evaluate the signals generated by the safety functions. So these signals were monitored, evaluated, and recorded through the AO module.

Also the signals generated by the safety functions can be observed visually in the digital LED displays in the front panel of each module.

In the factory product test, Toshiba tested every module by setting up an appropriate test bench that enables observation of the signals without the use of the AO module.

NRC QUESTION 28:

28. (Open Item 111) Please clarify the following with respect to the bases for excluding the following operability test items:

- a. Communication Operability: Section 7.2.2 of the Equipment Requirement Specification (FPG-RQS-C51-0001) does not include the Communication Operability test item. Therefore, it is not clear how Toshiba met the requirements in Section 5.3E of EPRI TR-107330 without formally including Communication Operability in its Operability Testing.
- b. Timer Tests: Please clarify the statement in Item 5.3.G in Table IV-4-1 of the LTR as Toshiba's basis for excluding the Timer Test item under Operability Testing.

RESPONSE:

- a. Section II-2.2.3.3 of the LTR states that the communication protocols used in the FPGA platforms are deterministic and the communication links that perform safety functions include data and time out error checking to ensure determinism. All detected errors are alarmed. The communication uses Manchester encoding, which requires defined waveforms to self-clock the data into the receiver. If the fiber optic cable waveforms are distorted, the communication will fail and an alarm will occur. Therefore, Toshiba determined that the acceptance criteria for the continuous verification of communication operability for the PRM and OPRM are that there is no alarm during equipment qualification or operability tests. By confirming the PRM and OPRM operated without alarm during equipment qualification and operability tests, Toshiba evaluated the communication operability required for PRM and OPRM. Toshiba considers that this evaluation meets the requirements in Section 5.3E of EPRI TR-107330.
- b. The PRM or OPRM application specific logic does not include any timer function. The EPRI TR provides generic requirements for qualifying a general purpose PLC. For the PRM and OPRM functions, the specific timing functions required are hardcoded into the logic, and then verified and validated during the software lifecycle, culminating in system validation testing.

NRC QUESTION 29:

29. (Open Item 112) EPRI TR-107330, Item 5.4B describes prudence testing to demonstrate that system performance is not degraded beyond acceptable limits if the serial communications link is subjected to potential cabling and cable interface faults. Please explain why you did not conduct comparable tests such as using optical attenuators

inserted in line with the serial link fiber optic cable to simulate degraded optical fiber system integrity or injecting steady-state optic signals into the serial fiber optic link to simulate cable and cable interface faults and measure system responses to the simulated faults. Our understanding is the equipment needed to implement such test methods is commercially available. The NRC staff noted that Toshiba states on Page 4 of E2-2016-000752, Revision 0 that the Toshiba protocol is proprietary and because the protocol is over fiber optic links, test equipment to provide controllable fiber optic signal degradation during operability testing is not available.

RESPONSE:

Toshiba conducted room temperature factory product tests using an attenuator in each of the fiber optic links. Toshiba confirmed that the fiber optic links remained operable with about []^{a.c} dbm light intensity and that no alarms were generated. Toshiba then confirmed that further decrease of the optical intensity does generate alarms by further attenuating the light intensity. This test confirmed that alarms are generated and that monitoring in the operability test is sufficient to detect and alarm when degraded fiber optic communication links occur. Toshiba does not interpret the requirements in TR-107330 as such that intentional degradation of the communication is required in the qualification testing. However, through the discussion with the NRC, Toshiba understood that the real intent of the questions is to confirm if Toshiba found any impacts on the response time by intentionally degrading the external fiber optic communication. Degrading the light intensity results in no change to the trip time, since messages are received correctly. Once light intensity degrades sufficiently, alarms occur. Until no messages are received (which is indicated by alarms), there is no degradation in the response time.

The PRM does not have any receiving port for external communication. The PRM has only transmit (TRN) modules to send data to external systems. The TRN module has only transmission ports and no receiving ports. There are no receiving modules for external data in the PRM. The PRM is not designed to accommodate any receive (RCV) modules for external communication. The installation of such RCV module is not allowed and is impossible by design. Because the PRM does not have any receiving ports, Toshiba did not conduct such test the NRC questioned, as there is no mechanism to introduce errors from light attenuation in data received by the PRM.

Regarding the RCV module and TRN module used for internal communication within the PRM, Toshiba conducted the factory test and operability/prudency test as stated earlier in this response.

NRC QUESTION 30:

30. (Open Item 112-4) EPRI TR-107330, Item 5.4C describes prudency testing to demonstrate that system performance is not degraded beyond acceptable limits if the serial communications link is subjected to noise. Please explain why Toshiba did not conduct comparable tests such as using programmable optical attenuators inserted in line with the serial link fiber optic cable to induce noise into the optical signal or injecting optic signals into the serial fiber optic link to couple white noise onto the optical signal. Our understanding is the equipment needed to implement such test methods is commercially available.

RESPONSE:

Please see the Toshiba response to the NRC Question 29 above.

NRC QUESTION 31:

31. (Open Item 115) For the electromagnetic interference/radio frequency interference (EMI/RFI) testing, Toshiba did not perform the MIL-STD-461E tests: (1) RE102, radiated emissions testing above 1 GHz and (2) RS103, radiated susceptibility testing above 1 GHz. Table III-2-3 of the LTR shows Toshiba's test levels for RE102 and RS103. In both cases the test levels are up to only 1 GHz. Please explain why Toshiba did not perform these tests.

RESPONSE:

RG. 1.180 C Regulatory Position Section 6 says "MIL-STD-461E contains test methods and criteria that can be applied to address radiated EMI/RFI emissions and susceptibility above 1 GHz for a selection of environments. IEC 61000-3 and IEC 61000-4 do not. The RE102 test is applicable above 1 GHz for up to 10 times the highest intentionally generated frequency within the equipment under test."

For the PRM, the intentionally generated frequencies are listed in Tables 3-2 and 3-3 of LTR Part V (Page 81-84/166), as the actual frequency of each FPGA. Ten times the highest frequency in that table is significantly less than 1 GHz. Hence the emissions testing needed to extend only to 1 GHz.

Toshiba did not test for radiated susceptibility (RS103) above 1 GHz, and thus accepts that either a utility employing this equipment must preclude the use of cell phones and radios near this equipment or accept an open issue from the USNRC in the SER requiring an evaluation by the utility.

NRC QUESTION 32:

32. (Open Item 116-1a) For EMI/RFI testing, please clarify the frequency range for compliance as shown in the tables and figures in Appendix B.3 of the "Qualification Test Summary Report." Specifically, Section 5.4.3.1 of the Qualification Test Summary Report (FPG-TRT-C51-0101) states the frequency range used was from 120 Hz to 10 kHz; however, Figure 5-7 of the "Equipment Requirement Specification" for the less than 1 kVA AC limit extends to 60 Hz. In addition, Table III-2-3 of the LTR shows the frequency range from 60 Hz to 10 kHz.

RESPONSE:

Toshiba will revise and docket the Qualification Test Summary Report (FPG-TRT-C51-0101) by the end of September to present the same test profile as Table III-2-3 of the LTR, which provides the correct data.

NRC QUESTION 33:

33. (Open Item 117-1) Regarding surge withstand capability testing, for the International Electrotechnical Commission (IEC) 61000-4-4, 4-5, and 4-12 tests, Toshiba specifies requirements in Sections 5.5.4 and 5.5.5 of the ERS for testing to low and medium exposure levels. However, Table III-2-3 of the LTR shows testing only to low exposure levels. Please clarify why testing appears to differ from the requirements stated in Sections 5.5.4 and 5.5.5 of the ERS.

RESPONSE:

Toshiba conducted low exposure test only, since the PRM system is installed in the room where the surge risk from lightning is low.

Toshiba will revise the ERS to incorporate this change in future revision.

NRC QUESTION 34:

34. (Open Item 117-4) When revising the "Qualification Test Summary Report" (FPG-TRT-C51-0101), please include an explanation of the impedance used for the electromagnetic compatibility susceptibility 100 kHz Ring Wave tests. Section 6.1.1 and 7.1 of IEC 61000-4-12 specify two values for impedance: 12 Ω and 30 Ω .

RESPONSE:

Toshiba and the Test Lab cannot find the record of the impedance value used. R.G. 1.180 Revision 1 does not specify the impedance, and references IEEE Std. C62.41-1991. IEEE Std. C62.41 specifies 12 Ω for the Category B Location. Toshiba conducted the IEC 61000-4-12 test at Low Exposure for a Category B Location; therefore, the impedance was likely 12 Ω . A HAEFLEY PIM 110 was used for the surge test and the factory default impedance is 12 Ω . With this understanding,

The test was intended to be performed at 12 Ω , but Toshiba and the Test Lab cannot confirm the actual setting used. Test results show that the specimen passed the short circuit test that was performed. This leaves two possibilities. First, the test was actually performed at the 12 Ω setting, and there is no issue. This is the default setting of the test equipment and the most likely scenario. However, there is still a possibility that the test was performed with 30 Ω . For this case, the test results are not confirmed against 12 Ω for Category B location test that brings more energy to the test specimen.

Toshiba considers that it should be assumed that 30 Ω was applied for the test to take conservative position for the appropriate evaluation in a situation where the impedance value cannot be confirmed. Toshiba considers that the assumption of 30 Ω is appropriate, because the PRM is designed to be connected to the end of the power supply system in nuclear power plants. Therefore, Toshiba assumes either impedance is workable, and that the higher impedance would not impact the surge withstand capabilities of the PRM.

Toshiba will revise the Qualification Test Summary Report to include the discussion above.

NRC QUESTION 35:

35. (Open Item 118-1) Toshiba states in Section III-2.2.3.5 of the LTR that when performing electrostatic discharge (ESD) testing, environmental conditions were kept to the “normal environmental basic conditions” shown in Section 4.3.6.1 of EPRI TR-107330. This section includes a humidity range from 40 percent to 95 percent. However, Section 8.1.2 of IEC 61000-4-2 specifies climatic conditions that include 30 percent to 60 percent humidity. In addition, Section 3.5.2 in Appendix B of EPRI TR-102323, Revision 1 specifies this relative humidity range. Please state the environmental conditions during the conduct of the ESD testing. Section 10 of IEC 61000-4-2 requires documentation of climatic conditions and drawing and/or pictures of the test setup and Equipment Under Test (EUT) arrangement.

RESPONSE:

The climatic condition during the ESD tests is 30-60% as stated in EPRI TR-102323 and IEC EN 61000-4-2. Toshiba will revise the LTR in a future revision to include this climate condition.

NRC QUESTION 36:

36. (Open Item 118-2) Based on the results obtained during ESD testing, it seems that access to the rear panels during operation should be restricted, but this is not required consistently in Toshiba documents. In particular, this requirement is not clear because Section II-A-4.5.6 of the LTR specifies minimizing access and the use of wrist bands. Section III-2.2.3.5 of the LTR has slightly different wording and describes preventing access or using wristbands.

Section 8.3.2 of IEC 61000-4-2 states that electrostatic discharges shall be applied (direct application) only to those points and surfaces of the EUT which are accessible to persons during normal use, and it excludes points and surfaces which are only accessible under maintenance. Section 3.5.2 of EPRI TR-102323 has similar wording. Note also, Section 3.3.5.2 of the Qualification Test Summary Report states the performance requirements and it specifies ESD application to test points which can be touched during normal operation.

Please clarify whether or not the points that were tested and failed would be accessible through the back panels during normal operation.

RESPONSE:

There is no reason for an operator to access the rear panels. Technicians accessing the rear panels will do so under work order, with the equipment bypassed. The work order will specify that grounded wrist straps are required. No US utility would allow access to the rear panels with the channel/division not bypassed, and thus not in “normal operation.”

The back panels in the units are accessible only when locked cabinet doors are opened. Thus, the back panels are not normally exposed to ESD. In normal use at a US plant, the cabinet doors are unlocked and opened only when work is to be done on the panels, such as maintenance or calibration, which is done with unit bypassed. Toshiba will revise the application guide, which is

included in LTR Part II as Appendix II-A, to state that the equipment behind the plane of the door on the back panels should not be touched unless the technician or engineer is wearing a grounded ESD wriststrap.

NRC QUESTION 37:

37. (Open Item 119-1) Regarding the Class 1E to Non-1E isolation test, please clarify the meaning of the following statement in Section 5.8 of the Qualification Test Summary Report: "...the High Voltage, which was used for the demonstration of Isolation Capability, was applied to the Non-1E side of analog output (AO) module, and it was confirmed that the safety-related functions which were performed in Class 1E side were not prevented by this Non-1E side distortions."

RESPONSE:

The safety-related functions defined in Section 4.1.2 of the ERS are not assigned to the AO module. However, since the AO module is connected electrically to the other modules by copper connections on the middle plane (backplane), the AO module is designed and manufactured in compliance with the requirements of a non-Class 1E to Class 1E isolator. This test was conducted by applying high voltage to the non-Class 1E side of the AO module and confirming that the high voltage did not affect the other modules on the middle plane or the performance of the PRM's safety-related functions. This test demonstrated that the AO module provided the required non-Class 1E to Class 1E isolation, since the safety-related functions continued without perturbation.

OPRM Equipment Qualification

NRC QUESTION 38:

38. (Open Item 123) The NRC staff noticed that the PRM system and OPRM unit were separately tested in different years and their equipment-qualification (EQ) testing documents were then prepared, respectively. However, the OPRM is just one unit of the PRNM system in the Neutron Monitoring System panel. In addition, the LTR submitted by Toshiba includes both the PRM system and OPRM unit. Please clarify or provide additional design information on how System Integration Requirements in Section 4.4.10 and Section 5.2.C of EPRI TR-107330 are met and whether the EQ testing was conducted for the integrated system.

RESPONSE:

It is possible to install one or the other separately. For the PRM, the FLOW, LPRM, and LPRM/APRM are qualified together. The OPRM can be supplied with the PRM, but is not specifically a subsystem of the Toshiba PRM. Toshiba considers that it is not mandatory or required to perform EQ on the integrated PRM and OPRM.

In the EQ of OPRM, the PRM simulator is used for the OPRM test. The PRM simulator provides the LPRM data via fiber optic transmission in the exactly same manner as the actual PRM. The PRM testing demonstrated that the TRN module survives the environmental stressors. There is sufficient overlap between the PRM and OPRM tests to demonstrate that both function.

NRC QUESTION 39:

39. (Open Item 124) The NRC staff noticed that the operability and prudence tests were not performed during the seismic test for the OPRM. The lack of operability and prudence tests during the seismic test is not consistent with requirements in Table 5-1 of EPRI TR-107330. This deviation could not be found in the Qualification Test Summary Report for the PRM system. Please clarify if this deviation is used for both OPRM and PRM systems. If this deviation is used for both the OPRM and PRM, please provide justification that supports this deviation.

RESPONSE:

EPRI TR-107330, Section 5.5 and Table 5-1 require performance of Operability and Prudence testing during the SSE seismic testing. The complete Operability Test requires approximately []^{ac} hours to perform, and requires personnel interaction with the equipment under test. The Prudence Test requires approximately []^{ac} hour to perform, and also requires personnel interaction with the equipment under test. A simulated safe shutdown earthquake (SSE) test is performed on a shake table and completes within []^{ac} seconds. Thus, sufficient time is not available to perform Operability or Prudence on the shake table during the short duration seismic events.

NRC QUESTION 40:

40. (Open Item 125) NRC staff noticed that in Table 7-2 in FC51-7012-1000, Rev. 2 for the OPRM EQ Test Plan, the abnormal environmental temperature condition tested is from 4 to 50 degrees C, which is consistent with EPRI TR-107330. However, Section 9.1.7 of FC51-7012-1000 states that the OPRM unit is designed to operate in the temperature range of 0 to 50 degrees C. Please clarify the inconsistency for the lower end temperature.

RESPONSE:

Toshiba confirmed that 4 to 50 °C is documented in Table 5-22 of the OPRM Equipment Design Specification (EDS) (FC51-3002-1000) and in Table 7-2 of the OPRM EQ Test Plan (FC51-7012-1000). Testing within 4 to 60 °C is shown in Figure 9-5 of the OPRM EQ Test Plan (FC51-7012-1000) Rev. 2. This is based on the consideration of adding test margin and the accuracy of the instruments. The description “0 to 50 degrees C” in Section 9.1.7 of the OPRM EQ Test Plan is a typo and will be corrected to “4 to 50 °C” in future revision.

Additional Questions

NRC QUESTION 41:

41. (Open Item 126) The description in Section II-A.3.2 of the LTR is not consistent with the response submitted to request for additional (RAI) Question 19. Specifically, the LTR states that the Power Factor Correction (PFC) module was part of the qualification equipment, but the RAI response states that the PFC module was not part of the qualification. Please clarify if the PFC module was part of the test specimen and if the description in the RAI 19 response is correct.

RESPONSE:

Toshiba confirmed that the OPRM unit and the PFC module are tested in an integrated manner in the qualification testing as the test specimen. The PFC module is an analog device and has no digital processing. Toshiba agrees that the PFC is not within the scope of the SER and the NRC review, However Toshiba understands qualification test results need to be reviewed with the condition that the OPRM unit was tested together with the PFC. Toshiba revises the response to RAI Question 19 in the Toshiba RAI response dated March 31, 2016 as follows:

The PFC module is a part of the test specimen, and is out of the scope of review for the OPRM unit.

Attachment A Revised Table IV-4-1 Conformance with EPRI TR-107330

Table IV-4-1 documents conformance of PRM and OPRM to EPRI TR-107330 (Reference (a46)). Table IV-4-1 shows the mapping of EPRI TR-107330 requirements to the PRM and OPRM. Table IV-4-2 through Table IV-4-10 are attached to provide supplemental information to Table IV-4-1.

Notes:

- “Comply” means the Toshiba NRW-FPGA-based Safety-Related I&C Systems comply with corresponding EPRI TR-107330 requirement.
- “N/A” means the EPRI TR-107330 requirement is not applicable to Toshiba NRW-FPGA-based Safety-Related I&C Systems.
- “Application Specific Requirements” means Toshiba NRW-FPGA-based Safety-Related I&C systems has its own application specific requirements which originates from system specific requirements for PRM and OPRM.
- “Comply with limited scope and/or condition” means that the systems could not be tested against full scope of the profile requirement of the specific test due to the limitation of the test facility or the system needed additional conditions to pass the specific test.
- “Exception” means Toshiba takes an exception to the corresponding EPRI TR-107330 requirement for the NRW-FPGA-based Safety-Related I&C system.

Table IV-4-1 Conformance with EPRI TR-107330

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
1	Scope. Description of TR scope.	No requirement
2	Definitions, Abbreviations, Acronyms. List of definitions, abbreviations, and acronyms used in the TR.	No requirement
3	Reference Documents. List of documents referenced in the TR.	No requirement
4	System Requirements. (section heading)	No requirement
4.1	Overview of Performance Basis. Descriptive information.	No requirement
4.2	Functional Requirements. (section heading)	No requirement
4.2.1	General Functional Requirements. Descriptive information.	No requirement

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
4.2.1.A	Response Time. The overall response time from an analog or discrete input exceeding its trip condition to the resulting discrete outputs being set shall be 100 milliseconds or less. Response time shall include time required for input filtering, input module signal conversion, main processor input data acquisition, two scan times of an application program containing 2000 simple logic elements, main processor output data transmission, digital output module signal conversion, and performance of self-diagnostics and redundancy implementation.	<p>Application Specific Requirements.</p> <p>The generic PLC requirement was converted to the following application specific requirements which are documented in Section II-2.2.2.2. Section 5.1.3.1 of ERS and Section 5.1.4 item 6 of EDS further describe the response time requirements for PRM and OPRM respectively. The PRM and the OPRM comply with these requirements.</p> <p>PRM</p> <p>(1) APRM Upscale (High-High)</p> <p>The PRM response time, which is measured as the total delay time from a step change of the LPRM input current to the change of the APRM trip auxiliary unit output, shall be equal to or less than 40 milliseconds.</p> <p>(2) Simulated Thermal Power Upscale</p> <p>Method 2 step 1 within 40 ms Method 2 step 2 within 6.0 ± 0.5 s</p> <p>OPRM</p> <p>A) The OPRM trip response time of the PRNM system from the core oscillation initiation detected by LPRM detector through LPRM subsystem to the OPRM trip function initiation from Relay unit shall not exceed []^{ac}ms.</p> <p>B) The OPRM trip response time of the OPRM unit from when the core oscillation initiation is detected by LPRM detector is input to the OPRM unit and thus to the OPRM trip function initiation by the OPRM unit shall not exceed []^{ac}ms.</p>
4.2.1.B	Discrete I/O. The PLC shall have the capability to provide a total of at least 400 discrete I/O points.	Application Specific Requirements. The I/O configuration of the Toshiba NRW-FPGA-based PRM and OPRM hardware is application specific. Therefore, the system configurations are known and fixed for each system.
4.2.1.C	Analog I/O. The PLC shall have the capability to provide a total of 100 analog I/O points.	Application Specific Requirements. The I/O configuration of the Toshiba NRW-FPGA-based PRM and OPRM hardware is application specific. Therefore, the system configurations are known and fixed for each system. For the PRM, 172 analog inputs are provided for the Local Power Range Monitors, with additional inputs for reactor flow. For the OPRM, the digitized data from the LPRM and flow inputs are used.
4.2.1.D	Combined I/O. The PLC shall have the capability to provide a total of 50 analog and 400 discrete I/O points.	Application Specific Requirements. The I/O configuration of the Toshiba NRW-FPGA-based PRM and OPRM hardware is application specific. Therefore the system configurations are known and fixed for each system.
4.2.2	Control Function Requirements. The PLC shall provide a high-level language designed for control algorithms.	Application Specific Requirements. The Toshiba NRW-FPGA-based PRM and OPRM hardware systems are application specific. The control function configuration (i.e., logic) is known and fixed for each system. The VHDL code employed is appropriate for the system functionality.

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
4.2.3	Availability/Reliability and FMEA. (section heading)	No requirement
4.2.3.1	Availability/Reliability Overview. Descriptive information.	No requirement
4.2.3.2	Availability/Reliability and Basic Requirements. The overall availability goal of the PLC is 0.99.	Comply. The hardware-based availability of the full PRM system for a BWR-5 is more than 0.99 (see Section III-3.2.1). The hardware-based availability of the OPRM equipment is more than 0.99 (see Section III-6.2.1).
4.2.3.3	Availability/Reliability Calculation Requirements. An availability calculation shall be prepared which conforms to IEEE Std 352.	Comply with limited scope and/or condition based on application specific usage of the system . An availability calculation is prepared in a manner that conforms to IEEE Std 352-1987. Twenty-four hour MTTR is used. The surveillance interval and the environmental stress are considered. Specific IO changes are not considered.
4.2.3.3.1	Availability/Reliability Calculation Requirements Applicable to Redundant PLCs. For PLCs that include redundancy, the availability calculation shall address additional, redundancy-specific considerations.	N/A. The Toshiba PRM or OPRM system does not include redundant components for signal processing. Redundancy is applied at the channel or division level. Toshiba interprets that the redundant LVPSs and fiber optic communication are not for redundant PLC.
4.2.3.4	PLC Fault Tolerance Requirements. Fault tolerance capability shall be addressed in the availability calculation, and included as part of the qualification envelope definition.	Comply. An Availability/Reliability Analysis for the PRM system is documented in Section III-3.2.1, and Availability/Reliability Analysis for the OPRM system is documented in Section III-6.2.1.
4.2.3.5	Failure State/FMEA Requirements. An FMEA analysis shall be performed in accordance with IEEE Std 352. The analysis shall evaluate the effects of failures of components in the PLC modules on the PLC performance.	Comply. A Failure Modes and Effects Analysis (FMEA) for the PRM is documented in Section III-3.2.2, and an FMEA for the OPRM is documented in Section III-6.2.2.

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
4.2.3.6	<p>Failure Detection Requirements. The PLC shall contain features to permit generating an alarm when the on-line fault detection detects a failure. Processor-to-processor communication for fault detection shall meet the given specific performance requirements.</p>	<p>Comply. The following diagnostic functions are provided:</p> <p>(a) Monitoring of the Low Voltage Power Supply module</p> <p>The Low Voltage Power Supply (LVPS) module shall monitor its output voltage. If the voltage of the LVPS becomes lower than the setpoint in either of the LVPS module, the STATUS module front panel shall provide the indication and generate discrete output for annunciation in the MCR.</p> <p>(b) Monitoring Low Voltage Supply for each module</p> <p>The LPRM, APRM, SQ-ROOT, FLOW, TRN, RCV, STATUS, CELL, DAT/ST, AGRD, and PBD modules shall monitor the input voltage from the LVPS modules. If the input voltage becomes lower than the setpoint, the module shall be reset, which generates a discrete output for annunciation in the MCR.</p> <p>(c) Monitoring of the FPGAs with a watchdog</p> <p>A watchdog timer shall monitor each FPGA that operates periodically as documented in Section II-2.2.3.3.</p> <p>(d) Checking data transmission between units through fiber optic cables</p> <p>The module receiving data from the other unit shall verify the periodic occurrence of the data transmissions, and the validity of transmitted data between units over fiber optic cables. The validity of data shall be verified by Cyclic Redundancy Check (CRC) in the transmitted data.</p> <p>Note: Parity check was used as the method for error checking in the PRM system, for which Toshiba performed the qualification test. Toshiba updated the FPGA logic to use CRC and qualified the modified transmit and receive modules in the OPRM qualification. PRM and OPRM products will have the TRN and RCV modules that support CRC.</p>

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
4.2.3.6 (continued)	(continued)	<p>(e) Checking data transmission from the modules in a same unit</p> <p>The APRM module and CELL module shall check the periodic transmission of the data frame from the TRN modules and the RCV modules. If a timeout error occurs, a Minor Failure signal shall be generated. The Minor Failure generates a discrete output for annunciation in the MCR.</p> <p>(f) Checking constants stored in Rewritable ROM</p> <p>Every Rewritable ROM storing constants used for the signal processing shall protect its stored values with parity bits or dual storage of each value. If an error is detected, a Minor Failure alarm shall be generated. The Minor Failure generates a discrete output for annunciation in the MCR.</p> <p>(g) Checking the voltage of the LPRM High Voltage Power Supply on each LPRM module.</p> <p>Each LPRM module shall monitor the voltage of the High Voltage Power Supply on that module. If the voltage becomes lower than the setpoint, the LPRM shall be inoperable. A single inoperable LPRM module does not affect the Safety-Related function, but a Minor Alarm will be generated to initiate replacement of the faulted module.</p> <p>(h) Checking the input value of the SQ-ROOT module</p> <p>The SQ-ROOT module shall perform range check for the input current value after digital conversion. If the input current value becomes lower than setpoint, the SQ-ROOT module shall output failure signal. The Minor Failure generates a discrete output for annunciation in the MCR.</p> <p>(i) Checking []^{a,c} on PBD module and AGRD module</p> <p>The PBD module and AGRD module shall perform check for the []^{a,c} If []^{a,c} is detected the PBD module and AGRD module shall output failure signal. The failure signal generates a discrete output for inoperable trip.</p> <p>(j) Checking []^{a,c} on CELL module, PBD module and AGRD module</p> <p>The CELL module, PBD module and AGRD module shall perform check for the []^{a,c} If []^{a,c} is detected the PBD module and AGRD module shall output failure signal. The failure signal generates a discrete output for inoperable trip.</p>
4.2.3.7.A	Recovery Capability Requirements. The PLC shall include a watchdog timer.	(See Item 4.2.3.6 in this table)

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
4.2.3.7.B	Recovery Capability Requirements. The PLC processor shall contain power bus monitoring features to assure that the processor successfully completes any memory writes and goes into a reset state when the supply voltage is outside of the range.	<p>N/A. The CELL, PBD, module AGRD modules of the OPRM use SRAMs for safety functions. The values of the SRAMs will be cleared to zero if the power supply fails. Because these modules apply a time average filter on the data, any data stored in the SRAM before the reset and re-initialization is useless and is discarded appropriately on power restoration.</p> <p>The PRM does not perform any memory writes during normal operation. Should the plant power supply fail or go out of range, the affected PRM Unit will reinitialize upon restoration of power.</p>
4.2.3.7.C	Recovery Capability Requirements. Output modules shall initialize to a known state.	<p>Comply. Whenever power is applied to the PRM or OPRM equipment, the equipment is initialized by the power-on reset function.</p> <p>All trip and alarm outputs remain tripped until the initialization process has completed (about 470 ms). After initialization, the trip and alarm outputs assume the states indicated by calculations and bypass settings.</p> <p>The power on reset function also is executed when the power supply low voltage is detected.</p> <p>The modules that have FPGAs are provided with a power supply monitoring IC, which provides about 150 ms or 470 ms reset action and initial startup of FPGA at the time when the module is energized. In addition, it executes a reset action when the power supply voltage lowers, i.e., if the power supply voltage continues to be low, the module remains in initialization state, and keeps all trip and alarm outputs in the tripped state.</p> <p>Note: The TRN module has about 470 ms reset time while other modules have about 150 ms reset time.</p> <p>The PRM and OPRM System perform run time diagnostics.</p>
4.2.3.8	Requirements for Use of Operating Experience. If operating experience is used as a basis for establishing module failure rates, the PLC manufacturer must have a problem reporting and tracking program.	N/A. Operating experience is not used as a basis for establishing module failure rates of the PRM or OPRM system.
4.2.4	Setpoint Analysis Support Requirements. An analysis shall be prepared to provide the information needed to support an application specific setpoint analysis per ISA RP 67.04.	<p>Comply. The PRM and OPRM trip setpoints can be adjustable by a technician during equipment maintenance or an operator during periodical surveillance service. The PRM and OPRM System support setpoint adjustments of equipment on the front panel of each module.</p> <p>Toshiba supplies sufficient data to support a utility's setpoint program.</p> <p>Section III-3.2.3 provides setpoint support analysis for the PRM and Section III-6.2.3 provides setpoint support analysis for the OPRM.</p>
4.3	Hardware Requirements. (section heading)	No requirement
4.3.1	General. (section heading)	No requirement

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
4.3.1.1	Background. Descriptive information.	No requirement
4.3.1.2	Requirements Common to All Modules. All modules shall meet or support the general requirements given in Section 4.2.1, and shall meet the range of environmental conditions given in Section 4.3.6. Special requirements apply to single module assemblies that include both inputs and outputs.	(Compliance documented in Items 4.2.1 and 4.3.6 in this table.)
4.3.1.3	External Device Requirements. External devices used to meet I/O module requirements shall meet the given specific requirements.	N/A. The PRM and OPRM do not require external devices, other than sensors and transmitters which are not part of this LTR.
4.3.1.4	General Redundancy Requirements. Redundant components may be included in the generic PLC platform.	N/A. The PRM or OPRM System does not include redundant components for signal processing. Toshiba interprets that the redundant LVPSS and fiber optic communication are not for redundant PLC.
4.3.2	Input Requirements. (section heading)	No requirement
4.3.2.1	Analog Input Requirements. The PLC shall include modules that provide analog inputs.	Comply. The PRM analog inputs are designed to interface with industry standard LPRM detectors and Flow transmitters. The required analog input design specifications are, therefore, known and satisfied. The OPRM has no analog inputs.
4.3.2.1.A	Monotonicity. The analog inputs shall be monotonic to $\pm 1/2$ LSB.	Comply. The PRM analog inputs have defined monotonicity, based on the design choice of analog-to-digital converter made for each specific module. Both modules are monotonic to $\pm 1/2$ LSB. The OPRM has no analog inputs.
4.3.2.1.B	Number of Channels. Each analog input module shall provide a minimum of four input channels.	Application Specific Requirements. The LPRM and SQ-ROOT modules include analog inputs. The LPRM module has one analog input channel and the SQ-ROOT module has one analog input channel. Those are based on the application specific requirements of the PRM
4.3.2.1.C	Over Range. The converted value of each analog input module shall remain at its maximum value for over range inputs up to twice rated.	Application Specific Requirements. The LPRM and SQ-ROOT modules take specific, appropriate actions when presented with an over range condition.
4.3.2.1.D	Under Range. The converted value of each analog input module shall remain at its minimum value for low range inputs up to the negative of the rated input value.	Application Specific Requirements. The LPRM and SQ-ROOT modules take specific, appropriate actions when presented with an under range condition.

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
4.3.2.1.E	Out of Range Indication. Over and under range conditions shall be indicated in a manner available to the application program.	Application Specific Requirements. The LPRM and SQ-ROOT modules take appropriate action when presented with these conditions.
4.3.2.1.1	Voltage Input Requirements.	N/A. There are no analog voltage inputs in the PRM or OPRM system.
4.3.2.1.2	Current Input Requirements. (section heading)	No requirement
4.3.2.1.2.A	Analog Current Input Module Ranges. The PLC shall include analog current input modules with ranges of: 4 to 20 mA and 10 to 50 mA or 0 to 50 mA.	Application Specific Requirement. The PRM FLOW analog input range of 4 to 20 mA is designed to interface with industry standard Flow transmitters. The LPRM input range of 0 to 3 mA is designed to interface with the conventional standard LPRM detectors. The required application-specific analog input design specifications are, therefore, known and satisfied.
4.3.2.1.2.B	Analog Current Input Module Accuracies. Overall accuracies shall be $\pm 0.35\%$ of the specified range.	Application Specific Requirements. The PRM analog inputs are designed to interface with industry standard LPRM detectors and Flow transmitters, with accuracies appropriate for the specific application. The required analog input design specifications are, therefore, known and satisfied. Please note the generic PLC requirement was converted to PRM application specific requirements. ERS section 5.1.4 addresses PRM system accuracy for example. LPRM input to output through by AO module 2.5% (2.0% of FS 0-125%) FLOW 3.75% (3.0 % of FS 0-125% for 0 to 50% FLOW) 2.5% (2.0 % of FS 0-125% for 50 to 125% FLOW) The OPRM does not have an AO module. Please see Item 4.3.3.1.1.B for more details.
4.3.2.1.2.C	Analog Current Input Module Resolution. The minimum resolution shall be 12 bits.	Comply. The analog inputs are designed to interface with industry standard LPRM detectors and Flow transmitters. The LPRM and FLOW modules convert analog input signals to 12 bits data. The required analog input design specifications are, therefore, known and satisfied.
4.3.2.1.2.D	Analog Current Input Module Common Mode Voltage. The common mode voltage capability shall be at least 10 volts.	N/A. The PRM analog inputs do not have differential voltage inputs with external current to voltage conversion. The PRM individual analog inputs are appropriately isolated, and self-powered.

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
4.3.2.1.2.E	Analog Current Input Module Common Mode Rejection Ratio. The common mode rejection ratio shall be at least 90 dB.	N/A. The PRM analog inputs do not have differential voltage inputs with external current to voltage conversion.
4.3.2.1.2.F	Analog Current Input Module Response Time. The overall response time of the analog current input modules must support the response time requirement given in Section 4.2.1.A.	(See Item 4.2.1.A Response Time in this table.)
4.3.2.1.2.G	Analog Current Input Module Group-to-Group Isolation. The group-to-group isolation shall be at least ± 30 volts peak for 4 to 20 mA inputs.	Comply. The FLOW analog current inputs are grouped by unit. The unit to unit isolation is assured by fiber optic cable.
4.3.2.1.2.H	Analog Current Input Module Class 1E to Non-1E Isolation. The Class 1E to Non-1E isolation capability shall meet the requirements of Section 4.6.4.	N/A. Since there is no system-specific requirement to accept non-safety analog data into the PRM or OPRM safety systems, the analog input modules do not need to perform Class 1E to Non-Class-1E isolation.
4.3.2.1.2.I	Analog Current Input Module Surge Withstand. Surge withstand shall be as given in Section 4.6.2.	(See Item 4.6.2 Surge in this table.)
4.3.2.1.2.J	Analog Current Input Module Input Impedance. The input impedance shall be 250 ohms maximum.	Application Specific Requirements. The PRM analog inputs are designed to interface with industry standard LPRM detectors and Flow transmitters.
4.3.2.1.3	RTD Input Requirements.	N/A. There is no RTD input in the PRM or OPRM system.
4.3.2.1.4	Thermocouple Input Requirements.	N/A. There is no Thermocouple input in the Toshiba NRW-FPGA -based PRM or OPRM system.
4.3.2.2	Discrete Input Requirements. The PLC shall include modules that provide discrete inputs. Each module shall provide a minimum of 8 input channels and include indicators that show the ON/OFF status of each point.	Application Specific Requirements. The Toshiba designs provide 4 ch inputs on the DIO module that is sufficient discrete input capabilities to meet the specific system needs. The DIO module does not include input channel status ON/OFF indicators for each point. However, the ON/OFF status of the important connected input channels is displayed in functionally translated manner on the front panel of another module to meet the system specific needs.
4.3.2.2.1	Discrete AC Input Requirements.	N/A. The PRM or OPRM hardware does not include Discrete AC input.
4.3.2.2.2	Discrete DC Input Requirements. (section heading)	No requirement

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
4.3.2.2.2.A	Discrete DC Input Module Types. The PLC shall include discrete DC input modules for nominal inputs of 125 VDC, 24 VDC, 15 VDC and 12 VDC.	Comply. The DIO are capable of operating with 24 VDC. Qualified relays will be used to interface to plant inputs when the input voltages do not match the DIO capabilities.
4.3.2.2.2.B	Discrete DC Input Module ON Transition. The input must transition to ON at 90 VDC max. (125 VDC input) or 20 VDC max. (24 VDC input).	Application Specific Requirements. The associated specification of the DIO module is based on the system specific requirements to be used to interface to plant inputs. Qualified relays will be used to interface to plant inputs when the input voltages do not match the DIO capabilities.
4.3.2.2.2.C	Discrete DC Input Module OFF Transition. The input must transition to OFF between 65 to 25 VDC (125 VDC input) or 15 to 6 VDC (24 VDC input).	Application Specific Requirements. The associated specification of the DIO module is based on the system specific requirements to be used to interface to plant inputs. Qualified relays will be used to interface to plant inputs when the input voltages do not match the DIO capabilities.
4.3.2.2.2.D	Discrete DC Input Module Operating Range. The module must operate for inputs up to at least 150 VDC (125 VDC input) or 40 VDC (24 VDC input).	Comply. The associated specification of the DIO module is based on the system specific requirements to be used to interface to plant inputs. Qualified relays will be used to interface to plant inputs when the input voltages do not match the DIO capabilities. The DIO Module can operate for input up to 40 VDC for 24 VDC input.
4.3.2.2.2.E	Discrete DC Input Module Response Time. The overall response time of the discrete DC input modules must support the response time requirement given in Section 4.2.1.A.	(See Item 4.2.1.A, Response Time in this table)
4.3.2.2.2.F	Discrete DC Input Module Group-to-Group Isolation. The group-to-group isolation shall be at least 600 volts peak for 125 VDC inputs or 40 volts peak for 24 VDC inputs.	Comply. Discrete inputs are grouped by unit. The unit to unit isolation is assured by fiber optic cable.
4.3.2.2.2.G	Discrete DC Input Module Class 1E to Non-1E Isolation. The Class 1E to Non-1E isolation capability shall meet the requirements of Section 4.6.4.	(See Item 4.6.4, Class 1E to Non-1E Isolation in this table.)
4.3.2.2.2.H	Discrete DC Input Module Surge Withstand. Surge withstand shall be as given in Section 4.6.2.	(See Item 4.6.2, Surge in this table.)
4.3.2.2.3	TTL Input Requirements.	N/A. There are no TTL inputs in the PRM or OPRM.
4.3.2.3	Other Inputs. (section heading)	No requirement

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
4.3.2.3.1	Pulse Input Requirements.	N/A. There are no pulse inputs in the PRM or OPRM.
4.3.3	Output Requirements. (section heading)	No requirement
4.3.3.1	Analog Output Requirements. The PLC shall include modules that provide analog outputs.	Comply. The PRM System analog outputs are to the plant data recorders and computer. The analog outputs are provided through qualified 1E to non-1E isolators. The PRM system can also provide communication links with a richer data stream, eliminating the requirement for calibration of these extra analog outputs.
4.3.3.1.A	Monotonicity. The analog outputs shall be monotonic to $\pm 1/2$ LSB.	Comply. The AO modules outputs are monotonic to $\pm 1/2$ LSB.
4.3.3.1.B	Number of Channels. Each analog output module shall provide a minimum of four output channels.	Comply. The AO module has sixteen output ports.
4.3.3.1.1	Analog Voltage Output Requirements. (section heading)	No requirement
4.3.3.1.1.A	Analog Voltage Output Module Ranges. The PLC shall include analog voltage output modules with ranges of: 0 to 10 VDC, -10 to 10 VDC and 0 to 5 VDC. The PLC shall provide differential outputs for these ranges.	Application Specific Requirements. The voltage output type AO module ranges are 0 to 5 volts, 0 to 1 volt, 1 to 5 volts, and 0 to 160 millivolts as appropriate based on the system specific requirements to match the requirements of the plant-specific interface.
4.3.3.1.1.B	Analog Voltage Output Module Accuracy. Overall accuracy shall be $\pm 0.3\%$ of full range.	Application Specific Requirements. The Toshiba designs provide appropriate accuracy to meet the specific system needs. The required analog output design specifications are, therefore, known and satisfied. The analog output accuracy of the PRM system are as follows: 1. LPRM function a. The LPRM drift over a period of two weeks does not exceed $\pm 1.0\%$ full scale (FS) at control room environmental conditions. b. The LPRM input-and-output linearity (inaccuracy) is within $\pm 2.0\%$ FS, at control room environmental conditions. Note: 1. FS is from 0% to 125% reactor power. 2. The LPRM drift and linearity are measured from the LPRM input current to the LPRM output through the AO module.

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
4.3.3.1.1.B (continued)	(continued)	<p>2. APRM function</p> <p>a. The APRM drift over a period of two weeks does not exceed ± 1.0 %FS at control room conditions.</p> <p>b. The APRM input-and-output linearity (inaccuracy) is within ± 2.0 % FS.</p> <p>c. The APRM function is designed such that, at control room environmental conditions, trip accuracy is as follows:</p> <p style="padding-left: 20px;">Scram signal: Within ± 2.0 % FS</p> <p style="padding-left: 20px;">Rod withdrawal signals: Within ± 3.0 % FS (FLOW: 0 to 50 %) Within ± 2.0 % FS (FLOW: 50 to 125 %)</p> <p>d. The trip reset point is -1.25 % below trip set point.</p> <p>Note: 1. FS is from 0% to 125% reactor power. 2. The APRM drift, linearity, and trip accuracy are measured from the LPRM input current to the APRM output through the AO module.</p> <p>3. FLOW function</p> <p>a. The FLOW function is designed such that, at control room environmental conditions, the drift over a period of two weeks shall not exceed ± 1.0 %FS.</p> <p>b. The FLOW function is designed such that the input-and-output linearity (inaccuracy) and the trip accuracy at control room environmental conditions is as follows.</p> <p style="padding-left: 20px;">Within ± 3.0 % FS (FLOW: 0 to 50 %) Within ± 2.0 % FS (FLOW: 50 to 125 %)</p> <p>c. The trip reset point is -1.25 % below trip set point.</p> <p>Note: 1. FS is from 0% to 125% recirculation flow. 2. The FLOW drift and linearity are measured from the FLOW unit input current to the FLOW output through the AO module.</p> <p>The drift is conservatively evaluated in the overall accuracy from the input to the output through the AO module.</p> <p>4. The OPRM has no analog output.</p>
4.3.3.1.1.C	Analog Voltage Output Module Resolution. The minimum resolution shall be 12 bits.	Comply. The Toshiba NRW-FPGA-based PRM analog outputs are designed to have 12 bits resolution to interface with the plant-specific data recorders and computer. The required analog output design specifications are, therefore, known and satisfied.
4.3.3.1.1.D	Analog Voltage Output Module Load Impedance. The outputs shall support a load impedance of 1 Kohm or less.	Application Specific Requirements. The Toshiba NRW-FPGA-based PRM analog outputs are designed to interface with to the plant-specific data recorders and computer. The output impedance is 1M ohm. The required analog output design specifications are, therefore, known and satisfied.

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
4.3.3.1.1.E	Analog Voltage Output Module Response Time. The overall response time of the analog voltage output modules must support the response time requirement given in Section 4.2.1.A.	(See Item 4.2.1.A, Response Time in this table.)
4.3.3.1.1.F	Analog Voltage Output Module Isolation. The group-to-group, module-to-module and module to backplane isolation shall meet the requirements of Section 4.6.4.	Comply. Analog voltage outputs are not grouped in the modules. The AO module outputs are isolated from the unit middle plane using photo couplers and a DC/DC converter.
4.3.3.1.1.G	Analog Voltage Output Module Surge Withstand. Surge withstand shall be as given in Section 4.6.2.	(See Item 4.6.2, Surge in this table.)
4.3.3.1.2	Current Output Requirements.	N/A. The AO module design does not include current output.
4.3.3.2	Discrete Output Requirements. The PLC shall include modules that provide discrete outputs.	Comply. The discrete input and output module receives discrete signals from external equipment and provides discrete outputs to external equipment. Signals are routed through the unit middle plane in the unit
4.3.3.2.A	Number of Channels. Each module shall provide a minimum of 8 output channels.	Comply. The discrete input and output module has 16 output ports.
4.3.3.2.B	Leakage Current. Leakage current in the OFF state of non-supervised (no internal ring back) modules shall be less than 80% of the minimum current needed to turn ON any digital input module.	Comply. The DIO modules in PRM or OPRM are used to drive a qualified relay that is selected to meet the specific plant application needs. Leakage current is less than 80 % of the minimum required relay coil current.
4.3.3.2.C	Output Circuit Interrupter. Outputs must include a circuit interrupter.	Comply. The DIO modules do not include output circuit interrupters. Toshiba will provide appropriate external interrupters when installed, as required by the customer.
4.3.3.2.D	Status Indication. Modules must include indicators that show the ON/OFF status of each point.	Application Specific Requirements. The DIO module does not include output channel status ON/OFF indicators for each point. However, on/off status of the output of the DIO module is monitored by other I&C systems.
4.3.3.2.1	Discrete AC Output Requirements.	N/A. There is no discrete AC output in the PRM or OPRM. AC outputs can be created through use of the existing DC outputs through a qualified relay, selected to meet the specific plant application needs.
4.3.3.2.2	Discrete DC Output Requirements. (section heading)	No requirement

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
4.3.3.2.2.A	Discrete DC Output Module Types. The PLC shall include discrete DC output modules for nominal outputs of 125 VDC, 48 VDC, 24 VDC, 15 VDC and 12 VDC.	Comply. The DIO modules in the PRM or OPRM are used to drive a qualified relay that is selected to meet the specific plant application needs (e.g., voltage). The DIO module provides 24VDC outputs.
4.3.3.2.2.B	Discrete DC Output Module Output Current. The outputs must operate with an output current between 50 mA and 0.5 amps with an inrush capability of at least 2 amps.	Application Specific Requirements. The DIO modules in PRM or OPRM are used to drive a qualified relay that is selected to meet the specific plant application needs (e.g., current). The DIO module minimum output current is 100 mA and maximum load current is [] ^{ac} A.
4.3.3.2.2.C	Discrete DC Output Module ON State Voltage Drop. The ON state voltage drop shall not exceed 2 VDC at 0.5 amps.	Comply. The DIO modules in PRM or OPRM are used to drive a qualified relay that is selected to meet the specific plant application needs (e.g., voltage). The on resistance of each DIO module output is [] ^{ac} Ω max. So the voltage drop will be [] ^{ac} V max at 0.5A.
4.3.3.2.2.D	Discrete DC Output Module OFF State Leakage. The OFF state leakage current shall not exceed 2 mA.	Comply. The DIO modules in PRM or OPRM are used to drive a qualified relay that is selected to meet the specific plant application needs. Off state leakage is [] ^{ac} μA.
4.3.3.2.2.E	Discrete DC Output Module Operating Range. The module points must operate for source inputs of 90 to 140 VDC min. (125 VDC output), 35 to 60 VDC min. (48 VDC output), and 20 to 28 VDC min. (24 VDC output).	Comply. The DIO modules in PRM or OPRM are used to drive a qualified relay that is selected to meet the specific plant application needs. The DIO module operates at [] ^{ac} VDC for 24 VDC output.
4.3.3.2.2.F	Discrete DC Output Module Response Time. The overall response time of the discrete DC output modules must support the response time requirement given in Section 4.2.1.A.	(See Item 4.2.1.A, Response Time in this table.)
4.3.3.2.2.G	Discrete DC Output Module Group-to-Group Isolation. The group-to-group isolation shall be at least twice nominal output.	Comply. Each PRM or OPRM System Discrete DC output module (DIO module) is designed to provide isolation from other modules.
4.3.3.2.2.H	Discrete DC Output Module Class 1E to Non-1E Isolation. The Class 1E to Non-1E isolation capability shall meet the requirements of Section 4.6.4.	Comply. Qualified relays will be used to meet the isolation requirements. (See Item 4.6.4, Class 1E to Non-1E Isolation in this table.) DIO has [] ^{ac} kVAC isolation in the DIO module design. However, the credited Class 1E to Non-Class 1E isolation is provided by external relays mounted in the same cabinet with the PRM and OPRM.
4.3.3.2.2.I	Discrete DC Output Module Surge Withstand. Surge withstand shall be as given in Section 4.6.2.	(See Item 4.6.2, Surge Withstand Capability in this table.)
4.3.3.2.3	Relay Output Requirements.	N/A. Toshiba will use commercially available qualified relays in the plants.

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
4.3.3.2.4	TTL Output Requirements.	N/A. There is no TTL output module in the Toshiba NRW-FPGA-based PRM or OPRM system.
4.3.4	Processor/Other System Component Requirements. (section heading)	No requirement
4.3.4.1	Processor Loop Time Requirements. Processor loop time shall support the response time requirement given in Section 4.2.1.A.	(See Item 4.2.1.A. Response Time in this table.)
	Also, processor loop time shall be faster than the longer of the analog input conversion time or the period associated with 2.5 times the analog filter cutoff frequency.	Comply. The FPGA signal processing time is designed to provide much faster signal processing time than the time addressed here.
4.3.4.2	Memory Capacity and Data Retention Capability Requirements. The memory capacity of the main processor shall provide sufficient memory to execute a single application program with the number of program elements given.	Comply. PRM and OPRM are application specific systems including the necessary logic in the FPGAs, and have sufficient data retention capacity in the FPGAs, EPROMs, EEPROMs, and SRAMs.
	The memory used to contain the program shall be capable of retaining the information for a minimum of 6 months with no power applied.	Comply. The NRW-FPGA anti-fuse programmable logic is sufficient to hold the logic required for each FPGA for the life of the FPGA.
	Any memory used for field modifiable constants shall be capable of at least 100,000 write cycles.	Comply. Any EEPROM used for field modifiable constants is capable of at least 100,000 write cycles.
4.3.4.3	Data Acquisition Requirements. The PLC shall be capable of transferring information between the main processor and I/O modules mounted in the same or expansion chassis. The data transfer rate shall support the response time requirement given in Section 4.2.1.A.	Comply. Each unit of the PRM or OPRM is capable of transferring information between modules in the same unit or other units in short time sufficient to support the response time requirements.

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
4.3.4.3.A	Main Chassis Interconnect Device Operation. Devices used to interface remote or expansion chassis to the main chassis shall meet the range of environmental conditions given in Section 4.3.6. Failures of the chassis interconnect devices shall not defeat the ability to transfer data on the main chassis.	Comply. The PRM or OPRM system operates not only within the normal environmental condition in the located area, but also within the abnormal environmental conditions of anticipated transients and accidents, in order to preserve the safety system functions. This includes the fiber optic cables used to couple units together, using transmit and receive modules in the units. The fiber optic cables and modules were included in the qualification. The PRM or OPRM units will be located in a mild environment such as the main control room, so only mild environmental conditions are considered. Thus the fiber optic cables and the middle plane, which Toshiba interprets as are the Main Chassis Interconnect Device from the context of the requirements, meet these environmental conditions. Details are provided in Section 4.3.6. Failures of one or more units shall not defeat any other unit's capability to transfer data.
4.3.4.3.B	Main Chassis Interconnect Device Failure. Failures of the chassis interconnect devices shall not affect memory capacity or main processor data retention.	Comply. The NRW-FPGA anti-fuse programmable logic is sufficient to hold the logic required for each FPGA. Any memory devices in the PRM or OPRM modules are not directly connected to the Main Chassis Interconnect devices, which Toshiba interprets as fiber optic cables and the middle planes from the context of the requirements. Thus, the memory devices are not affected by the failures of other units. Failure of other units does not affect the FPGA logic.
4.3.4.3.C	Main Chassis Interconnect Device Loss of Power. Loss of power to chassis interconnect devices shall not defeat the ability to transfer data on the main chassis or I/O on any other chassis.	Comply. Loss of power to one unit does not defeat the capability of other unit. In addition, loss of power to one module does not defeat the capability of other modules in the same unit.
4.3.4.3.D	Main Chassis Interconnect Device Class 1E to Non-1E Isolation. The Class 1E to Non-1E isolation capability shall meet the requirements of Section 4.6.4.	Comply. Fiber optic cable inherently provides Class 1E to Non-Class 1E isolation. Data isolation is provided by one-way transmission from safety to non-safety. The AO module has isolation devices to separate Class 1E from Non-Class 1E. The DIO is provided with external relays for isolation of Class 1E from Non-Class 1E.
4.3.4.3.E	Main Chassis Interconnect Device Surge Withstand. Surge withstand shall be as given in Section 4.6.2.	Comply. Fiber optic cable inherently provides surge protection.
4.3.4.3.F	Main Chassis Interconnect Device Data Acquisition Time. Data acquisition time shall be deterministic or manufacturer shall provide information to establish timing effect.	Comply. Data acquisition of the LPRM module and Flow module in each associated units and the transfer to other units are deterministic, cyclic, and sequential, thus the data acquisition time of the PRM or OPRM system is consistent with the overall system response time.
4.3.4.3.G	Redundant Inter-Processor Data Acquisition Backplane Busses. Descriptive information.	N/A. The PRM or OPRM hardware does not need redundant backplane busses and uses redundancy in fiber optic communication for LPRM data communication in the PRM and for APRM data input to the OPRM unit.
4.3.4.4	Communication Port Requirements. The main processor shall provide at least one communication port.	N/A. Special purpose communication links can be provided as necessary in a separate module to meet system requirements.

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
4.3.4.5	Coprocesor Module Requirements. Detailed requirements for coprocessors that may be installed in I/O slots but contain local processing capability independent of the main processor.	N/A. There is no Coprocessor in the Toshiba NRW-FPGA-based PRM or OPRM system.
4.3.4.6	Chassis Requirements. Chassis must be suitable for mounting in a standard 19 inch rack, and must have adequate strength and provide positive hold down of modules sufficient to meet seismic withstand requirements.	Comply Chassis that are used as the enclosure of the units are suitable for mounting in a standard 19 inch rack, have adequate strength for seismic conditions, and provide positive hold down for the modules. The chassis were qualified while mounted in a 19 inch rack. The chassis meets seismic requirements. The PRM Chassis are qualified using a test profile with a maximum 9.8g acceleration. The OPRM chassis was qualified using a test profile with a maximum 15.4g acceleration
4.3.4.7	Backup Devices/Redundancy Requirements. Descriptive information.	No requirement
4.3.4.7.A	Redundant Device Requirements. Transfer to a redundant device shall occur within the larger of the main processor scan cycle or three data conversion cycles of the failed module.	Comply. Each PRM or OPRM unit has two redundant LVPS modules that operate in parallel. Each LVPS module has enough capacity to supply power to all modules mounted in the chassis. There are redundant optical communications for LPRM data communication in the PRM and for APRM data input to the OPRM unit. The link is diagnosed as failed if errors are detected in three consecutive communication cycles.
4.3.4.7.B	Redundant Device Requirements. Undetected failures in redundant components shall be detectable during periodic surveillance.	N/A. Failures of one of redundant LVPS module as well as failure of one of redundant optical communication link between units are indicated in the STATUS module. Such failures are annunciated to the MCR. There are no identified undetected failures that cause the loss of functionality in redundant components.
4.3.4.7.C	Redundant Device Requirements. Diagnostics shall not result in indeterminate failure states and repetitive switching between redundant components.	N/A. The redundant LVPS modules and the redundant optical communication between units operate in parallel. The design does not provide any features that would result repetitive switching between redundant LVPS modules or between redundant optical communications links.
4.3.4.7.D	Redundant Device Requirements. Requirements for effect of transfer mechanism operation on input/output module operation.	Comply. Any failure of a redundant LVPS modules or the failure of a redundant optical communications between units causes no change in the analog input and output signals, which is well within the 5% requirement in EPRI TR-107330.
4.3.5	Programming Terminal Requirements. Special programming terminal hardware or software shall meet the requirements of Sections 4.4.4, 7.7.2 and 7.5.2.	N/A. The Toshiba NRW-FPGA-based systems do not require end user programming terminal hardware or software.
4.3.6	Environmental Requirements. (section heading)	No requirement

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
4.3.6.1	Normal Environmental Basic Requirements. The normal PLC operating environment is:	<p>Comply with limited scope and/or condition. Requirements are set as follows complying with this section. Qualification test results meet the requirement with limited scope. See Section 6.3.3 for the results.</p> <p>Normal Environmental Requirements (PRM, OPRM)</p> <p>Temperature Range 16 to 40°C</p> <p>Humidity Range 40 to 95% non-condensing</p> <p>Radiation Exposure Up to 10 Gy</p>
4.3.6.2	Abnormal Environmental Basic Requirements. The abnormal PLC operating environment is:	<p>Comply with limited scope and/or condition. Requirements are set as follows complying with this section. Qualification test results meet the requirement with limited scope. See Section 6.3.3 for the results.</p> <p>Abnormal Environmental Requirements (PRM, OPRM)</p> <p>Temperature Range 4 to 50°C</p> <p>Humidity Range 10 to 95% non-condensing</p> <p>Radiation Exposure Up to 10 Gy</p>
4.3.6.3	Environmental Withstand Specific Requirements. PLC shall operate for the temperature/humidity profile given in TR Figure 4-4 with operability as given in Section 5.3. Evaluations may be used to establish radiation withstand capability.	<p>Comply. The PRM and OPRM systems were qualified as follows, based on EPRI TR-107330 Figure 4-4 and Section 4.3.6:</p> <p>PRM:</p> <ul style="list-style-type: none"> a. High Temperature and Humidity: 140 °F and 95% relative humidity, which meets EPRI TR-107330 Section 4.3.6 and Figure 4-4 requirements (Toshiba notes that adding 5% margin to the relative humidity would most likely induce condensation, which is not included in Toshiba's qualification envelope). b. Low Temperature and Humidity: 35 °F and 10% relative humidity, which meets EPRI TR-107330 Section 4.3.6 requirements (Figure 4-4 requirements for humidity could not be met in this chamber, even with relaxation for non-simultaneous temperature and humidity, and Toshiba notes that the OPRM is constructed of similar components and had no issues at 40 °F and 5% relative humidity which could be achieved in the environmental test chamber use for the OPRM testing). <p>OPRM:</p> <ul style="list-style-type: none"> a. High Temperature and Humidity: 140 °F and 90% relative humidity, which meets EPRI TR-107330 Figure 4-4 requirements (Section 4.3.6 requirements for humidity were met in separate testing at Toshiba, see Note below). b. Low Temperature and Humidity: 40 °F and 5% relative humidity, which meets EPRI TR-107330 Section 4.3.6 and Figure 4-4 requirements. <p>Note: OPRM testing with 140 °F and 95% relative humidity profile was successfully met in the factory test which was performed under Toshiba's ISO 9001 program separately from the EQ test.</p>

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
4.3.7	EMI/RFI Withstand Requirements. The PLC shall withstand EMI/RFI levels given in EPRI TR-102323. When exposed to the radiated and conducted test levels, the PLC processors shall continue to function, I/O data transfer shall not be interrupted, discrete I/O shall not change state, analog I/O shall not vary more than 3%.	<p>Comply with limited scope and/or condition.</p> <p>The PRM and OPRM units are designed to minimize susceptibility to and generation of electromagnetic interference (EMI) and radio frequency interference (RFI).</p> <p>The PRM and OPRM units were subjected to test for EMI/RFI conditions that conform to the guidelines given in RG 1.180, Revision 1.</p> <p>The results of the susceptibility testing showed that the PRM and OPRM units continued to function correctly throughout all test exposure levels. For the emissions tests, the PRM and OPRM units were found to comply with the allowable equipment emissions levels.</p> <p>The PRM and the OPRM pass the test with the modifications described below.</p> <p>The first EMI Susceptibility Test failed. The hardware was re-designed to resolve the test failure. Therefore, for the second EMI/RFI, Surge Withstand Capability, EFT/B, ESD, and Class 1E to Non-1E Isolation tests, the new LPRM module and the new AO modules were replaced with the failed LPRM module and the failed AO modules. The re-designed LPRM and AO modules had additional capacitors to enhance electric-noise-withstand-capability and passed the test.</p> <p>For Low-Frequency Conducted Emissions (CE101), the addition of the additional inductance (coils) was needed in the PRM to pass the test. For the OPRM, the power factor corrector (PCF) was developed and added to the test specimen, which passed the CE101 test.</p> <p>For radiated susceptibility (RS103), Toshiba did not perform the test for the frequencies above 1 GHz for the PRM, and thus accepts that either a utility employing this equipment must preclude the use of cell phones and radios near this equipment or accept an open issue from the USNRC in the SER requiring an evaluation by the utility. RS103 test for the OPRM was conducted for the frequency up to 10 GHz.</p>
4.3.8	Electrostatic Discharge (ESD) Withstand Requirements. The PLC shall withstand ESD levels given in EPRI TR-102323.	<p>Comply. ESD testing in the PRM showed that the rear panels were susceptible. The back panels in the units are accessible only when locked cabinet doors are opened. Thus, the back panels are not normally exposed to ESD. In normal use at a US plant, the cabinet doors are unlocked and opened only when work is to be done on the panels, such as maintenance or calibration, which is done with unit bypassed. Toshiba's application guide will be revised to state that the equipment past the plane of the door on the back panels should not be touched unless the technician or engineer is wearing a grounded ESD wriststrap.</p> <p>No susceptibility was observed in the ESD test for the OPRM.</p> <p>Note: The climatic conditions during the ESD tests are 58 % (day 1) and 51 % (day 2) in the PRM tests, 40 % (day 1) and 42 % (day 2) in the OPRM tests, which is within the required range of 30 to 60 % relative humidity.</p>

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
4.3.9	Seismic Withstand Requirements. PLC shall be suitable for qualification as a Category 1 Seismic device. The PLC shall meet performance requirements during and after exposure to OBE and SSE levels shown in TR Figure 4-5. Relay contacts of relay output modules shall not chatter.	<p>Comply with limited scope and/or condition.</p> <p>It was found that Figure 4-5 of a later version of EPRI TR-107330 available on the EPRI website is slightly different from Figure 4-5 in the original October 1997 version which is the basis for the Toshiba RRS. The later version (available from the EPRI website) provides Figure 4-5 with a narrow peak spectral band. Specifically, the 5% damped SSE response spectrum control points of Figure 4-5 of the later version of EPRI TR-107330 are (1 Hz, 0.42 g); (4.5 Hz, 14 g); (16 Hz, 14 g); (33 Hz, 6.13 g); and (100 Hz, 6.13 g). The original version of Figure 4-5 includes a broader frequency. Specifically, the 5 % damped SSE response spectrum break points of this version of Figure 4-5 are (0.5 Hz, 0.1 g); (1 Hz, 0.8 g); (3 Hz, 14 g); (33 Hz, 14 g); (40 Hz, 7 g); and (100Hz, 7 g). The discussion here refers to the version of EPRI TR-107330 Figure 4-5 of the later version of EPRI TR-107330 as the “narrow” spectrum, and the original version of EPRI TR-107330 Figure 4-5 as the “broad” spectrum.</p> <p>Because of test table limitation of 9.8 g, Toshiba has had to take exception to the EPRI TR-107330 requirement of 14 g in the PRM testing. The PRM testing was conducted at a laboratory where the table could not satisfy the EPRI TR-107330 peak spectral limits. Specifically, the table could only satisfy a peak spectral demand of 9.8 g. PRM test results show that the “narrow” spectrum demand is satisfied with the following exceptions.</p> <ul style="list-style-type: none"> • The 14 g peak in the narrow spectrum was above the table capacity. The table capacity produced a peak that exceeded 9.8 g. • Exceedances in the frequency lower than 3.5 Hz are acceptable based on Clause 8.6.3.1(j) of IEEE Std. 344-2004 since there are clearly no resonances below 5 Hz. • An additional exception to the “broad” EPRI TR-107330 spectrum demand would have to be taken for the exceedance at the peak above 30 Hz. <p>Seismic testing for OPRM was conducted at a different facility several years after the PRM testing. The OPRM testing was conducted with the RRS in Figure II-A-4-5 that is based on the “broad” EPRI TR-107330 spectrum to ensure the test table could meet the seismic demand. The test results exceeded the requirements of the broad spectrum with the exception that exceedances in the frequency lower than 3.5 Hz are acceptable based on Clause 8.6.3.1(j) of IEEE Std. 344-2004 since there are clearly no resonances below 5 Hz. Accordingly, Toshiba believes that the OPRM system satisfies EPRI TR-107330 requirements for the “broad” spectrum with the noted exception.</p>
4.4	Software/Firmware. (section heading)	No requirement
4.4.1	Executive. (section heading)	No requirement
4.4.1.1	Background. Descriptive information.	No requirement

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
4.4.1.2	Main Processor Executive Capability Requirements. The main processor executive shall: (section Heading)	No requirement This requirement is made for microprocessor based platforms that uses an executive. The FPGA implementation of the PRM and OPRM meets requirements "A" through "J" without using any executive.
4.4.1.2.A	A. Acquire inputs from the modules.	Comply. FPGA acquires inputs from the modules.
4.4.1.2.B	B. Implement the application program in a continuous loop.	Comply. FPGA implements the signal processing in a continuous cycle.
4.4.1.2.C	C. Load outputs to the modules.	Comply. FPGA provides signal outputs.
4.4.1.2.D	D. Perform power-up and run time diagnostics.	Comply. Whenever power is applied to the PRM or OPRM module, the equipment is initialized by the internal power on reset function. All trip and alarm outputs remain de-energized and thus tripped until the initialization process has completed (about 470 ms). After initialization, the trip and alarm outputs assume the states indicated by calculations and bypass settings. The power on reset function also is executed when the output of both LVPS power supplies is low, and low voltage is detected. The modules that have FPGAs are provided with a power supply monitoring IC, which provides about 150 ms or 470 ms reset action and initial startup of FPGA at the time when the module is energized. In addition, it executes a reset action when the power supply voltage lowers, i.e., if the power supply voltage continues to be low, the module remains in initialization state, and keeps all trip and alarm outputs in the tripped state. Note: The TRN module has about 470 ms reset time while other modules have about 150 ms reset time. The PRM and OPRM perform run time diagnostics. (See Item 4.4.6 in this table.)
4.4.1.2.E	E. Manage communications.	Comply. The PRM and OPRM include dedicated function communication links to provide data to external systems.
4.4.1.2.F	F. Upload application programs.	N/A The FPGA used in the PRM and OPRM use non-rewritable FPGAs and therefore this requirement does not apply.
4.4.1.2.G	G. Support on-line diagnostics, maintenance, and troubleshooting.	(See Items 4.4.6 and 4.7 in this table.)
4.4.1.2.H	H. Implement the application program functions.	N/A. Application logic is implemented in FPGAs on the PRM or OPRM modules.
4.4.1.2.I	I. Perform power-up initialize functions.	(See Section 4.4.1.2.D in this table.)

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
4.4.1.2.J	J. Implement redundancy functions.	Comply. The Toshiba NRW-FPGA-based PRM system does not use redundant I/O. Redundant power feeds and power supplies are provided. Redundant fiber optic links are provided for LPRM data communication in the PRM and for APRM data input to the OPRM.
4.4.1.3	Program Flow Control Requirements.	Comply. Each execution of the PRM or OPRM application logic is preceded by an input module data request. The FPGA logic does not use interrupts.
4.4.1.4	Unintended/Unused Function Isolation Requirements. Descriptive information.	No requirement. Only functions that are used and documented are incorporated in the PRM and OPRM documentation on FPGAs. The Software/Hardware development process (see Section I) through software life cycle assures the integrity against Unintended/Unused Function isolation.
4.4.1.5	Coprocesor Executive Capability.	N/A. The PRM and OPRM do not use any coprocessors.
4.4.2	Media Requirements. Software media provided by the manufacturer shall be high quality and new. CD-ROMS or 3-1/2 inch floppy disks are acceptable. Packaging shall preclude damage during shipping. Media shall be clearly labeled including revision and serial number. Media shall include electronic identification.	N/A. Logic (or software) for on the PRM and OPRM is shipped in the FPGAs on the modules and is not shipped separately from the modules. Toshiba uses the Non-Rewritable (NRW)-FPGA, so Toshiba does not provide software media to utilities.
4.4.3	Ladder Logic Requirements.	N/A. The PRM and OPRM application logic is written in VHDL hardware programming language.
4.4.4	Software Tools Requirements. A tool shall be provided for programming, debugging, and documentation.	N/A. The PRM and OPRM are provided with permanently installed application specific logic, which means the utilities do not need any software tools for programming, debugging, documentation, or maintenance. Toshiba does not provide utilities with software tools for changing programs.
4.4.5	Configuration Identification. (section heading)	No requirement
4.4.5.1	Configuration Identification Background. Descriptive information.	No requirement
4.4.5.2	Configuration Management Aids Requirements. Descriptive information.	No requirement
4.4.5.2.A	Configuration Management. The PLC executive shall include a retrievable, embedded electronic revision level.	Comply. The PRM or OPRM modules do not have an equivalent of a PLC executive. Toshiba provides an equivalent configuration management capability since each module type number defines the programmable logic version installed in that module. Changes to the programmable logic will generate a new, unique module type number.

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
4.4.5.2.B	Configuration Management. Configuration information of configurable modules shall be retrievable in the field.	N/A. The PRM and OPRM system reconfigurations are only accomplished through mechanical devices (switches or pushbuttons) provided on the hardware chassis. The only configuration updated and provided externally is the gain adjustment factors for LPRMs.
4.4.5.2.C	Configuration Management. Software tools for modifying device configurations shall provide measures to prevent unauthorized access.	N/A. The PRM and OPRM system configuration cannot be modified by any software tool.
4.4.5.2.D	Configuration Management. PLC and support tools shall provide capability to extract and record database information, including program constants.	N/A. The PRM and OPRM systems do not need to implement data bases and modifiable program constants. The only configuration provided externally is the gain adjustment factors for LPRMs, which are set from an external core monitoring system.
4.4.5.2.E	Configuration Management. All PLC devices that include firmware shall be marked with an identifier that includes revision level.	Comply. All modules and units of PRM and OPRM are marked with an identifier that includes revision level, which Toshiba tracks.
4.4.5.2.F	Configuration Management. For PLCs with redundancy, tools shall provide capability to confirm that configurations are consistent.	Comply. The PRM and OPRM do not employ internal redundancy except for LVPS modules with each unit and redundant communication links for LPRM data communication in the PRM and for APRM data input to the OPRM. The Master Configuration List is the tool to manage the configuration items for consistency.
4.4.6	Diagnostics Requirements. (section heading)	No requirement
4.4.6.1	General Diagnostic Requirements. PLC must have sufficient diagnostics and test capability to detect all failures that could prevent the PLC from performing its intended safety function.	Comply. The PRM and OPRM have diagnostic functions to detect failures that could prevent the FPGA equipment from performing its intended safety function.
	Items 4.4.6.1.1 through 4.4.6.1.6 must be covered by on-line self test. Items 4.4.6.1.7 and 4.4.6.1.8 must be covered in power-up tests.	(See Items 4.4.6.1.1 through 4.4.6.1.8 in this table.)
	Short term diagnostics changes in module outputs shall be 2 milliseconds or less for DC outputs and 1/2 cycle or less for AC outputs. Capability to disable these diagnostics shall be provided.	N/A. The output modules of PRM and OPRM do not use output short term changes of state for self-tests or diagnosis.
4.4.6.1.1	Processor Stall. For PLCs with redundant processors, the PLC shall detect processor stall and halt operation of the failed processor.	N/A. The PRM and OPRM do not include redundant processors. However, failure of any FPGA to complete its required computations is detected and annunciated in the MCR.
4.4.6.1.2	Executive Program Error. Check of executive firmware integrity using a checksum or similar test.	N/A. The PRM and OPRM do not use executive firmware.

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
4.4.6.1.3	Application Program Error. Check of application program integrity using a checksum or similar test.	N/A. A checksum is verified during FPGA fusemap implementation. After programming, no additional checksums are possible, based on the FPGA internal configuration.
4.4.6.1.4	Variable Memory Error. Read/Write memory test by writing and reading back bit patterns that test both states of all bits, or similar test.	Comply. The PRM does not use read/write memory, and the application cannot be modified. The AGRD and PBD modules of OPRM have a small SRAM to retain a small amount of processed temporal data. The values in the SRAM are protected by error correcting code (ECC). Toshiba considers that the ECC works in compliance with the intention of this requirement
4.4.6.1.5	Module Communication Error. Check of communication data integrity.	<p>Comply. The TRN and RCV modules implement data transmission checks, between units, through fiber optic cables</p> <p>The module receiving data from the other unit shall verify the periodic occurrence of the data transmissions, and the validity of transmitted data between units over fiber optic cables. The data is protected by CRC included with the data.</p> <p>Checking data transmission from the modules in a same unit: The APRM module in the PRM and the CELL module in the OPRM check the periodic transmission of the data frame from the TRN and the RCV modules in the same unit. The AGRD and PBD modules of the OPRM check the periodic transmission of the data frame from the CELL module. If a timeout error occurs, a Minor Failure alarm is generated.</p>
4.4.6.1.6	Memory Battery Low. Check of memory battery capacity.	N/A. The PRM or OPRM system does not use any battery-backed memory.
4.4.6.1.7	Module Loss of Configuration. For software configurable modules, validate configuration.	N/A. The PRM or OPRM system does not use software configurable modules.
4.4.6.1.8	Failure of Watchdog Timer. Check of operation of watchdog timer.	Comply. Each module that has one or more FPGAs has one or two watchdog timers. Each watchdog timer can be checked for correct operation by the removal of a jumper. Watchdog timer time outs are detected and annunciated in the MCR.
4.4.6.1.9	Application not Executing. Failure to complete application program scan.	Comply. If a signal processing FPGA halts, the module containing the FPGA generates an inoperable signal. Failures of the Human Machine Interface (HMI) FPGAs do not generate an inoperable signal, but do generate a Minor Failure Alarm, except for the LPRM module. The watchdog timers are external, not built into the FPGA logic, and do not depend on the clock signal used by the FPGA. (See Item 4.4.6.1.8 in this table.)
4.4.6.1.10	Analog Output not Following. Failure of analog output to follow commanded value.	Comply. Failure of an analog output can be detected by an upscale or downscale alarm in the receiving equipment. The capability to support surveillance test is provided.

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
4.4.6.1.11	Analog Input not Responding. Failure of analog input to respond to input signal.	Comply. Gross failure of one analog input can be detected by upscale or downscale alarm in the receiving equipment. Failure of a single LPRM to a stuck value does not adversely affect operation of the power averages in the redundant PRM units or oscillation detection logic in the redundant OPRM units. The capability to support surveillance test is provided.
4.4.6.1.12	Discrete Input/Output not Responding. Failure of discrete input/output to operate correctly.	Comply. The PRM or OPRM systems do not have functions to detect the failure of discrete inputs or outputs. The capability to support surveillance test is provided.
4.4.6.1.13	Analog I/O out of Calibration. Analog input or output point out of calibration.	Comply. For PRM System, range check of analog input value is conducted. Analog output calibration would be part of periodic surveillance.
4.4.6.1.14	Power Supply out of Tolerance. Power supply to PLC is interrupted or a chassis power supply module fails.	Comply. The Low Voltage Power Supply (LVPS) module monitors its output voltage. If the voltage of the LVPS becomes lower than the setpoint $-10\% \pm 5\%$ in either of the LVPS module, the STATUS module (PRM) or the DAT/ST module (OPRM) front panel provides the indication.
4.4.6.2	On-Line Self-Test Requirements. On-line self-tests shall cover at least items 4.4.6.1.1 through 4.4.6.1.6 above. Results shall be made available to the application program.	(See Items 4.4.6.1.1 through 4.4.6.1.6 in this table.)
4.4.6.3	Power Up Diagnostics Requirements. Power up diagnostics shall include all on-line self tests, configuration verification, and test of failure to complete a scan. Application program execution shall be inhibited if power up diagnostics detect a failure.	<p>Comply. Whenever power is applied to the PRM or OPRM module, the equipment is initialized by the power on reset function.</p> <p>All trip and alarm outputs remain de-energized and thus tripped until the initialization process has completed (about 470 ms). After initialization, the trip and alarm outputs assume the states indicated by calculations and bypass settings.</p> <p>Power on reset function is also executed when the power supply low voltage is detected.</p> <p>The modules that have FPGAs are provided with a power supply monitoring IC, which provides about 150 ms or 470 ms reset action and initial startup of FPGA at the time when the module is energized. In addition, it executes a reset action when the power supply voltage lowers, i.e., if the power supply voltage continues to be low, the module remains in initialization state, and keeps all trip and alarm outputs in the tripped state.</p> <p>Note: The TRN module has about 470 ms reset time while other modules have about 150 ms reset time.</p> <p>The PRM System is capable of performing run time diagnostics.</p>
4.4.7	Data and Data Base. (section heading)	No requirement.

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
4.4.7.1	The data base resident in a PLC are those items necessary to cause the application program to operate as designed or to establish the configuration and/or types of I/O modules connected to the PLC.	N/A. The Toshiba NRW-FPGA -based PRM or OPRM do not have a resident data base for the application program.
4.4.7.2 A	The PLC shall support usage of user-defined program constants that are contained in non-volatile memory. For redundant systems, features shall be provided to confirm that the constants in redundant processors are the same.	Comply. The PRM and OPRM have non-volatile memory to store constants. The PRM and OPRM do not have redundant processors.
4.4.7.2 B	The PLC shall provide functions to permit reading and modifying the constants in the application program. For redundant systems, features shall be included to assure that the modification of constants is consistent between the redundant processors.	Comply. The FPGA logic used in the PRM and OPRM has functions to read and modify constants such as gain constants and setpoints from the front panel or by the rotary switch in the module. The PRM and OPRM do not have redundant processors.
4.4.7.2 C	The PLC shall provide features to prevent modifications to the local data table over peer-to-peer communication paths and any other on-line communication paths.	Comply. In the PRM and OPRM, constants stored in non-volatile memory cannot be modified over any kind of on-line communication path, and the communication paths do not support any messages other than the pre-defined data transfer messages, which are not programmed or designed to modify constants.
4.4.7.2 D	The PLC shall provide features to permit transmitting inputs, outputs, and calculated values to other devices over a serial port.	Comply. The PRM and OPRM can transmit inputs, outputs, status, and calculated values to other devices over a (serial) fiber optic communication link.
4.4.8	Other Non-Ladder Logic Programming Languages.	N/A. The PRM and OPRM application logic will be designed in VHDL, which is a specific hardware programming language. No other languages are supported.
4.4.9	Sequence of Events Processing Requirements.	N/A. The PRM and OPRM are provided with an application specific logic. Sequence of events logic is not provided in the PRM or OPRM, but can be created in external systems based on data sent by the PRM and OPRM.
4.4.10	System Integration Requirements. An appropriate level of system integration and integration testing shall be applied to the test specimen and TSAP.	(See Item 5.2.C in this table.)
4.5	Human/Machine Interface (HMI). (section heading)	No requirement
4.5.1	Human/Machine Interface (HMI) Background. Descriptive information.	No requirement

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
4.5.2	Requirements for Human/Machine Interface Functions. Descriptive information.	No requirement
4.5.2.A	HMI Functions. PLC shall support switching a loop controller between manual and automatic via switch inputs. For control loops with integral action, auto/manual tracking shall be provided.	N/A. The PRM and OPRM applications do not include loop controllers logics.
4.5.2.B	HMI Functions. PLC shall support setpoint adjustments via switch inputs. Adjustments shall include increase, decrease, and rate of change of setpoint.	Comply. The PRM and OPRM setpoints are adjustable by a technician during equipment maintenance or an operator during periodical surveillance service. The PRM and OPRM support setpoint adjustments through the front panel. Adjustments include increasing and decreasing the selected setpoint.
4.5.2.C	HMI Functions. PLC shall support manual initiation of equipment via switch inputs. PLC shall support detection of manually initiated equipment.	N/A. The PRM or OPRM functions do not require manual initiation of equipment.
4.5.2.D	HMI Functions. PLC shall support display of status of discrete and continuous value parameters via connected devices.	Comply. Status of discrete and continuous value parameters are shown on the front panel indication on each module.
4.5.2.E	HMI Functions. PLC shall support sending information to a serial port device. Information sent shall include input, output and internal variable values, on-line diagnostics, sequence of events (SOE) data, and results of calculations, comparisons and bit manipulations.	Comply. The PRM or OPRM does not support sending information to a serial port device. Instead, the PRM and OPRM can provide fiber optic communication ports, running a defined protocol, sending defined datasets to external safety or non-safety systems.
4.5.3	Requirements for Interactive Features. The PLC shall provide mechanisms to prevent unauthorized access to or inadvertent use of on-line functions.	N/A. The PRM and OPRM are provided with an application specific logic that cannot be modified. This feature is not required. A keylock switch is provided for each module to prevent inadvertent setpoint changes.
4.5.4	Requirements for Operator Action System Response Times. For any operator action that requires PLC confirmation, the PLC shall include features to enable confirmation within 0.5 seconds.	Comply. Operator action that requires FPGA processing is executed sequentially with rapid response to operator action. For operator actions that require confirmation, the HMI FPGAs in each module providing the required processing ensures quick response.
4.5.5	Display Requirements. Status shall be easily visible.	Comply. Status of each function is shown on the indicators on the front panel of each module.
4.5.6	Alarm Processing Requirements. Descriptive information.	No requirement

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
4.5.6.A	Alarm Processing. PLC shall have ability to compare inputs or derived parameters to setpoints.	Comply. The PRM and OPRM have ability to compare the signal input and calculated values to appropriate setpoints, and generate alarms or trip signals.
4.5.6.B	Alarm Processing. PLC shall have ability to latch an alarm condition and reset based on alarm reset condition.	Comply. The PRM and OPRM have ability to latch alarm conditions and reset based on alarm reset conditions. The module front panels of the PRM and OPRM provide a manual reset button to perform this action.
4.5.6.C	Alarm Processing. PLC shall have ability to blink an output indicator.	Application Specific Requirement. The PRM and OPRM have the ability to provide an alarm signal to the plant annunciator which has the capability to flash an annunciator. The front panel HMI LEDs on the PRM and OPRM modules do not blink. The alarm status can be communicated to external systems where the alarm status can be recorded and integratedly displayed with blink as needed.
4.5.6.D	Alarm Processing. PLC shall have ability to acknowledge an alarm.	Application Specific Requirement. The PRM and OPRM provide alarm signals that lock in until the alarm condition clears and is reset. All alarm acknowledgements is performed by the external, annunciator system and not by the Toshiba safety equipment.
4.5.6.E	Alarm Processing. Application program shall have ability to capture results of self-diagnostics.	Application Specific Requirement. The PRM or OPRM does not use an application program to capture results of self-diagnostics. When a failure is detected, an inoperable signal or minor failure alarm is generated, which is latched by the detected condition, and indicated on the module detecting the self-diagnostic failure. The alarm status can be communicated to external systems where the alarm status can be recorded.
4.5.6.F	Alarm Processing. Application program shall have ability to store results of items A through E in a buffer and transmit the data via a communication port.	Application Specific Requirement. Alarms and internal conditions are transmitted on the fiber optic output link to external safety or non-safety systems where the status of the alarms is stored.
4.5.7	Hard Manual Backup. Descriptive information.	No requirement
4.6	Electrical. (section header)	No requirement
4.6.1	Power Supply Requirements. (section heading)	No requirement
4.6.1.1	PLC Power Sources and Power Supply Requirements. Descriptive information.	No requirement
4.6.1.1.A	Power supplies. AC sources shall operate from at least 90 VAC to 150 VAC and 57 to 63 Hz. AC sources shall operate at the temperature and humidity range given in Section 4.3.6.	Comply. The PRM and OPRM operate on an AC source range of 90 to 150 VAC and frequency range of 57 to 63 Hz (EPRI TR-107330 Section 4.6.1). Each LVPS module is capable of supplying 1.2 times the bus loading in a fully loaded main chassis. The LVPS modules operate under the qualified temperature and humidity of the main control room as demonstrated during EQ testing.

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
4.6.1.1.B	Power supplies. DC sources shall operate from at least 20.4 VDC to 27.6 VDC. DC sources shall operate at the temperature and humidity range given in Section 4.3.6.	N/A. The PRM or OPRM configuration does not have and is not qualified with a low voltage DC power source.
4.6.1.1.C	Power supplies. DC sources shall operate for seven days from a 30VDC source.	N/A. The PRM or OPRM configuration does not have and is not qualified with a low voltage DC power source.
4.6.1.1.D	Power supplies. Power supplies shall be capable of supplying 1.2 times bus loading for a fully loaded main chassis.	Comply. The PRM and OPRM operate on an AC source range of 90 to 150 VAC and frequency range of 57 to 63 Hz (EPRI TR-107330 Section 4.6.1). Each LVPS module is capable of supplying 1.2 times the bus loading in a fully loaded main chassis.
4.6.1.1.E	Power supplies. Power supplies shall be capable of supplying 1.2 times bus loading for a fully loaded expansion chassis.	N/A. The PRM or OPRM do not have or require an expansion chassis.
4.6.1.1.F	Power Sources. Hold up time for AC sourced power supplies shall be 40 ms.	Comply. During Hold up time for AC power sources (40 ms), discrete I/O values do not change and analog I/O values do not change, which is within the EPRI TR-107330 requirement for less than a 5% of full scale change.
4.6.1.1.G	Power supplies. Power supplies shall meet the EMI/RFI, surge withstand and ESD requirements of Sections 4.3.7, 4.6.2 and 4.3.8.	(See Item 4.3.7 EMI/RFI in this table.) (See Item 4.6.2 Surge in this table.) (See Item 4.3.8 ESD in this table.)
	Sources shall meet the grounding requirements of Section 4.6.8.	(See Section 4.6.8 in this table.)
4.6.1.1.H	Power supplies. Requirements for fan cooled power supplies.	N/A. The PRM and OPRM system does not require or provide forced air cooling for the power supplies or for the units.
4.6.1.1.I	Power supplies. Faults in redundant power sources shall not prevent operation of the alternate supply.	Comply. The failure of one of the redundant power supplies does not cause the discrete I/O values to change state, and the analog I/O values do not change which is within the EPRI TR-107330 requirements for less than 5% of full scale change.
4.6.1.2	Loop Power Supply Requirements. Power supply modules shall be provided for external devices. Modules shall provide at least 500 mA at 24 VDC. The modules shall meet requirements A, B, C, F, G and H above.	N/A. The PRM and OPRM do not provide or require Loop Power Supplies. The FLOW inputs are powered from external sources.

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
4.6.2	Surge Withstand Capability Requirements. PLC platform shall withstand IEEE Std C62.41 ring wave and combination wave, 3000 volt peak surges. Withstand capability applies to power sources, analog and discrete I/O interfaces, and communication port interfaces. Per Section 6.3.5, surge testing shall be conducted in accordance IEEE Std C62.45.	<p>Comply with limited scope and/or condition. Power sources meet surge withstand criteria. IEEE Std C62.45 does not address surge testing of I/O and communications circuits. External communications are on fiber optic links, which do not require surge withstand testing, as they are nonconductive. These circuits were tested in accordance with RG 1.180 Revision 1, IEC 61000-4-5, and IEC 61000-4-12. For the PRM testing the repetition time of the ring wave is []^{ac}seconds which is longer than the 1 second requirement. However, since the period of the ring wave (30 μs) is very short compared to the required 1-second repetition rate, the effect of the transient can be considered over and the longer []^{ac}second rate will, therefore, not affect the conclusion of the test. For the PRM, the ring wave test was expected to be performed with 12 Ω coupling impedance. This is the default setting of the test equipment and the most likely scenario. However, this is not described in the test procedures or test record and it cannot be confirmed that the test was performed with 12 Ω, not 30 Ω. If the possibility that the test was performed with 30 Ω cannot be fully denied, in this possibility, the test results may not reflect the requirement for 12 Ω, which provides more energy to the test specimen.</p> <p>In the OPRM testing, the repetition time of the ring wave was []^{ac}seconds. The OPRM ring wave test was performed with 12 Ω coupling impedance</p>
4.6.3	Separation. Descriptive information.	No requirement
4.6.4	Class 1E/Non-1E Isolation Requirements. The PLC modules shall provide isolation of at least 600 VAC and 250 VDC applied for 30 seconds. Isolation features shall conform to IEEE Std 384. Isolation testing shall be performed on the modules.	Comply. Isolation capability of Class 1E to Non-Class 1E was tested with 600 VAC and 250 VDC applied for 30 seconds. Test level voltages were applied to the test points and the test specimen of the PRM unit operated normally during and after the application. There are no additional Class 1E to non-Class 1E isolators for the OPRM.
4.6.5	Cable/Wiring Requirements. Manufacturer shall supply all PLC hardware interconnecting cabling. All cabling shall be suitable for UL Class 2 service. Specifically, withstand rating shall be larger of 3 times the signal level voltage or 150 volts. Temperature rating shall be 60°C or greater. Vendor shall identify the quantities of PVC type wire and cable used in the system.	<p>Comply.</p> <ol style="list-style-type: none"> 1. The PRM and OPRM include all cabling and wiring necessary to connect and operate the units (and the system). 2. All cables and connectors do not contain any polyvinylchloride (PVC). 3. All cables are suitable for UL Class 2 service. Specifically, the provided cables shall have a withstand rating of more than 3 times the signal level voltage or at least 150 volts. 4. All cables have a temperature rating of 60°C or greater.
4.6.6	Termination Requirements. Modules shall be able to be removed without disconnecting field wiring.	Comply. Modules can be removed without disconnecting field wiring.

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
4.6.6 (continued)	Features shall be provided to substitute test signals or monitoring instruments for field connections. Connectors to the PLC shall have positive hold down mechanisms.	Comply. Test signals or monitoring instruments can be connected with PRM and OPRM units by connectors for field connections. Connectors to the modules have positive hold down mechanisms.
	Connectors and terminations to the PLC shall be qualified with the generic PLC.	Comply. Any connectors and terminations to the units are included in qualification testing.
4.6.7	Backup Power. Descriptive information.	No requirement
4.6.8	Grounding/Shielding Requirements. The PLC equipment shall meet IEEE Std 1050 and EPRI TR-102323 grounding requirements. This includes supporting connection to single point, multi-point and floating ground systems, and providing separate ground connection points on each chassis for AC ground, DC ground, and signal ground.	Comply. The PRM and OPRM meet IEEE Std 1050 and EPRI TR-102323 grounding requirements. This includes supporting connection to single point, multi-point, and floating ground systems, and providing a ground connection point on each chassis.
	The PLC equipment shall meet IEEE Std 1050 and EPRI TR-102323 shielding requirements. This includes providing shielding connection points for the I/O module field terminations.	Comply. The PRM and OPRM meet IEEE Std 1050 and RG 1.180 Revision 1 shielding requirements. This includes providing shielding connection points for the I/O module field terminations.
4.7	Maintenance. (section heading)	No requirement
4.7.1	Maintenance Background. Descriptive information.	No requirement
4.7.2	Diagnosis/Built-in Testability Requirements. Descriptive information.	No requirement
4.7.3	Module Replacement Requirements. The PLC shall contain features to aid in module replacement.	Comply. Each module is designed for easy access of removal and installation as documented in Section II-2.1.3.
	The maintenance manual shall contain a description of any hardware configuration item for each module.	Comply. The Instructions for the LPRM Unit (Reference (d45)), Instructions for the LPRM/APRM Unit (Reference (c46)), Instructions for the FLOW Unit (Reference (d47)), and the OPRM Unit User's Manual (Reference (c27)) include each hardware configuration item for each unit.
	The module hold downs shall be easily accessible and provide ease of removal and reinstallation.	Comply. The module is designed for easy access for removal and installation as documented in Section II-2.1.3.

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
4.7.4	Preventive Maintenance Requirements. Equipment manuals shall contain preventive maintenance information. Preventive maintenance shall also include components identified in Section 4.7.8.2.	Comply. The Instructions for the LPRM Unit (Reference (d45)), Instructions for the LPRM/APRM Unit (Reference (d46)), Instructions for the FLOW Unit (Reference (d47)), and the OPRM Unit User's Manual (Reference (c27)) include information for preventive maintenance, including air filter cleanliness, termination checks, power supply checks, and instrument ground checks.
4.7.5	Surveillance Testing Requirements. The PLC shall support IEEE Std 338 surveillance testing.	Application Specific Requirement. Although the Toshiba NRW-FPGA-based PRM and OPRM do not support all the recommendations in the EPRI TR, the hardware does support the applicable requirements of IEEE Std 338 Surveillance Testing, including Channel Checks, Calibration Verification, Functional Tests, Time Response Tests, and Analog Trip Signal Tests. Section II-A-2.8 discusses surveillance capabilities of the PRM and OPRM.
4.7.6	Output Bypass/Control Devices. Descriptive information.	No requirement.
4.7.7	Hot Repair Capability. The PLC shall support installing I/O modules with backplane power applied. Low power modules shall support removal with field power applied. When output modules are removed from the backplane, the state of the outputs should be known.	Exception. Since Toshiba's engineers concluded that the additional hardware required to support hot-swap will increase the module complexity unnecessarily, the PRM or OPRM does not support powered removal or installation of components with power applied.
4.7.8	Manufacturer System Life Cycle Maintenance. (section heading)	No requirement.
4.7.8.1	Parts Replacement Life Cycle Requirements. The baseline configuration of the qualified PLC shall be established.	Comply. Configuration management is conducted in accordance with internal Toshiba procedures as documented in Section I-3.12 for the current process and Section I-A-4.9 for the original process. The design baseline of the qualified units is maintained in Toshiba's configuration management system. The Instructions for the LPRM Unit (Reference (d45)), Instructions for the LPRM/APRM Unit (Reference (d46)), Instructions for the FLOW Unit (Reference (d48)), and the OPRM Unit User's Manual (Reference (c27)) contain information on parts replacement, consistent with information in Toshiba's configuration management system.
	Records shall be maintained for revision history and changes.	Comply. Each module has a type number as shown in Table II-2-6 in Section II-2.2.4. When there is a design change, the module type number is changed. The type number and all applicable configuration item data is maintained in configuration management.
	Records shall be maintained for tracking failures.	Comply. Failures are controlled as nonconformance under the Toshiba QA program and are recorded and tracked.
	Testing shall be performed as necessary to maintain a qualified platform based on future revisions or replacements.	Comply. Toshiba will perform testing as necessary to maintain a qualified platform based on future hardware or FPGA programmable logic revisions or component replacements.
	The information necessary fulfill these task shall be obtained from manufacturer.	Comply. The information necessary to fulfill these tasks shall be maintained and provided by Toshiba.

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
4.7.8.2	Component Aging Analysis Requirements. A periodic surveillance and maintenance interval shall be determined per IEEE Std 323 to account for any significant aging mechanisms.	Comply. System specific periodic surveillance and maintenance intervals will be determined. There are no significant aging mechanisms, based on an evaluation of IEEE Std 323. The maintenance frequency is discussed in Section II-A-2.8.
4.7.9	Maintenance Human Factors. Descriptive information.	No requirement
4.7.9.A	Special PLC Manufacturer Equipment. The manufacturer shall provide documentation for PLC support equipment.	N/A. No special tools are required for routine maintenance of the PRM system.
4.7.9.B	Test Equipment Connections. Test equipment connections shall be supported by documentation and hardware, including interconnection devices. The manufacturer shall provide any special instruction for use of test equipment connections.	Comply. The Instructions for the LPRM Unit (Reference (d45)), Instructions for the LPRM/APRM Unit (Reference (d46)), Instructions for the FLOW Unit (Reference (d47)), and the OPRM Unit User's Manual (Reference (c27)) include information for maintenance, including requirements for measuring and test equipment and connection of M&TE.
4.7.9.C	Job Aids. Aids for operating the PLC equipment shall be provided.	Comply. The Instructions for the LPRM Unit (Reference (d45)), Instructions for the LPRM/APRM Unit (Reference (d46)), Instructions for the FLOW Unit (Reference (d47)), and the OPRM Unit User's Manual (Reference (c27)) include necessary information for operation, maintenance, surveillance, and calibration of the PRM system.
4.7.9.D	Help Screens. Help screens for software used to support maintenance shall be provided.	N/A. In the future, Toshiba may determine that supplying a software tool for validation of certain ROM content would be appropriate, in which case, Toshiba will supply a software tool for such validation to customers. Such a software tool would include any required help screens. This software tool is not part of the current Topical Report.
4.8	Requirements for Third Party/Sub-Vendor Items. All items provided by sub-vendors or third parties shall be subjected to all applicable requirements and tests. Compatibility of operation with the PLC shall be demonstrated through tests.	Comply. All items provided by sub-vendors or third parties are subjected to all applicable Toshiba requirements and tests performed by Toshiba. Compatibility of operation with the FPGA-based unit is demonstrated through tests. Toshiba performed CG survey and CDR for Third Party/Sub-Vendors as documented in Section I-2.2.2 and Section I-A-3.2.2.
4.9	Other. (section heading)	No requirement
4.9.1	Data Handling and Communication Interface Overview. Descriptive information.	No requirement

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
4.9.1.1	Peripheral Communication Requirements. The PLC executive and/or application software tools shall provide features to prevent loss of serial communication from degrading the application program. Communication overhead time shall be deterministic. Peripheral communications shall support at least 1000 character communication buffers. (Note: 1 character = 1 byte. A real variable uses 8 bytes or eight characters). Serial communications shall support checksum (or equivalent) data quality checks. Requirements for redundant communication hardware.	N/A. This requirement does not apply since the PRM and OPRM do not require or use a PLC and their peripheral communication port. If serial communication is provided to an external system, the loss or degradation of that serial communication link will not degrade the operability of the safety function.
4.9.1.2	PLC Peer-to-Peer Communication Requirements. Peer-to-peer link shall meet requirements of Section 4.3.4.4, except item B. Communication time shall be deterministic. Communication errors shall not affect other portions of the application program or inhibit the PLC scan cycle. Queues for communicated data shall be supported and queue status shall be available to the communication program. Loss of communication shall be detected and made available to the application program. Use of the peer-to-peer communication link shall support the response time requirement given in Section 4.2.1.A.	Comply. Communication on fiber optic communication links between units is documented in Section II-2.1.4.3.
4.9.2	Overall System Security Requirements. Switching the main processor from RUN mode to other modes shall be by key lock switch.	Comply. Since no portion of the application program can be changed at the utility, the PRM application cannot be changed from the front panel. Switches and keylocks are used to change configuration parameters including constants as documented elsewhere (Item 4.4.7.2.B) in these responses. The configuration, including adjustable parameters, is protected by keylock switches. Toshiba implements an SDOE-compliant process for the design, development, manufacturing, review, and testing of these systems.
	Features shall ensure that redundant components operate in the same mode, and that program changes are loaded into all redundant processors.	N/A. The PRM or OPRM does not use redundant processors.

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
4.9.2 (continued)	Provisions shall prevent modification of the application program and operating system while the PLC is on-line.	N/A. The application logic of the PRM and OPRM is installed in the NRW-FPGAs, and cannot be modified in the field.
4.9.3	Heartbeat Requirements. The PLC shall provide capability to activate a "heartbeat" external to the PLC.	Application Specific Requirement. The Toshiba PRM hardware does not include an available output point to operate an external "heartbeat" indicator. Rather, each module includes separate internal hardware to verify that each module completes its programmable logic program within the expected time frame. Each module receiving data from a separate FPGA module verifies that the module transmitting data sends the data in a timely manner. Thus, Toshiba provides an equivalent implementation of this requirement using internal hardware separate from the programmable logic.
4.9.4	Hazardous Materials Requirements. Material data sheets shall be provided for all hazardous materials associated with the PLC.	Comply. There are no hazardous materials in the PRM or OPRM.
4.10	Shipping and Handling Requirements. Packaging and shipping shall be in accordance with ANSI N45.2.2.	Comply. Packaging and shipping will be in accordance with ANSI N45.2.2 Level A when shipped to the plant.
4.10.1	Packaging Requirements. Descriptive information.	No requirement
4.10.1.A	Items Shipped. Shall be packaged to avoid damage or degradation due to various environmental and handling factors which may be encountered during shipping and storage.	Comply. Items will be packaged to avoid damage or degradation due to various environmental and handling factors which may be encountered during shipping and storage when shipped to the plant, including maintenance of cyber security.
4.10.1.B	Items Shipped. Packaging shall include desiccant materials as required.	Comply. Packaging will include desiccant materials as required by the customer.
4.10.1.C	Items Shipped. Items shall be inspected for cleanliness prior to packaging. Items not immediately packaged shall be protected from contamination.	Comply. Items will be inspected for cleanliness prior to packaging when shipped to the plant. Items not immediately packaged will be protected from contamination when shipped to the plant.
4.10.1.D	Items Shipped. Cushioning shall be provided to protect against shock and vibration.	Comply. Cushioning will be provided to protect against shock and vibration when shipped to the plant.
4.10.1.E	Items Shipped. Items and containers shall be marked with appropriate identification.	Comply. Items and containers will be marked with appropriate identification when shipped to the plant.
4.10.1.F	Items Shipped. Copies of packing lists shall be included with each carton shipped.	Comply. Copies of packing lists will be included with each carton shipped when shipped to the plant.
4.10.1.G	Items Shipped. ESD sensitive items shall be appropriately packaged, handled and marked.	Comply. ESD sensitive items will be appropriately packaged, handled, and marked when shipped to the plant. This will include all modules having integrated circuits.

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
4.10.1.H	Items Shipped. Packaging shall be suitable for movement using hand trucks.	Comply. Packaging will be suitable for movement using hand trucks when shipped to the plant.
4.10.1.I	Items Shipped. Special handling or storage requirements shall be marked on the containers.	Comply. Special handling or storage requirements will be marked on the containers when shipped to the plant.
4.10.1.J	Items Shipped. See Section 4.4.2 for requirements for software storage media.	N/A. The PRM or OPRM do not provide software media to utilities. The NRW-FPGA is not rewritable, so no media is necessary, as the program is permanently embedded in the FPGA antifuse memory.
4.10.2	Shipping Requirements. Requirements for mode of shipping, use of fully enclosed vehicles, special handling and stacking instructions as necessary, and container markings and protective covers.	Comply. Shipping requirements will be specified when shipped to the plant. Requirements will include use of fully enclosed vehicles, special handling and stacking instructions as necessary, and container markings and protective covers.
4.10.3	Storage Requirements. Storage and shelf life requirements shall be provided for all PLC items.	Comply. Storage requirements will be provided for all items. Requirements for storage will include temperature, humidity, and any static control requirements.
5	Acceptance/Operability Testing. Descriptive information.	No requirement
5.1	Acceptance/Operability Testing Overview. The development, design and performance of acceptance testing shall use the documentation requirements of Section 8.14.	(See Item 8.14 in this table.)
5.2	Pre-Qualification Acceptance Test Requirements. Descriptive information.	No requirement
5.2.A	Application Software Objects Testing. Testing of the software objects in the PLC library shall be performed. This testing shall be in addition to any testing performed by the manufacturer.	Comply. All FPGA application programs are developed using Functional Elements (FEs) as documented in Part V (VVR of PRM) and Part VI (VVR of OPRM) of this LTR. FEs are similar to Application Software Objects (ASOs). FEs are written by Toshiba and are completely tested using pattern test methods. The pattern tests are considered to be comparable to application software objects acceptance (ASOA) tests.
5.2.B	Initial PLC Calibration. The generic qualification sample PLC shall be calibrated to NIST traceable sources. The acceptance criteria are that the analog I/O modules meet the manufacturer's specifications	Comply. The test specimens were tested using test equipment calibrated to sources traceable to the National Metrology Institute of Japan (NMIJ). NMIJ is a signatory to the Bureau International des Poids et Mesures (BIPM), as is the National Institute of Standard and Technology (NIST). Test facility's calibrations are thus traceable to NIST. The acceptance criteria are that the equipment accuracy meets the requirements specified in Section 5.1.4 of the ERS.
5.2.C	System Integration. System integration testing portion of TSAP V&V shall be performed during acceptance testing.	Comply. The system integration testing portion of the V&V phase in the digital system life cycle is performed during system validation testing as documented in Part V (VVR of PRM) and Part VI (VVR of OPRM) of this LTR.

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
5.2.D	Operability Tests. The Operability Test shall be performed during acceptance testing.	Comply. The operability test is performed during pre-qualification testing, and during qualification testing as documented in Section III-2.1.1 and Section III-2.2 for the PRM qualification test, and in Section III-5.1.1 and Section III-5.2 for the OPRM qualification test.
5.2.E	Prudency Tests. The Prudency Test shall be performed during acceptance testing.	Comply. The prudency test is performed during pre-qualification testing, and during qualification testing as documented in Section III-2.1.1 and Section III-2.2 for PRM qualification test, and in Section III-5.1.1 and Section III-5.2 for the OPRM qualification test.
5.2.F	Burn-In Test. A minimum 352 hour burn-in test shall be performed during acceptance testing.	Comply. Toshiba's 352 hour burn-in test was performed on the PRM units as documented in Section III-2.1.1. For OPRM unit, the 352 hours burn-in occurred during system validation test.
5.3	Operability Test Requirements. Descriptive information.	No requirement
5.3.A	Accuracy. Accuracy checks shall be performed on the analog input/output modules.	<p>Comply. Accuracy checks were performed for PRM safety-related functions for analog inputs and outputs in the operability test during the PRM qualification testing. Test results for the PRM qualification testing are documented in Section III-2. The acceptance criteria for the PRM are described in the ERS Section 7.2.2.A as follows"</p> <p>Accuracy checks shall be performed for PRM safety-related functions defined in Section 4.1.2 for analog inputs and outputs. Minimum five point linearity checks shall be made on the analog inputs and outputs. The test shall be performed on at least one channel of each type of analog inputs and /outputs in the qualification envelope.</p> <p>For the OPRM, there are no analog inputs or outputs, and thus this does not apply, as documented in Section 5.1.5.3 of the EDS (Reference (c28)).</p>

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
5.3.B	<p>Response Time. Response time of analog input to discrete output and discrete input to discrete output sequences shall be measured. For baseline (acceptance) testing, the acceptance criteria are that the measured response time shall not vary more than 20% from the value calculated from manufacturer's data. For all subsequent testing, the measured value shall not vary more than 10% from the baseline.</p>	<p>Comply. For PRM, the response time between receiving an analog input and generating a discrete output for safety-related functions and the response time between receiving a discrete input and generating a discrete output for those safety-related functions defined in ERS Section 4.1.2 is measured in such a way that repeatable results can be obtained. The acceptance criteria are that the measured response time for the baseline testing shall be equal to or less than the response time given in Section 5.1.3.1 of the ERS.</p> <p>The acceptance criteria for the response time shown in Item 4.2.1A of the EPRI TR-107330 do not include the variance threshold for the response time. The criteria only require the measured values should be less than the required value. This is based on the system requirements. Toshiba's evaluation is based on the properties of an FPGA system, where signal processing is done by hardware not by sequentially executed software like in a PLC.</p> <p>In the operability tests conducted during the qualification tests, Toshiba only performed a limited number of the tests conducted in the pre-qualification test. For details please see Table IV-4-2 Toshiba evaluated the variance per the NRC question and confirmed the variance is within requirements.</p> <p>For the OPRM, there are no analog inputs or outputs. The requirement for the response time of the OPRM unit is defined in EDS Section 5.1.4 item 6B which does not include the variance threshold for the response time. The criteria only require the measured values should be less than the required value. This is based on the system requirements. The response time test was conducted in the System Validation Testing. The results of the response time test for OPRM are documented in the Part VI of this LTR.</p>

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
5.3.C	<p>Discrete Input Operability. Discrete inputs shall be tested for capability to detect changes in the inputs.</p>	<p>Application Specific Requirement. For the PRM and OPRM, the discrete inputs were tested for their ability to detect changes for safety-related functions in operability test during qualification testing.</p> <p>For the PRM, Section 7.2.2 C of the ERS states as follows: The discrete inputs shall be tested for their ability to detect changes for safety-related functions defined in Section 4.1.2. These tests shall be performed on at least one channel of each type of discrete input module. The acceptance criteria is that the operational modes of safety-related functions shown in Section 4.1.2 shall be changed according to discrete input within the unit and module requirements given in Sections 5.2.2.2 and 5.2.2.3. The DIO module is responsible for setting the operation mode of the PRM. Toshiba tested that the operational mode was set correctly. The DIO module was fully tested in the factory against manufacturing specification. The Reference to the test results are as follows: Changes of the safety-related setpoint by DI status were tested in accordance with the Operability Test Procedure (FPG-TPRC-C51-1009 Rev.5). The results of the Operability Tests were recorded in the Operability Test Record (FPG-06-ETR-001-03), the Pre-Operation Test Record (FPG-06-ETR-002-02), the Environmental Test Record (FPG-06-ETR-002-04a), the Seismic Test Record (FPG-06-ETR-002-05), the Preparation for EMC Test Record (FPG-06-ETR-002-6a), the Post Qualification Tests (Before re-exchange of modules) Record (FPG-06-ETR-002-11), and the Post Qualification Tests (After re-exchange of modules) Record (FPG-06-ETR-002-13).</p> <p>For the OPRM Section 5.2.1 of the OPRM Unit Detailed Design Specification (OPRM Unit DDS) (Reference (C29)) discusses Filtering Initialization Circuit and Algorithm Initialization Function when APRM Bypass Input is cancelled (APRM Bypass turns to disable from enable.)</p> <p>The Reference to the test results are as follows: APRM bypass discrete input was tested in the operability test in accordance with Operability Test Procedure (FC51-7021-1003 Rev.1) Section 6.4. The results of the Operability Tests were recorded in the Performance Proof (Pre-Qualification for EQ Test) Test Record (FC51-7021-1011), the Environmental Qualification Test Record (FC51-7021-1012), the Seismic Test Record (FC51-7021-1014), the Performance Proof (Post-Qualification for EQ Test) Test Record (FC51-7021-1015), the Performance Proof (Pre-Qualification for EMC Test) Test Record (FC51-7021-1026), and the Performance Proof (Post-Qualification for EMC Test) Test Record (FC51-7021-1027).</p>

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
5.3.D	Discrete Output Operability. Discrete outputs shall be tested for ability to operate within rated voltages and currents.	<p>Application Specific Requirement. For the PRM and OPRM, the discrete outputs for safety-related functions were tested for their ability to perform their safety related functions in operability test during qualification testing.</p> <p>For the PRM, ERS Section 7.2.2 D states as follows:</p> <p>The discrete output for safety-related functions defined in Section 4.1.2 shall be tested for their ability. The test shall be performed on at least one channel of each type of discrete output in the qualification envelope. The acceptance criteria are that the discrete output of safety-related function which is shown in Section 4.1.2 shall be changed within the unit and module requirements given in Sections 5.2.2.1, 5.2.2.2, and 5.2.2.3.</p> <p>Toshiba confirmed that the DIO modules perform the required safety functions. The DIO modules are designed to operate in the environmental conditions, and nothing tested would change the voltage or current capabilities of the output points. Since the outputs are either votes to trip or annunciation points, there is no requirement to drive high power or high current loads. The testing provided was appropriate for inputs to reactor trip systems and annunciators. The monitoring of the output of DIO module was performed through relays which are driven by the DIO module. These relays are parts of the test equipment and provide isolation.</p> <p>For the OPRM, Section 5.2.2.3.5 of the EDS defines the requirement for trip and alarm generation. Tests were conducted in accordance with Operability Test procedure (FC51-7021-1003 Rev.1) Sections 6.3, 6.5, and 6.7.</p> <p>For documentation of the test record, please see Item 5.3 C in this table.</p>
5.3.E	Communication Operability. If any communication functions are included in the qualification envelope, then operability of the ports shall be tested. Tests shall look for degradation in bit rates, signal levels and pulse shapes of communication protocol.	<p>Application Specific Requirement. No acceptance criterion is defined in the PRM ERS and the OPRM EDS, because Toshiba considered this to be a requirement for copper-based electronic serial communication ports, which the PRM and the OPRM do not have. The PRM does not have a fiber optic receiver for data outside the PRM. The OPRM only receives data from the LPRM and APRM units. The PRM and the OPRM do have fiber optic communication for internal communication, which Toshiba tested in the factory by intentionally degrading the light intensity by inserting the attenuator in the fiber communication line, and also tested in the qualification test by monitoring the alarms.</p> <p>This EPRI TR-107330 requirement to check degradation in bit rates, signal levels, and pulse shapes of communication protocol is not appropriate to fiber optic communication. The PRM and the OPRM bit rate is immaterial, within reasonable bounds, as the fiber optic signal is self-clocking. To implement this during EQ test would require Toshiba to place modules or extenders to hook up instruments, which is not the actual operational state of the unit and would not provide EQ testing results consistent with the intended in-plant configuration. Thus Toshiba relied on communications alarms to detect faults and failures in the fiber optic communication. The intentional attenuation of light intensity in internal data links within the PRM and the OPRM was one of the test items during factory module tests.</p>

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
5.3.F	Coprocesor Operability. If any coprocessors are included in the qualification envelope, then tests shall be performed specifically on these coprocessors.	N/A. The PRM or OPRM does not use coprocessors.
5.3.G	Timer Tests. Accuracy of timer functions shall be tested.	N/A. The PRM or OPRM does not provide any separate timer functions. The EPRI TR provides generic requirements for qualifying a general purpose PLC. For the PRM and OPRM functions, the specific timing functions required are hardcoded into the logic, and then verified and validated during the software lifecycle, culminating in system validation testing.
5.3.H	Test of Failure to Complete Scan Detection. The function of the mechanism to detect failure to complete a scan shall be tested. The power up testing of this feature may be used to establish its operability.	Comply. The PRM or OPRM does not need separate scan failure detection. Each module includes separate hardware to verify that each module completes its programmed logic within the expected time frame. Each module receiving data from a separate FPGA module verifies that the module transmitting data sends the data in a timely manner. Thus, Toshiba provides an equivalent implementation of this requirement using internal hardware and programmed logic. The logic is implemented in a parallel implementation, and detection of failure to complete an FPGA-specific function is detected and alarmed by hardware watchdog timers external to the FPGAs. If the logic is not completing in an acceptable time, the watchdog time expires, which triggers the INOP alarm which Toshiba monitored during all testing.
5.3.I	Failover Operability Tests. If redundancy with automatic transfer to a redundant device is used, tests shall be performed to establish operability of the failover hardware.	<p>Comply. For the PRM and OPRM, failover to the redundant AC power source test was performed during operability testing during qualification testing. For the PRM and OPRM, Toshiba performed tests in which the voltage of one of the two redundant Low Voltage Power Supplies (LVPSs) outputs of each unit were lowered to the level at which Fail signal status occurred to the LVPS module, and confirmed that each redundant power supply operated correctly without generating "Fail" signal. The tests were performed during the Pre and Post Qualification Testing.</p> <p>The DIO module that has safety functions was monitored and the recorded officially in the PRM and the OPRM. For the PRM, the monitoring of the analog output (AO) module that has non-safety function is not included in the acceptance criteria and the results are not included in the official test records. However, Toshiba confirmed that a recorder monitored the output of the analog output module, reviewed the results, and confirmed that the results were acceptable.</p> <p>The OPRM does not have an AO module.</p> <p>For the documentation of test record, please see Item 5.3 C in this table.</p>

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
5.3.J	Loss of Power Test. The AC and DC power sources shall be shut off for at least 30 seconds and reapplied.	<p>Comply. The AC power source was shut off for at more than 30 seconds and then reapplied. For the PRM and OPRM, the loss of power tests were performed during operability testing during qualification testing.</p> <p>The DIO module that has safety functions was monitored and was used to demonstrate power fail and recovery during the PRM testing and during the OPRM testing. For the PRM, the monitoring of the AO module that has no safety function is not included in the acceptance criteria and the results are not described in the official test records. However, Toshiba confirmed that a recorder monitored the output of the AO, reviewed the results, and confirmed that the results were acceptable.</p> <p>The OPRM does not have AO module.</p> <p>For the documentation of test record, please see Item 5.3 C in this table.</p>
5.3.K	Power Interrupt Test. The AC power sources shall be interrupted for a 40 millisecond hold-up time.	<p>Comply. The AC power source is interrupted for 40 ms. For the PRM and OPRM, the power interruption tests were performed during the operability testing during qualification testing.</p> <p>Power to both of the redundant power supplies was interrupted. The DIO that has safety functions was monitored and the recorded officially in the PRM and the OPRM, For the PRM, the monitoring of analog output module that has not safety function is not included in the acceptance criteria and the results are not included in the official test records. However, Toshiba confirmed that a recorder monitored the output of the AO module, reviewed the results, and confirmed that the results were acceptable.</p> <p>The OPRM does not have AO module. For the documentation of test record, please see Item 5.3 C in this table.</p>
5.4	Prudency Testing Requirements. The Prudency tests shall be performed with the power supply sources at the minimum values specified in Section 4.6.1.1.	<p>Comply. Failure of one of the redundant LVPS modules is simulated in the fault simulation test. The PRM and OPRM system successfully detected the failure and continued normal operation with power from the other LVPS module in the prudency test during qualification testing.</p> <p>For the documentation of test record, please see Item 5.3 C in this table.</p>

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
5.4.A	Burst of Events Test. Tests shall be performed to verify operation of the PLC under highly dynamic input/output variation conditions.	<p>Application Specific Requirement.</p> <p>For the PRM: The Burst of Events test is designed to ensure that a programmable logic controller (PLC) can cope with a burst of discrete input (DI) changes occurring simultaneously without causing increased scan processing time. This effect does not happen in FPGAs with parallel logic. For the PRM and OPRM, there is no general purpose DI. However, Toshiba did demonstrate that the special purpose DIs operate correctly within the requirements.</p> <p>Each logic element can work in parallel with synchronization of the clock signals, which are far shorter than the response time. The timeout of the signal processing is monitored by the watchdog timer.</p> <p>For Discrete Input (DI) toggling, all DIs (Reactor Operational Mode, APRM Bypass, and FLOW Bypass) are toggled. The acceptance criterion is that APRM High-High Trip occurs within 40 milliseconds after the Reactor Operational Mode DI is changed to OFF.</p> <p>In this DI toggling, the APRM High-High Trip is the only safety related output which changes its status with DI toggling. Accordingly, Toshiba considers that this test satisfies the requirements in Section 5.4A of EPRI TR-107330.</p> <p>For Analog Input (AI) toggling, all AIs (LPRM inputs and Flow inputs) are toggled. The acceptance criterion is that APRM High-High Trip occurs within []^{acc} milliseconds after the APRM AO outputs exceed 120.0% level. In this AI toggling, the APRM High-High Trip is the only safety related output that changes its status with DI toggling. The accuracy was verified in the operability test. Toshiba considers that this test satisfies the requirements of Section 5.4A of EPRI TR-107330.</p> <p>To test the output and communication against the EPRI TR-107330 requirements, the test specimen would require different FPGA logic. In keeping with Equipment Qualification testing requirements, Toshiba considered it is more appropriate to perform type testing with the real PRM logic rather than create and test with FPGA logic with significant differences.</p> <p>For the OPRM: The PRM Bypass signal toggling test, LPRM Level Toggling test, and APRM Level and Core Flow Level Toggling tests were performed in accordance with Prudency Test Procedure (FC51-7021-1003) Section 6.2, Burst of Events.</p> <p>For the documentation of test record, please see Item 5.3 C in this table.</p>

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
5.4.B	<p>Failure of Serial Port Receiver Test. The receiving device connected to the main processor serial communication port shall be simulated to fail in various modes. PLC response time shall be verified to not degrade unacceptably.</p>	<p>Application Specific Requirement. There is no Serial Port Receiver for the PRM. The Failure of Serial Port Receiver Test was performed for the OPRM optical serial transmission port during the OPRM prudency test.</p> <p>Toshiba conducted room temperature factory product tests using an attenuator in each of the fiber optic links. Toshiba confirmed that the fiber optic links remained operable with about []^{ac}dbm light intensity and that no alarms were generated. Toshiba then confirmed that further decrease of the optical intensity does generate alarms by further attenuating the light intensity. This test confirmed that alarms are generated and that monitoring in the operability test is sufficient to detect and alarm when degraded fiber optic communication links occur. Toshiba does not interpret the requirements in TR-107330 as such that intentional degradation of the communication is required in the qualification testing.</p> <p>However, through the discussion with the NRC, Toshiba understood that the real intent of the questions is to confirm if Toshiba found any impacts on the response time by intentionally degrading the external fiber optic communication. Degrading the fiber optic communications has no adverse effects on time response as long as communication is still occurring.</p> <p>The PRM and the OPRM does not have any receiving port for external communication. The PRM has only transmit (TRN) modules to send data to external systems. The TRN module has only transmission ports and no receiving ports. There are no receiving modules for external data in the PRM and the OPRM. The PRM and the OPRM are not designed to accommodate any RCV modules for external communication. The installation of such an RCV module is not allowed and is impossible by the design of the programmable logic. Because the PRM and the OPRM do not have any external receiving ports, Toshiba did not conduct a failure of the serial port receiver test during equipment qualification testing. Toshiba views the tests performed at the factory sufficient demonstration for the PRM.</p> <p>Since the back panel and chassis design is unique to the PRM, the general serial communication boards that can be used in PLC cannot be used in the PRM. Regarding the RCV module and TRN module used for internal communication within the PRM, Toshiba conducted the factory test and operability/prudency test as stated earlier in this response. Please note that Failure of Serial Port Receiver Test was performed for the OPRM optical serial transmission port during the OPRM prudency test by plugging out the other end of the fiber optic cable connected the test equipment that works for sending the LPRM data.</p> <p>For the documentation of test record, please see Item 5.3 C in this table.</p>
5.4.C	<p>Serial Port Noise Test. The transmit line to the main processor serial communication shall be subject to white noise. PLC response time shall be verified to not degrade unacceptably.</p>	<p>Application Specific Requirement. Please see Item 5.4.B in this table.</p>

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
5.4.D	Fault Simulation. For PLCs that include redundancy, failures in redundant elements shall be simulated.	<p>Comply. For the PRM and OPRM, failure of one of the redundant LVPS modules was simulated in prudency test during qualification testing. The PRM and OPRM system successfully detected the failure (using self-diagnosis) and transferred to the other LVPS module. The PRM and continued normal operation without suffering any degraded operation.</p> <p>Please see Item 5.3. I in this table.</p> <p>For the documentation of test record, please see Item 5.3 C in this table.</p>
5.5	<p>Operability/Prudency Testing Applicability Requirements. As a minimum, Operability and Prudency tests shall be performed:</p> <ul style="list-style-type: none"> - During acceptance testing: Operability – All, Prudency – All - During environ. testing: Operability – All, Prudency – All - During seismic testing: Operability – All, Prudency – All - After seismic testing: Operability – All, Prudency – None - During EMI/RFI testing: Operability – All except analog I/O checks, Prudency – Only burst of events test - After ESD testing: Operability – All, Prudency – None 	<p>Comply. For the PRM and OPRM, operability and prudency tests were performed at the Pre-qualification test, the Environmental test, Post SSE test, and Performance Proof test during qualification test. Test results for the PRM qualification testing are documented in Section III-2, and test results for the OPRM qualification are documented in Section III-5. For the documentation of test record, please see Item 5.3 C in this table.</p> <p>Comply with limited scope and/or condition. Due to the short duration of seismic SSE tests, and special set-up required for the EMI/RFI tests, complete Operability and Prudency Tests cannot be performed during the seismic event or during EMI/RFI testing. Toshiba chose to monitor the equipment operation during the test and perform the operability and prudency tests before and after the tests to ensure that the PRM and OPRM remained operable during and after the seismic event and EMI/RFI testing.</p> <p>Separate Table IV-4-3 and Table IV-4-4 provide the test details of the PRM Operability/Prudency testing.</p> <p>Separate Table IV-4-8 and Table IV-4-9 provide the test details of the OPRM Operability/Prudency testing</p>
5.6	Application Software Objects Acceptance (ASOA) Testing. Requirements for ASOA testing.	<p>(See Item 5.2.A in this table.)</p> <p>All ASOA testing was performed under the 10CFR50 Appendix B program during Verification and Validation.</p>
6	Qualification Testing and Analysis. Descriptive information.	No requirement
6.1	Qualification Process Overview. Descriptive information.	No requirement
6.1.1	PLC System Qualification Overview. Descriptive information.	No requirement

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
6.2	PLC System Test Configuration Requirements. Descriptive information.	No requirement
6.2.1	Test Specimen Hardware Configuration Requirements. Hardware configuration shall be developed and documented consistent with the requirements of Sections 6.5 and 8.6.2.	(See Items 6.5 and 8.6.2 in this table.)
6.2.1.A	Module Types. The test specimen shall include at least one type of module needed to encompass the requirements of Section 4.3. Multiple samples of configurable modules shall be included to cover the different configurations. For T/C modules, only one T/C type needs to be tested unless different types use different signal conditioning.	Comply. The test specimens for the qualification testing of the PRM and OPRM includes all modules needed to encompass the system requirements for one division. Section II-A-3 provides the Unit/Module configuration qualified for the PRM and for the OPRM.
6.2.1.B	Module Types. The test specimen shall include modules needed to support Operability testing.	Comply. The PRM and OPRM test specimens for the qualification testing included all modules needed to support system testing. Section II-A-3 provides the Unit/Module configuration qualified for the PRM and for the OPRM.
6.2.1.C	Ancillary Devices. The test specimen shall include at least one of each type of ancillary device needed to meet the TR requirements.	Comply. The test specimens for the qualification testing of the PRM and OPRM includes all equipment needed to meet the system specific requirements. Section II-A-3 provides the Unit/Module configuration qualified for the PRM and for the OPRM.
6.2.1.D	Chassis Types. The test specimen shall include at least one of each type of chassis needed to meet the TR requirements. Connections between chassis shall use maximum permissible cable lengths.	Comply. The test specimens for the qualification testing of the PRM and OPRM includes all required unit chassis needed to meet the system requirements. Section II-A-3 provides the Unit/Module configuration qualified for the PRM and for the OPRM.
6.2.1.E	Power Supplies. The test specimen shall include the power supplies needed to meet the TR requirements. Additional resistive loads shall be placed on each power supply output so that the power supply operates at rated conditions.	Comply. The test specimens for the qualification testing of the PRM and OPRM includes the LVPS modules needed to meet the system requirements. Section II-A-3 provides the Unit/Module configuration qualified for the PRM and for the OPRM.
6.2.1.F	Dummy Modules. Dummy modules shall be used to fill all remaining slots in the main chassis and at least one expansion chassis. The dummy modules shall provide a power supply and weight load approximately equal to an eight point discrete input module.	Comply. The PRM and OPRM test specimens for the qualification testing included dummy modules to fill all remaining slots in each unit chassis. Section II-A-3 provides the Unit/Module configuration qualified for the PRM and for the OPRM.

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
6.2.1.G	Termination Devices. The test specimen shall include at least one of each type of termination device and associated cabling used to provide field connections.	Comply. The PRM and OPRM test specimens for the qualification testing included all required connectors in the modules. Section II-A-3 provides the Unit/Module configuration qualified for the PRM and for the OPRM.
6.2.1.H	Redundant Devices. The test specimen shall include any devices needed to implement any redundancy included in the qualification envelope.	Comply. The test specimens for the qualification testing for the PRM and OPRM include redundant LVPS modules. Redundant fiber optic cables were provided for LPRM data communication in the PRM. Section II-A-3 provides the Unit/Module configuration qualified for the PRM and for the OPRM.
6.2.1.I	Additional Modules. The test specimen shall include any additional modules needed to support Operability and Prudency testing and to support module arrangement variations.	Comply. The test specimens for the qualification testing for the PRM and OPRM includes all required modules needed to support Operability and Prudency testing. Section II-A-3 provides the Unit/Module configuration qualified for the PRM and for the OPRM.
6.2.1.1	Test Specimen Hardware Arrangement Requirements.	Comply. The hardware configuration of the Test Specimen is the qualified PRM or OPRM system. The Test Specimen for PRM qualification included one LPRM/APRM unit, one LPRM unit, and one FLOW unit. An additional FLOW unit was provided as test equipment, along with test equipment to simulate LPRM and FLOW unit inputs. The Test Specimen for OPRM qualification includes one OPRM unit and test equipment to provide test data to the OPRM. Section II-A-3 provides the Unit/Module configuration qualified for the PRM and for the OPRM.
6.2.2	Test Specimen Application Program (TSAP) Configuration Requirements.	Comply. The Toshiba NRW-FPGA-based PRM and OPRM systems were manufactured with the application specific logic required for each system. Rather than creating a TSAP, Toshiba used a BWR-5 specific PRM program. The Operability and Prudency testing were tailored to that application logic.
6.2.2.1	Coprocesor TSAP Requirements. If a coprocessor uses a high-level language, then it shall have its own TSAP which implements the given functions.	N/A. The Toshiba NRW-FPGA-based PRM or OPRM systems do not use coprocessors.
6.2.3	Test Support Equipment Requirements. Test equipment to support Acceptance and Operability testing shall be provided.	Comply. The test support equipment was documented for the PRM and OPRM qualification testing. Test support equipment for PRM qualification is documented in the Preliminary Technical Evaluation Report (PTER) (Reference (d38)). Test support equipment for OPRM qualification is documented in the Environmental Qualification Report (Reference (c20)), EMC Qualification Report (Reference (c21)), and Dynamic Qualification Report (Reference (c22)).

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
6.2.3.A	Test Support Equipment. Equipment shall include panels for connecting and simulating inputs and outputs.	Comply. Panels for connecting to the inputs and outputs and equipment for simulating inputs and monitoring outputs were provided for the PRM and QPRM qualification test. Test support equipment for PRM qualification is documented in the Preliminary Technical Evaluation Report (PTER) (Reference (d38)). Test support equipment for the OPRM qualification is documented in the EQ Test Plan (Reference (c10)) and EMC Test Plan (Reference (c11)).
6.2.3.B	Test Support Equipment. Equipment shall include test and measurement equipment with required accuracy.	Comply. Test and measurement equipment with required accuracy was provided for the PRM and OPRM qualification tests. Test support equipment for the PRM qualification tests is documented in the Preliminary Technical Evaluation Report (PTER) (Reference (d38)). Test support equipment for the OPRM qualification tests is documented in the EQ Test Plan (Reference (c10)) and EMC Test Plan (Reference (c11)).
6.2.3.C	Test Support Equipment. Equipment shall include special tools and devices needed to support testing.	Comply. Tools and devices needed to support testing were provided for the PRM and OPRM qualification test. Test support equipment for the PRM qualification tests is documented in the Preliminary Technical Evaluation Report (PTER) (Reference (d38)). Test support equipment for the OPRM qualification tests is documented in the EQ Test Plan (Reference (c10)) and EMC Test Plan (Reference (c11)).
6.2.3.D	Test Support Equipment. All test equipment shall be controlled per IEEE Std 498.	Comply. All test equipment used in the PRM and OPRM qualification testing were controlled per IEEE Std 498.
6.3	Qualification Tests and Analysis Requirements. All testing shall be performed on a calibrated system with all user setpoint values adjusted to default values.	Comply. All tests were performed on the calibrated PRM and OPRM systems with setpoint values adjusted to the values defined in the test procedures.
6.3.1	Aging Requirements. Testing shall include environmental, electrostatic discharge (ESD), seismic, EMI/RFI and surge withstand testing. Environmental testing shall be performed first.	Comply. For convenience in testing, environmental testing for the PRM and OPRM qualification tests were performed before the other tests. Test results for the PRM qualification testing are documented in Section III-2. Test results for the OPRM are documented in Section III-5.
6.3.2	EMI/RFI Test Requirements. EMI/RFI testing to be performed as described in Section 4.3.7. Susceptibility tests to be performed at 25%, 50% and 75% of specified levels in addition to the specified levels.	Exception. The EMI/RFI tests for the PRM and OPRM qualification tests were performed at the maximum levels and the equipment passed, so no further threshold testing was required. Test results for the PRM qualification testing are documented in Section III-2. Test results for the OPRM qualification testing are documented in Section III-5.

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
6.3.2.1	EMI/RFI Mounting Requirements. Test specimen shall be mounted on a non-metallic surface six feet above floor with no secondary enclosure.	<p>Comply with limited scope and/or condition. Due to space limitations in the test facility's EMI/RFI chamber, the PRM and OPRM test specimens were not mounted six feet above the floor. The test specimens were mounted on an open metal rack that provided no significant shielding within the restrictions of the test chamber.</p> <p>Test specimen mounting for the EMI/RFI testing for the PRM qualification testing is documented in the Qualification Summary Test Report (Reference (d16)). Test mounting for the EMI/RFI testing for the OPRM qualification testing is documented in the EMC Qualification Report (Reference (c21)).</p>
	EMI/RFI Mounting Requirements. PLC shall be grounded per manufacturer's recommendations.	<p>Comply. The PRM and OPRM test specimens were connected to ground. The grounding used for these tests meets the grounding and shielding requirements documented in the Application Guide.</p> <p>Test specimen mounting for the EMI/RFI testing in the PRM qualification testing is documented in the Qualification Summary Test Report (Reference (d16)). The mounting for the EMI/RFI testing for the OPRM qualification testing is documented in the EMC Qualification Report (Reference (c21)).</p>

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
6.3.3	<p>Environmental Testing Requirements. Testing shall be performed using the temperature and relative humidity profile given in TR Figure 4-4. Margin shall be applied to maximum and minimum specified temperatures and humidifies. Power sources shall be set to maximize heat dissipation. PLC shall be energized with TSAP operating. One-half of all discrete and relay outputs shall be on and energized to rated current. All analog outputs shall be set to one-half to two-thirds full scale output.</p>	<p>Comply with limited scope and/or condition. Environmental testing was performed to the environmental withstand requirements documented in EPRI TR-107330 to assure that the PRM and OPRM systems do not fail due to temperature and humidity stressors.</p> <p>Environmental tests were performed with power supply conditions that resulted in maximum heat dissipation into the PRM and OPRM systems. Test results for the PRM environmental tests are documented in the Qualification Test Summary Report (Reference (d16)) Test results for the OPRM environmental tests are documented in the Environmental Qualification Report (Reference (c20)).</p> <p>The PRM and the OPRM systems were qualified as follows, based on EPRI TR-107330 Figure 4-4 and Section 4.3.6:</p> <p>PRM:</p> <ul style="list-style-type: none"> a. High Temperature and Humidity: 140 °F and 95% relative humidity, which meets EPRI TR-107330 Section 4.3.6 and Figure 4-4 requirements (Toshiba notes that adding 5% margin to the relative humidity would most likely induce condensation, which is not included in Toshiba's qualification envelope). b. Low Temperature and Humidity: 35 °F and 10% relative humidity, which meets EPRI TR-107330 Section 4.3.6 requirements (Figure 4-4 requirements for humidity could not be met in this chamber, even with relaxation for non-simultaneous temperature and humidity, and Toshiba notes that the OPRM is constructed of similar components and had no issues at 40 °F and 5% relative humidity which could be achieved in the environmental test chamber used for testing the OPRM). <p>OPRM:</p> <ul style="list-style-type: none"> a. High Temperature and Humidity: 140 °F and 90% relative humidity, which meets EPRI TR-107330 Figure 4-4 requirements (Section 4.3.6 requirements for humidity were met in separate testing at Toshiba, see Note below). b. Low Temperature and Humidity: 40 °F and 5% relative humidity, which meets EPRI TR-107330 Section 4.3.6 and Figure 4-4 requirements. <p>Note: OPRM testing with 140 °F and 95% relative humidity profile was successfully met in the factory test which was performed under Toshiba's ISO 9001 program separately from the EQ test.</p>

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
6.3.3.1	Environmental Test Mounting Requirements. PLC shall be mounted on a simple structure. Air temperature at bottom of chassis shall be monitored. No additional cooling fans shall be included.	Comply. The PRM and OPRM test specimens were mounted in the environmental chamber on a simple structured rack that does not enclose the chassis. Air temperature was monitored at the bottom of the chassis. No additional cooling fan was included in the chamber. Test specimen mounting for the environment testing in the PRM qualification testing is documented in the Qualification Summary Test Report (Reference (d16)). Test specimen mounting for the OPRM qualification testing is documented in the Environmental Qualification Report (Reference (c20)).
6.3.4	Seismic Test Requirements. PLC shall be vibration aged using five OBEs with the RRS as shown in TR Figure 4-5 followed by an SSE with the RRS shown in TR Figure 4-5. Testing shall conform to IEEE Std 344. Tri-axial, random, multi-frequency tests shall be used. Repairs during testing shall conform to IEEE Std 344.	Comply with limited scope and/or condition. Seismic testing uses five OBEs with the Required Response Spectrum (RRS) as shown in EPRI TR-107330 followed by an SSE in both the PRM and OPRM qualification testing. Test results of the PRM qualification testing are documented in Section III-2. Test results for the OPRM qualification are documented in Section III-5. Due to the limitations of the Test facilities, the SSE profile in the ERS requirement could not be achieved in the PRM test. Achieved responses will be provided in the Qualification Test Summary Report Revision 2 that has the seismic qualification profile for the PRM. The OPRM achieved the desired seismic test profile for 5% dumping SSE. See Item 4.3.9 for more details.
6.3.4.1	Seismic Test Mounting Requirements. Test specimen shall be mounted per manufacturer's recommendations. Mounting structure shall have no resonances below 100 Hz. Most susceptible mounting configuration shall be tested. All mounting screws shall be torqued to known values.	Comply. The PRM and OPRM test specimens were mounted on a structure that is stiff enough so that there are no resonances below 100Hz with the test specimen mounted on the test structure and the shake table. A resonance search was performed to verify this requirement for both PRM and OPRM. Test specimen mounting for the seismic test for the PRM qualification testing is documented in the Qualification Summary Test Report (Reference (d16)). The mounting for the seismic test for the OPRM qualification testing is documented in the Dynamic Qualification Report (Reference (c22)).
6.3.4.2	Seismic Test Measurement Requirements. Relay contacts shall be monitored for chatter. One half of the relays shall be energized and on half de-energized. One quarter of the relays shall transition from ON to OFF and one quarter from OFF to ON during the tests. The PLC shall be powered with the TSAP operating. One half of the discrete outputs shall be ON and loaded to their rated current. Power sources shall be at lower voltage and frequency limits. One or more response accelerometers shall be mounted on each chassis.	N/A. Relay contacts were not included in the PRM and OPRM qualification tests.

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
6.3.4.3	Seismic Test Performance Requirements. Seismic test shall include a resonance search, five OBE's, one SSE and an Operability test.	Comply. The following tests were performed in the order shown for both the PRM and the OPRM qualification: (1) Resonance Search (2) Five tri-axial OBEs (3) One tri-axial SSE (4) Operability Test Test results for the PRM qualification testing are documented in Section III-2. Test results for the OPRM qualification testing are documented in Section III-5.
6.3.4.4	Seismic Test Spectrum Analysis Requirements. The test response spectrum from the control and specimen response accelerometers shall be reported at 1/2, 1, 2, 3 and 5% damping.	Comply. The test response spectrum from the control and specimen response accelerometers provided 1/2, 1, 2, 3 and 5% damping for the PRM and the OPRM qualification testing. Test results for the PRM qualification testing are documented in Section III-2. Test results for the OPRM qualification are documented in Section III-5.
6.3.5	Surge Withstand Capability Testing. Surge testing shall be conducted per Section 4.6.2 and IEEE Std C62.45.	N/A. See Item 4.6.2 in this table for a description of the testing performed.
6.3.5.1	Surge Withstand Test Mounting Requirements. Test specimen shall be mounted on a non-metallic surface six feet above floor with no secondary enclosure. PLC shall be grounded per manufacturer's recommendations.	Comply with limited scope and/or condition. Due to space limitations in the test facility's EMI/RFI chamber, the PRM and OPRM test specimens were not mounted six feet above the floor while performing this test. The test specimens were mounted on an open metal rack that provided no significant shielding. The test specimens were grounded to meet Toshiba's requirements. Test specimen mounting for the Surge Withstand testing for the PRM qualification testing is documented in the Qualification Summary Test Report (Reference (d16)). The mounting for the OPRM qualification testing is documented in the EMC Qualification Report (Reference (c21)).
6.3.6	Class 1E to Non-Class 1E Isolation Testing. Test specimen shall be mounted on a non-metallic surface six feet above floor with no secondary enclosure. PLC shall be grounded per manufacturer's recommendations.	Comply with limited scope and/or condition. Due to space limitations in the test facility's EMI/RFI chamber, the PRM test specimen was not mounted exactly six feet above the floor while performing this test. The PRM test specimen was mounted on an open metal rack that provided no significant shielding. The PRM test specimen was grounded based on Toshiba's requirements. For OPRM, Class 1E to Non-Class 1E isolation testing was not performed. Test specimen mounting for the PRM for Class 1E to Non-Class 1E testing for the PRM qualification testing is documented in the Qualification Summary Test Report (Reference (d16)).
6.4	Other Tests and Analysis. (section heading)	No requirement

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
6.4.1	FMEA. An FMEA analysis of the PLC shall be performed.	<p>Comply. Separate Failure Modes and Effects Analysis (FMEA) were performed for the PRM and OPRM in accordance with IEEE Std 352-1987. For each component in each module, the analysis evaluates the component failure modes and effects on the PRM and OPRM units' performance.</p> <p>The FMEA for PRM is discussed in Section III-3.2.2. The FMEA for the OPRM is discussed in Section III-6.2.2.</p>
6.4.2	Electrostatic Discharge (ESD) Testing Requirements. ESD testing of the PLC shall be performed per EPRI TR-102323.	<p>Comply. ESD tests were performed to assure that the PRM and OPRM test specimen do not fail due to service condition for an ESD event level at a severity of Level 4, as specified in IEC 61000-4-2. (EPRI TR-107330 Section 4.3.8. and EPRI TR-102323, Appendix B, Section 3.5).</p> <p>ESD testing in the PRM showed that the rear panels were susceptible. The back panels in the units are accessible only when locked cabinet doors are opened. Thus, the back panels are not normally exposed to ESD. In normal use at a US plant, the cabinet doors are unlocked and opened only when work is to be done on the panels, such as maintenance or calibration, which is done with unit bypassed. Toshiba's application guide will be revised to state that the equipment past the plane of the door on the back panels should not be touched unless the technician or engineer is wearing a grounded ESD wriststrap. Please see Item 4.3.8 in this table.</p>
6.4.3	Power Quality Tolerance Requirements. Power quality tolerance testing shall be performed during acceptance testing, at the end of the elevated temperature test while still at high temperature and following seismic tests. The same AC source shall be connected to redundant power supplies during testing.	<p>Comply. Power Quality Tolerance tests to the input voltage range were performed in operability tests during qualification testing for both the PRM and OPRM.</p> <p>The redundant power supply modules were tested with the same AC power supply connected to both modules during the test.</p> <p>For the documentation of test record, please see Item 5.3 C in this table.</p>
6.4.4	Requirements for Compliance to Specifications. Test instrumentation measurement accuracy shall be considered. Compliance to specifications shall be considered for each module or grouping of modules.	<p>Comply. The Master Test Plan (Reference (d19)) defines the acceptance criteria for the PRM qualification testing, conforming to the requirements in Section 6.4.4 of EPRI TR-107330. The EQ Test Plan (Reference (c10)) and the EMC Qualification Test Plan (Reference (c11)) define the acceptance criteria for the OPRM qualification testing.</p>
6.4.4.A	Environmental Test Compliance. Environmental Operability test results shall be evaluated for compliance to specifications.	<p>Comply. Environmental Operability test results were evaluated for compliance to the specification for both PRM and OPRM qualification testing.</p> <p>Test results for the PRM environmental tests are documented in the Qualification Test Summary Report (Reference (d16)). Test results for the OPRM environmental tests are documented in the Environmental Qualification Report (Reference (c20)).</p>

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
6.4.4.B	Seismic Test Compliance. The seismic levels achieved during testing shall be used as the seismic withstand response spectrum.	<p>Comply with limited scope and/or condition. The seismic levels achieved during testing were used as the seismic withstand response spectrum in qualification testing for both the PRM and the OPRM.</p> <p>Due to the limitations of the Test facilities, the SSE profile in the ERS requirement could not be achieved in the PRM test. Achieved responses will be provided in the Qualification Test Summary Report Revision 2 that has the seismic qualification profile for the PRM. The OPRM achieved the desired seismic test profile. See Item 4.3.9 for more details.</p>
6.4.4.C	Class 1E to Non-Class 1E Test Compliance. Test levels shall be checked for compliance to Section 4.6.4 specifications.	<p>Comply. Test levels were checked for compliance to the specifications in the PRM qualification testing. The result of the PRM qualification testing is documented in Section III-2.</p> <p>For OPRM, Class 1E to Non-Class 1E isolation testing was not performed, as there are no non-Class 1E elements.</p>
6.4.4.D	Surge Withstand Test Compliance. Test levels shall be checked for compliance to Section 4.6.2 specifications.	<p>Comply. Test levels were checked for compliance to the specifications in qualification testing for both the PRM and the OPRM.</p> <p>Test results for the PRM qualification testing are documented in Section III-2. Test results for the OPRM qualification testing are documented in Section III-5.</p>
6.4.4.E	EMI/RFI Test Compliance. PLC performance shall be checked for compliance to Section 4.3.7 specifications.	<p>Comply with limited scope and/or condition. The performance of the PRM units was checked for compliance to the specifications in qualification testing for both the PRM and the OPRM.</p> <p>Test results for the PRM qualification testing are documented in Section III-2, and test results for the OPRM qualification testing are documented in Section III-5.</p> <p>The PRM and the OPRM pass the test with the modifications described below.</p> <p>The first EMI Susceptibility Test failed. The hardware was re-designed to resolve the test failure. Therefore, for the second EMI/RFI, Surge Withstand Capability, EFT/B, ESD and Class 1E to Non-1E Isolation tests, the new LPRM module and the new AO modules replaced the failed LPRM module and the failed AO modules. The re-designed LPRM and AO modules had additional capacitors to enhance electric-noise-withstand-capability and passed the test.</p> <p>For the Low-Frequency Conducted Emissions (CE101), additional inductance (coils) was needed in the PRM power leads to pass the test. For the OPRM, the PCF was developed and added to the test specimen, which passed CE101 test.</p>
6.4.4.F	Power Quality Test Compliance. Results shall be evaluated for compliance to Sections 4.6.1 and 4.2.3.7 specifications.	<p>Comply. Power quality tests were performed during operability testing during qualification testing for both the PRM and OPRM.</p> <p>For the documentation of test record, please see Item 5.3 C in this table.</p>

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
6.4.4.G	ASOA Test Compliance. Results shall be evaluated for compliance to Section 5.6 requirements.	(See Item 5.2.A in this table.)
6.4.4.H	Quality Assurance Program Compliance. Results of audits of manufacturer's QA Program shall be checked for compliance to Section 7 requirements.	Comply. Quality Assurance Program Compliance. Results of annual internal audits of QA Programs were checked. Toshiba concluded that the QA program was implemented effectively.
6.4.5	Human Factors. Descriptive Information.	No requirement
6.5	Quality Assurance Measures Applied to Qualification Testing. (Section Heading)	No requirement
6.5.A	Quality Assurance Measures Applied to Qualification Testing. Test program TSAP development shall meet the requirements of 10 CFR 50, Appendix B.	Comply. The FPGA logic lifecycle meets the requirements of 10 CFR 50, Appendix B, as documented in various USNRC Regulatory Guides and in the Standard Review Plan, Chapter 7, BTP 7-14. Section I-2.1 describes the QA programs in the current process. Section I-A-3 describes the QA process in the original process.
6.5.B	Quality Assurance Measures Applied to Qualification Testing. Hardware procurement shall meet the requirements of 10 CFR 50, Appendix B.	Comply. The hardware used for the qualification tests meets the requirements of 10 CFR 50, Appendix B. The procurement process in the current process is documented in Section I-2.2.3. The procurement process in the original process is documented in Section I-A-3.2.3.
6.5.C	Quality Assurance Measures Applied to Qualification Testing. Test specimen chain of custody shall meet the requirements of 10 CFR 50, Appendix B.	Comply. The PRM and OPRM test specimens were controlled in accordance with the Toshiba QA program, which complies with 10 CFR 50 Appendix B Program. Section I-2 describes the QA program used in the current process. Section I-A-3.1 describes the QA program used in the original process.
6.5.D	Quality Assurance Measures Applied to Qualification Testing. Tests and data analysis shall meet the requirements of 10 CFR 50, Appendix B.	Comply. Tests and data analysis were conducted in accordance with the Toshiba QA program, which complies with 10 CFR 50 Appendix B Program. Section I-2 describes the QA program used in the current process. Section I-A-3.1 describes the QA program used in the original process.
7	Quality Assurance. Descriptive information.	No requirement
7.1	QA Overview. Descriptive information.	No requirement
7.2	10 CFR 50 Appendix B Requirements for Safety-Related Systems. Descriptive information.	No requirement

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
7.2.A	10 CFR 50 Applicability. Regulations apply to all qualification activities.	Comply. The PRM and OPRM system qualification activities were performed in accordance with the requirements of the US Nuclear Regulations (including 10 CFR 50, Appendix B) and the Toshiba Corporation, Power Systems Company, Nuclear Energy (PSNE) QA Program. Section I-2 describes the QA program used in the current process. Section I-A-3.1 describes the QA program used in the original process.
7.2.B	10 CFR 50 Applicability. Regulations apply to application specific activities.	Comply. The PRM and OPRM system specific activities were performed in accordance with the requirements of the US Nuclear Regulations (including 10 CFR 50, Appendix B) and the Toshiba Corporation, Power Systems Company, Nuclear Energy (PSNE) QA Program. Section I-2 describes the QA program used in the current process. Section I-A-3.1 describes the QA program used in the original process.
7.2.C	10 CFR 50 Applicability. Regulations apply to any application-specific activities for dedication activities.	Comply. The commercial grade dedication activities for the PRM and OPRM were performed in accordance with the requirements of the US Nuclear Regulations (including 10 CFR 50, Appendix B) and the Toshiba Corporation, Power Systems Company, Nuclear Energy (PSNE) QA Program. Section I-2.2 describes the commercial grade dedication (CGD) process and activities performed under the current process. Section I-A-3.2 describes the commercial grade dedication process and activities performed under the original process.
7.2.D	10 CFR 50 Compliance. Manufacture's quality processes other than 10 CFR 50 shall be shown to be commensurate with 10 CFR 50.	Comply. For the PRM, NED used its CGD processes in procurement of the PRM from NICSD, and the manufacturer worked under its ISO 9001 quality program at that time. NED evaluated the process of NICSD and other suppliers, and issued a Job Order indicating QA program requirements to improve their process as described in Section I-A-3.2.2. For the OPRM, NICSD used its CGD processes in procurement of the OPRM modules from the module supplier. NICSD performed supplier evaluation as described in Section I-2.2.2.
7.2.E	10 CFR 50 Compliance. The qualifier shall perform audits to confirm that the manufacturer's quality process has been applied to the PLC product.	Comply. Audits were conducted to confirm that various quality programs in different Toshiba divisions were applied to the PRM and OPRM qualification activities.
7.2.F	10 CFR 50 Compliance. Audits performed against manufacturer programs other than 10 CFR 50 shall demonstrate that the program process is commensurate with 10 CFR 50.	Comply. Toshiba has integrated 10 CFR 50, Appendix B into their nuclear quality assurance program. The activities performed under ISO 9001 quality programs used work products that were commercial grade dedicated successfully under Toshiba's commercial grade dedication program.

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
7.2.G	V&V Program Evaluation. The qualifier shall evaluate the manufacturer's V&V program to the criteria in Section 7.4.	Comply. The V&V efforts for the PRM and OPRM were conducted under Toshiba's nuclear QA program, which complies with 10 CFR 50 Appendix B Program. Sections I-3.10 and I-3.11 describe software V&V as applied under the current process. Section I-A-4.8 describes software V&V as applied under the original process.
7.2.H	Qualification Test Witnessing. The Qualifier shall have the right to witness qualification tests.	N/A. The PRM and OPRM qualification tests were conducted under the Toshiba's nuclear QA program, which complies with 10 CFR 50 Appendix B Program. Section I-2 describes the QA program as applied under the current process. Section I-A-3.1 describes the QA program as applied under the original process.
7.3	10 CFR 21 Compliance Requirements. Section lists 10 CFR 21 compliance requirements of a utility which applies the PLC in a safety-related application. The PLC manufacturer shall support problem reporting and tracking as described in Section 7.8.	N/A. The requirements are for the utility. Toshiba will support problem reporting and tracking as the manufacturer. For Toshiba's compliance with problem reporting and tracking, see the response to Item 7.8 in this table, which states "As described in Section I-3.3.7, Toshiba will address any problem that occurs in the Operation and Maintenance phases of the system lifecycle."
7.4	Verification and Validation Requirements. Qualifier shall evaluate the manufacturer's V&V process for software, firmware and software tools against IEEE Std 7-4.3.2 and IEEE Std 1012. The qualifier shall confirm the following basic requirements are met: a) there is a V&V Plan for the PLC product, b) software development shall be done in accordance with a life cycle approach (see IEEE Std 1074-1995), and c) the software requirements document shall be reviewable.	Comply. The V&V efforts for the PRM and OPRM were conducted under Toshiba's nuclear QA program, which complies with 10 CFR 50 Appendix B Program. Section I-3.10 and Section I-3.11 describes software V&V as applied under the current process. Section I-A-4.8 describes software V&V as applied under the original process.
7.5	Manufacturer Qualification Maintenance Throughout Product Life Cycle. (section heading)	No requirement (Requirements are described in subsections.)
7.5.1	Overview of Manufacturer Qualification Maintenance Throughout Product Life Cycle (descriptive information)	No requirement

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
7.5.2	Requirements for Manufacturer Qualification Maintenance Throughout Product Life Cycle. The qualifier shall obtain documentation confirming that the PLC manufacturer will ensure upward compatibility, maintain rigor of processes, commit to at least five year support for the qualified PLC configuration, and commit to six months notice before withdrawing product support.	Comply. Toshiba, including the module supplier described in Section I-1.5.1, will ensure upward compatibility, maintain processes of, commit to at least five years support for the qualified configuration, and commit to six months notice before withdrawing product support.
7.5.3	Life Cycle Support for Tools Requirement. PLC manufacturer shall ensure continued access to the same versions of application software development tools, or capability to reconstruct functionality with using revised tools.	Comply. Both PRM and OPRM do not need any engineering tool for operation. For potential needs for the FPGA logic modification, Toshiba will maintain the same versions of software tools, or capability to reconstruct the same functionality with the newer versions of software tools under the configuration management documented in Section I-3.12.2.1.
7.6	Compensatory Quality Activities for Legacy Software. (section heading)	No requirement
7.6.1	Overview of Compensatory Quality Activities for Legacy Software. (descriptive information)	No Requirement
7.6.2	Requirements for Compensatory Quality Activities for Legacy Software. Using the guidance of EPRI TR-106439, the qualifier may compensate for shortcomings of legacy software by evaluating documented operating experience in applications similar to nuclear safety related applications, and by performing tests of legacy software to confirm conformance to requirements. The manufacturer shall place legacy software under configuration control once baselined.	Comply. Toshiba treats functional elements (FEs) as legacy software. Control of FEs is documented in Section I-2.2. New FEs will be processed under Toshiba's current Appendix B program.
7.7	Configuration Management. (section heading)	No requirement
7.7.1	Configuration Management Overview. Descriptive information.	No requirement

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
7.7.2	Hardware Configuration Management Requirements. The scope shall include revisions to module design, module component configuration, compatibility of revised modules with existing hardware, and manufacturer documentation.	Comply. Configuration Management includes the module type number which identifies the FPGA version, module design, and module component configuration. Configuration management is documented in Section I-3.12 for the current process and in Section I-A-4.9 for the original process.
7.7.2.A	Hardware Configuration Management Review. The utility (and the Qualifier) shall evaluate the manufacturer configuration management process for design revisions to NQA-1.	Comply. Toshiba, as the Qualifier, reviews the configuration management. Configuration management is documented in Section I-3.12 for the current process and in Section I-A-4.9 for the original process.
7.7.2.B	Hardware Configuration Management Review. The utility (and the Qualifier) shall evaluate the manufacturer configuration management process for methods of identification of each constituent component within the PLC modules to NQA-1.	Comply. Toshiba, as the Qualifier, reviews the configuration management. Configuration management is documented in Section I-3.12 for the current process and in Section I-A-4.9 for the original process.
7.7.2.C	Hardware Configuration Management Review. The utility (and the Qualifier) shall evaluate the manufacturer configuration management process for methods of document control to NQA-1.	Comply. Toshiba, as the Qualifier, reviews the configuration management. Configuration management is documented in Section I-3.12 for the current process and in Section I-A-4.9 for the original process.
7.7.3	Software Configuration Management Requirements. The scope of software configuration management includes creation and revision of firmware, runtime software libraries, software engineering tools, and documentation.	Comply. Configuration Management includes each module type number which identifies the FPGA version, module design, and module component configuration. Configuration management is documented in Section I-3.12 for the current process and in Section I-A-4.9 for the original process.
7.7.3.A	Software Configuration Management Review. The utility (and the Qualifier) shall evaluate the manufacturer software configuration management process for definition of organization and responsibilities using Reg. Guide 1.169, Section C.	Comply. Toshiba, as the Qualifier, reviews the configuration management. Configuration management is documented in Section I-3.12 for the current process and in Section I-A-4.9 for original process.
7.7.3.B	Software Configuration Management Review. The utility (and the Qualifier) shall evaluate the manufacturer software configuration management process for methods of configuration identification, control, status and audits using Reg. Guide 1.169, Section C.	Comply. Toshiba, as the Qualifier, reviews the configuration management. Configuration management is documented in Section I-3.12 for current process and in Section I-A-4.9 for original process.

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
7.7.3.C	Software Configuration Management Review. The utility (and the Qualifier) shall evaluate the manufacturer configuration management process to ensure sub-tier suppliers maintain comparable levels of configuration management using Reg. Guide 1.169, Section C.	Comply. Toshiba, as the Qualifier, reviews the configuration management. Configuration management is documented in Section I-3.12 for the current process and in Section I-A-4.9 for the original process.
7.8	Problem Reporting/Tracking Requirements. PLC manufacturer shall maintain a problem reporting and tracking system that includes classification of problems, description of problems, identification of affected hardware, type of application, description of configuration, name of reporting site and means to contact site, type of site, and cumulative operating time of PLC when problem occurred. Manufacturer shall provide a mechanism for making this information available to all nuclear utility users.	Comply. As described in Section I-3.3.7, Toshiba will address any problem that occurs in the Operation and Maintenance plant lifecycle phases. .
8	Documentation. Descriptive information.	No requirement
8.1	Equipment General Overview Document Requirements. Descriptive information.	No requirement
8.1.A	Manufacturer Documentation. Documentation shall include a description of the PLC.	Comply. Description of each unit, chassis, module, and FPGA is documented in design documents as documented in Section I-3.3.2 and I-3.3.3 for the current process and I-A-4.2 for the original process.
8.1.B	Manufacturer Documentation. Documentation shall include a description of the chassis interconnections.	Comply. The PRM and OPRM system unit interconnections are documented in Section II-A-7 (Application Guide).
8.1.C	Manufacturer Documentation. Documentation shall include a module overview and selection guide.	Comply. Appendix II-B, Module Summary Description, of this LTR provides a complete module overview for PRM and OPRM. For the PRM and OPRM, Toshiba selects the appropriate modules and generates the plant specific configuration and programmable logic applications.
8.1.D	Manufacturer Documentation. Documentation shall include a description of the overall I/O capacity and processing speeds.	Comply. Appendix II-A provides the system configuration including the number of the I/Os. Section II-2.2.2.2 provides the response time. ERS of FPGA based Units (Reference (d36)) and EDS for PRNM (Reference (c28)) provide more detailed information.
8.1.E	Manufacturer Documentation. Documentation shall include installation information.	Comply. Toshiba will provide necessary information including the Instructions for the LPRM Unit (Reference (d45)), Instructions for the LPRM/APRM Unit (Reference (d46)), Instructions for the FLOW Unit (Reference (d47)), and the OPRM Unit User's Manual (Reference (c27)) document the installation information.

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
8.1.F	Manufacturer Documentation. Documentation shall include handling and storage requirements.	Comply. The Instructions for the LPRM Unit (Reference (d45)), Instructions for the LPRM/APRM Unit (Reference (d46)), Instructions for the FLOW Unit (Reference (d47)), and the OPRM Unit User's Manual (Reference (c27)) include handling and storage requirements.
8.1.G	Manufacturer Documentation. Documentation shall include a description of the self-diagnostics and redundancy features.	Comply. Appendix II-B, Module Summary Description, of this LTR includes a summary of the self-diagnostics. Further details are documented in the LPRM Unit EDS (Reference (d42)), the LPRM/APRM Unit EDS (Reference (d43)), the FLOW monitoring Unit EDS (Reference (d44)), and the OPRM Unit Detailed Design Specification (Reference (c29)).
8.2	Equipment General Specifications Requirements. Manufacturer documentation shall provide general specifications for the PLC.	Comply. ERS of FPGA based Units (Reference (d36)) and EDS for PRNM (Reference (c28)) provide general specifications. In addition, the FPGA Design Specification provides general specification of for the FPGA as documented in Section I-3.3.1 for the current process and Section I-A-4.2 for the original process. Design specifications and the system descriptions provide specific requirements for the PRM and OPRM.
8.3	Operator's Manual Requirements. Manufacturer documentation shall include information on operation of the PLC.	Comply. Instructions for the LPRM Unit (Reference (d45)), Instructions for the LPRM/APRM Unit (Reference (d46)), Instructions for the FLOW Unit (Reference (d47)), and the OPRM Unit User's Manual (Reference (c27)) include information on operation of the PRM and OPRM.
8.4	Programmer's Manual Requirements. Manufacturer shall provide detailed information on the use of the functions available in the PLC processors.	N/A. Based on the NRW-FPGA technology, utilities cannot change the programmable logic in the FPGAs. Therefore, Toshiba does not provide the utility with a Programmer's Manual for the NRW-FPGA-based PRM or OPRM system.
8.5	Equipment Maintenance Manual Requirements. Manufacturer documentation shall contain information for calibration, trouble shooting, maintenance, required special tools or software, and communication protocols.	Comply. Instructions for the LPRM Unit (Reference (d45)), Instructions for the LPRM/APRM Unit (Reference (d46)), Instructions for the FLOW Unit (Reference (d47)), and the OPRM Unit User's Manual (Reference (c27)) provide guidance for troubleshooting, calibration, surveillance, and other utility functions during the Operation and Maintenance plant system lifecycle.
	Manufacturer documentation shall include results of component aging analysis.	N/A. Aging analysis is not necessary where equipment is qualified for use only in mild environments (RG 1.209). Toshiba also notes there are no significant aging mechanisms in this FPGA-based equipment.
8.6	Qualification Documentation Requirements. The qualifier shall provide all documentation supporting the qualification of the generic PLC platform. The qualifier shall submit all such documentation to the customer(s) for review and approval.	Comply. Toshiba, the qualifier, will provide all documents which support the qualification of the PRM and OPRM to the NRC and to customers.

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
8.6.1	Programmatic Documentation Requirements. (descriptive information)	No requirement
8.6.1.A	Programmatic Documentation. A test plan shall be prepared which includes test plans for environmental, seismic, surge, Class 1E to Non-1E, EMI/RFI, availability/reliability, FMEA and ASOA qualification activities.	Comply. The Master Test Plan (Reference (d19)) for the PRM qualification testing as well as the EQ Test Plan (Reference (c10)) and EMC Qualification Test plan (Reference (c11)) for the OPRM qualification testing were prepared. These include test plans for radiation exposure, environmental (temperature and humidity), seismic, EMI/RFI, surge, EFT/B, ESD, and Class 1E to Non-Class 1E testing.
8.6.1.B	Programmatic Documentation. Test specifications shall be prepared which include equipment identifications, interfaces and service conditions.	Comply. The Master Test Plan (Reference (d19)) for the PRM qualification testing as well as the EQ Test Plan (Reference (c10)) and EMC Qualification Test plan (Reference (c11)) for the OPRM qualification testing were prepared. These include documentation of the required equipment identification, interfaces, and conditions.
8.6.1.C	Programmatic Documentation. Procedures shall be prepared for qualification testing.	Comply. Test procedures for the PRM Qualifications testing (Reference (d20) – (d29)) and the test procedures for OPRM qualification testing (Reference (c12) – (c19)) were prepared to direct the performance, evaluation, and data recording for each qualification test.
8.6.1.D	Programmatic Documentation. Test reports shall be prepared for each qualification test performed.	Comply. The Qualification Test Summary Report (Reference (d16)) was prepared for PRM qualification testing. The EQ Report (Reference (c20)), EMC Qualification Report (Reference (c21)), and Dynamic Qualification Report (Reference (c22)) were prepared for the OPRM qualification testing.
8.6.1.E	Programmatic Documentation. Reports on audits performed on the manufacturer shall be prepared.	Comply. Toshiba prepares and retains audit reports for each audit (Reference (d3) – (d6)).
8.6.1.F	Programmatic Documentation. Reports on design evaluations shall be prepared.	Comply. The Final Technical Evaluation Report (Reference (d39)) was prepared for design evaluation of the PRM. The Final Technical Evaluation Report (Reference (c26)) was prepared for design evaluation of the OPRM. Section II-A-2.4 describes “Failure Analysis” and Section II-A-2.6 describes “Setpoint Support Analysis.”
8.6.2	Technical Items and Acceptance Criteria Documentation Requirements. (descriptive information)	No requirement
8.6.2.A	Technical Items Documentation. Documentation shall include test specimen requirements.	Comply. The Preliminary Technical Evaluation Report (PTER) (Reference (d38)) includes test specimen requirements for the PRM qualification testing. The EQ Test Plan (Reference (c10)) and EMC Qualification Test plan (Reference (c11)) include test specimen requirements for the OPRM qualification testing.
8.6.2.B	Technical Items Documentation. Documentation shall include test specimen purchasing records.	Comply. The Job Order includes purchasing activities for the test specimen as documented in Section I-3.3.1.5 for current process and in Section I-A-4.2.1 for the original process.

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
8.6.2.C	Technical Items Documentation. Documentation shall include TSAP development documentation.	Comply. In the PRM and OPRM system qualification project, the equipment being qualified had the actual PRM and OPRM system logic embedded in the FPGAs. This approach meets the intent of this requirement (TSAP development documentation), which is used to test the range of possible PLC program features that may be employed when the PLC is programmed for a specific application to ensure that the system-level test is meaningful.
8.6.2.D	Technical Items Documentation per Sections 8.8, 8.9, 8.10, 8.12 and 8.13.	(See Items 8.8, 8.9, 8.10, 8.12 and 8.13 in this table.)
8.6.2.E	Technical Items Documentation. See Section 8.14.	(See Item 8.14 in this table.)
8.6.3	Application Guide Documentation Requirements. A qualification summary document shall be provided. The document shall describe the qualification envelope and provide the configuration information.	Comply. Section II-A-4 (Application Guide) of this LTR describes the summaries for the PRM and OPRM qualification testing. More details are documented in Qualification Test Summary Report (Reference (d16)) for the PRM, and Environmental Qualification Report for OPRM (Reference (c20)), EMC Qualification Report for OPRM (Reference (c21)), and Dynamic Qualification Report for OPRM (Reference (c22)) for the OPRM.
8.6.3.A	Application Guide. Guide shall include results of environmental Operability testing to support each specific safety related application.	Comply. Test results for the PRM and OPRM environmental operability tests are documented in Section II-A-4 (Application Guide).
8.6.3.B	Application Guide. Guide shall include results of seismic testing including seismic withstand capability for all damping values used in test data analysis.	Comply. Test results for the PRM and OPRM seismic tests are documented in Section II-A-4 (Application Guide). The Application Guide includes the torque requirements for screws and fasteners.
8.6.3.C	Application Guide. Guide shall include results of Class 1E to Non-1E isolation testing.	Comply. Test results for the PRM Class 1E to Non-Class 1E isolation testing are documented in Section II-A-4. For the OPRM, Class 1E to Non-1E isolation testing was not required, and was thus not conducted.
8.6.3.D	Application Guide. Guide shall include results of surge withstand testing.	Comply. Test results for the PRM and OPRM surge withstand testing are documented in Section II-A-4 (Application Guide).
8.6.3.E	Application Guide. Guide shall include results of EMI/RFI testing.	Comply. Test results for the PRM and OPRM EMI/RFI testing are documented in Section II-A-4 (Application Guide).
8.6.3.F	Application Guide. Guide shall include results of power quality testing.	Comply. The power quality testing was conducted during the operability test in the PRM and OPRM qualification testing. The results of the PRM and OPRM qualification testing are documented in Section II-A-4 (Application Guide).
8.6.3.G	Application Guide. Guide shall describe any combination of software objects or special purpose objects created to support testing.	N/A. No software objects or special purpose objects are used in testing. Toshiba uses the final, shippable application for all qualification testing.

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
8.6.3.H	Application Guide. Guide shall include a description of the as-tested PLC configuration.	Comply. The unit, module, wiring, support equipment, and interconnection configuration of the PRM and OPRM qualification testing is documented in Section II-A-3 (Application Guide).
8.6.3.I	Application Guide. Guide shall include a description of the executive software and software tools revision levels included in qualification.	N/A. The PRM and OPRM do not include executive software, and thus did not require any software tools for the qualification.
8.6.3.J	Application Guide. Guide shall include a description of the as-tested PLC configuration.	Comply. The unit, module, wiring, support equipment, and interconnection configuration of the PRM and OPRM qualification testing is documented in Section II-A-3 (Application Guide).
8.6.3.K	Application Guide. Guide shall include a summary of the FMEA and availability analysis.	Comply. The FMEA and availability analysis are documented in Section III-3.2.2 for the PRM and in Section III-6.2.2 for the OPRM.
8.6.3.L	Application Guide. Guide shall include the setpoint analysis support document.	Comply. The setpoint support analysis is documented in Section III-3.2.3 for PRM and in Section III-6.2.3 for OPRM.
8.6.3.M	Application Guide. Guide shall include information from manufacturer audits and surveys applicable to future purchasing.	N/A. Since Toshiba performed commercial grade dedication on commercial products, this data is not required in the Application Guide.
8.6.3.N	Application Guide. Guide shall include a description of the redundancy features included in qualification.	Comply. The Application Guide Section II-A-3 provides the PRM and OPRM tested system configurations including redundant LVPSs and dual communication lines.
8.6.3.O	Application Guide. Guide shall include a description of external devices included in qualification.	Comply. The Application Guide Section II-A-3 describes Power Factor Correction modules (PFCs) as external modules to the units and included in the OPRM qualification.
8.6.3.P	Application Guide. Guide shall include a description of the PLC configuration management methods.	Comply. The Application Guide includes the configuration data (module numbers) applicable to a given installation. The plant-specific portion of the Application Guide will be revised for each utility if changes are required to modules, which results in new module numbers.
8.6.3.Q	Application Guide. Guide shall include a summary of the component aging analysis.	N/A. Aging analysis is not necessary where equipment is qualified for use only in mild environments. USNRC RG 1.209 does not require equipment aging for mild environment. Toshiba also notes there are no significant aging mechanisms in this FPGA-based equipment.
8.6.3.R	Application Guide. Guide shall include a description of the mounting methods used in seismic qualification	Comply. The mounting methods used in the PRM and OPRM qualification testing is documented in Sections III-2.2.2 and III-5.2.2.

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
8.6.3.S	Application Guide. Guide shall include a description of qualification envelopes for specific modules if different from the overall envelope.	Comply. The PRM and OPRM qualification used the same qualification envelopes for all modules except the seismic qualification for the PRM. The envelopes for the PRM and OPRM qualification testing is documented in Section II-A-4 (Application Guide).
8.6.3.T	Application Guide. Guide shall include a description of any application level hardware or software features that are assumed in order to meet qualification requirements.	Comply. LTR application guide section II-A-4.5.3 EMI/RFI Test for BWR-5 PRM System says: "specific exceedance was found during CE101 in the power leads. From approximately 100 Hz to 700 Hz, emissions exceed the limit shown in Regulatory Guide 1.180 Revision 1. This excess comes from the waveform distortion due to the AC/DC power supply (i.e. LVPS module) in the PRM system. To suppress this emission, Toshiba inserted a filter into the AC power line to the LVPS module, and confirmed that the test results satisfy the requirement with this corrective measure as shown in Table II-A-4-5. Systems supplied for use in the US would either use this power line filter or the PFC module used for the OPRM type testing. Either approach would successfully mitigate the LVPS emissions peaks."
8.6.4	Supporting Analyses Documentation Requirements. Documentation shall be provided of the FMEA and Availability/Reliability Analyses.	Comply. The FMEA and availability analyses are documented in Section III-3.2.2 for PRM and in Section III-6.2.2 for OPRM. These LTR sections will be supplied with the Application Guide.
8.6.5	Class 1E to Non-Class 1E Isolation Test Plan. A Class 1E to Non-1E Isolation test plan and report shall be provided. The test plan shall be reviewed and approved by the utility.	Comply. The Master Test Plan (Reference (d19)) provides the test plan for Class 1E to Non-1E Isolation Test. Toshiba will provide the plan to utilities. The Qualification Test Summary Report (Reference (d16)) provides the report for Class 1E to Non-Class 1E Isolation test. A summary of the results is documented in the Application Guide. For OPRM, Class 1E to Non-Class 1E Isolation Test is not required, and was thus not conducted.
8.7	V&V Documentation Requirements. (section heading)	No requirement
8.7.A	V&V Documentation. Documentation shall include a software quality assurance plan.	Comply. The systems are implemented under a programmable logic life cycle that includes a Software Quality Assurance Plan as documented in Section I-3.4 for the current process in Section I-A-4.3 for the original process. The Verification and Validation Plan for PRM (Reference (d41)) and Verification and Validation Plan for OPRM (Reference (c6)) were also prepared. Documentation is generated to document the activities and findings from independent V&V.
8.7.B	V&V Documentation. Documentation shall include a software requirements specification.	Comply. The systems are implemented under a programmable logic life cycle that includes unit design specification documents describing software requirement specifications as documented in Section I-3.3.2 for the current process and in Section I-A-4.2.2 for the original process.

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
8.7.C	V&V Documentation. Documentation shall include a software design description.	Comply. The systems are implemented under a programmable logic life cycle that includes appropriate FPGA design descriptions as documented in Section I-3.3.3 for the current process and in Section I-A-4.2.3 for the original process.
8.7.D	V&V Documentation. Documentation shall include a software V&V plan.	Comply. The systems are implemented under a programmable logic life cycle that includes a Software V&V Plan as well as appropriate V&V documentation as documented in Section I-3.10 for the current process and in Section I-A-4.8 for the original process.
8.7.E	V&V Documentation. Documentation shall include a software V&V report.	Comply. The systems are implemented under a programmable logic life cycle that includes appropriate V&V phase summary reports and a final summary report as documented in Section I-3.11 for the current process and in Section I-A-4.8 for the original process.
8.7.F	V&V Documentation. Documentation shall include software user documentation.	Comply. The systems are implemented under a programmable logic life cycle that includes appropriate user documentation as documented in Section I-3.3.2.3 for the current process and in Section 3.2 of Attachment-5 of Part V for the original process.
8.7.G	V&V Documentation. Documentation shall include a software configuration management plan.	Comply. The systems are implemented under a programmable logic life cycle that includes a Software Configuration Management Plan as documented in Section I-3.12 for the current process and in Section I-A-4.9 for the original process.
8.8	System Description Requirements. A test specimen hardware and software description document shall be provided.	Comply. Hardware and software documents for the PRM and OPRM test specimen were prepared in accordance with the software/hardware development lifecycle documented in Section I-3.3 for PRM and documented in Section I-A-4.2 for the OPRM. The Application Guide Section II-A-3 provides the PRM and OPRM tested system configurations.
8.9	Critical Characteristics Listing Requirement. A critical characteristics listing document shall be provided.	Comply. The Final Technical Evaluation Report for the PRM (Reference (d39)) and the Final Technical Evaluation Report for the OPRM (Reference (c26)) list the Critical Characteristics.
8.10	System Drawing Requirements. (Section Heading)	No requirement (Requirements are described in subsections.)
8.10.A	System Drawing Requirements. Documents shall include a functional description of the test specimen.	Comply. The Preliminary Technical Evaluation Report (PTER) (Reference (d38)) includes test specimen requirements for the PRM qualification testing. The EQ Test Plan (Reference (c10)) and EMC Qualification Test plan (Reference (c11)) include test specimen requirements for the OPRM qualification testing.
8.10.B	System Drawing Requirements. Documents shall include a schematic of the test specimen.	Comply. The Preliminary Technical Evaluation Report (PTER) (Reference (d38)) includes test specimen schematics for the PRM qualification testing. The EQ Test Plan (Reference (c10)) and EMC Qualification Test plan (Reference (c11)) include test specimen schematics for the OPRM qualification testing. Both sets of schematics include all test equipment and wiring for the test equipment.

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
8.10.C	System Drawing Requirements. Documents shall include diagrams that define the TSAP.	(See Item 8.6.2.C in this table.)
8.10.D	System Drawing Requirements. Drawings shall show test specimen wiring, power distribution and grounding.	Comply. The Preliminary Technical Evaluation Report (PTER) (Reference (d38)) includes test specimen internal and external wiring, power distribution and grounding for the PRM qualification testing. The EQ Test Plan (Reference (c10)) and EMC Qualification Test plan (Reference (c11)) include test specimen internal and external wiring, power distribution, and grounding for the OPRM qualification testing. Test documents include the test specimen internal and external wiring, power distribution and grounding.
8.10.E	System Drawing Requirements. Drawings shall show layout of test specimen chassis, modules and qualification test fixtures.	Comply. The Preliminary Technical Evaluation Report (PTER) (Reference (d38)) includes a description of the layout of the test specimen chassis, modules, internal and external wiring, and qualification test fixtures for the PRM qualification testing. The EQ Test Plan (Reference (c10)) and EMC Qualification Test plan (Reference (c11)) include description for layout of the test specimen chassis, modules, internal and external wiring, and qualification test fixtures for the OPRM qualification testing.
8.10.F	System Drawing Requirements. Drawings shall show test specimen mounting and mounting fixtures, including special installation requirements.	Comply. The Master Test Plan for PRM (Reference (d19)) includes the description of the test specimen mounting and mounting fixtures, including special installation requirements. The EQ Test Plan (Reference (c10)) and EMC Qualification Test Plan (Reference (c11)) for the OPRM includes a description of the test specimen mounting and mounting fixtures, including special installation requirements.
8.11	System Software/Hardware Configuration Document Requirements. Software and hardware configuration used for qualification testing shall be documented, including identification and revision of executive software, module firmware, software tools, downloadable PLC executive packages, and the TSAP (including printout). The identification, revision level and serial number of hardware shall be documented.	Comply. The Master Configuration List for the PRM (Reference (d48)) and the Master Configuration List for the OPRM (Reference (c30)) document all module type numbers.
8.12	System Database Documentation Requirements. The TSAP database used for qualification testing shall be documented.	(See Item 8.6.2.C in this table.)
8.13	System Setup/Calibration/Checkout Procedure Requirements. All setup, calibration and checkout procedures used during qualification shall be documented.	Comply. All setup, calibration, and checkout procedures used during qualification are documented in the System Set-Up and Check-out Test Procedure for the PRM (Reference (d20)) and the Setup and Check-out Test Procedure for the OPRM (Reference (c12)).

Section No	Summary of EPRI TR-107330 Requirements	Compliance with EPRI TR-107330 Requirements (or N/A)
8.14	System Test Documentation Requirements. A test plan and test report shall be provided covering qualification Operability testing. The documents shall include test requirements, acceptance criteria, sequence of testing, data recording methods, test equipment requirements and a test data summary.	Comply. The Master Test Plan (Reference (d19)) provides the test plan for Operability Testing and .the Qualification Test Summary Report (Reference (d16)) provides the report for Operability Testing for the PRM. The EQ Test Plan (Reference (c10)) and EMC Qualification test Plan (Reference (c11)) provide the test plan for Operability Testing and the EQ report (Reference (c20)), EMC Qualification Report (Reference (c21)), and Dynamic Qualification Report (Reference (c22)) provides the report for Operability Testing for the OPRM.
8.15	Manufacturer's Quality Documentation Requirements. The manufacturer shall provide its Quality Assurance Plan.	Comply. The systems are implemented under a programmable logic life cycle that includes a Software Quality Assurance Plan. Section I-3.4.1 describes the software quality assurance plan in the current process and Section I-A-4.3 describes the software quality assurance plan in the original process. As described in I-2.2.2.1, NICSD surveyed or evaluated the module supplier's quality system.
8.16	Manufacturer's Certifications Requirements. Manufacturer shall provide certificates of conformance for all test specimen hardware.	Comply. The Final Technical Evaluation Report document conformance for all test specimen hardware. The activity in the current process is documented in Section I-2.2.3, and the activity in the original process is documented in Section I-A-3.2.3.

Table IV-4-2 Response Time Operability Test Results

		A3.1(Ical= 40 μA)			A3.3(Ical= 2,400 μA)			A3.2(Ical= 400 μA)			
		APRM High High (ms)	TPM High(0s) (ms)	TPM High(6s) (s)	APRM High High (ms)	TPM High(0s) (ms)	TPM High(6s) (s)	APRM High High (ms)	TPM High(0s) (ms)	TPM High(6s) (s)	
Pre-Qualification Test (Base Line)]a,c
Radiation Exposure											
Environmental Test	Before High Temperature and High Humidity Exposure										
	During High Temperature and High										
	After(End of) *)High Temperature and High Humidity Exposure										
	Exposure										
	During Low Humidity Exposure										
	After (End of *) Low Humidity Exposure										
After *) all Environmental											
Exchange of Modules (LPRM Modules was exchanged for HNS013 from HNS011. AO Modules was exchanged for HNS515/516/517/518 from HNS511/512/513/514.											
Before EMC Test]a,c
During EMC Test											
After EMC Test											
Isolation Test(Class 1E to Non 1E Test)											
Post Qualification Test(Before re-exchange of modules)											
Re-Exchange of Modules (LPRM Modules was exchanged for HNS011 from HNS013. AO Modules was exchanged for HNS511/512/513/514 from HNS515/516/517/518.											
Post-Qualification Test(After re-exchange of modules)]a,c

*) Note for Clarification: The Operability Tests were performed at the end of each environment test run and again after all the environmental tests were complete.

Table IV-4-3 Mapping of PRM Operability Tests to Table-5-1 in EPRI TR-107330

Test Condition(Toshiba qualification tests)		Description of TR-107330 Table 5-1 Operability Tests (Section 5.3)		Operability Test for PRM	
		Scope	Test Item	Performed Tests (See Note A at the end of Table)	Justification/Explanation
Pre-Qualification Test(Base Line)		"All"	A. Accuracy	(1), (2), (3), (7)	
			B. Response time	(4), (5), (6)	
			C. Discrete input operability	(9)	
			D. Discrete output operability	(4), (5), (6), (8)	
			E. Communication operability	Confirm no communication alarms occurred	
			F. Coprocessor operability	N/A	The PRM does not use coprocessors.
			G. Timer Tests	N/A	The PRM does not provide any separate timer functions.
			H. Test of failure to complete scan detection	(13), (14), (15)	
			I. Failover Operability Tests	(10), (11), (12), (16)	
			J. Loss of power test	(17)	
			K. Power Interrupt Test.	(18)	
Radiation Exposure		No Description			
Environmental Test	Before High Temperature and High Humidity Exposure	No Description	A. Accuracy	(2), (7)	See Note B (i)
			B. Response time	(5) Response time measurement of TPM H, in which the TPM time constant is set to \square^{ac} second was not performed	See Note B (ii)
			C. Discrete input operability	(9)	
			D. Discrete output operability	(5)	See Note B (v)
			E. Communication operability	Confirm no communication alarms occurred.	

Test Condition(Toshiba qualification tests).	Description of TR-107330 Table 5-1 Operability Tests (Section 5.3)		Operability Test for PRM		
	Scope	Test Item	Performed Tests (See Note A at the end of Table)	Justification/Explanation	
		F. Coprocessor operability	N/A	The PRM does not use coprocessors.	
		G. Timer Tests	N/A	The PRM does not provide any separate timer function.	
		H. Test of failure to complete scan detection	Test Items (13), (14), and (15) were not performed.	See Note B (iii)	
		I. Failover Operability Tests	(16) Test Items (10), (11), and (12) were not performed.	See Note B (iv)	
		J. Loss of power test	(17)		
		K. Power Interrupt Test.	(18)		
	During High Temperature and High Humidity Exposure	No Description			Toshiba monitored the equipment operation during the tests. Table IV-4-6 in this attachment shows the acceptance criteria for the output signals.
	After (End of) High Temperature and High Humidity Exposure	"ALL" at the point per Figure 4-4	A. Accuracy	(2), (7)	See Note B (i)
			B. Response time	(5) Response time measurement of TPM H, in which the TPM time constant is set to \square_{sec} second was not performed	See Note B (ii)
			C. Discrete input operability	(9)	
			D. Discrete output operability	(5)	See Note B (v)
E. Communication operability			Confirmed no communication alarms occurred.		
F. Coprocessor operability			N/A	The PRM does not use coprocessors.	
G. Timer Tests			N/A	The PRM does not provide any separate timer function.	

Test Condition (Toshiba qualification tests)	Description of TR-107330 Table 5-1 Operability Tests (Section 5.3)		Operability Test for PRM	
	Scope	Test Item	Performed Tests (See Note A at the end of Table)	Justification/Explanation
		H. Test of failure to complete scan detection	Test Item (13), (14), and (15) were not performed.	See Note B (iii)
		I. Failover Operability Tests	(16) Test Items (10), (11), and (12) were not performed.	See Note B (iv)
		J. Loss of power test	(17)	
		K. Power Interrupt Test.	(18)	
During Low Temperature Exposure	No Description			Toshiba monitored the equipment operation during the tests. Table IV-4-6 in this attachment shows the acceptance criteria for the output signals.
After (End of) Low Temperature Exposure	"ALL" at the point per Figure 4-4	A. Accuracy	(2), (7)	See Note B (i)
		B. Response time	(5) Response time measurement of TPM H, in which the TPM time constant is set to \square^{ac} second was not performed	See Note B (ii)
		C. Discrete input operability	(9)	
		D. Discrete output operability	(5)	See Note B (v)
		E. Communication operability	Confirmed no communication alarms occurred.	
		F. Coprocessor operability	N/A	The PRM does not use coprocessors.
		G. Timer Tests	N/A	The PRM does not provide any separate timer functions.
		H. Test of failure to complete scan detection	Test Items (13), (14), and (15) were not performed.	See Note B (iii)

Test Condition(Toshiba qualification tests)	Description of TR-107330 Table 5-1 Operability Tests (Section 5.3)		Operability Test for PRM		
	Scope	Test Item	Performed Tests (See Note A at the end of Table)	Justification/Explanation	
During Low Humidity Exposure	No Description	I. Failover Operability Tests	(16) Test Items (10), (11), and (12) were not performed.	See Note B (iv)	
		J. Loss of power test	(17)		
		K. Power Interrupt Test.	(18)		
	After (End of) Low Humidity Exposure	"ALL" at the point per Figure 4-4	A. Accuracy	(2), (7)	See Note B (i)
			B. Response time	(5) Response time measurement of TPM H, in which the TPM time constant is set to \square^{ac} second was not performed	See Note B (ii)
			C. Discrete input operability	(9)	
			D. Discrete output operability	(5)	See Note B (v)
			E. Communication operability	Confirmed no communication alarms occurred.	
			F. Coprocessor operability	N/A	
			G. Timer Tests	N/A	
			H. Test of failure to complete scan detection	Test Items (13), (14), and (15) were not performed.	See Note B (iii)
			I. Failover Operability Tests	(16) Test Items (10), (11), and (12) were not performed.	See Note B (iv)
			J. Loss of power test	(17)	
K. Power Interrupt Test.	(18)				
After all	"ALL" at the	A. Accuracy	(2), (7)	See Note B (i)	

Test Condition(Toshiba qualification tests)	Description of TR-107330 Table 5-1 Operability Tests (Section 5.3)		Operability Test for PRM		
	Scope	Test Item	Performed Tests (See Note A at the end of Table)	Justification/Explanation	
Environmental	point per Figure 4-4	B. Response time	(5) Response time measurement of TPM H, in which the TPM time constant is set to \square^{ac} second was not performed	See Note B (ii)	
		C. Discrete input operability	(9)		
		D. Discrete output operability	(5)		See Note B (v)
		E. Communication operability	Confirmed no communication alarms occurred.		
		F. Coprocessor operability	N/A		The PRM does not use coprocessors.
		G. Timer Tests	N/A		The PRM does not provide any separate timer functions.
		H. Test of failure to complete scan detection	Test Items (13), (14), and (15) were not performed.		See Note B (iii)
		I. Failover Operability Tests	(16) Test Items (10), (11), and (12) were not performed.		See Note B (iv)
		J. Loss of power test	(17)		
		K. Power Interrupt Test.	(18)		
Seismic Test	Before Seismic Test	No Description			
	During Seismic Test	"All"	A. Accuracy B. Response time C. Discrete input operability D. Discrete output operability E. Communication operability F. Coprocessor operability	No operability test was performed but output signals are monitored. Due to the short duration of the seismic tests, Operability Tests cannot be performed during the seismic event. Toshiba chose to monitor the equipment operation during the test and performed the operability tests before and after the tests to ensure that the PRM remained operable during and after the seismic event. The acceptance criteria during the Seismic test is	

Test Condition(Toshiba qualification tests)		Description of TR-107330 Table 5-1 Operability Tests (Section 5.3)		Operability Test for PRM	
		Scope	Test Item	Performed Tests (See Note A at the end of Table)	Justification/Explanation
After Seismic Test			G. Timer Tests		described in the Seismic test procedure. The analog outputs and discrete outputs of each unit are set as shown in Table IV-4-5 in this attachment with their acceptance criteria.
			H. Test of failure to complete scan detection		
			I. Failover Operability Tests		
			J. Loss of power test		
			K. Power Interrupt Test.		
	"All"	A. Accuracy	(1), (2), (3), (7)		
		B. Response time	(4),(5),(6)		
		C. Discrete input operability	(9)		
		D. Discrete output operability	(4),(5),(6),(8)		
		E. Communication operability	Confirm no communication alarms occurred		
		F. Coprocessor operability	N/A	The PRM does not use coprocessors.	
		G. Timer Tests	N/A	The PRM does not provide any separate timer functions.	
		H. Test of failure to complete scan detection	(13), (14), (15)		
		I. Failover Operability Tests	(10), (11), (12), (16)		
J. Loss of power test	(17)				
K. Power Interrupt Test.	(18)				
Exchange of Modules (LPRM Modules was exchanged for HNS013 from HNS011. AO Modules was exchanged for HNS515/516/517/518 from HNS511/512/513/514.					
EMC Test	Before EMC Test	No Description	A. Accuracy	(1), (7) Test Items (2) and (3) were not performed.	The LPRM and AO modules were modified to enhance immunity against EMC. As a test after modification, accuracy was tested using worst case configuration for the LPRM modules.
			B. Response time	(4) Test Items (5) and (6) were not performed.	The LPRM and AO modules were modified to enhance immunity against EMC. As a test after modification, accuracy was tested using worst case configuration for the LPRM

Test Condition(Toshiba qualification tests)	Description of TR-107330 Table 5-1 Operability Tests (Section 5.3)		Operability Test for PRM	
	Scope	Test Item	Performed Tests (See Note A at the end of Table)	Justification/Explanation
				modules.
		C. Discrete input operability	(9)	
		D. Discrete output operability	(4), (8) Test Items (5) and (6) were not performed.	Because modification to the LPRM and AO modules does not influence discrete outputs, Tests (4) and (8) are sufficient.
		E. Communication operability	Confirmed no communication alarms occurred	
		F. Coprocessor operability	N/A	The PRM does not use coprocessors.
		G. Timer Tests	N/A	The PRM does not provide any separate timer functions.
		H. Test of failure to complete scan detection	(13), (14) Test Item (15) was not performed. Test Items (13) and (14) were only performed for the LPRM module.	Because the LPRM module was the only module that was modified and contained FPGAs.
		I. Failover Operability Tests	(10), (11), (12) Test (16) was not performed.	Because the LPRM module and AO modules were only modules that were modified.
		J. Loss of power test	(17)	
		K. Power Interrupt Test.	(18)	
During EMC Test	"All except A"	A. Accuracy		Due to the special set-up required for the EMC tests, Operability Tests cannot be performed during EMC testing. Toshiba chose to monitor the equipment operation during the test and perform the operability tests before and after the tests to ensure that the PRM remained operable during and after the EMC testing. Table IV-4-7 in this attachment shows the acceptance criteria for the output signals.
		B. Response time	The operability tests were not performed.	
		C. Discrete input operability	The operability tests were not performed.	
		D. Discrete output operability	The operability tests were not performed.	
		E. Communication operability	Confirmed no communication alarms occurred	

Test Condition(Toshiba qualification tests)	Description of TR-107330 Table 5-1 Operability Tests (Section 5.3)		Operability Test for PRM		
	Scope	Test Item	Performed Tests (See Note A at the end of Table)	Justification/Explanation	
		F. Coprocessor operability	N/A		
		G. Timer Tests	N/A		
		H. Test of failure to complete scan detection	The operability tests were not performed.		
		I. Failover Operability Tests	The operability tests were not performed.		
		J. Loss of power test	The operability tests were not performed.		
		K. Power Interrupt Test.	The operability tests were not performed.		
	After EMC Test	"All"	A. Accuracy	The operability tests were not performed.	Tests were carried out as Post Qualification Tests (After re-exchange of modules).
			B. Response time		
			C. Discrete input operability		
			D. Discrete output operability		
			E. Communication operability		
			F. Coprocessor operability		
			G. Timer Tests		
			H. Test of failure to complete scan detection		
		I. Failover Operability Tests			
		J. Loss of power test			
		K. Power Interrupt Test.			
Isolation Test(Class 1E to Non Class 1E Isolation Test)	No Description		Note: Toshiba conducted Class 1E to Non Class 1E Isolation Test		
Post Qualification Test(Before re-exchange of modules)	No Description	A. Accuracy	(1), (7) Tests (2) and (3) were not performed.	The LPRM and AO modules were modified to enhance immunity against EMC. As a test after modification, accuracy was tested using worst case configuration for the LPRM modules.	

Test Condition(Toshiba qualification tests)	Description of TR-107330 Table 5-1 Operability Tests (Section 5.3)		Operability Test for PRM	
	Scope	Test Item	Performed Tests (See Note A at the end of Table)	Justification/Explanation
		B. Response time	(4) Test Items (5) and (6) were not performed.	The LPRM and AO modules were modified to enhance immunity against EMC. As a test after modification, accuracy was tested using worst case configuration for the LPRM modules.
		C. Discrete input operability	(9)	
		D. Discrete output operability	(4), (8) Test Items (5) and (6) were not performed.	Because modification to the LPRM and AO modules does not influence discrete outputs, Tests (4) and (8) are sufficient.
		E. Communication operability	Confirmed no communication alarms occurred	
		F. Coprocessor operability	N/A	The PRM does not use coprocessors.
		G. Timer Tests	N/A	The PRM does not provide any separate timer functions.
		H. Test of failure to complete scan detection	(13), (14) Test Item (15) was not performed. Test Items (13) and (14) were performed only on LPRM module.	Because the LPRM module was the only module that was modified and contained FPGAs.
		I. Failover Operability Tests	(10), (11), (12) Test Item (16) was not performed.	Because the LPRM module and AO modules were only modules that were modified.
		J. Loss of power test	(17)	
		K. Power Interrupt Test.	(18)	
Re-Exchange of Modules (LPRM Modules was exchanged for HNS011 from HNS013. AO Modules was exchanged for HNS511/512/513/514 from HNS515/516/517/518.				
Post-Qualification Test(After re-exchange of modules)	No Description	A. Accuracy	(1), (2), (3), (7)	
		B. Response time	(4), (5), (6)	
		C. Discrete input operability	(9)	
		D. Discrete output operability	(4), (5), (6), (8)	
		E. Communication operability	Confirmed no communication alarms occurred	
		F. Coprocessor operability	N/A	The PRM does not use coprocessors.

Test Condition(Toshiba qualification tests)	Description of TR-107330 Table 5-1 Operability Tests (Section 5.3)		Operability Test for PRM	
	Scope	Test Item	Performed Tests (See Note A at the end of Table)	Justification/Explanation
		G. Timer Tests	N/A	The PRM does not provide any separate timer functions.
		H. Test of failure to complete scan detection	(13), (14), (15)	
		I. Failover Operability Tests	(10), (11), (12), (16)	
		J. Loss of power test	(17)	
		K. Power Interrupt Test.	(18)	

Note A

- (1) Linearity test for APRM level, TPM level, and LPRM level at the LPRM gains 40 μ A/100%
- (2) Linearity test for APRM level, TPM level, and LPRM level at the LPRM gains 400 μ A/100%
- (3) Linearity test for APRM level, TPM level, and LPRM level at the LPRM gains 2400 μ A/100%
- (4) APRM Upscale (High-High) trip and TPM Upscale trip response time test at the LPRM gains 40 μ A/100%
- (5) APRM Upscale (High-High) trip and TPM Upscale trip response time test at the LPRM gains 400 μ A/100%
- (6) APRM Upscale (High-High) trip and TPM Upscale trip response time test at the LPRM gains 2400 μ A/100%
- (7) Linearity test for FLOW level
- (8) APRM Inoperable trip function test
- (9) DI function test
- (10) Low voltage power supply failure test for the LPRM unit
- (11) Low voltage power supply failure test for the LPRM/APRM unit
- (12) Low voltage power supply failure test for the FLOW unit
- (13) Watchdog function test for the LPRM unit
- (14) Watchdog function test for the LPRM/APRM unit
- (15) Watchdog function test for the FLOW unit
- (16) Current value test of the Square Root module in the FLOW unit
- (17) Loss of power test
- (18) Power interruption test

Note B

- (i) Test Items (1) and (3) were not performed, because the LPRM gain or the Ical setting change can be made only by manual operation on the front panel, which was not accessible while the PRM was in the chamber.

Fresh LPRM detectors send over 400 μ A signals to the LPRM module, and the signal level decreases by aging in the core. Toshiba selected 400 μ A setting as the Ical value, which is generated to simulate the LPRM detectors signal for testing. The LPRM module is calibrated using data from a Traversing In-core Probe (TIP) in actual plants.

The Ical setting is implemented by selecting one resistor from a resistor array in the input of each LPRM module. Since all three selectable resistors are in the same resistor array and all selectable resistors were tested in the factory test, Toshiba selected the 400 μ A setting that is the most commonly used in actual operation due to the limitation mentioned above. Toshiba chose to confirm the accuracy of the PRM for all Ical settings in the Post qualification testing. Toshiba did not observe any degradation in accuracy for all Ical settings,

(ii) Test (4) and (5) with the TPM time constant $\square^{\text{a.c}}$ second were not performed, because the TPM time constant can be changed only by manual operation on the front panel of the PRM module, which was not accessible while the PRM was in the chamber. Toshiba set the TPM time constant to 6 seconds, which is consistent with Toshiba recommendations for the initial value in the plant.

(iii) Test (13), (14), and (15) were not performed, because the watchdog function test requires intentionally expiring the watchdog timer by removing a jumper pin on the PC board of the test specimen and stop the reset signals from FPGAs to the watchdog timer. This was not possible while the PRM was in the chamber. Instead, Toshiba monitored the equipment operation during the tests. An alarm was generated by the watchdog timer when the jumper pin was removed.

(iv) Test (10), (11), and (12) were not performed, because the output voltage of the LVPS module, which is in the chamber, can be changed only by manual operation on the front panel of the LVPS module.
Toshiba monitored the equipment operation during the tests. An alarm is generated when the voltage of LVPS module was lowered.

(v) Tests (4) and (6) were not performed, because the LPRM gain or the Ical setting change can be made only by manual operation on the front panel, which was not accessible while the PRM was in the chamber. Since the Ical value does not influence discrete output operability, Test (5) is sufficient to ensure discrete output operability. Test (8) was not performed, because the APRM Inoperable trip is generated only by manual operation on the front panel of the APRM or LPRM modules. The operation changes the mode of the APRM or LPRM module to other than "OP," and makes the number of the operable LPRM modules, i.e., LPRM modules in the "OP" mode, less than the "minimum number of operable LPRM modules" set value. Toshiba monitored the equipment operation during the tests. An inoperable signal is generated when the mode of the APRM module and LPRM modules were changed.

Table IV-4-4 Mapping of PRM Prudency Tests to Table-5-1 in EPRI TR-107330

Test Condition(Toshiba qualification tests)		Description of TR-107330 Table 5-1 Prudency Tests(Section5.4)		Prudency Test	
		Test Point	Item	What is done(refer to note)	Justification/Explanation
Pre-Qualification Test(Base Line)		"All"	A. Burst of events test.	(19), (20)	
			B. Failure of serial port receiver test.	N/A	There is no serial port receiver in the PRM.
			C. Serial port noise test.	N/A	The Toshiba NRW-FPGA-based PRM uses fiber optic links.
			D. Fault simulation.	(21)	The test was performed during the operability test. (Note A (10), (11), and (12)) Failure simulation test is to disconnect the one AC Power source for LVPS1 module of each test specimen unit.
Radiation Exposure		No Description			
Environmental Test	Before High Temperature and High Humidity Exposure	No Description			
	During High Temperature and High Humidity Exposure	No Description			
	After(End of *)High Temperature and High Humidity Exposure	"ALL at end of high temp/RH only"	A. Burst of events test.	(19), (20)	
			B. Failure of serial port receiver test.	N/A	There is no serial port receiver in the PRM.
		C. Serial port noise test.	N/A	The Toshiba NRW-FPGA-based PRM uses fiber optic links.	
		D. Fault simulation.	The tests were not performed.	Test (21) was not performed because the AC Power of the test specimen in the chamber could not be disconnected. Toshiba chose to monitor the equipment operation during the test. Table IV-4-6 in this attachment shows the acceptance criteria for the output signals. An alarm is generated when the voltage was	

Test qualification tests)	Condition(Toshiba	Description of TR-107330 Table 5-1 Prudency Tests(Section5.4)		Prudency Test	
		Test Point	Item	What is done(refer to note)	Justification/Explanation
					lowered.
	During Low Temperature Exposure	No Description			
	After (End of *) Low Temperature Exposure	No Description			
	During Low Humidity Exposure	No Description			
	After (End of *) Low Humidity Exposure	No Description			
	After *) all Environmental	No Description			
Seismic Test	Before Seismic Test	No Description			
	During Seismic Test	"All"	A. Burst of events test.	The all Prudency tests were not performed.	Due to the short duration of the seismic tests, Prudency Tests cannot be performed during the seismic event. Toshiba chose to monitor the equipment operation during the test.
			B. Failure of serial port receiver test.		
			C. Serial port noise test.		
D. Fault simulation.					
After Seismic Test	"None"				
Exchange of Modules (LPRM Modules was exchanged for HNS013 from HNS011. AO Modules was exchanged for HNS515/516/517/518 from HNS511/512/513/514.					
EMC Test	Before EMC Test	No Description			
	During EMC Test	"A only"	A. Burst of events test.	The tests were not performed.	Due to the special set-up required for the EMC tests,

Test qualification tests)	Condition(Toshiba)	Description of TR-107330 Table 5-1 Prudency Tests(Section5.4)		Prudency Test	
		Test Point	Item	What is done(refer to note)	Justification/Explanation
					Prudency Tests cannot be performed during EMC testing. Toshiba chose to monitor the equipment operation during the test and perform the operability tests before and after the tests to ensure that the PRM remained operable during and after the EMC testing. Table IV-4-7 in this attachment shows the acceptance criteria for the output signals.
	After EMC Test	"None"			
Isolation Test(Class 1E to Non 1E Test)		No Description			
Post Qualification Test(Before re-exchange of modules)		No Description			
Re-Exchange of Modules (LPRM Modules was exchanged for HNS011 from HNS013. AO Modules was exchanged for HNS511/512/513/514 from HNS515/516/517/518.					
Post-Qualification Test(After re-exchange of modules)		No Description	A. Burst of events test.	(19), (20)	
			B. Failure of serial port receiver test.	N/A	There is no serial port receiver in the PRM.
			C. Serial port noise test.	N/A	The Toshiba NRW-FPGA-based PRM uses fiber optic links.
			D. Fault simulation.	(21)	The test was performed during the operability test. (Note A (10), (11), and (12)) Failure simulation test is to disconnect the one AC Power source for LVPS1 module of each test specimen unit.

Note: Prudency Test item
(19) DI Toggling test
(20) AI Toggling test
(21) Failure simulation test

Table IV-45 Acceptance Criteria for Output Signals Monitored during Seismic Test

Signals		Target Value (For analog outputs, input signals were adjusted so that the value of each analog output signal became as the target value shown below)	Acceptance Criteria (For analog outputs, acceptable deviation from the target value)
Analog output	LPRM #1 in LPRM/APRM unit		n.c
	APRM in LPRM/APRM unit		
	TPM in LPRM/APRM unit		
	FLOW in LPRM/APRM unit		
	LPRM #1 in LPRM unit		
	Loop a FLOW in FLOW unit		
	FLOW in FLOW unit		
Discrete output	APRM FAIL in LPRM/APRM unit	Occurred*	Not change
	APRM INOP in LPRM/APRM unit	Not Occurred	Not change
	APRM High-High in LPRM/APRM unit	Not Occurred	Not change
	TPM High in LPRM/APRM unit	Not Occurred	Not change

* To simulate the APRM Fail during seismic test, removed the optical cable #327 from the LPRM/APRM Unit during the seismic test. The cable #327 is an optical transmission cable from the FLOW Unit.

Table IV-4-6 Acceptance Criteria for Output Signals Monitored during Environmental Test

Time (min)	Input		Expected Output (Acceptance criteria)						
	LPRM Input Current (μ A)	FLOW Input Current (mA)	LPRM Output (Computer) (mV)	APRM/TPM ¹⁾ Output (Computer) (mV)	FLOW Output (Computer) (mV)	TPM High Set point (Computer) (mV)	APRM High-High Trip Discrete Output	TPM High Trip Discrete Output	APRM INOP Discrete Output
0-15							Not Occur ²⁾	Not Occur ³⁾	Not Occur
15-30							Not Occur	Not Occur	Not Occur
30-45							Occur ²⁾	Occur ³⁾	Not Occur
45-60							Occur	Occur	Not Occur

Note:

- 1) TPM Output is a first order lag of APRM Output with 6 seconds time constant.
- 2) APRM High-High trip occurs about 40 ms after the change of LPRM Signal.
- 3) TPM High trip occurs about 40 ms after the TPM Output change.

Table IV-4-7 Acceptance Criteria for Output Signals Monitored during EMC Test

Time (s)	Input		Expected Output (Acceptance Criteria)							APRM High-High Trip Discrete Output			
	LPRM (μA)	FLOW (mA)	HNS511/ HNS515 LPRM (V)	<small>]</small> ^{a.c}	HNS514/ HNS518 LPRM (mV)	<small>]</small> ^{a.c}	HNS512/ HNS516 APRM (V)	<small>]</small> ^{a.c}	HNS514/ HNS518 APRM (mV)		<small>]</small> ^{a.c}	HNS512/ HNS516 FLOW (V)	HNS513/ HNS517 FLOW (V)
0													
1													
2													
3													
4													
5													
6													
7													
8													
9													
10													
11													
12													
13													
14													
15													
16													
17													
18													
19													
20													

Not Occur

Occur

Table IV-4-8 Mapping of OPRM Operability Tests to Table-5-1 in EPRI TR-107330

Test Condition (Toshiba qualification tests)		Description of TR-107330 Table 5-1 Operability Tests (Section 5.3)		Operability Test for OPRM		
		Scope	Test Item	Performed Tests (See Note at the end of Table)	Justification/Explanation	
Performance Proof Test (Pre-Qualification Test for EQ test (Base Line))	"All"	A. Accuracy	N/A		The OPRM does not have analog input and output.	
		B. Response time	N/A		The OPRM does not have analog input.	
		C. Discrete input operability	(7)			
		D. Discrete output operability	(3),(4),(5),(6)			
		E. Communication operability	(1),(2)			
		F. Coprocessor operability	N/A		The OPRM does not use coprocessors.	
		G. Timer Tests	N/A		The OPRM does not provide any separate timer function.	
		H. Test of failure to complete scan detection	Confirmed no watchdog time alarms occurred			
		I. Failover Operability Tests	(8)			
		J. Loss of power test	(10)			
		K. Power Interrupt Test.	(11)			
Environmental Test	Wear Aging Test	No Description				
	After the Wear Aging test	No Description	A. Accuracy	N/A		The OPRM does not have analog input and output.
			B. Response time	N/A		The OPRM does not have analog input.
			C. Discrete input operability	(7)		
			D. Discrete output operability	(3),(4),(5),(6)		
			E. Communication operability	(1),(2)		
			F. Coprocessor operability	N/A		The OPRM does not use coprocessors.
			G. Timer Tests	N/A		The OPRM does not provide any separate timer function.
			H. Test of failure to complete scan detection	Confirmed no watchdog time alarms occurred		
			I. Failover Operability Tests	(8)		
			J. Loss of power test	(10)		
			K. Power Interrupt Test.	(11)		

Test Condition (Toshiba qualification tests)	Description of TR-107330 Table 5-1 Operability Tests (Section 5.3)		Operability Test for OPRM	
	Scope	Test Item	Performed Tests (See Note at the end of Table)	Justification/Explanation
Preparation of Temperature and Humidity Environment Test	No Description			
During High Temperature and High Humidity Environment Test	No Description			
After (End of) High Temperature and High Humidity Environment Test	"ALL" at the point per Figure 4-4	A. Accuracy	N/A	The OPRM does not have analog input and output.
		B. Response time	N/A	The OPRM does not have analog input.
		C. Discrete input operability	(7)	
		D. Discrete output operability	(3),(4),(5),(6)	
		E. Communication operability	(1),(2)	
		F. Coprocessor operability	N/A	The OPRM does not use coprocessors.
		G. Timer Tests	N/A	The OPRM does not provide any separate timer function.
		H. Test of failure to complete scan detection	Confirm no watchdog time alarms occurred	
		I. Failover Operability Tests	(8)	Tests numbered from (8-4) to (8-12) were not performed. The key switch is on the front panel of the module, which was not accessible while the OPRM was in the chamber.
		J. Loss of power test	(10)	
	K. Power Interrupt Test.	(11)		
During Low Temperature Environment Test	No Description			
After (End of) Low Temperature Environment Test	"ALL" at the point per Figure 4-4	A. Accuracy	N/A	The OPRM does not have analog input and output.
		B. Response time	N/A	The OPRM does not have analog input.
		C. Discrete input operability	(7)	
		D. Discrete output operability	(3),(4),(5),(6)	
		E. Communication operability	(1),(2)	
		F. Coprocessor operability	N/A	The OPRM does not use coprocessors.
		G. Timer Tests	N/A	The OPRM does not provide any separate timer function.

Test Condition (Toshiba qualification tests)	Description of TR-107330 Table 5-1 Operability Tests (Section 5.3)		Operability Test for OPRM	
	Scope	Test Item	Performed Tests (See Note at the end of Table)	Justification/Explanation
		H. Test of failure to complete scan detection	Confirmed no watchdog time alarms occurred	
		I. Failover Operability Tests	(8)	Test numbered from (8-4) to (8-12) were not performed. The key switch is on the front panel of the module, which was not accessible while the OPRM was in the chamber.
		J. Loss of power test	(10)	
		K. Power Interrupt Test.	(11)	
During Low Humidity Environment Test	No Description			
After (End of) Low Humidity Environment Test	"ALL" at the point per Figure 4-4	A. Accuracy	N/A	The OPRM does not have analog input and output.
		B. Response time	N/A	The OPRM does not have analog input.
		C. Discrete input operability	(7)	
		D. Discrete output operability	(3),(4),(5),(6)	
		E. Communication operability	(1),(2)	
		F. Coprocessor operability	N/A	The OPRM does not use coprocessors.
		G. Timer Tests	N/A	The OPRM does not provide any separate timer function.
		H. Test of failure to complete scan detection	Confirmed no watchdog time alarms occurred	
		I. Failover Operability Tests	(8)	Test numbered from (8-4) to (8-12) were not performed. The key switch is on the front panel of the module, which was not accessible while the OPRM was in the chamber.
		J. Loss of power test	(10)	
K. Power Interrupt Test.	(11)			
Translation to Ambient Environmental Condition	No Description			
After All Environmental Test	"ALL" at the point per Figure 4-4	A. Accuracy	N/A	The OPRM does not have analog input and output.
		B. Response time	N/A	The OPRM does not have analog input.
		C. Discrete input operability	(7)	
		D. Discrete output operability	(3),(4),(5),(6)	

Test Condition (Toshiba qualification tests)		Description of TR-107330 Table 5-1 Operability Tests (Section 5.3)		Operability Test for OPRM	
		Scope	Test Item	Performed Tests (See Note at the end of Table)	Justification/Explanation
			E. Communication operability	(1),(2)	
			F. Coprocessor operability	N/A	The OPRM does not use coprocessors.
			G. Timer Tests	N/A	The OPRM does not provide any separate timer function.
			H. Test of failure to complete scan detection	Confirmed no watchdog time alarms occurred	
			I. Failover Operability Tests	(8)	
			J. Loss of power test	(10)	
			K. Power Interrupt Test.	(11)	
Post-Shipment Performance Proof Test. Note: Seismic Tests were performed after EMC Tests. Post-Shipment Performance Proof Test was performed at the Seismic Test site after the shipment of the test specimen and the test equipment from the EMC Test site to the Seismic Test site.		"All"	A. Accuracy	N/A	The OPRM does not have analog input and output.
			B. Response time	N/A	The OPRM does not have analog input.
			C. Discrete input operability	(7)	
			D. Discrete output operability	(3),(4),(5),(6)	
			E. Communication operability	(1),(2)	
			F. Coprocessor operability	N/A	The OPRM does not use coprocessors.
			G. Timer Tests	N/A	The OPRM does not provide any separate timer function.
			H. Test of failure to complete scan detection	Confirmed no watchdog time alarms occurred	
			I. Failover Operability Tests	(8)	
			J. Loss of power test	(10)	
Seismic Test		Preparation Seismic Test	No Description		
		During Seismic Test(OBEs and SSE)	"All"	A. Accuracy B. Response time C. Discrete input operability D. Discrete output operability E. Communication operability F. Coprocessor operability G. Timer Tests	No operability test was performed but output signals are monitored.

Test Condition (Toshiba qualification tests)		Description of TR-107330 Table 5-1 Operability Tests (Section 5.3)		Operability Test for OPRM	
		Scope	Test Item	Performed Tests (See Note at the end of Table)	Justification/Explanation
After Seismic Test			H. Test of failure to complete scan detection		The discrete outputs and optical outputs are set as shown in Table IV-4-10 in this attachment with their acceptance criteria.
			I. Failover Operability Tests		
			J. Loss of power test		
			K. Power Interrupt Test.		
	"All"		A. Accuracy	N/A	The OPRM does not have analog input and output.
			B. Response time	N/A	The OPRM does not have analog input.
			C. Discrete input operability	(7)	
			D. Discrete output operability	(6)	
			E. Communication operability	Confirmed no communication alarms occurred	
			F. Coprocessor operability	N/A	The OPRM does not use coprocessors.
			G. Timer Tests	N/A	The OPRM does not provide any separate timer function.
			H. Test of failure to complete scan detection	Confirmed no watchdog time alarms occurred	
			I. Failover Operability Tests	(8)	Test numbered from (8-4) to (8-12) were not performed. The key switch is on the front panel of the module, which was not accessible while the OPRM was on the Vibration table.
			J. Loss of power test	Confirmed at the performance proof test (Pre—Qualification for EMC Test)	
	K. Power Interrupt Test.	Confirmed at the performance proof test (Pre—Qualification for EMC Test)			
Performance Proof Test(Pre-Qualification for EMC Test)	No Description		A. Accuracy	N/A	The OPRM does not have analog input and output.
			B. Response time	N/A	The OPRM does not have analog input.
			C. Discrete input operability	(7)	
			D. Discrete output operability	(3),(4),(5),(6)	

Test Condition (Toshiba qualification tests)		Description of TR-107330 Table 5-1 Operability Tests (Section 5.3)		Operability Test for OPRM	
		Scope	Test Item	Performed Tests (See Note at the end of Table)	Justification/Explanation
			E. Communication operability	(1),(2)	
			F. Coprocessor operability	N/A	The OPRM does not use coprocessors.
			G. Timer Tests	N/A	The OPRM does not provide any separate timer function.
			H. Test of failure to complete scan detection	Confirmed no watchdog time alarms occurred	
			I. Failover Operability Tests	(8)	
			J. Loss of power test	(10)	
			K. Power Interrupt Test.	(11)	
EMC Test	During EMC Test	"All except A"	A. Accuracy B. Response time C. Discrete input operability D. Discrete output operability E. Communication operability F. Coprocessor operability G. Timer Tests H. Test of failure to complete scan detection I. Failover Operability Tests J. Loss of power test K. Power Interrupt Test.	No operability test was performed but output signals are monitored.	Due to the special set-up required for the EMC tests, Operability Tests cannot be performed during EMC testing. Toshiba chose to monitor the equipment operation during the test and perform the operability tests before and after the tests to ensure that the OPRM remained operable during and after the EMC testing. The acceptance criteria during the EMC test is described in the EMI/RFI test procedure. The discrete outputs and optical outputs are set as shown in Table IV-4-10 in this attachment with their acceptance criteria.
Performance Proof Test(Post-Qualification Test for EMC Test)		No Description	A. Accuracy	N/A	The OPRM does not have analog input and output.
			B. Response time	N/A	The OPRM does not have analog input.
			C. Discrete input operability	(7)	
			D. Discrete output operability	(3),(4),(5),(6)	
			E. Communication operability	(1),(2)	
			F. Coprocessor operability	N/A	The OPRM does not use coprocessors.
			G. Timer Tests	N/A	The OPRM does not provide any separate timer function.
			H. Test of failure to complete scan detection	Confirmed no watchdog time alarms occurred	
			I. Failover Operability Tests	(8)	
			J. Loss of power test	(10)	

Test Condition (Toshiba qualification tests)	Description of TR-107330 Table 5-1 Operability Tests (Section 5.3)		Operability Test for OPRM	
	Scope	Test Item	Performed Tests (See Note at the end of Table)	Justification/Explanation
Performance Proof Test (Post-Qualification Test for EQ Test)	No Description	K. Power Interrupt Test.	(11)	
		A. Accuracy	N/A	The OPRM does not have analog input and output.
		B. Response time	N/A	The OPRM does not have analog input.
		C. Discrete input operability	(7)	
		D. Discrete output operability	(3),(4),(5),(6)	
		E. Communication operability	(1),(2)	
		F. Coprocessor operability	N/A	The OPRM does not use coprocessors.
		G. Timer Tests	N/A	The OPRM does not provide any separate timer function.
		H. Test of failure to complete scan detection	Confirmed no watchdog time alarms occurred	
		I. Failover Operability Tests	(8)	
		J. Loss of power test	(10)	
	K. Power Interrupt Test.	(11)		

Note: Operability Test item

- (1) APRM/FLOW level input and output Function Test
- (2) LPRM Ch-data input and output Function Test
- (3) Amplitude Based detection Algorithm (ABA) Trip Function Test
- (4) Growth Rate detection Algorithm (GRA) Trip Function Test
- (5) Period Based Detection Algorithm (PBDA) Trip Function Test
- (6) OPRM Automatic Bypass Function Test
- (7) OPRM Function Change by APRM Bypass Signal Test
- (8) Failure Detection and Self-Diagnosis Test
 - (8-1) Start the test pattern (APRM Inoperative occurs).
 - (8-2) Start the test pattern (APRM Unit Data 1 and 2 error).
 - (8-3) Start the APRM data (All LPRM levels are 50 % at OPRM Region).
 - (8-4) Turn the key switch of the CELL module to "STANDBY" position.
 - (8-5) Turn the key switch of the CELL module to "CAL" position.
 - (8-6) Turn the key switch of the CELL module to "OP" position.
 - (8-7) Turn the key switch of the AGRD module to "STANDBY" position.
 - (8-8) Turn the key switch of the AGRD module to "CAL" position.
 - (8-9) Turn the key switch of the AGRD module to "OP" position.
 - (8-10) Turn the key switch of the PBD module to "STANDBY" position.

- (8-11) Turn the key switch of the PBD module to "CAL" position.
- (8-12) Turn the key switch of the PBD module to "OP" position.
- (8-13) Start the test pattern (Number of Active OPRM Cell is lower than the setpoint).
- (8-14) Start the test pattern (All LPRM levels are 50 % at OPRM Region).
- (9) Power Quality Tolerance Test
- (10) Loss of Power Test
- (11) Power Interruption Test

Table IV-4-9 Mapping of OPRM Prudency Tests to Table-5-1 in EPRI TR-107330

Test Condition (Toshiba qualification tests)		Description of TR-107330 Table 5-1 Prudency Tests(Section5.4)		Prudency Test for OPRM	
		Test Point	Item	What is done(See Note at the end of Table)	Justification/Explanation
Performance Proof Test (Pre-Qualification Test for EQ test (Base Line))		"All"	A. Burst of events test.	(12), (13), (14)	
			B. Failure of serial port receiver test.	(15), (16), (17)	
			C. Serial port noise test.	N/A	The OPRM uses fiber optic links.
			D. Fault simulation.	(18)	
Environmental Test	Wear Aging Test	No Description			
	After the Wear Aging test	No Description			
	Preparation of Temperature and Humidity Environment Test	No Description			
	During High Temperature and High Humidity Environment Test	No Description			
	After (End of) High Temperature and High Humidity Environment Test	"ALL at end of high temp/RH only"	A. Burst of events test.	(12), (13), (14)	
			B. Failure of serial port receiver test.	(15), (16), (17)	
			C. Serial port noise test.	N/A	The OPRM uses fiber optic links.
D. Fault simulation.			The tests were not performed.	Test (18) was not performed because the AC Power switches of the test specimen in the chamber could not be turned off. Toshiba chose to monitor the equipment operation during the test. An alarm is generated when one of the AC power sources is shut off.	
During Low Temperature Environment Test	No Description				

Test Condition (Toshiba qualification tests)		Description of TR-107330 Table 5-1 Prudency Tests(Section5.4)		Prudency Test for OPRM	
		Test Point	Item	What is done(See Note at the end of Table)	Justification/Explanation
	After (End of) Low Temperature Environment Test	No Description			
	During Low Humidity Environment Test	No Description			
	After (End of) Low Humidity Environment Test	No Description			
	During High Temperature and High Humidity Environment Test	No Description			
	Translation to Ambient Environmental Condition	No Description			
	After All Environmental Test	No Description			
Post-Shipment Performance Proof Test. Note: Seismic Tests were performed after EMC Tests. Post-Shipment Performance Proof Test was performed at the Seismic Test site after the shipment of the test specimen and the test equipment from the EMC Test site to the Seismic Test site.		"All"	A. Burst of events test.	(12), (13), (14)	The OPRM uses fiber optic links.
			B. Failure of serial port receiver test.	(15), (16), (17)	
			C. Serial port noise test.	N/A	
			D. Fault simulation.	(18)	
Seismic Test	Preparation Seismic Test	No Description			
	During Seismic Test	"All"	A. Burst of events test.	The all Prudency tests were not	Due to the short duration of the seismic tests, Prudency Tests

Test Condition (Toshiba qualification tests)		Description of TR-107330 Table 5-1 Prudency Tests(Section5.4)		Prudency Test for OPRM	
		Test Point	Item	What is done(See Note at the end of Table)	Justification/Explanation
	(OBEs and SSE)		B. Failure of serial port receiver test. C. Serial port noise test. D. Fault simulation.	performed.	cannot be performed during the seismic event. Toshiba chose to monitor the equipment operation during the test. The acceptance criteria during the EMC test is described in the EMI/RFI test procedure. The discrete outputs and optical outputs are set as shown in Table IV-4-10 in this attachment with their acceptance criteria.
	After Seismic Test	"None"			
Performance Proof Test (Pre-Qualification for EMC Test)		No Description	A. Burst of events test.	(12), (13), (14)	
			B. Failure of serial port receiver test.	(15), (16), (17)	
			C. Serial port noise test.	N/A	The OPRM uses fiber optic links.
			D. Fault simulation.	(18)	
EMC Test	During EMC Test	"A only"	A. Burst of events test.	The tests were not performed.	Due to the special set-up required for the EMC tests, Prudency Tests cannot be performed during EMC testing. Toshiba chose to monitor the equipment operation during the test and perform the Prudency tests before and after the tests to ensure that the OPRM remained operable during and after the EMC testing. The acceptance criteria during the EMC test is described in the EMI/RFI test procedure. The discrete outputs and optical outputs are set as shown in Table IV-4-10 in this attachment with their acceptance criteria.
Performance Proof Test(Post-		No Description	A. Burst of events test.	(12), (13), (14)	

Test Condition (Toshiba qualification tests)	Description of TR-107330 Table 5-1 Prudency Tests(Section5.4)		Prudency Test for OPRM	
	Test Point	Item	What is done(See Note at the end of Table)	Justification/Explanation
Qualification Test for EMC Test)		B. Failure of serial port receiver test.	(15), (16), (17)	
		C. Serial port noise test.	N/A	The OPRM uses fiber optic links.
		D. Fault simulation.	(18)	
Performance Proof Test(Post- Qualification Test for EQ Test)	No Description	A. Burst of events test.	(12), (13), (14)	
		B. Failure of serial port receiver test.	(15), (16), (17)	
		C. Serial port noise test.	N/A	The OPRM uses fiber optic links.
		D. Fault simulation.	(18)	

Note: Prudency Test item

(12) Bypass Signal Toggling test

(13) LPRM Level Toggling test

(14) APRM Level and Core Flow Level Toggling test

(15) Parity Error in the Optical Transmission Input Signals test

(16) All LPRM Signals Loss test

(17) One Side of the Redundant APRM Signals Loss Test

(18) Fault Simulation Test

Table IV-4-10 Acceptance Criteria for Output Signals Monitored during Seismic Test and EMC Test for OPRM

	Signals	Target Value	Acceptance Criteria	
Discrete output	SCRAM	-	Occurred	
	PBDA TRIP	-	Not occurred	
	GRA TRIP	-	Occurred	
	ABA TRIP	-	Not occurred	
	OPRM_INOP	-	Not occurred	
	OPRM_FAIL	-	Not occurred	
	OPRM AT BYP	-	Not occurred	
	Trip Interval time (T _{cy})	$\left[\begin{matrix} \frac{2}{3} \\ s \end{matrix} \right]^{2/c}$	+/-	$\left[\frac{2}{3} \right]^{2/c}$
	Trip Interval time (T _{ga})	$\left[\begin{matrix} s \end{matrix} \right]$	+/-	$\left[\begin{matrix} s \end{matrix} \right]$
	Trip Interval time (T _{ap})	$\left[\begin{matrix} s \end{matrix} \right]$	+/-	$\left[\begin{matrix} s \end{matrix} \right]$
Trip Interval time (T _{pp})	$\left[\begin{matrix} s \end{matrix} \right]$	+/-	$\left[\begin{matrix} s \end{matrix} \right]$	
Optical output (ELCS/ PICS data)	SCRAM	-	Occurred	
	PBDA TRIP	-	Not occurred	
	GRA TRIP	-	Occurred	
	ABA TRIP	-	Not occurred	
	OPRM_INOP	-	Not occurred	
	OPRM_FAIL	-	Not occurred	
	OPRM AT BYP	-	Not occurred	
	Trip Interval time (T _{cy})	$\left[\begin{matrix} \frac{2}{3} \\ s \end{matrix} \right]^{2/c}$	+/-	$\left[\frac{2}{3} \right]^{2/c}$
	Trip Interval time (T _{ga})	$\left[\begin{matrix} s \end{matrix} \right]$	+/-	$\left[\begin{matrix} s \end{matrix} \right]$
	Trip Interval time (T _{ap})	$\left[\begin{matrix} s \end{matrix} \right]$	+/-	$\left[\begin{matrix} s \end{matrix} \right]$
Trip Interval time (T _{pp})	$\left[\begin{matrix} s \end{matrix} \right]$	+/-	$\left[\begin{matrix} s \end{matrix} \right]$	

ELCS: Engineering Safety Features Logic & Control System

PICS: Plant Information and Control System

Attachment B Changes from Revision 0

No.	Page	Item	Current (Rev.1)	Previous (Rev.0)	Reason
1	All pages	Header	Rev. <u>1</u>	Rev. <u>0</u>	New revision
2	12	Response to NRC question No. 17	<p>The PRM and the OPRM systems were qualified as follows, based on EPRI TR-107330 Figure 4-4 and Section 4.3.6:</p> <p><u>PRM:</u></p> <p>(i) High Temperature and Humidity: 140 °F and 95% relative humidity, which meets EPRI TR-107330 Section 4.3.6 and Figure 4-4 requirements (Toshiba notes that adding 5% margin to the relative humidity would most likely induce condensation, which is not included in Toshiba’s qualification envelope).</p> <p>(ii) Low Temperature and Humidity: 35 °F and 10% relative humidity, which meets EPRI TR-107330 Section 4.3.6 requirements (Figure 4-4 requirements for humidity could not be met in this chamber, even with relaxation for non-simultaneous temperature and humidity, and Toshiba notes that the OPRM is constructed of similar components and had no issues at 40 °F and 5% relative humidity which could be achieved in the environmental test chamber used for testing the OPRM).</p> <p><u>OPRM:</u></p> <p>(i) High Temperature and Humidity: 140 °F and 90% relative humidity, which meets EPRI TR-107330 Figure 4-4 requirements (Section 4.3.6 requirements for humidity were met in separate testing at Toshiba, see Note below).</p> <p>(ii) Low Temperature and Humidity: 40 °F and 5% relative humidity, which meets EPRI TR-107330 Section 4.3.6 and Figure 4-4 requirements.</p> <p>Note: OPRM testing with 140 °F and 95% relative humidity profile was successfully met in the factory test which was performed under Toshiba’s ISO 9001 program separately from the EQ test.</p>	<p>Based on the explanation above, the PRM system was qualified as follows:</p> <p>(i) High Temperature and Humidity: 140 °F (with 18 °F margin) and 95% relative humidity (no margin)</p> <p>(ii) (ii) Low Temperature and Humidity: 35 °F (5 °F margin) and 10% relative humidity (no margin)</p>	Supplemental explanation for clarification

No.	Page	Item	Current (Rev.1)	Previous (Rev.0)	Reason
3	26	Response to NRC question No. 36	...the equipment <u>behind</u> the plane of the door...	...the equipment <u>past</u> the plane of the door...	Supplemental explanation for clarification
4	29	Attachment A Paragraph 1.	-	<u>The change record of Table IV-4-1 is provided in Attachment B.</u>	
5	31	Table IV-4-1, Section 4.2.3.3	<u>Comply with limited scope and/or condition based on application specific usage of the system.</u> An availability calculation is prepared in a manner that conforms to IEEE Std 352-1987. <u>Twenty-four hour MTTR is used. The surveillance interval and the environmental stress are considered. Specific IO changes are not considered.</u>	<u>Comply.</u> An availability calculation is prepared in a manner that conforms to IEEE Std 352-1987. Comply	Update for clarification
6	31	Table IV-4-1, Section 4.2.3.3.1,	... <u>communication</u>...	...communication...	Typo correction
7	34	Table IV-4-1, Section 4.2.3.7.C	The modules <u>that have FPGAs are</u> provided with a power supply monitoring IC, <u>which provides</u> about 150 ms <u>or 470 ms</u> reset action and initial startup of FPGA at the time when the module is energized. In addition, it executes a reset action when the power supply voltage lowers, i.e., if the power supply voltage continues to be low, the module remains in initialization state, and keeps all trip and alarm outputs in the tripped state. <u>Note: The TRN module has about 470 ms reset time while other modules have about 150 ms reset time.</u>	The module <u>is provided</u> with a power supply monitoring IC, <u>and it executes</u> about 150 ms reset action and initial startup of FPGA at the time when the module is energized. In addition, it executes a reset action <u>also at the time</u> when the power supply voltage lowers, i.e., if the power supply voltage continues to be low, the module remains in initialization state, and keeps all trip and alarm outputs in the tripped state.	Update for clarification
8	35	Table IV-4-1, Section 4.3.1.4	... <u>communication</u>...	...<u>communiication</u> ...	Typo correction
9	35	Table IV-4-1, Section 4.3.2.1 C	... <u>over range</u>...	...<u>overrange</u> ...	Typo correction
10	35	Table IV-4-1, Section 4.3.2.1 D	... <u>under range</u>...	...<u>underrange</u> ...	Typo correction

No.	Page	Item	Current (Rev.1)	Previous (Rev.0)	Reason
11	37	Table IV-4-1, Section 4.3.2.1.2.H	... <u>non-safety</u>...	...<u>nonsafety</u> ...	Typo correction
12	38,	Table IV-4-1, Section 4.3.2.2.2.B	...requirements to be used...	..requirements to <u>to</u> be used...	Typo correction
13	38	Table IV-4-1, Section 4.3.2.2.2.C	...requirements to be used...	..requirements to <u>to</u> be used...	Typo correction
14	38	Table IV-4-1, Section 4.3.2.2.2.D	...requirements to be used...	..requirements to <u>to</u> be used...	Typo correction
15	38	Table IV-4-1, Section 4.3.2.2.2.D	...DIO capabilities_The...	...DIO capabilities.The...	Typo correction
16	40	Table IV-4-1, Section 4.3.3.1.1.B 2	d. The trip reset point is -1.25 % below trip set point	d. The trip reset point is -1.25 % FS below trip set point	Typo correction
17	40	Table IV-4-1, Section 4.3.3.1.1.B 3	c. The trip reset point is -1.25 % below trip set point	c. The trip reset point is -1.25 % FS below trip set point	Typo correction
18	42	Page 41, Table IV-4-1, Section 4.3.3.2.2.A	...DIO <u>module</u>...	...DIO <u>mudule</u> ...	Typo correction
19	45	Table IV-4-1, Section 4.3.4.7.A	..is <u>diagnosed</u> as failed if errors are <u>detected</u> in three <u>consecutive communication</u> cycles.”	.. is <u>diaganosed</u> as failed if errors are <u>deceted</u> in three <u>consecutive cummmunication</u> cycles.	Typo correction
20	46	Table IV-4-1, Section 4.3.6.1	<u>Comply with limited scope and/or condition. Requirements are set as follows complying with this section. Qualification test results meet the requirement with limited scope. See Section 6.3.3 for the results.</u>	Comply.	Update for clarification
21	46	Table IV-4-1, Section 4.3.6.1	-- (This note is moved to Section 4.3.8.)	Note: The climatic condition during the ESD tests is 30-60% as stated in EPRI TR-102323 and IEC EN 61000-4-2.	Supplemental explanation for clarification

No.	Page	Item	Current (Rev.1)	Previous (Rev.0)	Reason
22	46	Table IV-4-1, Section 4.3.6.2	Comply with <u>limited scope and/or condition. Requirements are set as follows complying with this section. Qualification test results meet the requirement with limited scope. See Section 6.3.3 for the results.</u>	Comply.	Update for clarification
23	46	Table IV-4-1, Section 4.3.6.3	<p>Comply. The PRM and OPRM <u>systems were qualified as follows, based on EPRI TR-107330 Figure 4-4 and Section 4.3.6:</u></p> <p>PRM:</p> <p>a. High Temperature and Humidity: 140 °F and 95% relative humidity, <u>which meets EPRI TR-107330 Section 4.3.6 and Figure 4-4 requirements (Toshiba notes that adding 5% margin to the relative humidity would most likely induce condensation, which is not included in Toshiba's qualification envelope).</u></p> <p>b. Low Temperature and Humidity: 35 °F and 10% relative humidity, <u>which meets EPRI TR-107330 Section 4.3.6 requirements (Figure 4-4 requirements for humidity could not be met in this chamber, even with relaxation for non-simultaneous temperature and humidity, and Toshiba notes that the OPRM is constructed of similar components and had no issues at 40 °F and 5% relative humidity which could be achieved in the environmental test chamber use for the OPRM testing).</u></p> <p>OPRM:</p> <p>a. High Temperature and Humidity: 140 °F and 90% relative humidity, <u>which meets EPRI TR-107330 Figure 4-4 requirements (Section 4.3.6 requirements for humidity were met in separate testing at Toshiba, see Note below).</u></p> <p>b. Low Temperature and Humidity: 40 °F and 5% relative humidity, <u>which meets EPRI TR-107330 Section 4.3.6 and Figure 4-4 requirements.</u></p> <p>Note: OPRM testing with 140 °F and 95% relative humidity profile was successfully <u>met</u> in the factory test <u>which was performed under Toshiba's ISO 9001 program</u> separately from the EQ test.</p>	<p>Comply. The PRM and OPRM units were qualified <u>using the temperature/humidity profile given in the EPRI TR-107330.</u></p> <p>PRM:</p> <p>a. High Temperature and Humidity: 140 °F <u>(with 18 °F margin)</u> and 95% relative humidity <u>(no margin)</u></p> <p>b. Low Temperature and Humidity: 35 °F <u>(5 °F margin)</u> and 10% relative humidity <u>(no margin)</u></p> <p>OPRM:</p> <p>a. High Temperature and Humidity: 140 °F <u>(with 18 °F margin)</u> and 90% relative humidity <u>(no margin to EPRI TR-107330 Figure 4-4 profile)</u></p> <p>b. Low Temperature and Humidity: 40 °F <u>(no margin)</u> and 5% relative humidity <u>(5% margin)</u></p> <p>Note: OPRM testing with 140 °F and 95% relative humidity profile was <u>successfully performed</u> in the factory test separately from the EQ test.</p>	Supplemental explanation for clarification

No.	Page	Item	Current (Rev.1)	Previous (Rev.0)	Reason
24	47	Table IV-4-1, Section 4.3.7	<p>... which passed the CE101 test. <u>For radiated susceptibility (RS103), Toshiba did not perform the test for the frequencies above 1 GHz for the PRM, and thus accepts that either a utility employing this equipment must preclude the use of cell phones and radios near this equipment or accept an open issue from the USNRC in the SER requiring an evaluation by the utility. RS103 test for the OPRM was conducted for the frequency up to 10 GHz.</u></p>	<p>which passed the CE101 test. ==</p>	Supplemental explanation for clarification
25	47	Table IV-4-1, Section 4.3.8	<p>Note: <u>The climatic conditions during the ESD tests are 58% (day 1) and 51% (day 2) in the PRM tests, 40% (day 1) and 42% (day 2) in the OPRM tests, which is within the required range of 30 to 60% relative humidity.</u></p> <p>(This note was moved from Section 4.3.6.1 with the changes marked by underlines.)</p>	--	Update for clarification
26	49	Table IV-4-1, Section 4.4.1.2.D	<p><u>The modules that have FPGAs are provided with a power supply monitoring IC, which provides about 150 ms or 470 ms reset action and initial startup of FPGA at the time when the module is energized. In addition, it executes a reset action when the power supply voltage lowers, i.e., if the power supply voltage continues to be low, the module remains in initialization state, and keeps all trip and alarm outputs in the tripped state.</u></p> <p><u>Note: The TRN module has about 470 ms reset time while other modules have about 150 ms reset time.</u></p>	<p><u>Each module is provided with the power supply monitoring IC, which provides about 150 ms reset action and initial startup of FPGA at the time when the module is energized. In addition, it executes a reset action also at the time when the power supply voltage lowers, i.e. if the power supply low voltage continues to be low, the module remains in initialization state, and keeps all trip and alarm outputs tripped.</u></p>	Update for clarification
27	51	Table IV-4-1, Section 4.4.6.1	...millise <u>conds</u>...	...millise <u>onds</u> ...	Typo correction
28	53	Table IV-4-1, Section 4.4.6.1.11	... a stuck value does not adversely <u>ffect</u> operation of ...	... a stuck value does not adversely <u>effect</u> operation of ...	Typo correction

No.	Page	Item	Current (Rev.1)	Previous (Rev.0)	Reason
29	53	Table IV-4-1, Section 4.4.6.3	The modules that have FPGAs are provided with a power supply monitoring IC, which provides about 150 ms or 470 ms reset action and initial startup of FPGA at the time when the module is energized. In addition, it executes a reset action when the power supply voltage lowers, i.e., if the power supply voltage continues to be low, the module remains in initialization state, and keeps all trip and alarm outputs in the tripped state. <u>Note: The TRN module has about 470 ms reset time while other modules have about 150 ms reset time.</u>	<u>Each module is provided with the power supply monitoring IC, which provides about 150 ms reset action and initial startup of FPGA at the time when the module is energized. In addition, it executes a reset action also at the time when the power supply voltage lowers, i.e. if the power supply low voltage continues to be low, the module remains in initialization state, and keeps all trip and alarm outputs tripped.</u>	Update for clarification
30	54	Table IV-4-1, Section 4.4.7.2.B	...setpoints...	...setpointst...	Typo correction
31	55	Table IV-4-1, Section 4.5.2.E	...non_safety...	...nonsafety...	Typo correction
32	56	Table IV-4-1, Section 4.5.6.F	...non_safety...	...nonsafety...	Typo correction
33	60	Table IV-4-1, Section 4.7.5	Application Specific <u>Requirement</u>	Application Specific <u>Requirement</u>	Typo correction
34	67	Table IV-4-1, Section 5.3.C	Application Specific <u>Requirement</u>	Application Specific <u>Requirement</u>	Typo correction
35	68	Page 65, Table IV-4-1, Section 5.3.E	Application Specific <u>Requirement</u>	Application Specific <u>Requirement</u>	Typo correction
36	68	Page 65, Table IV-4-1, Section 5.3.E	No acceptance criterion is defined in the PRM <u>ERS</u> and the OPRM <u>EDS</u> ...”	No acceptance criterion is defined in the PRM and the OPRM,...	Grammatical Correction

No.	Page	Item	Current (Rev.1)	Previous (Rev.0)	Reason
37	69	Table IV-4-1, Section 5.3.I	<p>...testing during qualification testing. <u>For the PRM and OPRM, Toshiba performed tests in which the voltage of one of the two redundant Low Voltage Power Supplies (LVPSs) outputs of each unit were lowered to the level at which Fail signal status occurred to the LVPS module, and confirmed that each redundant power supply operated correctly without generating "Fail" signal. The tests were performed during the Pre and Post Qualification Testing.</u></p> <p>The DIO module...</p>	<p>...testing during qualification testing.</p> <p>The DIO module...</p>	Supplemental explanation for clarification
38	69	Table IV-4-1, Section 5.3.I	... the analog output (AO) module that has <u>non</u> -safety function ...	... the analog output (AO) module that has <u>no</u> safety function ...	Typo correction
39	70	Table IV-4-1, Section 5.3.K	...AO module. <u>For</u> ...	"..AO module. <u>For</u> ."	Typo correction
40	71	Table IV-4-1, Section 5.4.A	Application Specific <u>Requirement</u>	Application Specific Requirement	Typo correction
41	72	Table IV-4-1, Section 5.4.B	Application Specific <u>Requirement</u>	Application Specific Requirement	Typo correction
42	72	Table IV-4-1, Section 5.4B, 4 th paragraph,	... <u>demonstration</u>...	...<u>demonstration</u> ...	Typo correction
43	72	Table IV-4-1, Section 5.4.B, 5 th paragraph,	...in this response. Please note that Failure of Serial Port Receiver Test was performed for the OPRM optical serial transmission port during the OPRM prudency test by <u>plugging</u> out the other end of the <u>fiber</u> optic <u>cable</u> connected the test equipment that works for sending the LPRM data.	...in this response. Please note that Failure of Serial Port Receiver Test was performed for the OPRM optical serial transmission port during the OPRM prudency test by <u>plugging</u> out the other end of the <u>fober</u> optic <u>cale</u> connected the <u>the</u> test equipment that works for sending the LPRM data.	Typo correction
44	72	Table IV-4-1, Section 5.4.C	Application Specific <u>Requirement</u>	Application Specific Requirement	Typo correction
45	73	Table IV-4-1, Section 5.5, 6 th line	...Operability/ <u>Prudency</u>...	...Operability/ <u>Pridency</u> ...	Typo correction

No.	Page	Item	Current (Rev.1)	Previous (Rev.0)	Reason
46	73	Table IV-4-1, Section 5.5, 7 th line	<u>Separate Table IV-4-8.....Operability/Prudency ...</u>	<u>Sparate Table IV-4-8 ... Operability/<u>Pridency</u>...</u>	Typo correction
47	78	Table IV-4-1, Section 6.3.3,	<p>Comply with limited scope and/or condition. The PRM and OPRM systems were qualified were qualified as follows, <u>based on EPRI TR-107330 Figure 4-4 and Section 4.3.6:</u></p> <p>PRM:</p> <p>a. High Temperature and Humidity: 140 °F and 95% relative humidity, <u>which meets EPRI TR-107330 Section 4.3.6 and Figure 4-4 requirements (Toshiba notes that adding 5% margin to the relative humidity would most likely induce condensation, which is not included in Toshiba's qualification envelope).</u></p> <p>b. Low Temperature and Humidity: 35 °F and 10% relative humidity, <u>which meets EPRI TR-107330 Section 4.3.6 requirements (Figure 4-4 requirements for humidity could not be met in this chamber, even with relaxation for non-simultaneous temperature and humidity, and Toshiba notes that the OPRM is constructed of similar components and had no issues at 40 °F and 5% relative humidity which could be achieved in the environmental test chamber use for the OPRM testing).</u></p> <p>OPRM:</p> <p>a. High Temperature and Humidity: 140 °F and 90% relative humidity, <u>which meets EPRI TR-107330 Figure 4-4 requirements (Section 4.3.6 requirements for humidity were met in separate testing at Toshiba, see Note below).</u></p> <p>b. Low Temperature and Humidity: 40 °F and 5% relative humidity, <u>which meets EPRI TR-107330 Section 4.3.6 and Figure 4-4 requirements.</u></p> <p>Note: OPRM testing with 140 °F and 95% relative humidity profile was successfully <u>met</u> in the factory test <u>which was performed under Toshiba's ISO 9001 program</u> separately from the EQ test.</p>	<p>Comply with limited scope and/or condition. The PRM and OPRM units were qualified <u>using the temperature/humidity profile given in the EPRI TR-107330.</u></p> <p>PRM:</p> <p>a. High Temperature and Humidity: 140 °F (with 18 °F margin) and 95% relative humidity (<u>no margin</u>)</p> <p>b. Low Temperature and Humidity: 35 °F (<u>5 °F margin</u>) and 10% relative humidity (<u>no margin</u>)</p> <p>OPRM:</p> <p>a. High Temperature and Humidity: 140 °F (with 18 °F margin) and 90% relative humidity (<u>no margin to EPRI TR-107330 Figure 4-4 profile</u>)</p> <p>b. Low Temperature and Humidity: 40 °F (<u>no margin</u>) and 5% relative humidity (<u>5% margin</u>)</p> <p>Note: OPRM testing with 140 °F and 95% relative humidity profile was successfully <u>performed</u> in the factory test separately from the EQ test.</p>	Supplemental explanation for clarification

No.	Page	Item	Current (Rev.1)	Previous (Rev.0)	Reason
48	80	Table IV-4-1, Section 6.3.4.4	Comply. The test response spectrum from the control and specimen response accelerometers provided 1/2, 1, 2, 3 and 5% damping for the PRM and the OPRM qualification testing. Test results for the PRM qualification testing are documented in Section III-2. Test results for the OPRM qualification are documented in Section III-5	Comply with <u>limited scope and/or condition</u> . The test response spectrum from the control and specimen response accelerometers provided 1/2, 1, 2, 3 and 5% damping for the PRM and <u>5 % damping</u> for the OPRM qualification testing. <u>The 5% damping was selected for OPRM testing in accordance with the IEEE std 344-1987 as endorsed by RG 1.100.</u> Test results for the PRM qualification testing are documented in Section III-2. Test results for the OPRM qualification are documented in Section III-5.	Update for clarification
49	84	Table IV-4-1, Section 7.2.D	... <u>program</u>...	...<u>progr</u> am...	Typo correction
50	86	Table IV-4-1, Section 7.5.3	For <u>potential</u> needs for the FPGA logic <u>modification</u> ,...	For <u>potentia</u> l needs for the FPGA logic <u>modificati</u> on,...	Typo correction
51	89	Table IV-4-1, Section 8.6	... <u>review</u> and...	... <u>review</u> and...	Typo correction
52	92	Table IV-4-1, Section 8.6.3.R	... <u>mounting</u>...	...<u>mouting</u> ...	Typo correction
53	97	Table IV-4-2 Environmental Test and Seismic Test	Blank rows were deleted.	-	Typo correction
54	107	Table IV-4-3, Note B, item (i), 2 nd paragraph	Toshiba <u>selected</u> the 400 μ A setting...	Toshiba <u>chose</u> 400 μ A setting...	Grammatical correction
55	108	Table IV-4-3, Note B, item (i), 3 rd paragraph	Toshiba <u>selected</u> the 400 μ A setting that is <u>the</u> most <u>commonly</u> used in actual operation due to the limitation mentioned above.	Toshiba <u>chose</u> 400 μ A setting that is most used in <u>the</u> actual operation due to the limitation mentioned above.	Typo correction

No.	Page	Item	Current (Rev.1)	Previous (Rev.0)	Reason																																			
56	108	Table IV-4-3, Note B, item (i), 3 rd paragraph	Toshiba did not observe...	Toshiba did not observed...	Grammatical correction																																			
57	108	Table IV-4-3, Note B, item (iii)	(iii) Test (13), (14), and (15) were not performed, because the watchdog function test <u>requires</u> intentionally expiring the watchdog timer by removing a jumper pin on the PC board of the test specimen and stop the reset signals from FPGAs to the watchdog timer. <u>This was not possible while the PRM was in the chamber. Instead,</u> Toshiba monitored the equipment operation during the tests. An alarm was generated by the watchdog timer when the jumper pin was removed.	(iii) Test (13), (14), and (15) were not performed, because the watchdog function test <u>needs</u> intentionally expiring the watchdog timer by removing a jumper pin on the PC board of the test specimen, <u>which was in the chamber,</u> and stop the reset signals from FPGAs to the watchdog timer. Toshiba monitored the equipment operation during the tests. An alarm was generated by the watchdog timer when the jumper pin was removed.	Grammatical correction																																			
58	108	Table IV-4-3, Note B, item (v) last sentence	An inoperable <u>signal</u> is...	...An inoperable is...	Grammatical Correction																																			
59	119	Table IV-4-8, Before "Seismic Test"	<table border="1"> <tr> <td rowspan="11"> Post-shipment Performance Proof Test. Note: Seismic Tests were performed after EMC Tests. Post-shipment Performance Proof Test was performed at the Seismic Test site after the shipment of the test specimen and the test equipment from the EMC Test site to the Seismic Test site. </td> <td rowspan="11">"All"</td> <td>A. Accuracy</td> <td>N/A</td> <td>The OPRM does not have analog input and output.</td> </tr> <tr> <td>B. Response time</td> <td>N/A</td> <td>The OPRM does not have analog input.</td> </tr> <tr> <td>C. Discrete input operability</td> <td>(7)</td> <td></td> </tr> <tr> <td>D. Discrete output operability</td> <td>(3),(4),(5),(6)</td> <td></td> </tr> <tr> <td>E. Communication operability</td> <td>(1),(2)</td> <td></td> </tr> <tr> <td>F. Coprocessor operability</td> <td>N/A</td> <td>The OPRM does not use coprocessors.</td> </tr> <tr> <td>G. Timer Tests</td> <td>N/A</td> <td>The OPRM does not provide any separate timer function.</td> </tr> <tr> <td>H. Test of failure to complete scan detection</td> <td>Confirmed no watchdog time alarms occurred</td> <td></td> </tr> <tr> <td>I. Failover Operability Tests</td> <td>(8)</td> <td></td> </tr> <tr> <td>J. Loss of power test</td> <td>(10)</td> <td></td> </tr> <tr> <td>K. Power Interrupt Test.</td> <td>(11)</td> <td></td> </tr> </table>	Post-shipment Performance Proof Test. Note: Seismic Tests were performed after EMC Tests. Post-shipment Performance Proof Test was performed at the Seismic Test site after the shipment of the test specimen and the test equipment from the EMC Test site to the Seismic Test site.	"All"	A. Accuracy	N/A	The OPRM does not have analog input and output.	B. Response time	N/A	The OPRM does not have analog input.	C. Discrete input operability	(7)		D. Discrete output operability	(3),(4),(5),(6)		E. Communication operability	(1),(2)		F. Coprocessor operability	N/A	The OPRM does not use coprocessors.	G. Timer Tests	N/A	The OPRM does not provide any separate timer function.	H. Test of failure to complete scan detection	Confirmed no watchdog time alarms occurred		I. Failover Operability Tests	(8)		J. Loss of power test	(10)		K. Power Interrupt Test.	(11)		-	Additional Information
Post-shipment Performance Proof Test. Note: Seismic Tests were performed after EMC Tests. Post-shipment Performance Proof Test was performed at the Seismic Test site after the shipment of the test specimen and the test equipment from the EMC Test site to the Seismic Test site.	"All"	A. Accuracy	N/A			The OPRM does not have analog input and output.																																		
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No.	Page	Item	Current (Rev.1)	Previous (Rev.0)	Reason					
60	122	Table IV-4-8, Note Operability Test item, item (8-1)	(APRM <u>Inoperative</u> occurs)	(APRM <u>Inoprative</u> occurs)	Typo correction					
61	125	Table IV-4-9, Before "Seismic Test"	<table border="1"> <tr> <td data-bbox="527 435 682 792"> Post-Shipments Performance Proof Test. Note: Seismic Tests were performed after EMC Tests. Post- Shipment Performance Proof Test was performed at the Seismic Test site after the shipment of the test specimen and the test equipment from the EMC Test site to the Seismic Test site. </td> <td data-bbox="682 435 737 792">"All "</td> <td data-bbox="737 435 926 792">A. Burst of events test.</td> <td data-bbox="926 435 1060 792"></td> <td data-bbox="1060 435 1249 792"> Due to the short duration of the seismic tests, Prudency Tests cannot be performed during the seismic event. Toshiba chose to monitor the equipment operation during the test. The acceptance criteria during the EMC test is described in the EMI/RFI test procedure. The discrete outputs and optical outputs are set as shown in Table IV 4 10 in this attachment with their acceptance criteria. </td> </tr> </table>	Post-Shipments Performance Proof Test. Note: Seismic Tests were performed after EMC Tests. Post- Shipment Performance Proof Test was performed at the Seismic Test site after the shipment of the test specimen and the test equipment from the EMC Test site to the Seismic Test site.	"All "	A. Burst of events test.		Due to the short duration of the seismic tests, Prudency Tests cannot be performed during the seismic event. Toshiba chose to monitor the equipment operation during the test. The acceptance criteria during the EMC test is described in the EMI/RFI test procedure. The discrete outputs and optical outputs are set as shown in Table IV 4 10 in this attachment with their acceptance criteria.	-	Additional Information
Post-Shipments Performance Proof Test. Note: Seismic Tests were performed after EMC Tests. Post- Shipment Performance Proof Test was performed at the Seismic Test site after the shipment of the test specimen and the test equipment from the EMC Test site to the Seismic Test site.	"All "	A. Burst of events test.		Due to the short duration of the seismic tests, Prudency Tests cannot be performed during the seismic event. Toshiba chose to monitor the equipment operation during the test. The acceptance criteria during the EMC test is described in the EMI/RFI test procedure. The discrete outputs and optical outputs are set as shown in Table IV 4 10 in this attachment with their acceptance criteria.						