Toshiba Corporation Generic Qualification Program for FPGA-Based Safety-Related I&C Systems

February, 2004

Notice

Meanings of colors are as follows:

- Magenta: A key point of the presentation
- Blue: Easy to see

Table of Contents

Part 1: Introduction

Introduction

- Toshiba had a pre-review meeting with USNRC on August 20th, 2003
- Toshiba submitted TR Revision 0
- Purpose of this meeting is as follows:
  - To respond to USNRC's comments on August 20th, 2003 meeting
  - To discuss Toshiba Topical Report
  - To discuss additional items

Focus of Presentation

- USNRC's comments
  - Verification of Netlists
  - Verification of Tools
  - Timing verification
  - Hidden Circuit
  - Pending items
    - Electro-Migration (Occurred at K-5)

How to qualify manufacturing processes from VHDL to FPGA

- Additional topics
  - Product Change control

Presentation Overview

- Project general description
- Verification & Validation:
  - Measures for qualification of an NRW-FPGA based system as safety-related
- Qualification Plan:
  - Implementation of the established qualification process
- Supplemental issues

Definition of FPGA

- **FPGA**: Field Programmable Gate Array
  -An FPGA is an integrated circuit that can be logic-implemented.
- **NRW-FPGA**: Non-Rewritable FPGA
  -A type of FPGA that can not be rewritten once implemented.
- **VHDL** : **V**ery High Speed Integrated Circuit **H**ardware **D**efinition **L**anguage
  -A hardware description language which defines FPGA circuit.

Part 2: Project General Description

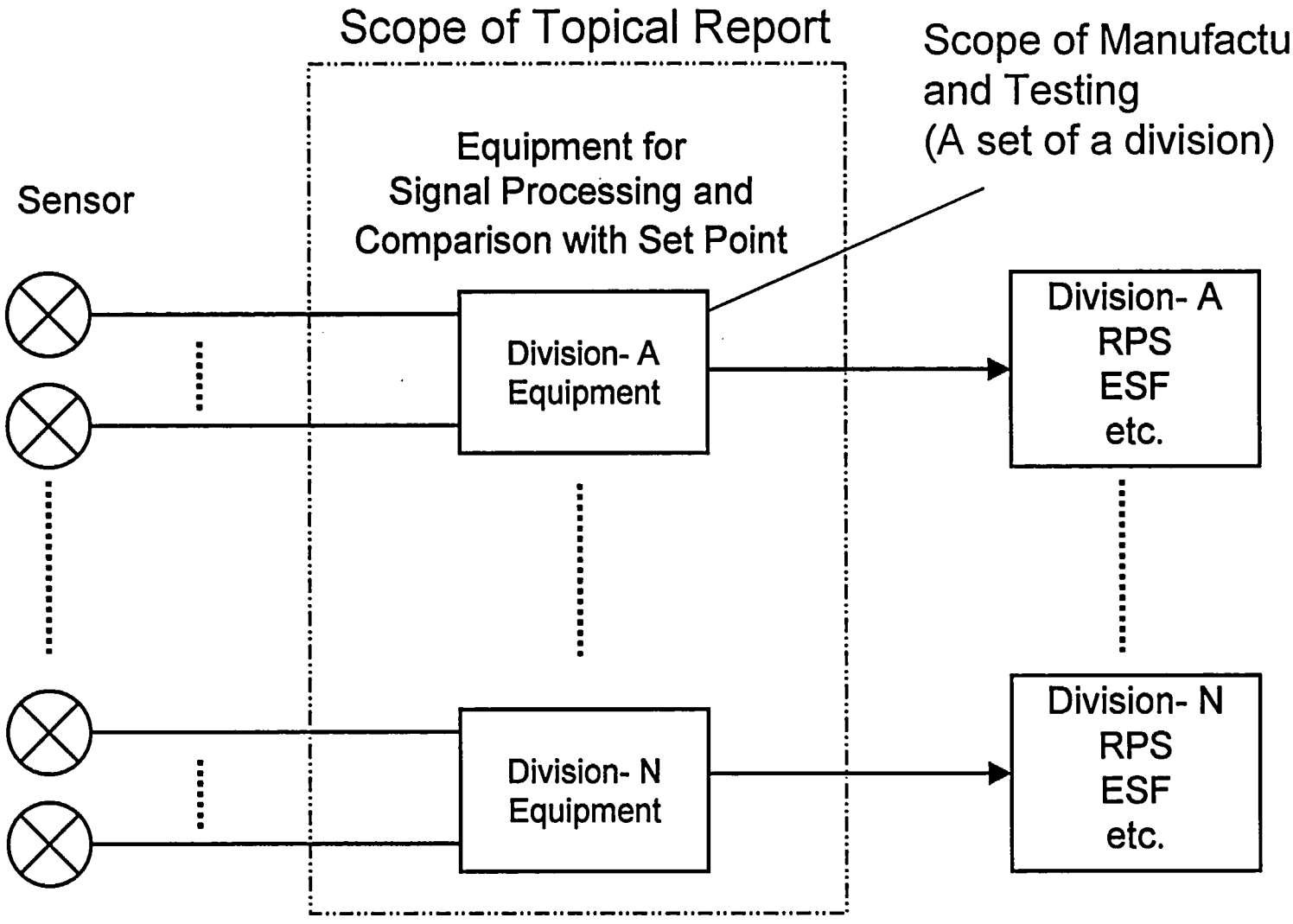
Scope of Topical Report

- The scope of the generic qualification program includes the following safety systems:
  - Power Range Monitor (PRM)
  - Trip Module (TM)

Scope of Design, Manufacturing and Tests

- Design:
  - FPGA-based safety-related I&C system (PRM and TM)
  - Detectors are not changed from conventional system
- Manufacturing:
  - A set of one division of FPGA-based equipment
  - Detectors are not changed from conventional system
- Tests:
  - Requirements for a division will be tested
  - Detector signals will be simulated by signal generator

Scope of Design, Manufacturing and Tests



Key Issue of the Project

- Key issue of the project:
  - How to qualify NRW-FPGA based I&C systems as safety related
- To resolve key issues:
  - Implement special manufacturing processes
  - Implement special Verification and Validation (V&V) procedures
- Goal of the project:
  - To show that applying the special processes and procedures is adequate for qualifying the NRW-FPGA based I&C system as safety-related

Anticipated Schedule

- August, 2003: Pre-Review meeting with USNRC
- February, 2004: Review meeting with USNRC
- May, 2004: Review meeting with USNRC
- June, 2004: System V&V and Hardware Testing Completed
- June, 2004 : Topical Report Submittal to NRC

Part 3: Verification and Validation

Key Issue of V&V

- Measures for qualification of an NRW-FPGA based system as safety-related
  - clarify latent risks which may cause common mode failure
  - implement procedures to avoid the risks

Risks and Countermeasures

- Risks for NRW-FPGA based systems:
  - NRW-FPGA circuits are processed using software-based design and manufacturing tools
  - Difficult to fully confirm circuits embedded on FPGAs
- Countermeasures to the risks:
  - Develop special manufacturing processes
  - Develop special V&V procedures

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V-NFHDI and V-FDHI (Hardware related)

- Verify the contents of the design documents
- Sign off on the documents after the verification
- These activities are also performed as part of V&V

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Part 4: Qualification Plan

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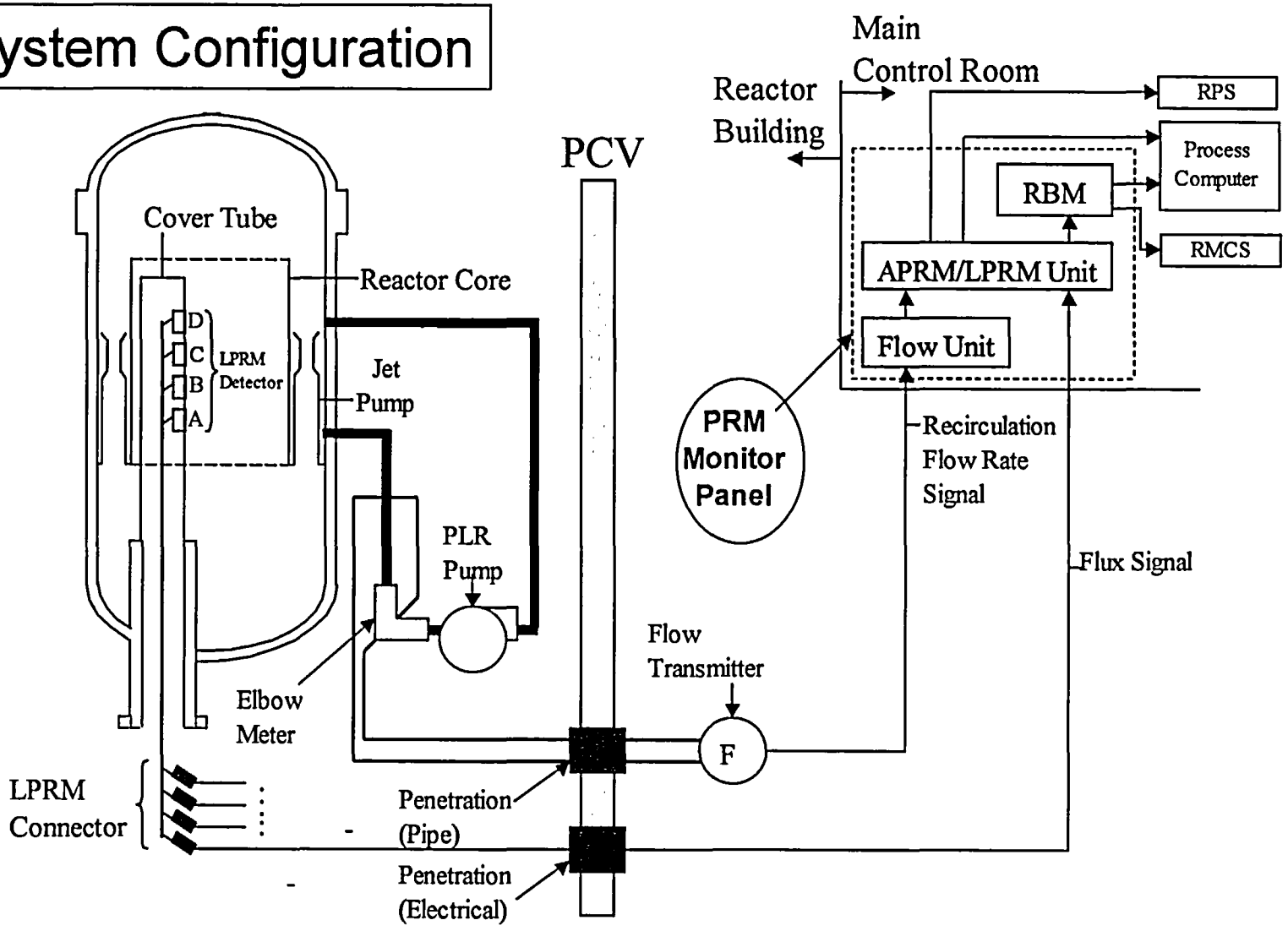
Power Range Monitor

System Configuration



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Part 5: Response to USNRC's comments

Revised Points from the August Meeting

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Part 6: Summary

Summary

- Following items are presented based on the description of Topical Report (TR)
  - Qualification procedures of this project are key issues
  - Measures to implement these procedures
- Discussed the following:
  - Responses to USNRC's comments
  - Additional issues

Part 7: Supplemental

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