

PSNN-2015-0053

- ☒ Safety-related
☐ Non-Safety-related
☐ ASME CODE
☐ Others ()

Document No.	FPG-PLN-C51-0003	Rev	4
--------------	------------------	-----	---

The use of the information contained in this document by anyone for any purpose other than that for which it is intended is not authorized. In the event the information is used without authorization from TOSHIBA CORPORATION, TOSHIBA CORPORATION makes no representation or warranty and assumes no liability as to the completeness, accuracy, or usefulness of the information contained in this document.

TOSHIBA CORPORATION
 NUCLEAR ENERGY SYSTEMS & SERVICES
 DIV.

NRW-FPGA-Based PRM System Qualification Project

Document Title Qualification Plan

CUSTOMER NAME	None
PROJECT NAME	NRW-FPGA-Based PRM System Qualification Project
ITEM NAME	PRM Equipment
ITEM NO.	C51
JOB NO.	FPG

Date	Issued by	Approved by	Reviewed by	Prepared by	Document Filing No.
Mar 31, 2016	Second Electrical System Design & Engineering Group	N. Oda Mar 31, 2016	N. Oda Mar 31 2016	<i>T. Miyagaki</i> Mar 30, 2016	RS-5074045

TOSHIBA CORPORATION Nuclear Energy Systems & Services Division

Rev No.	Date	History	Approved by	Reviewed by	Prepared by
0	July.7.2005	The first issue	N.Oda	Y.Goto	T.Miyazaki
1	Nov.9, 2005	Updated	N.Oda	Y.Goto	T.Miyazaki
2	July.7, 2007	Updated	N.Oda	Y.Goto	T.Miyazaki
3	Apr 14, 2008	Error Correction	N.Oda	Y.Goto	T.Miyazaki
4	See Cover Page	Revised for clarification	N.Oda	N.Oda	T.Miyazaki

Table of Contents

1. Purpose	4
2. References	4
3. Definitions, Abbreviations & Acronyms	5
3.1. Definitions	5
3.2. Abbreviations & Acronyms	5
4. Scope of the Qualification Plan	7
5. Applicable Safety Functions and Design Requirements	9
6. Documentation of Whether the Procurement is a CG Item or a CG Service	9
7. Documentation of Initial Evaluation that CG Item has the Potential to Satisfy Applicable Safety Functions and Design Requirements	9
8. Documentation of CG Definition	10
8.1. CG Items	10
8.2. CG Service	11
9. Qualification, Acceptance and Procurement Approach	12
9.1. Procurement Approach	15
9.2. Qualification Approach	18
9.3. Additional Activities for the Qualification	25
9.3.1. Software Qualification Activities by NED	25
9.3.2. Commercial Grade Survey	26
9.3.3. CDR of NICSD and Actel	26
10. Scope of Overall I&C System to be Qualified	27

1. Purpose

This Qualification Plan is prepared for the Non-rewritable Field Programmable Gate Array (NRW-FPGA) Based Power Range Monitor (PRM) System Qualification Project. The purpose of this qualification plan is as follow:

- To describe how to document the applicable safety functions and design requirements for the Test Specimen to be used in the qualification project.
- To describe how to document the determination that the NRW-FPGA-Based PRM System may be procured on a Unit basis from commercial grade item (CGI).
- To describe how to document the determination that supports services for system testing may be procured as a commercial grade service (CGS).
- To describe how to state the plan for qualification and acceptance for the CGIs and CGSs, including the required qualification activities and the required procurement and acceptance activities needed for this project.

This Qualification Plan is prepared per the requirements of Procedure AS-200A110 (Reference 2(4)), Step 3.1.2, in place of a Dedication Plan to be used for CG procurements. Use of a Qualification Plan, in place of a Dedication Plan, is described in Section 4.

Qualification Plan Revision 4 is revised to correct the description of Section 4 to clarify that this Qualification Plan is established in place of a Dedication Plan.

2. References

The latest revision is applicable about following documents.

- (1) FPG-PLN-A70-0001, "Project Quality Assurance Manual"
- (2) FPG-RQS-C51-0001, "Equipment Requirement Specification of FPGA-Based Units"
- (3) PP-FPG-IM001, "Procurement Planning Sheet"
- (4) AS-200A110, "Procedure for Commercial Grade Items and Services"
- (5) PP-FPG-IM006, "Procurement Planning Sheet"

3. Definitions, Abbreviations & Acronyms

3.1. Definitions

(1) Software Verification and Validation (V&V)

(a) Verification consists of activities performed on the results of each development phase to ensure that the phase was completed appropriately and correctly. Satisfactory verification shall be indicated by the Independent Reviewer's signature on the document being verified.

(b) Validation is performed on the final product of the code implementation and integration phase. Validation is used to ensure that the final product satisfies user requirements. Validation is performed as defined in test procedures which include a description of how adherence to each requirement will be demonstrated.

(2) Critical Digital Review (CDR)

Critical Digital Review (CDR) is a technical review of the software development process. CDR is a tool that can be used in the supplier selection and evaluation process (as part of Commercial Grade Dedication activities).

(3) Commercial Grade Dedication (CGD)

When applied to nuclear power plants licensed pursuant to 10 CFR Part 30, 40, 50, 60, dedication is an acceptance process undertaken to provide reasonable assurance that CGI to be used as a basic component will perform its intended safety function and, in this respect, is deemed equivalent to an item designed and manufactured under a 10 CFR Part 50, Appendix B, QA program.

(4) Inspection

Activity such as measuring, examining, testing or gauging one or more characteristics of a product, an activity or a process, or a combination thereof and determining whether the results are in conformity with specified requirements in order to establish whether conformity is achieved for each characteristic.

(5) Testing

An element of verification for the determination of the capability of an item to meet specified requirements by subjecting the item to a set of physical, chemical, environmental, or operating conditions.

3.2. Abbreviations & Acronyms

APRM: Average Power Range Monitor

BWR:	Boiling Water Reactor
CC:	Critical Characteristics
CCA:	Critical Characteristics for Acceptance
CCD:	Critical Characteristics for Design
CDR:	Critical Digital Review
CG:	Commercial Grade
CGD:	Commercial Grade Dedication
CGI:	Commercial Grade Item
CGS:	Commercial Grade Service
CTM:	Compliance and Traceability Matrix
ECWD:	Electrical Cable Wiring Diagram
ERS:	Equipment Requirement Specification
FE:	Functional Element
FMEA:	Failure Mode and Effect Analysis
FPGA:	Field Programmable Gate Array (a programmable logic device).
I&C:	Instrumentation and Control
LPRM:	Local Power Range Monitor
MCL:	Master Configuration List
MTP:	Master Test Plan
NED:	Nuclear Energy System & services Division
NICSD:	Nuclear Instrumentation and Control Systems Department
NQAD:	Nuclear Quality Assurance Department.
NRW-FPGA:	Non-Rewritable FPGA. A type of FPGA that cannot be rewritten after the logic is implemented on it.
OPRM :	Oscillation Power Range Monitor
PHA:	Preliminary Hazard Analysis
PQAP:	Project Quality Assurance Plan
PRM:	Power Range Monitor
PTER:	Preliminary Technical Evaluation Report
QA:	Qualify Assurance
RTM:	Requirement Traceability Matrix
SER:	Safety Evaluation Report
SQAP:	Software Quality Assurance Plan
SS:	System Design Specification
SSC:	System, Structure and Component

VHDL: Very High Speed Integrated Circuit Hardware Definition Language.
(A hardware description language which defines FPGA circuit).
V&V: Verification and Validation

4. Scope of the Qualification Plan

Note that, the Units that compose the PRM System for this qualification project to be procured will not be used in a safety-related application in a nuclear plant. Instead, the Units will be assembled into a Test Specimen. The Test Specimen is subject to the process of acceptance, which must provide reasonable assurance that the item received (in this case, the Units for the Test Specimen and the interconnecting cables between Units in the Test Specimen) is the item which was specified. The qualification process will then be used to assure that the assembled PRM System is appropriate for intended plant safety applications based on demonstrating compliance to a set of generic design and performance requirements. Ultimately the customers (the US utilities) will be responsible for assuring the specific PRM they procure from Toshiba is appropriate for their specific plant applications.

Therefore, a Qualification Plan for the NRW-FPGA-Based PRM System Qualification Project is established in place of a Dedication Plan.

Per AS-200A110 (Reference 2(4)), a Dedication Plan will perform the following functions:

- Document the applicable safety functions and design requirements for the item or service to be procured.
- Document the decision as to whether the procurement is for an item or a service.
- Document the results of an initial evaluation to confirm that a CGIs or CGSs has the potential to satisfy the safety functions and design requirements.
- Document the determination that the commercial grade definition is applicable for the desired procurement.

Identify the approach for qualification and acceptance for the CGIs, including the required qualification activities, and the required procurement and acceptance activities.

In addition to the above functions, this qualification plan will also identify the

equipment to be qualified with additional information.

5. Applicable Safety Functions and Design Requirements

Safety functions and design requirements from applicable input documents are summarized in the Equipment Requirement Specification (ERS) (Reference 2(2)). The ERS defines functional requirements for FPGA-Based PRM Units (and cable connecting the Units), design conditions and applicable codes and standards. The ERS also specifies equipment requirements and conditions for testing to be qualified.

6. Documentation of Whether the Procurement is a CG Item or a CG Service

The PRM Units and interconnecting cables to be procured are items specified in the Procurement Planning Sheet (Reference 2(3)).

In addition to the items, the following services are procured from Fuchu Complex for supporting System Integration Testing and Qualification Testing.

- Design and rental of Test Equipment
- Wiring design and rack fabrication.
- Storage of Test Specimen
- Assembly of Test Specimen
- Disassembly and Packing for shipment (marking and labeling for packaging) for qualification testing

7. Documentation of Initial Evaluation that CG Item has the Potential to Satisfy Applicable Safety Functions and Design Requirements

Major design input documents for establishing the ERS (Reference 2(2)) are the PRM System Design Specification for Japanese Plants, EPRI TR-107330 and the vendor

package specifying the commercial products by Fuchu Complex.

It is expected that the PRM System Design Specification for Japanese Plants is similar to the system specification for US nuclear plants, because the plant design for Japanese BWRs comes from the US BWR design. Also, by the process of establishing the ERS, it has already been confirmed that the CGIs will be in compliance with US regulations.

Therefore, it is reasonably determined that the CGIs (that is, the PRM Units and interconnecting cable) have the potential to satisfy applicable safety functions and design requirements.

The qualification project will ultimately determine whether the PRM System Test Specimen will meet the applicable requirements.

8. Documentation of CG Definition

8.1. CG Items

Per AS-200A110 (Reference 2(4)), Section 3.1.1, procurement can be made using (Commercial Grade Dedication) CGD if the following three criteria are met:

- A unique nuclear standard is not imposed in the purchase order.
- The item/service is currently used in applications other than U.S. nuclear facilities.
- The item/service may be ordered on the basis of specifications set forth in the supplier's published catalog/service descriptions

The table below states the bases for the conclusion that the CG definition is satisfied for this procurement of CGIs.

Requirement	Basis for Meeting Requirement
A unique nuclear standard is not imposed in the purchase order.	For the NRW-FPGA-Based PRM System Qualification Project, NED will use a purchase order that does not impose special nuclear standards. In particular, NED will NOT invoke 10 CFR 50 Appendix B requirements on Fuchu Complex for this procurement.
The item/service is currently used in applications other than U.S. nuclear facilities.	Prior to completion of the qualification project, the Fuchu Complex PRM Units will be placed in service at one or more Japanese nuclear power plants. Accordingly, the PRM Units will be in commercial use prior to completion of the qualification project.
The item/service may be ordered on the basis of specifications set forth in the supplier's published catalog/service descriptions.	NED will procure standard Units from the Fuchu Complex product line, which is prepared in advance for the Japanese nuclear industry. No special requirements for the US marketplace will be imposed in the purchase order, other than hold points and witness points which will not affect the activities of Fuchu Complex for this procurement.

8.2. CG Service

The table below states the bases for the conclusion that the CG definition is satisfied for this service.

Requirement	Basis for Meeting Requirement
A unique nuclear standard is not imposed in the purchase order.	NED will use a purchase order that does not impose special nuclear standards. In particular, NED will NOT invoke 10 CFR 50 Appendix B requirements on Fuchu Complex for this procurement.
The item/service is currently used in applications other than U.S. nuclear facilities.	Similar activities to these services are performed for Japanese nuclear plants continually.
The item/service may be ordered on the basis of specifications set forth in the supplier's published catalog/service descriptions.	Similar activities to the service are used for developing commercial products specified in the supplier's published catalog descriptions. (Reference Fuchu Complex Catalog 05-03TD030)

9. Qualification, Acceptance and Procurement Approach

Toshiba has decided to follow the process shown in Toshiba's procedure for CGD Procedure AS-200A110 (Reference 2(4)), to perform the procurement and qualification of the PRM test system. This CGD procedure requires that the following activities be performed as shown in Figure 1 of AS-200A110.

- Perform Initial Evaluation
- Develop Dedication Plan
- Perform Preliminary Technical Evaluation
- Identify Critical Characteristics and Prepare Acceptance Plan
- Prepare Technical Procurement and QA Specification
- Issue P.O to Supplier
- Verify Critical Characteristics and Accept Item or Service
- Perform Qualification Analyses
- Perform Qualification Testing
- Perform Technical Evaluation
- Assemble CGD Package

The relationship between the documents produced in this process for this project is shown in Figure 9-1.

This section will discuss each of these activities and how each activity will be accomplished in this qualification project.

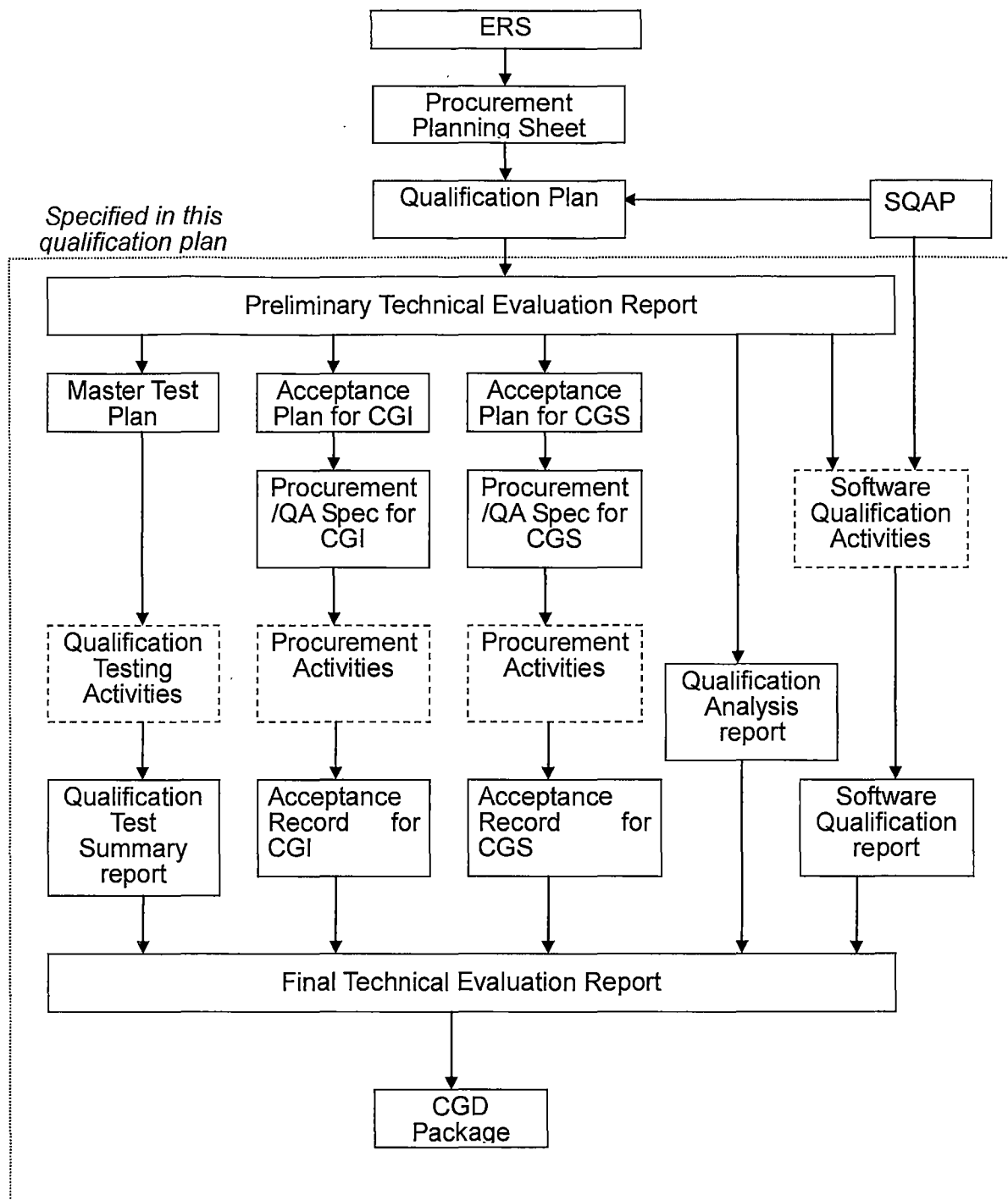


Figure 9-1 Relationship Between Project Documents

9.1. Procurement Approach

NED will procure the Test Specimen as a CGI, and test support service as a CGS from Fuchu Complex.

Before this procurement, NED will confirm that Fuchu Complex will be an acceptable commercial vendor for the scope of supply. The confirmation activities will include performing a CG survey of Fuchu Complex, performing a Critical Design Review (CDR) of NICSD, and performing a CDR of Actel as specified in Section 9.3.

The Test Specimen to be procured will consist of the following items:

- LPRM Unit (Fuchu Complex Type No. HNU100)
- LPRM/APRM Unit (Fuchu Complex Type No. HNU200)
- FLOW Unit (Fuchu Complex Type No. HNU300)
- Interconnecting cable { } ^{a,c} Type
 No. { } ^{a,c}

The procurement will require Fuchu Complex to perform FPGA testing, module testing, and Unit testing.

NED will also require that Fuchu Complex provide test support services for the System Integration Testing, and Qualification Testing. The test support service to be procured will consists of services specified in Section 6.

In order to clarify the specific scope of the CGSs, Figure 9-2 shows the relationship of CGSs with the related NED activities.

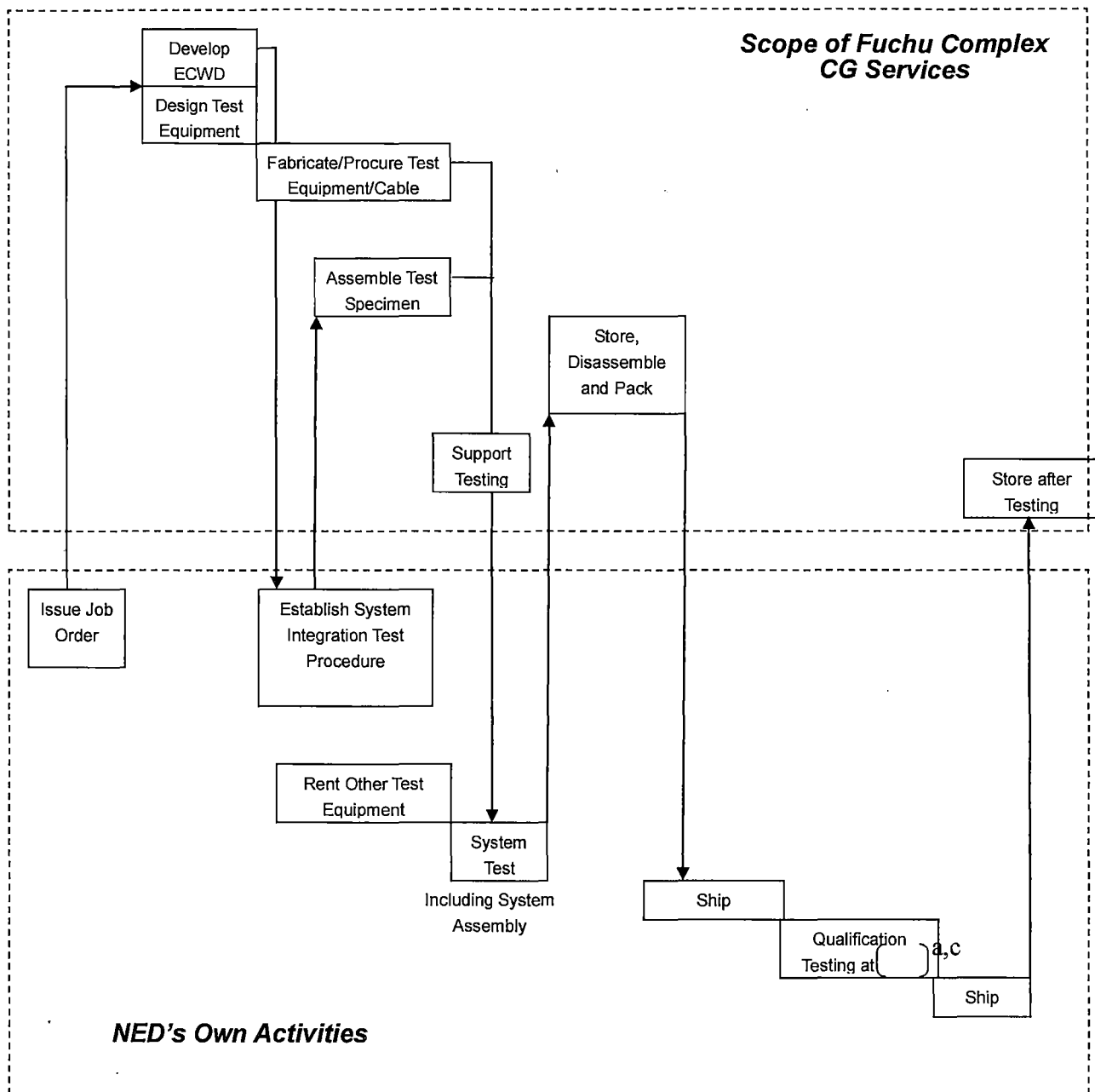


Figure 9-2 Relationship Between CG Services and NED's Own Activities

Based on the Job Order for the CGSs, Fuchu Complex will first perform ECWD Development and Test Equipment design. Also, Fuchu Complex will provide cables external to the Test Specimen Units. NED will establish system test procedures and rent some of the Test Equipment, other Test Equipment will be designed and fabricated by

Fuchu Complex.

NED will accept the Test Specimen Units and interconnecting cables procured as CGI after assembling the test system and performing system integration testing. The system integration testing will be performed at Fuchu Complex, and Fuchu Complex will provide a testing location and support services such as electrical power during the testing. Fuchu Complex will store the Test Specimen and Test Equipment at Fuchu Complex after acceptance.

Prior to shipping to ()^{a,c} for qualification testing, Fuchu Complex will disassemble and pack the Test Specimen and Test Equipment for shipment.

NED will ship the packed Test Specimen and Test Equipment to ()^{a,c} (by procurement of this service from a shipment firm) and perform qualification testing at ()^{a,c}. After the qualification testing, NED will ship the Test Specimen and Test Equipment to Fuchu Complex.

Therefore, specified scope of the CGSs is as follows:

- ECWD Design and development
- Design of Test Equipment
- Fabrication/Procurement of Test Equipment/cables
- Assembly of the Test Specimen
- Providing System Integration Test Support
- Packing for shipment (including marking and labeling for packaging)

Related NED activities are as follows:

- Issue CG Services Job Order
- Development of System Test Procedure
- Rental of some Test Equipment
- System Integration Testing including Test System assembly
- Shipment of the Test Specimen and Test Equipment to and from ()^{a,c}
- All Activities at ()^{a,c}

9.2. Qualification Approach

This section specifies qualification activities specified in Figure-1 of AS-200A110 (Reference 2(4)) for this project.

1. Perform Initial Evaluation

It is necessary to perform an initial evaluation of the CGI/CGS to confirm that the CGI/CGS has the potential to satisfy the safety functions and design requirements. To perform this step, Toshiba identifies the requirements for the system to be qualified on the ERS (Reference 2(2)).

Since there is no customer for the qualification project, Toshiba has decided to define the requirements based on:

- EPRI TR-107330 requirements.
- Requirements from a recent procurement request from a Japanese plant.

Because the ERS was also developed based on the vendor packages of the commercial product, the ERS will contain all Critical Characteristics for design (CCDs) for the Test Specimen and some CCDs for the test support service.

Based on the initial evaluation, the procurement planning sheet (Reference 2(3)) is issued.

2. Develop Dedication Plan

For this project, this qualification plan is established in place of a Dedication Plan as stated in Section 4. In addition to fulfilling the role of a Dedication Plan, this qualification plan documents the scope of the equipment to be qualified.

3. Perform Preliminary Technical Evaluation

The process of CGD is intended to ensure that all design requirements and safety functions are satisfied (i.e., form, fit and function). This is accomplished by identifying the CCDs which, when satisfied provide reasonable assurance that the

design requirements and safety functions are satisfied. To ensure that the CGI/CGS satisfies the CCDs, Critical Characteristics for Acceptance (CCAs) are identified which, when satisfied provide reasonable assurance that the item/service is as specified and will satisfy the CCDs and thus will satisfy the design requirements and safety functions. To document the CCDs and CCAs, a Preliminary Technical Evaluation Report (PTER) is prepared.

The purpose of the PTER is to describe results of the preliminary technical evaluation to ensure that the NRW-FPGA-Based PRM System meets all safety design and quality requirements for US nuclear plant applications as one of major activities for CGD. The preliminary technical evaluation includes identification of the requirements to be imposed on Fuchu Complex as part of the commercial grade procurement of the test system, and required qualification activities by NED. Note that since this project should be sufficient for the establishment of the qualification envelope for PRM System that will be provided to US market; therefore, qualification testing and analysis are performed in accordance with IPSNE 10 CFR50 Appendix B QA Program.

After completing procurement and qualification activities (including qualification testing and analysis, and software qualification), a final technical evaluation report will be established based on this PTER, and the results of qualification activities.

For this project, all CCDs for the Test Specimen must be contained in the ERS. Therefore, the PTER will specify CCDs for the Test Specimen by extraction from all requirements specified in the ERS. If it is found that the ERS lacks any CCDs, the ERS will be revised. On the other hand, some (not all) CCDs for the test support service are contained in the ERS. Therefore, the preliminary technical evaluation will develop additional CCDs for test support service and identify all CCDs for the test support service.

The PTER categorizes all Critical Characteristics (CCs) by the activities that will be performed to verify that each is satisfied. The following activities are performed to verify CCs in this project:

- Requirements to be imposed on the commercial vendor as CGI.
- Requirements to be imposed on the commercial vendor as CGS.
- The analyses that will be performed to ensure that the system to be specified is

- representative or bounds the system configuration for US customer orders, and for the EPRI TR-107330 qualification requirements.
- The testing that will be performed to ensure that the system to be specified is representative or bounds the system configuration for US customer orders, and for the EPRI TR-107330 qualification requirements.
- Software qualification activities to be performed by NED.

Generally, CCAs are a subset of CCDs. However, some CCAs are not CCDs; for instance, CCAs such as item catalog numbers are not CCDs. For this project, the PTER will specify all CCAs for CGI and CGS procurement acceptance activities based on CCDs to be imposed on the commercial vendor.

The source for the CCs is specified in Table 9-1.

Table 9-1 The Source for CCs

Document	Test Specimen		Test Support Service	
	CCDs	CCAs	CCDs	CCAs
ERS	All are defined	Some CCAs can be derived from the ERS	Some are defined	Some CCAs can be derived from the ERS
PQAP	None	Some CCAs can be derived from the PQAP	None	Some CCAs can be derived from the PQAP
PTER	None are defined; all are listed	None are defined; all are listed	Some are defined; all are listed	Some are defined; all are listed

For the qualification project, there are many requirements in the ERS that are not critical characteristics, but must still be satisfied. For instance:

- Certain documentation and test requirements from the ERS are not design requirements or safety functions; and therefore are not CCs.
- Certain requirements in from the ERS do not have measurable or identifiable attributes; accordingly, there are no CCs associated with these requirements.

Although these ERS requirements are not CCs, these are still important requirements that must be satisfied. Accordingly, for this project, the PTER will define the activities needed to reasonably assure that all ERS requirements are satisfied: those that can be

considered to be CCs, and those other requirements that do not meet the definition of a CC.

Fuchu Complex will perform FPGA tests, module tests and Units tests as part of Fuchu Complex's normal commercial manufacturing process. After the Unit testing, Fuchu Complex will perform the test support services (which include assembly of the Test Specimen and provision of Test Equipment) as a CGS. NED will accept the test support services and perform system integration test under the NED Test Control Procedure. The PTER will also specify the scope for the system integration testing.

4. Prepare Acceptance Plans for CGI and CGS

From the PTER, the System Engineer prepares the Acceptance Plans for CGI and CGS which will identify CCs for acceptance, acceptance criteria, and methods of acceptance.

Regardless of the acceptance method or combination of the methods used, a documented acceptance inspection is required as part of the acceptance process of an item.

5. Prepare Technical Procurements and QA Specifications for CGI and CGS

The System Engineer prepares the Technical Procurement Specification for CGI based on the following documents:

- PTER (includes SQAP and ERS)
- Outputs of software qualification activities by NED
- Outputs of other activities specified in Section 9.3
- Acceptance Plan

The System Engineer will include special requirements in the Technical Procurement Specification as required to permit acceptance of the items. These may include hold points for source surveillances, requirements for certificates of conformance, and requirements for assistance with special tests and inspections. The specific requirements will be determined as part of the Acceptance Plan.

For the project, Functional Elements (FEs) will be used by Fuchu Complex. Creating FEs library is out-of-scope of this project. The acceptability of using these FEs will be

confirmed by NED in this project.

The NED QA Engineer will prepare the QA Specification for CGI based on the following documents as a minimum:

- Technical Procurement Specification
- Acceptance Plan
- PQAP
- Outputs of other activities specified in Section 9.3

For specific application project, customer requirements might differ from the requirements specified in the ERS. In this case, NED will need to change the generic qualification project ERS and technical procurement specification. The acceptability of the design change will be confirmed by Fuchu Complex when Fuchu Complex reviews the procurement documents for the customer specific project.

In addition, the Technical Procurement Specification, QA specification, and Acceptance Plan for CGS will be prepared.

6. Issue Purchase Orders to Supplier

Because the supplier is Fuchu Complex for this project, NED's purchase order will be created using the Job Order process.

Fuchu Complex will review the NED procurement documents attached to the Job Orders, and ask for any clarification. Fuchu Complex will then perform procurements, manufacturing and testing (other than system integration testing).

7. Verify CCs and Accept Item or Service

NED will verify the CCAs by the acceptance methods specified in the acceptance plan. For the project, CG Survey of Fuchu Complex (Method-2) and Source Verification (Method-3) will be selected as acceptance methods. System Integration Testing will also be performed as part of final acceptance of the Test Specimen (this is considered Special Testing, which is Method-1). Major activities for performing acceptance are as follows;

- NED will perform CG survey specified in Section 9.3.
- For the source verification, required activities by NED will be specified in source verification plan and required activities by Fuchu Complex will be specified in the technical procurement specification and QA specification. NED will perform in-process source verification and document the results as source verification records.
- For system integration testing, NED will perform the testing in accordance with NED test control procedures and project specific test procedures.

8. Perform Qualification Analyses

NED will perform analyses necessary to qualify related safety characteristics based on design output and applicable codes and standards. The items to be qualified by analysis for the Units are identified in EPRI TR-107330 and the ERS (Reference (2)).

EPRI TR-107330 details a program of qualification analyses to demonstrate hardware acceptability for safety related applications. The recommended analyses to be performed are intended to provide utilities with information needed to support safety analyses for most applications of digital control equipment in U.S. nuclear power plants.

NED will perform the required qualification analyses and prepare the following Qualification Analysis Reports:

- FMEA Report
- Reliability and Availability Analysis Report
- Setpoint Support Analysis Report

9. Perform Qualification Testing

The Master Test Plan (MTP) will be prepared based on the PTER. The MTP identifies test requirements and acceptance criteria from the PTER for each characteristic to be qualified by test.

The qualification tests consist of three categories as follows:

(1) Pre-Qualification Tests

These tests are performed prior to the qualification test in order to ensure the correct

operation of the system and to provide baseline performance data on operation of the Test Specimen. These tests are performed at Fuchu Complex and at ()^{a,c} test facility.

(2) Qualification Tests

These tests are performed in order to confirm that the Test Specimen meets the requirements provided in the ERS, and that the Test Specimen is suitable for operation while subject to stress conditions. These tests are performed on the assembled qualification test system after it passes the Pre-Qualification tests. These tests are performed at ()^{a,c}

(3) Performance-Proof Tests

These tests are performed on the assembled qualification test system as a final demonstration of acceptable system performance. These tests are performed at ()^{a,c}

NED test procedures will be prepared based on the MTP. Tests are performed by NED and ()^{a,c} personnel at ()^{a,c} in accordance with the test procedures. NED will purchase test services for use of equipment and personnel from ()^{a,c}

Because ()^{a,c} has a QA program in accordance with 10CFR50 Appendix B, NED purchases the services using its standard procurement process for 10CFR AppendixB based QA program vendor procurement. This requires NED to perform an audit of ()^{a,c} and place ()^{a,c} on the NED Approved Supplier List for these services.

NED procures the service of shipment of the Test System from a shipping firm. Before shipment of the Test System, NED QA Group reviews or witnesses the shipping vendor as a source verification during the shipping. Shipment of items is controlled under Toshiba 10CFR50 AppendixB based QA Program.

NED and ()^{a,c} personnel qualified in accordance with an 10CFR50 Appendix B QA Program will perform the testing based on the test procedures, and prepare test reports. Each test report identifies:

- Test Results
- Maintenance, modification and/or repair occurring during the test
- Deviations occurring during the test.

NED will establish the Qualification Test Report based on the MTP and all test reports

as test summary documents. This report will be referred into the Topical Report.

10. Perform Technical Evaluation

After all qualification and procurement activities are completes, NED will prepare a Technical Evaluation Report to document these activities. This report will be the Topical Report. This is effectively the end of the qualification project, although the project will remain open to address any questions from the US NRC while the TR is being reviewed.

11. Assemble CGD Package

NED will assemble the CGD package based on following documents or records.

- Qualification Plan
- Technical Evaluation Report
- Acceptance Records of the Test Specimen and Test support service
- Software Qualification Report
- Qualification Test Report
- Qualification Analysis Reports

9.3. Additional Activities for the Qualification

This section specifies additional qualification project activities, beyond the typical CGD process specified in Figure-1 of AS-200A110 (Reference 2(4)).

9.3.1. Software Qualification Activities by NED

This generic qualification project includes a software qualification process, for the logic to be implemented in the FPGAs. All required activities have been specified in the SQAP. All required activities consist of NED's activities and Fuchu Complex's activities to be imposed in the procurement specification for CGI. Therefore, software qualification activities by NED will be required.

Software qualification activities by NED are as follows:

- Develop V&V Plan
- Develop Preliminary Hazard Analysis (PHA) Report

- Prepare Requirement Tracability Matrix (RTM)
- Update the RTM and PHA Report at each phase
- Perform CDR of Fuchu Complex and Actel specified in Section 9.3.3.
- Prepare software qualification summary report

Some necessary information from Fuchu Complex will be provided to NED, based on requirements specified the procurement specification for CGI.

9.3.2. Commercial Grade Survey

As stated in section 9.2, NED intends that some of CCAs are to be accepted by Commercial Grade Survey. Therefore, NED will perform a CG Survey of Fuchu Complex, which has an ISO QA Program.

To perform the survey, a survey plan is prepared to ensure that the survey evaluates supplier controls over each expected CCA of the Test Specimen and test support service. The survey report shall document the method of control that Fuchu Complex uses and whether the control is adequate.

The survey will be performed before issuance of procurement documents to Fuchu Complex and Fuchu Complex will be identified in NED's Approved Vendor List based on success of the survey. The survey report will be used for developing the procurement documents.

9.3.3. CDR of NICSD and Actel

CDR is a technical review of the software development process. CDR is a tool that can be used in the supplier selection and evaluation process (as part of CGD activities). Results of CDR may identify additional activities to be performed by either the buyer or supplier to mitigate design issues, process deficiencies, or quality concerns.

CDR can share the information of vendors with CG Survey specified in Section 9.3.2. CDR is one method that can be used for acceptance of CCs, as specified in the CGD procedures.

NED will perform CDR of NICSD and prepare the CDR report. If process

deficiencies are identified in the CDR, NED may decide to perform additional in-process source surveillance inspections during the design or manufacturing processes. These additional surveillances will be specified in the Job Order to Fuchu Complex. In addition to performing CDR of NICSD, CDR of Actel is required for NED because Actel is the vendor that provides the FPGAs and Tools.

The CDR report will be used for preparing the procurement specification for CGI.

10. Scope of Overall I&C System to be Qualified

This project qualifies the PRM System for use at US nuclear power plants. Figure 10-1 shows the typical configuration of the PRM System at a US plant. The figure shows that there are multiple channels in a plant PRM System.

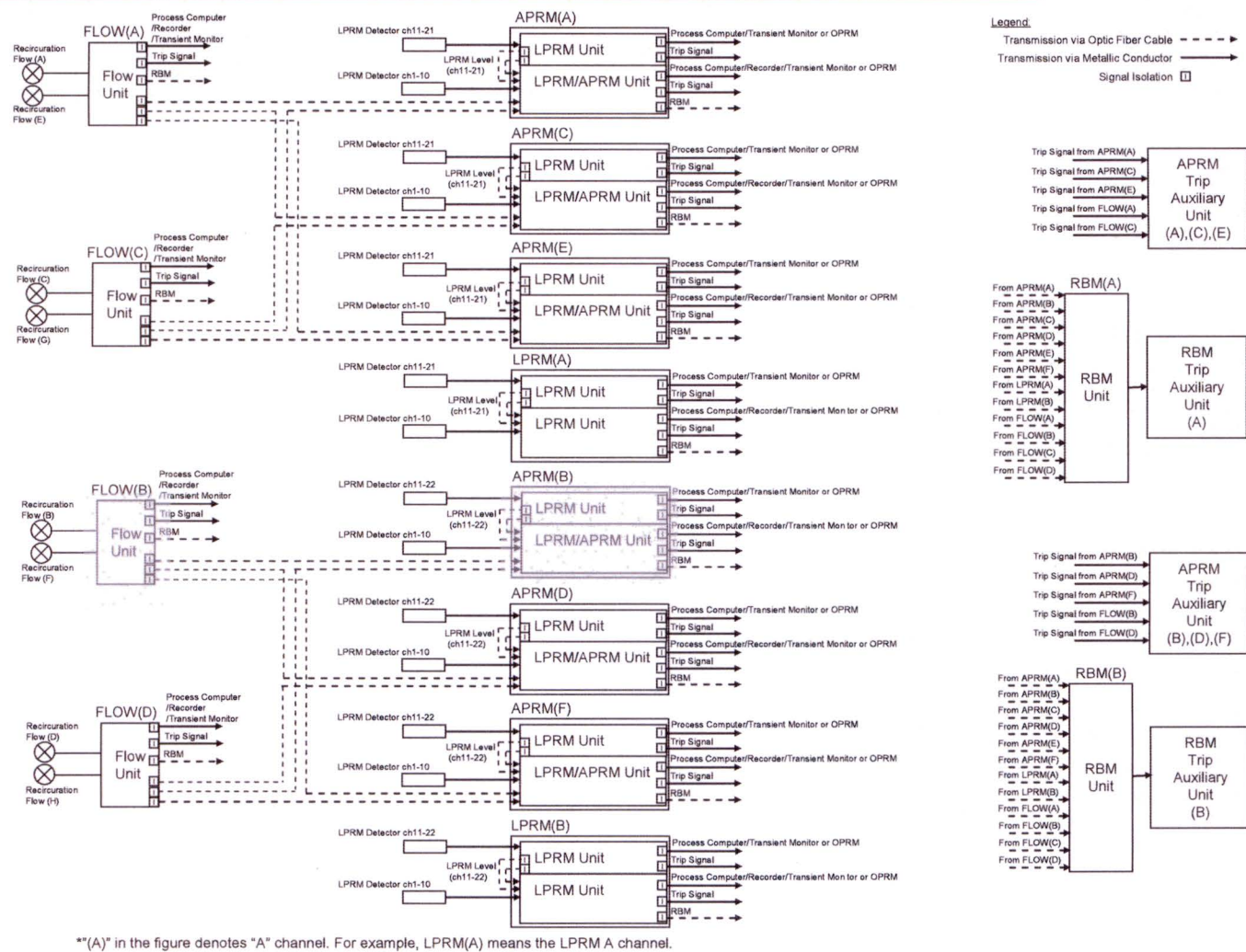


Figure 10-1: Project Scope, Compared to Typical System Configuration at US Plant

The PRM System monitors reactor power by measuring neutron flux level, and generates a trip signal when the power exceeds a specified setpoint. There are four subsystems in a PRM system:

- (1) Local Power Range Monitor (LPRM) subsystem
- (2) Average Power Range Monitor (APRM) subsystem
- (3) Recirculation Flow Measurement subsystem
- (4) Rod Block Monitor (RBM) subsystem

The APRM Subsystem consists of six channels, and the Recirculation Flow Measurement subsystem consists of four channels. LPRM signals are divided, and each LPRM signal is assigned either to one of the six APRM channels, or to one of the two independent LPRM channels. Each APRM channel contains an LPRM Unit and an LPRM/APRM Unit. Each LPRM Channel contains two LPRM Units. Each Recirculation Flow Measurement channel contains a Flow Unit. The RBM Subsystem consists of two channels, and each channel contains one RBM Unit. Therefore, at a typical BWR-5 with 172 LPRM detectors, the PRM System contains ten LPRM Units, six LPRM/APRM Units, four Flow Units and two RBM Units.

The scope of equipment included in the qualification project for the Test Specimen is shown in Figure 10-1 using shading. As shown in the figure, the scope of the project includes qualification of the following Units of the PRM System:

- Local Power Range Monitor (LPRM) Unit
- LPRM/Average Power Range Monitor (APRM) Unit
- Recirculation Flow Unit

These Units use NRW-FPGA-Based technology for signal processing.

The RBM is not a safety system (i.e., non-Class 1E) and is therefore not qualified in this project.

This project does not include qualification of sensors, associated field cables, electrical penetrations and instrument rack with flow differential pressure transmitter, since it is expected that the US utility replaces these equipments.

The project does not include qualification of relays.

Also, the project does not include qualification of the Oscillation Power Range Monitor (OPRM). The OPRM will be separately qualified.

PRM System typical architecture is shown in Figure 10-2. Each Unit consists of some modules, chassis and middle plane (prefabricated wiring-board). Each module consists of one or more Print Circuit (PC) boards and a panel. The role of panel is to fix PC boards and provide Human-Machine Interface in the module. PC boards has some Qualified Integration Circuit (QIC) made from FPGA and logic on each FPGA is made of Functional Elements (FEs).

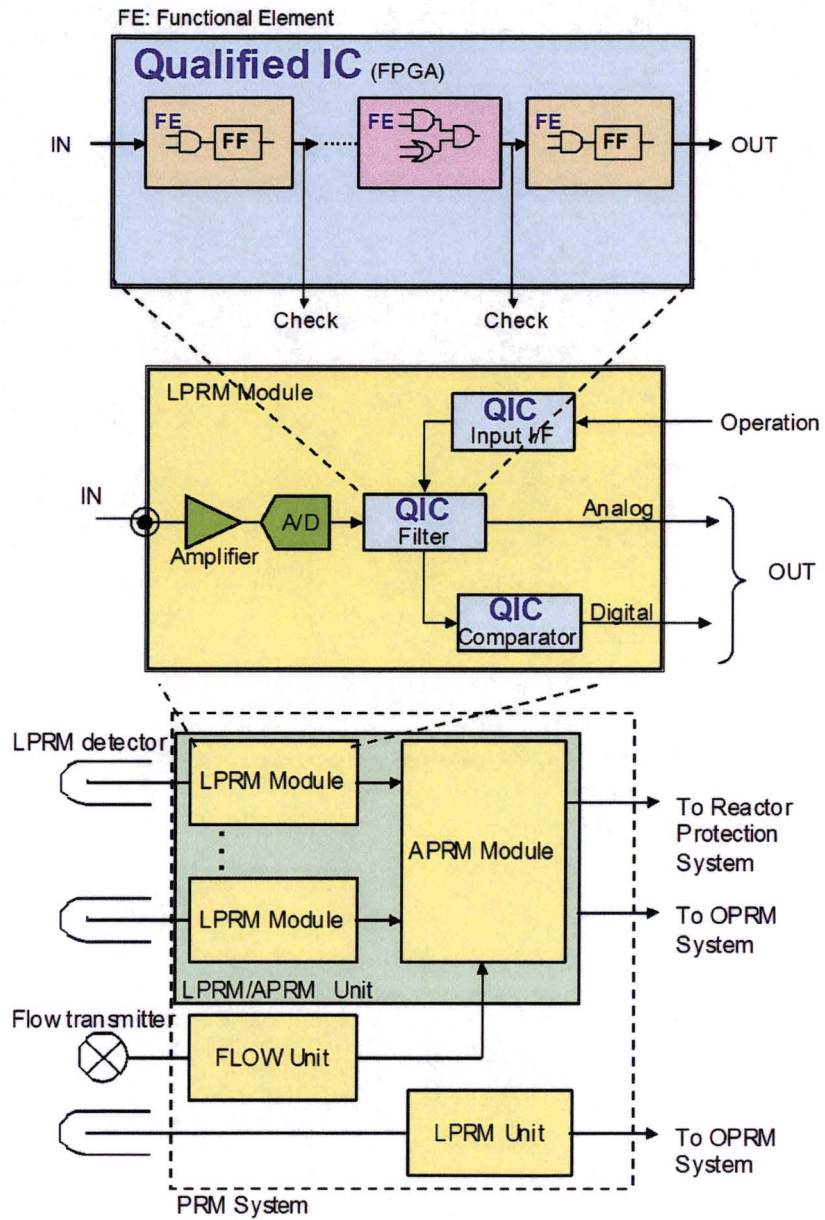


Figure 10-2 Hierarchy of Unit to be qualified