NON-PROPRIETARY

Enclosure 3 – RAI Response

RAI Letter Dated July 6, 2015

NRC QUESTION:
Documents to be docketed

1. Please docket the documents identified below

Power Range Monitoring (PRM) System

- Equipment Requirement Specification (ERS) (FPG-RQS-C51-0001)
- Qualification Plan for the PRM System (FPG-PLN-C51-0003)
- Preliminary Technical Evaluation Report (PTER) (FPG-DRT-C51-0001)
- Acceptance Plan for the PRM System (FPG-PLN-C51-0008, FPG-PLN-C51-0010, and FPG-PLN-C51-0025)
- Compliance to Electric Power Research Institute (EPRI) NP-5652 and EPRI Technical Report (TR)-106439 (IM-2014-001234)
- Master Test Plan (MTP) (FPG-PLN-C51-0005)
- Final Technical Evaluation Report (FTER) for PRM System (FPG-DRT-C51-0102)
- Qualification Test Summary Report (FPG-TRT-C51-0101)
- Software Quality Assurance Plan (FPG-PLN-C51-0002)
- Verification and Validation Plan (FPG-PLN-C51-0006)
- Failure Mode and Effects Analysis (FMEA) (FPG-DRT-C51-0018)
- Availability/Reliability Analysis Report (FPG-TRT-C51-0018)
- Setpoint Support Analysis Report (FPG-TRT-C51-0003)

Oscillation Power Range Monitoring (OPRM) Unit

- Equipment Design Specification (EDS) (FC51-3002-1000)
- Commercial Grade Dedication (CGD) Plan for OPRM unit (FA32-7021-1000)
- Commercial Dedication Instruction (CDI) for the OPRM unit (9B8K0046, 9B8K0047, 9B8K0048 Rev.3, 9B8K0049, 9B8K0050, 9B8K0051, 9B8K0053, 9B8K0054, 9B8K0055, 9B8K0056, 9B8K0057)
- Preliminary Technical Evaluation
- Equipment Qualification (EQ) Test Plan (FC51-7012-1000)
- EMC Test Plan (FC51-7012-1001)
- Final Technical Evaluation Report for the OPRM Unit (FC51-1505-1001)
- Software Quality Assurance Plan (FA32-3701-1001)
- Verification and Validation Plan (FA32-3709-1000)
- FMEA (C51-3704-1101)
- Availability/Reliability Analysis Report (C51-3809-1000)
- Setpoint Support Analysis Report (FC51-1505-0002)
- Dynamic Qualification Report for Safety-Related OPRM (FC51-7513-1003)
- EQ Report for Safety-Related OPRM (FC51-7513-1000)
- EMC Qualification Report for Safety-Related OPRM (FC51-7513-1001)
- Aging Analysis Report for Safety-Related OPRM (FC51-1505-0001)

- Software Safety Analysis Report (FC51-3704-1101)

RESPONSE:

Toshiba dockets these documents by the end of August.

NRC QUESTION:
Commercial Grade Dedication

2. The PTER (FPG-DRT-C51-0001) comments about the critical characteristics for design (CCD) and critical characteristics for acceptance (CCA). In particular, Section 4.2.2 describes the process for selecting CCDs and CCAs. Section 4.2 refers to Appendix A where a "summary for CCDs and CCAs for the test specimen" is provided.

Because Appendix A includes all the system requirements from the ERS, it is not clear if the entire information in Appendix A refers to all critical characteristics of the system.
The problem with Appendix A is that it identifies all requirements from EPRI TR-107330 without distinguishing the type of critical characteristics for each requirement.

This is acceptable for critical characteristics associated with physical and performance characteristics, but not for dependability characteristics. Dependability characteristics address process attributes to build the system, which are not identified in EPRI TR-107330, "Generic Requirements Specification for Qualifying a Commercially Available PLC for Safety-Related Applications in Nuclear Power Plants."

In addition, the Acceptance Plan (FPG-PLN-C51-0008) documents the critical characteristics of the PRM system. However, it is not clear how the critical characteristics in the Acceptance Plan relate to those identified in Appendix A of the PTER.

Based on this information, the staff has identified the following requests:

a. Please identify the critical characteristics for the PRM system and OPRM unit.
b. Please explain the relationship between the requirements in Appendix A of the PTER and the critical characteristics identified in the Acceptance Plan. Also, please identify what characteristics are considered CCD or CCA.
c. Table 1-1 of the PTER lists the sources to identify critical characteristics. However, this table lists the PTER itself as a source. It is not clear how the PTER can be a source. Please clarify this circular reference.

RESPONSE:

a. For the PRM system, the CCs (Critical Characteristics) are identified as CCA (Critical Characteristics for Acceptance) for CGI (Commercial Grade Item) in Appendix A of the PTER (FPG-DRT-C51-0001 Rev. 0). For the OPRM system, the CCs are identified as CCAs in Section 5 of the CDIs (Commercial Dedication Instructions) for each module.

b. For the PRM system, the acceptance plan identifies the acceptance method for each CCA identified in Appendix A of the PTER (FPG-DRT-C51-0001 Rev.0).

For the OPRM system, Section 5 of the CDI for each module identifies acceptance methods for CCAs. CCDs are properties or attributes which are essential for the CG items and CG services. CCAs are identifiable and measurable attributes or variable of the CG items and CG services which once selected to be verified, provide reasonable assurance for the CG items and CG services.

For the PRM system, Appendix A of the PTER identifies CCDs by referring to the section of the documents where the CCD is described. For the OPRM system, Section 4 of the CDI identifies CCDs for each module.

Regarding dependability of the PRM system, Appendix A of PRM PTER lists s "quality of design and manufacture" as a CCA for CGI. For the OPRM system, Section 8 of the OPRM PTER (FC51-1505-1000 Rev.0) describes CCs relating to "built-in quality" and "configuration control and traceability." Thus the dependability described in EPRI TR-106439 as a typical CC is considered for both PRM and OPRM.

c. For the PRM system, Section 4.3 of the PTER provides requirements for the test system and identifies the PRM CCAs for procuring the test support service. The test support service includes test system design and test equipment supply as CG services. Therefore, the PTER is the source of the CCAs for the test support services procured as CG Services.

Appendix B-1 and B-2 of the PTER describes that the requirements provided in Section 4.3 of the PTER satisfy the ERS requirements for the commercial grade test support services.

NRC QUESTION:

Design Process

3. Topical Report (TR) Table II-B-1 identifies Toshiba modules for the PRM system and the OPRM unit. Please identify which modules were developed using the original process and which were developed using the current process. Also, identify what modules have not been developed and manufactured yet, if any.

RESPONSE:

Toshiba will revise Table II-B-1 to add the information defining which process was used for each module. All modules in this table are qualified modules. The MUX module explained in Section II-2.2.4 of this LTR is the only module which has not been dedicated and qualified. The MUX module was developed under the module supplier's ISO 9001 QA. This LTR does not present any specific module that has not been developed and manufactured. The MUX module requires commercial grade dedication and qualification.

NRC QUESTION:

Design Process

4. Please provide figures illustrating the relationship between the different design documents and the system lifecycle for the PRM system and the OPRM unit.

RESPONSE:

The following figures illustrate the relationship between the different design documents and the system lifecycle for the PRM system and the OPRM unit.

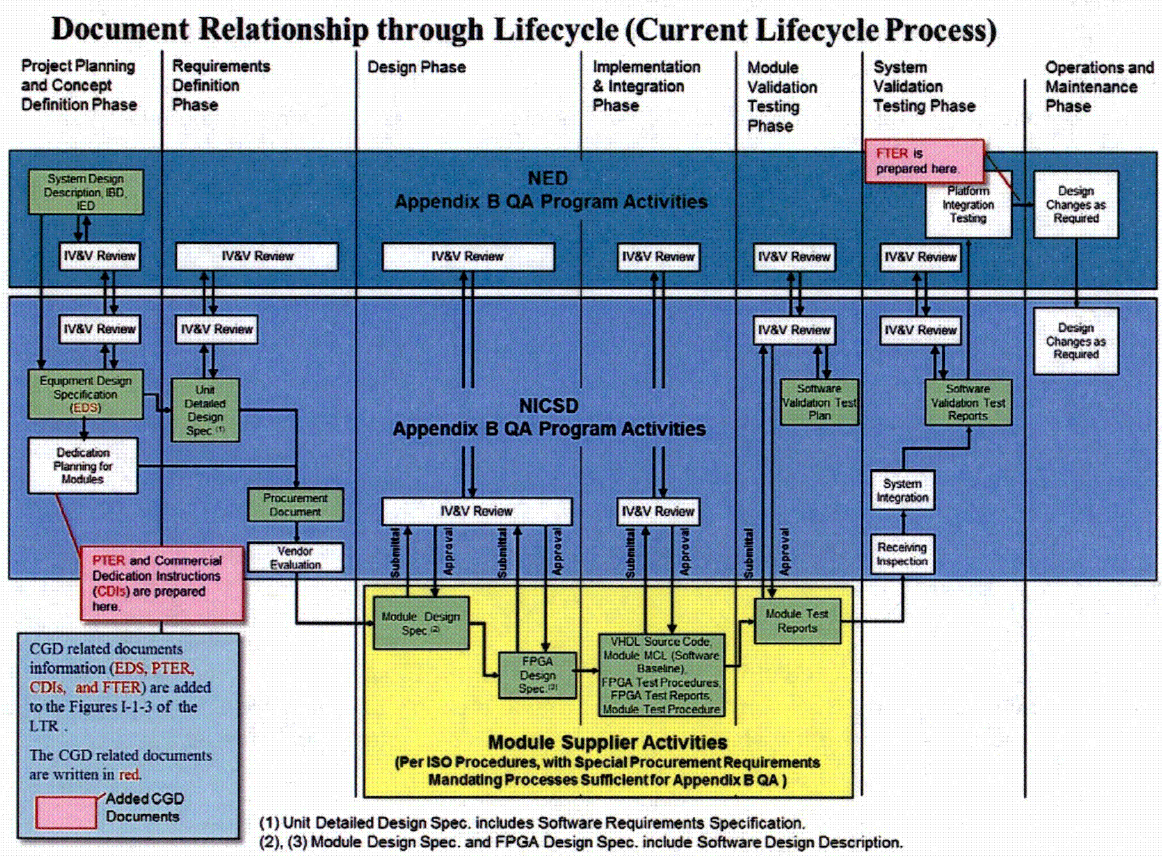

Figure 4-1 Document Relationship through Current Lifecycle Phase (OPRM)

Document Relationship through Lifecycle (Original Lifecycle Process)

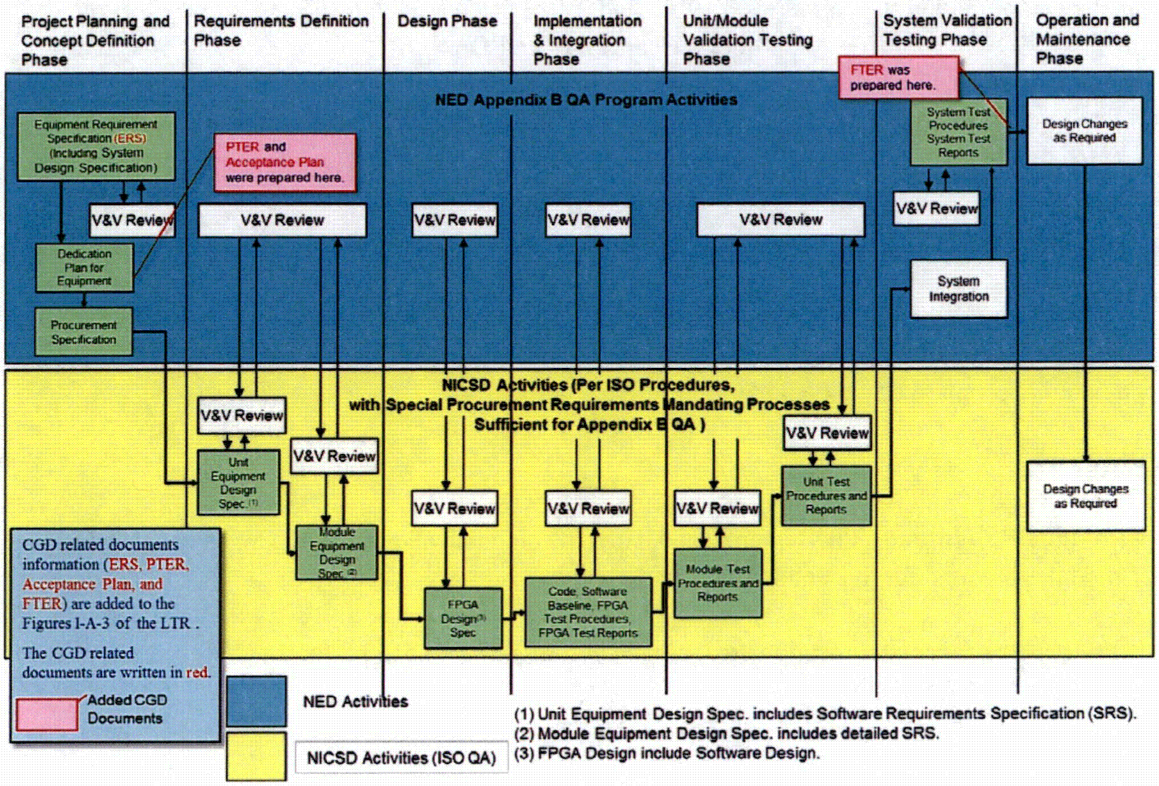

Figure 4-2 Document Relationship through Original Lifecycle Phase (PRM)

NRC QUESTION:

Design Process

5. It is the staff's understanding the Preliminary Technical Evaluation Report (FPG-DRTC51-0001) was prepared in accordance with the ERS (FPG-RQS-C51-0001). However, the relationship between the PTER and the EDS (FC51-3002-1000) and the relationship between the ERS and EDS are not clear.

Furthermore, the EDS defines the system design requirements for the neutron monitoring system (RS-5155709) for the Advanced Boiling Water Reactor (ABWR). Therefore, the EDS is not related with the PRM system for the BWR-5 (which is the scope of the staff's review). Please explain the scope and relationships among the following documents: ERS, EDS, and PTER.

RESPONSE:

The ERS is the top level design document used in the original process applied to the PRM. In the current process, Toshiba does not generate an ERS. Instead, Toshiba generates two levels of documents. The upper level is assigned to Software Design Description (SDD), which describes system level requirements, and the lower level is assigned to Equipment Design Specification (EDS), which breaks down the system

level requirements into the equipment design requirements. The EDS includes the elements of System Architecture Description (SAD) and Software Interfaces Document (SID) which is required as output of Requirements Definition Phase in Sections 3.10.3.3 and 3.10.3.4 of the SPP, respectively. See Section 13.1.6 of the NICSD SMP for a description of the content of an EDS.

In the original process, the PTER is prepared based on the ERS. In the current process, the PTER is prepared based on the EDS.

NRC QUESTION:
Design Process

6. The ERS does not identify the requirements associated with system communication. Please explain what document or section(s) of the ERS identifies these requirements.

RESPONSE:

Figure 5-1 of the ERS illustrates PRM internal and external communications. The figure shows that TRN and RCV modules are used for this communication.

Detailed requirements for communication are included in ERS Sections 5.2.3.8 for the TRN module and Section 5.2.3.9 for the RCV module.

NRC QUESTION:
Power Supply

7. The TR, Section II-2.2.5.2, describes the power supply redundancy for the Neutron Monitoring System (NMS). In addition, TR, Section II-2.2.2.5.1, item (2) Average Power Range Monitor (APRM), (d.) Discrete Output Interfaces, states the discrete output interface of the APRM unit requires external power supply. The scope of the NRC review only covers the PRM system and OPRM unit; it does not include the NMS. As a consequence, this section does not describe the power supply to be provided for the PRM system and OPRM unit. Please describe how power will be provided and distributed to the modules in the system. Also, please describe what component will provide the power necessary for the APRM output interface.

RESPONSE:

Toshiba has revised Part II of LTR in Revision 2. LTR Section II-2.2.3.1.3 now describes how internal power supply redundancy for the PRM and OPRM functions. Toshiba expects that the pair of low voltage power supplies (LVPSs) in each unit will be supplied from one or two separate external power sources. The pair of LVPSs in each chassis then provides redundant power to the unit. Power is distributed through the middle planes. The DIO module, which provides the APRM discrete outputs, uses photo-MOS relays that make a current loop driven by the trip auxiliary unit, an external device, if a trip condition occurs. The trip auxiliary unit is outside the scope of the LTR. The DIO module design specification (5G8HC110) provides further information on the discrete outputs.

NRC QUESTION:
Power Supply

8. Section 5.1.6 of the ERS defines a requirement to monitor the voltage of the High Voltage Power Supply (HVPS). However, the document does not mention anything else about the HVPS. Furthermore, the TR does not describe this component for neither the PRM system nor the OPRM unit. Please describe the HVPS and how it is used in the system.

RESPONSE:

Section 5.2.3.2 of the ERS includes a statement indicating that, "The LPRM module shall supply power to the LPRM detectors at least 3 mA at 100 VDC." Each LPRM includes one High Voltage Power Supply (HVPS) to provide up to 100 VDC to power the LPRM detector, though the word "High Voltage" is not used.

NRC QUESTION:
System Description

9. The TR does not explain if the system includes cooling fans or if it will use natural circulation to cool the components. Please describe the system cooling capabilities.

RESPONSE:

The system does not require forced air cooling. The system is designed for natural circulation, through louvers on the top and bottom of the rear doors of the cabinets in which the system is installed. Forced cooling through fans is not required, and Toshiba did not qualify and does not plan to supply fans or other forced air cooling. Toshiba will revise Section II-2.1.3 of the LTR to include this information.

NRC QUESTION:
System Description

10. The TR, Section II-A.2.7 states modules with Electrically Erasable Programmable Read- Only Memory (EEPROM) will verify the setpoint values using parity bits or dual storage. The TR does not provide enough information about EEPROM and Erasable Programmable Read Only Memory (EPROM). Please provide the following information:
a. Identify modules that contain EEPROM and/or EPROM.
b. Describe how data stored in the EEPROM or EPROM is verified.

RESPONSE:

Toshiba will revise the LTR to include the following information. If additional documentation aids in understanding, Toshiba will provide reference to the separate documents. Toshiba will ensure that the references are provided.

a. The following table lists the modules that contain EEPROM and/or EPROM.

Module	EEPROM	EPROM
LPRM module	X	Not Used
APRM module	X	X
SQ-ROOT module	Not Used	X
CELL module	X	X
AGRD module	X	Not Used
PBD module	X	Not Used

b. Toshiba revised Part II of LTR in Revision 2. Section II-A-2.7 now describes how data is stored in EEPROM and verified.

For EPROM, Toshiba uses One Type Programmable (OTP) EPROM, which has no window usually used for erasing its data by exposing the chip to ultraviolet (UV) light. Since UV light is shielded, the data in OTP EPROMs is reliable. Accordingly, Toshiba believes that no additional diagnostic measures are required for the OTP EPROM. However, the NICSD hazards analysis in the SSAR (FC51-3704-1101) reported a possibility that data corruption of EPROM may lead to a single spurious trip or loss of one division trip, when a single failure is assumed. Specifically, the EPROM stores the following values in the OPRM:

- Filter constant table for conditioning and time average filters, and
- Conversion table, which assigns LPRM detectors to each OPRM cell.

To address the concern from the hazards analysis, Toshiba will provide the following methods to check the EPROM data:

- For the conditioning and time average filters constants, enter test LPRM levels, which oscillate at specified frequencies and check whether the resulting Normalized Oscillation Signals match the expected signal values. If they match, the values in EPROM are not corrupted.
- For the conversion table, enter a unique value as each LPRM level, and check that the Normalized Oscillation Signal outputs match the expected values. If they match, the values in EPROM are not corrupted.

NRC QUESTION:

System Description

11. The TR, Appendix II-B, describes the modules included in the PRM system and OPRM unit. Several module descriptions talk about "rotary switches" and "push buttons." The figures illustrating these modules indicate where the push buttons are, but they don't indicate where the rotary switches are located.

Please identify where the rotary switches are located. Also, please describe the functions these rotary switches perform and how they are used.

RESPONSE:

The rotary switches are located on the printed circuit boards internal to the modules, not on the front panels. For example, Figure 3.1 of the CELL Module Design Specification (5G8HC104) draws rotary switches, called "digital switch" on the schematic. Each rotary switch allows setting one or a series of digits. For example, a 4-digit rotary switch is used to set the filter cutoff frequency in the CELL module.

NRC QUESTION:
System Description

12. The EDS (FC51-3002-1000) states one division of the PRM system includes one Relay Unit. The ERS (FPG-RQS-C51-0001) states the PRM system includes the trip auxiliary unit. Finally, the PTER states the PRM system includes the trip auxiliary unit. Please confirm the trip auxiliary unit and relay unit are not in the scope of review for the PRM system and OPRM unit.

RESPONSE:

The Relay Unit and the trip auxiliary unit are not in the scope of the review.

NRC QUESTION:
System Description

13. The TR, Section II-2.2.2.1, states: "the Local Power Range Monitor (LPRM) monitors local neutron flux in the power range between 1 % and 125 % of the rated power." However, Section 4.2 of the ERS states: "the LPRM detectors provide measurement of core local power from 1% to above 100% of the rated power." and, Section 5.1.1 of the ERS states: "The PRM System shall be designed to provide adequate flux monitoring information from one percent through 125% reactor power." Please explain the correct range of operation for the LRM detectors.

RESPONSE:

The range of the LPRM detector that Toshiba is providing is 1% to 125 %. The LPRM module is designed to accept this range of signals.

Note: Section 4.2 of the ERS explains an overall functions and configuration of the PRM System. The sentence "the LPRM detectors provide measurement of core local power from 1% to above 100% of the rated power" means the LPRM detector must be able to monitor the reactor power to levels greater than 100%. This sentence will be revised to state 125% in the LTR.

NRC QUESTION:
System Description

14. Section 1 of the EDS (FC51-3002-1000) states: The scope of this EDS is to specify requirements for the equipment design of the LPRM, APRM and OPRM comprising the Power Range Neutron Monitor (PRNM), which is a part of the NMS. Toshiba identified this document to provide the requirements for the OPRM unit (which is the only part to be reviewed by the staff). However, the requirements for the OPRM in this document are not clearly identified, since it identifies all requirements for a PRNM system. Please identify the requirements relevant to just the OPRM unit, since the requirements in the EDS associated with the LPRM and APRM are out of the scope of the NRC evaluation (because they apply to the ABWR design).

RESPONSE:

The RTM for the OPRM (FC51-3704-1004) shows which requirements are applicable to the OPRM.

NRC QUESTION:
System Description

15. The TR, Section II-2 describes the FPGA-based system. In particular, Section II-2.1.3 describes the units, which consists of a chassis where modules are mounted. However, this section does not provide sufficient information about the chassis configuration. Therefore, please describe the following:
a. How the chassis is configured.
b. How the system recognizes the correct module is inserted.
c. If the position of the module in the chassis is pre-defined, and specific in the backplane.

RESPONSE:

a. The position of the module in the chassis is pre-defined, and specific in the backplane (middle plane) according to its type. Sections 3.10 and 3.11 of IM-2015-000152 Rev.1 (ML15085A149) explain the configuration of the chassis.

b. Since the position of the module is pre-defined, if modules are inserted incorrectly, the chassis including the module will show unusual behavior or indication. For example, the APRM module counts the number of operable LPRM modules (i.e., that healthy LPRM modules are installed correctly) and the APRM will become inoperable if the number of operable LPRM modules is less than the set value. Therefore the system needs any special measures to recognize the correct module is inserted.
   Refer to ERS Section 5.2.3.3 (FPG-RQS-C51-0001 Rev.7).

c. As written above, the position of the module in the chassis is pre-defined, and specific in the backplane (middle plane) according to its type. The system will not work correctly if the modules are not installed as designed and documented.

NRC QUESTION:
System Communication

16. The TR, Part IV, Section IV-5, Conformance with Interim Staff Guidance (ISG)-04, Staff Position 1.2, notes the system uses parity check to verify errors in the PRM system, for which Toshiba performed the qualification test. In this item Toshiba added a comment saying it would update the FPGA logic to use Cyclic Redundancy Check (CRC) to identify data corruption. Please explain if Toshiba has modified the FPGA logic to use CRC instead of parity check.

RESPONSE:

Toshiba modified the original TRN and RCV FPGA logic to use cyclic redundancy check (CRC) in addition to parity checks on data. The LTR, Part II, Section II-A-2.7 explains self-diagnosis including communication diagnosis. Toshiba has updated Part IV, Section IV-5 to be consistent with Part II.

Section 3.13 of IM-2015-000152 Rev.1 (ML15085A149) provides further information on the new version of the TRN and RCV modules that have CRC. These modules were qualified with the OPRM. These modules can be applied to the PRM.

NRC QUESTION:
System Communication

17. The TR is not consistent with the terms used to describe communication. Specifically, the following terms are used: fiber optic links, serial link, point-to-point copper serial communication link, three-wire electrical communication link, and hardwired connections. Please clarify what the terms listed previously refer to and for which of the following data transmission type they correspond to:

- Data transmission between modules,
- Data transmission on the middle plane, and
- Data transmission between FPGAs.

RESPONSE:

Toshiba revised LTR Part II to Revision 2 to clarify the terms.
Section II-2.1.4.2 "Communication between Modules on Middle Plane" describes as follows:

> The modules mounted in a same unit communicate over copper connections printed on the two middle planes. For these data links, three-wire electrical communication links are used.
>
> In the copper lines, the data are transmitted as Complementary Metal Oxide Semiconductor (CMOS) level signals on the three associated copper lines, and data is transmitted serially.
>
> For discrete input and output (DIO) modules, the middle planes provide an individual hardwired connection for each input and output.

The serial communication between modules takes place on the middle plane. Serial communication between modules is performed in one direction, over copper serial communication links, using the three-wire electrical protocol consisting of a data stream, a clock driven by the data source, and a parallel synchronizing pulse to mark the end of the data stream which is also driven by the data source.

Section II-2.1.4.1 "Communication between FPGAs" describes as follows:

Data is transferred between FPGAs over serial and parallel electrical communication links.

IM-2015-000152 Rev.1 (ML15085A149) provides further information on communication.

NRC QUESTION:
System Communication

18. Section 3.3.4 of the Nuclear Instrumentation and Control Systems Department's (NICSD's) Critical Digital Review Report (FPG-DRT-C51-0005) and Section 5.2.3.3 of the ERS describe how the APRM module receives data from the LPRM modules. In these descriptions, Toshiba uses the following sentence: "The dual electrical communication links are used in the data transmission from the TRN and RCV modules." The use of this sentence in these descriptions is not clear. Therefore, please clarify the following:
a. Are the dual electrical communication links the same fiber optic link described in Section II-2.1.4.3 of the TR?
b. Are the dual electrical communication links only used for communication between the TRN in the LPRM unit and the RCV module in the APRM/LPRM unit? Also, confirm these links are not used to transfer data from the LPRM modules mounted in the same LPRM/APRM unit through the TRN module.

RESPONSE:

"The dual electrical (copper) communication links are used in the data transmission from the TRN and RCV modules." refers to the communication among the modules inside the chassis (unit), which is internal communication in the chassis. Dedicated dual electrical (copper) serial links on the chassis middle planes is used for this communication.

a. The copper and fiber optic communication links are not the same. LTR Section II-2.1.4.3 describes the serial communication between TRN and RCV in separate chassis (units), which is inter chassis communication. Serial fiber optic communication is used for this purpose between the chassis.

b. The dual electrical communication links are only used for the following communications:
   PRM
   - From the TRN modules to the APRM module in the LPRM/APRM unit for the LPRM data
   - From the RCV modules to the APRM module in the LPRM/APRM unit for the LPRM data

   OPRM

- From the RCV modules to the CELL module in the OPRM unit for the APRM data

The dual electrical communication links are not used for communication from the LPRM modules to the TRN module mounted in the same the APRM/LPRM unit. The communication links from the TRN module to the receiver on the APRM module through the middle plane uses dual electrical communication links as described above.

NRC QUESTION:
System Communication

19. The TR and the NICSD's Critical Digital Review Report (FPG-DRT-C51-0005) do not provide sufficient information about data transmission. Specifically, the staff needs clarification on the following items:
a. Descriptions of where the clock signal and load pulse for transmitting data are generated and how they are used.
b. Communication mechanism for analog input or output modules.
c. Description of how data is transferred from the hardwired discrete input or output.

RESPONSE:

a. The clock signal and load pulse are generated by the FPGA that sends the data.
   Section 3.2.1 (2) of the NICSD CDR explains the three-wire electrical (copper) links transmitting LPRM data on the unit middle plane. The clock signal and the load signal are transferred on separate signal lines. For communication between units using fiber optic cable, separate lines for clock signal and load pulse are not necessary because Manchester encoding is used.
b. Analog signals are transferred as [ ][a,c]-bit digital data over the three-wire electrical (copper) serial link on the unit middle plane. A separate set of electrical lines is provided.
c. A separate single-ended electrical (copper) line is provided for each discrete signal on the unit middle plane. The ground reference is shared within the unit.

NRC QUESTION:
System Communication

20. The TR does not provide clear information on how data is transferred through the TRN and RCV modules. Instead, the information seems to be scattered throughout supporting documents (e.g., TRN module design specification) with no clear connections. In addition, the translation seems to be confusing and unclear about data format, messages, FPGAs, etc.
Therefore, please provide clear and detailed information for the staff to evaluate system communication in accordance with ISG-04. Below are some examples of insufficient information provided in the TR. Note these are just a few examples, and there are more items that require clear description for the staff to evaluate the system communication:

a. Section 3 of the TRN module design specification (5G8HC108) describes two operation modes for the TRN module. But this section seems to describe at least three modes. Then the NICSD's Critical Digital Review Report describes three operation modes. In addition, Section 3 of this design specification describes the type of signal that will be received for different Unit types (1, 2, or 3) depending on the operation mode. However, this document does not describe what these unit types are, the operation modes, and how they relate. Therefore, it is not clear how many operation modes there are, what they do, and why communication changes based on the unit type.

b. Section 5.1 of the TRN module design specification (5G8HC108) describes the input signals. Then Section 5.2 describes the output signals. However, based on information provided in this document, data received is modified and then transferred to other modules (i.e., block diagram in Figure 3.1). This document does not describe how the input signals are modified and transmitted as output signals.

c. Section 5.1 of the TRN module design specification (5G8HC108) describes the input signals. This document does not describe what type of input signal is used in the OPRM unit.

d. According to the description provided in the TRN and RCV module design specifications (5G8HC108 and 5G8HC109, respectively), the TRN and RCV modules includes a primary and a secondary communication link. However, these documents do not explain how the module switches from one link to the other, when one link fails. Also, it is not clear what happens if both links fail.

e. According to the description in Section II-2.1.4.3 of the TR and Section 3.2.1, item (1), of the NICSD's Critical Digital Review Report, if successive data frames with corrupted data are sent, the RCV would reject the message. On the other hand, the RCV module design specifications (5G8HC109) describes correct data should be received several times for the RCV module to accept it and the module will stop if data is not received in the pre-defined period. It is not clear if data should be received several times before it is accepted as correct or marked as invalid data.

RESPONSE:

a. Toshiba agrees that the language is not clear in the documents translated from Japanese. What is meant is that the TRN module has three operational modes from the context that the module may be used in three types of units, Unit Type 1 (LPRM unit), Unit Type 2 (FLOW unit), and Unit Type 3 (LPRM/APRM or OPRM units). The TRN operational mode is based on whether the TRN accepts multiplexed data in the installed Unit Type as explained below.

b. When the TRN is used in the LPRM Unit (Unit Type 1) or Flow Unit (Unit Type 2), the TRN works only in Mode 1. In Mode 1, the TRN receives Digital Data from the LPRM modules or the Flow modules in that unit over individual copper internal chassis communication links, and sends out the data frame to other units through dual fiber optic links, for example, to the LPRM/APRM unit, as shown in the blue line in Figure 20-1.

a,c

Figure 20-1 Functional Block Diagram of TRN module Mode 1, inserted in LPRM or FLOW unit

When the TRN is used in the LPRM/APRM Unit (Unit Type 3), the TRN works in both modes. In Mode 1, TRN receives the digital data over individual copper intra chassis communication links from each LPRM module in the same chassis. The TRN then sends out the LPRM data frame to the APRM module in the same unit over a separate copper intra chassis communication link, as shown by the blue line in Figure 20-2.

In Mode 2, the TRN receives multiplexed data from the APRM module over a separate copper intra-chassis communication link and sends out the data frame to another unit, like the Rod Block Monitor (RBM) using fiber optic transmitters, as shown by the green line in Figure 20-2. The two Data Processing elements on the TRN (Train A and Train B) can be configured to enable Mode 1 or Mode 2 independently.

a,c

Figure 20-2 Functional Block Diagram of TRN module Mode 2, inserted in LPRM/APRM unit

When the TRN is used in the OPRM (Unit Type 3), the TRN works only in Mode 2. The TRN receives multiplexed data from the DAT/ST module using a separate copper intra-chassis communication link and sends out the Data frame to the other unit or other systems, as shown by the blue line in Figure 20-3.

a,c

Figure 20-3 Functional Block Diagram of TRN module Mode 2, inserted in OPRM unit

Section 5.1.1 of 5G8HC108 describes the digital data input in the section titled "Serial Data Input."
Section 5.1.2 of 5G8HC108 describes multiplexed data in the section titled "Multiplexed Data Input."
Section 5.2.1 of 5G8HC108 describes the data frame in the section titled "Multiplexed Data Output." This section describes the data formats for each unit type.
Section 5.2.1 of 5G8HC108 describes the data frame sent using the fiber optic transmitter in the section titled "Optical Data Output."

c. The OPRM unit receives data from the LPRM unit, the APRM unit (in the case of ABWR), and will receive data from the LPRM/APRM unit (in the case of BWRs). The data is multiplexed. The data from the LPRM unit and the LPRM/APRM unit includes LPRM levels. The data from the APRM unit and the LPRM/APRM unit includes the APRM levels, Core Flow levels, and alarms.

d. Design of the four communication ports in the TRN or RCV module does not distinguish primary or secondary. The module accepting data (APRM or CELL) through dual electrical (copper) communication links determines whether the data stream is considered primary or secondary. For example, [ ][a,c] of the CELL module accepts APRM Unit Data 1 and 2, and uses Data 1 as primary. When the primary fails, the CELL module uses the secondary (Data 2). When both links fail, the CELL module becomes inoperable. The "INOP LED" on the CELL module front panel is turned on, and an Inoperative signal is transferred to a discrete output for use by external equipment.

e. The RCV module determines that the TRN module is active after three acceptable messages are received in a row. The RCV module marks the TRN module as inactive after the RCV module fails to receive three acceptable messages in a row. The receiving status of the RCV modules are indicated on the front panel of the STATUS module (PRM) or DAT/ST module (OPRM).

NRC QUESTION:
Surveillance Testing and Diagnostics

21. The TR, Section II-A-2.8 describes system features associated with surveillance testing. Specifically, this section states the Toshiba system can be designed to provide the capabilities necessary for surveillance testing. However, this section does not describe the principles and the methodology to be used to perform surveillance tests in order to verify the capability of safety systems to perform their functions in accordance with the design and safety requirements. Please provide the following information:

a. The principles and the methodology used to perform surveillance tests.
b. The TR, Section II-A-2.8 states Toshiba concluded that a surveillance frequency of once a month is reasonable. Please explain how Toshiba determined this frequency to be reasonable.

RESPONSE:

a. The PRM system and the OPRM system were designed to provide surveillance capabilities considering conformance to USNRC Standard Review Plan, Chapter 7, Branch Technical Position (BTP) 7-17 as described in LTR Part II, Section II-A-2.8. The PRM and OPRM were designed to support surveillance testing using methods similar to those used by analog systems, with the addition of maintenance methods described in the response to Item 10. The PRM and OPRM are digital systems, and have various types of self-diagnostic capabilities. Toshiba performed FMEAs for the PRM and OPRM, and confirmed that many failure modes, which could not be found without performing surveillance testing in conventional analog systems, can be found at run-time. Nevertheless, the FMEAs suggested that a few failure modes could not be found by the self-diagnostic capabilities provided. The surveillance testing would focus on these failure modes.

b. An adequate frequency of the surveillance testing will be determined, based on the FMEAs and reliability evaluation for the failure modes that could not be found by self-diagnostic capabilities and that have significant effects on the plant. Toshiba will rewrite Section II-A-2.8 in the revised LTR.