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TOSHIBA CORPORATION  
 NUCLEAR ENERGY SYSTEMS & SERVICES  
 DIV.

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Compliance to EPRI NP-5652 and EPRI TR-106439  
 for Toshiba NRW-FPGA-based PRM and OPRM

Note :  
 This document provides compliance to EPRI NP-5652 and EPRI TR-106439 for Toshiba NRW-FPGA-based PRM and OPRM.

000	Aug 7, 2015	Initial Issue	S.Odanaka Aug 7, 2015	J. Hayashi Aug. 7, 2015	J. Miyagaki Aug 6, 2015
Revision	Date	Contents	Approved by	Reviewed by	Prepared by

Nuclear Energy Systems & Services Division  
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## Compliance to EPRI NP-5652

Table A CTM for EPRI NP-5652

EPRI NP-5652	Compliance	Comments
Section 1. BACKGROUND AND DOCUMENT BASIS	---	No requirement
Section 2 GENERIC PROCESS	---	No requirement, section title
2.1 Determining Safety Function of Item  Perform an evaluation of to determine if an item is safety-related.	Comply	<u>OPRM</u> Section 5.2 of FC51-1505-1000 "Preliminary Technical Evaluation Report for FPGA-based Safety-Related Systems" (OPRM PTER) classifies items comprising OPRM into those that have 1) safety functions, 2) effects on safety functions, and 3) others; Section 5.3 classifies services in the same manner.  <u>PRM</u> Section 4.1 of FPG-DRT-C51-0001 "Preliminary Technical Evaluation Report" (PRM PTER) describes determination process of the design requirements and safety functions.
2.2 Confirming Item Meets Definition of Commercial Grade  Confirm that item meets the criteria set forth in the commercial grade item definition.	Comply	<u>OPRM</u> Sections 5.4 and 5.5 of OPRM PTER identify commercial grade items and commercial services.  <u>PRM</u> Section 8 of FPG-PLN-C51-0003 "Qualification Plan" (PRM QP) identifies Commercial Grade (CG) Items (CGIs) and CG Service.
2.3 Identification of Critical Characteristics  Identify the critical characteristics to be verified.	Comply	<u>OPRM</u> Sections 6.1 and 6.2 of OPRM PTER describe determination of Critical Characteristic (CC). Section 8.1 of OPRM PTER describes identification of CC for Acceptance (CCA) and verification methods for CGI; Section 8.2 of OPRM PTER describes identification of CCA and verification methods for CG services. NICSD prepares a Commercial Dedication Instruction (CDI) to identify CCs for each CGI, e.g., the CELL module, AGRD module, and PBD module.  <u>PRM</u> Section 4.2 of PRM PTER describes selection of CCDs and CCAs for CGIs; Section 4.3 of PRM PTER describes CC for Designs (CCDs) and CCAs for CG services.

EPRI NP-5652	Compliance	Comments
<p>2.4 Selecting Appropriate Acceptance Method</p> <p>Select acceptance methods from four acceptable methods.</p>		<p><u>OPRM</u> Sections 8.1 and 8.2 of OPRM PTER describe selection of acceptance methods.</p> <p><u>PRM</u> Section 9.2.7 of PRM QP, describe selection of acceptance methods.</p>
<p>2.5 Acceptance Delegation</p> <p>The party responsible for acceptance of the CGI must include the acceptance process within its 10 CFR 50, Appendix B program.</p>	Comply	<p><u>OPRM</u> NICSD has an acceptance process of CGIs under its appendix B QA.</p> <p><u>PRM</u> NED had and has an acceptance process of CGIs under its appendix B QA.</p>
<p>2.6 Reportability and Traceability</p> <p>The reportability and traceability of CGIs should be controlled in accordance with the purchaser's reportability and traceability programs applicable to other safety-related items.</p>	Comply	<p><u>OPRM</u> The QA program of NICSD includes a reporting procedures complying to 10 CFR 50.</p> <p><u>PRM</u> The QA program of NED includes a reporting procedures complying to 10 CFR 50.</p>
3 Acceptance Methods	---	Section title, no requirement
3.1 Method 1 - Special Tests and Inspections	Comply	<p><u>OPRM</u> See CTM to EPRI TR-106439 (Table B). Section 9 of OPRM PTER describes application of these methods for OPRM. Sections 9.1.2, 9.2.2, 9.3.2, and 10 of FC51-1505-1001 "Final Technical Evaluation Report for FPGA-based Safety-Related Systems" (OPRM FTER) provides additional information on application of these methods.</p>
3.2 Method 2 - Commercial Grade Survey of Supplier		
3.3 Method 3 - Source Verification		
3.4 Method 4 - Acceptable Supplier/Item Performance Record	Not Used	<p><u>OPRM and PRM</u> Method 4 is not used.</p>
3.5 Combination of Two or More Methods.	Comply	<p><u>OPRM and PRM</u> Method 1, 2, and 3 are used in combination, as described above in 3.1, 3.2, and 3.3.</p>
4 Reference	---	No requirement
5 Bibliography	---	No requirement

## Compliance to EPRI TR-106439

Table 4-1 of EPRI TR-106439 shows a “critical characteristics matrix” that lists typical critical characteristics falling into the three categories: Physical, performance, and dependability characteristics, and provides examples of critical characteristics, their acceptance criteria, methods of verification, and application of methods.

Table B was prepared using Table 4-1 of EPRI TR-106439 as a template, to show where or in which documents the critical characteristics, acceptance criteria, and methods of verification for the FPGA-based I&C systems are provided.

Table C was prepared using Table 4-2 of EPRI TR-106439 as a template, to show assessment of “Built-in Quality” for OPRM and PRM.

### Table B Critical Characteristic Matrix for OPRM and PRM

Critical Characteristics for Acceptance (CCA)	Acceptance Criteria	Method of Verification
Physical (Product/part identifier)		---
<u>OPRM:</u> Section 8.1 of OPRM PTER (or Final Technical Evaluation Report (FTER)) describes identification of simple CCAs, such as “Dimension” and “Mass”, with their acceptance criteria.		Special test and Inspection (Method 1)
<u>PRM:</u> Appendix A of PRM FTER provides methods of verification for each CC, including those fall into physical category.		Special test and Inspection (Method 1)
Performance (Required functionality)		---
<u>OPRM:</u> PPDD, the module supplier, performs functional testing of the modules before shipping. Section 8 of OPRM PTER describes identification of CCs depending on supplier testing.		EQ and EMC testing (Method 1) Commercial Grade (CG) survey (Method 2)
<u>PRM:</u> Appendix A of PRM FTER provides methods of verification for each CC, including those fall into performance category.		Special test and Inspection (Method 1) EQ and EMC testing (Method 1) CG survey (Method 2)
Dependability		---
<u>OPRM:</u> Section 8 of OPRM PTER describes CCs relating to “built-in quality” and “configuration control and traceability.”		CG survey (Method 2) V&V activities (Method 3)
<u>PRM</u> Appendix A of PRM FTER provides methods of verification for each CC, including those in the dependability category.		CG survey (Method 2) Source Verification (Method 3) V&V activities (Method 3)

**Table C Assessment of “Built-in Quality” for OPRM and PRM**

Activities Used in Assessment of Item Quality	OPRM and PRM
Review of the design, its documentation, and hardware and software implementations	<p><u>OPRM</u> Design and test documents for respective modules and FPGA logics, and RTMs were reviewed in the IV&amp;V process. (Section 9.1.2 (7) of OPRM FTER)</p> <p><u>PRM</u> The design relating to software requirements were accessed based on V&amp;V information from the vendor. (Item for ERS 5.3 in Appendix A of PRM FTER) The V&amp;V activities included hardware verification.</p>
Review of the design/ development process and its documentation, as it was applied for the item being evaluated	<p><u>OPRM</u> NICSD conducted CG surveys that reviewed the design and development process (Section 9 of OPRM PTER)</p> <p><u>PRM</u> NED conducted CG surveys (e.g., Item for FPG-PLN-A70-0001 “Project Quality Assurance Manual” (PRM PQAM) 6.4 in Appendix A of PRM PTER)</p>
Review of qualifications and experience of personnel involved in design and verification	<p><u>OPRM</u> The CG survey of PPDD included review of qualification and experience of personnel (Section 9.2 of OPRM PTER)</p> <p><u>PRM</u> NED conducted CG surveys (e.g., Item for PRM PQAM 6.4 in Appendix A of PRM PTER)</p>
Review of vendor QA program and practices, including SQA	<p><u>OPRM</u> NICSD requires PPDD to apply software related QA procedures, which PPDD established under their ISO-9001 QA process (Section 9.1 of OPRM PTER)</p> <p><u>PRM</u> NED conducted CG surveys (e.g., Item for PRM PQAM 6.4 in Appendix A of PRM PTER)</p>
Review of vendor configuration control program and practices	<p><u>OPRM</u> The CG survey of PPDD included review of configuration control. (Section 9.2 of OPRM PTER)</p> <p><u>PRM</u> NED conducted CG surveys (e.g., Item for PRM PQAM 6.4 in Appendix A of PRM PTER)</p>

Activities Used in Assessment of Item Quality	OPRM and PRM
Failure analysis	<p>OPRM</p> <p>FC51-3704-1101 "Nuclear Instrumentation &amp; Control Systems Department Software Safety Analysis Report for Safety-Related Oscillation Power Range Monitor (OPRM) (Design Phase)" addresses the OPRM failure analysis</p> <p><u>PRM</u></p> <p>FPG-DRT-C51-0018 "Requirements Definition Phase Hazard Analysis Report" addresses the PRM failure analysis</p>
Review of vendor testing	<p><u>OPRM and PRM</u></p> <p>V&amp;V activities review the vendor testing</p>
Review of product operating history	<p><u>OPRM and PRM</u></p> <p>FPG-DRT-C51-0005 "NICSD' CDR Report" and FPG-DRT-C51-0006 "Actel's CDR Report" report operating history of FPGA-based I&amp;C equipment and FPGA devices</p> <p>Note: Method 4 was not used as an acceptance method for PRM and OPRM equipment</p>

### Reference Documents

Abbreviated Title Used in Tables	Document No.	Title	Scope
OPRM FTER	FC51-1505-1001	Final Technical Evaluation Report for FPGA-based Safety-Related Systems	OPRM
OPRM PTER	FC51-1505-1000	Preliminary Technical Evaluation Report for FPGA-based Safety-Related Systems	OPRM
PRM FTER	FPG-DRT-C51-0102	Final Technical Evaluation Report	PRM
PRM PQAM	FPG-PLN-A70-0001	Project Quality Assurance Manual	PRM
PRM PTER	FPG-DRT-C51-0001	Preliminary Technical Evaluation Report	PRM
PRM QP	FPG-PLN-C51-0003	Qualification Plan	PRM
-	FC51-3704-1101	Nuclear Instrumentation & Control Systems Department Software Safety Analysis Report for Safety-Related Oscillation Power Range Monitor (OPRM) (Design Phase)	OPRM
-	FPG-DRT-C51-0018	Requirements Definition Phase Hazard Analysis Report	PRM
-	FPG-DRT-C51-0005	NICSD's CDR Report	PRM
-	FPG-DRT-C51-0006	Actel's CDR Report	PRM/OPRM