US-APWR

3rd Pre-Application Review Meeting
Instrumentation & Control System Design

November 28, 2006

Mitsubishi Heavy Industries, Ltd.

Introduction

Meeting Attendants

- **Shinji Kawanago (Representative of I&C Licensing)**
  - ✓ Engineering Manager
  - ✓ MHI Nuclear Energy System, Inc.
- **Makoto Takashima (Responsible for all I&C Design)**
  - ✓ Deputy Chief Engineer
  - ✓ Water Reactor Engineering Department
  - ✓ Mitsubishi Heavy Industries, LTD.
- **Katsumi Akagi (Responsible for Digital Platform)**
  - ✓ Manager
  - ✓ Control & Protection Systems Section
  - ✓ Mitsubishi Electric Corporation
- **Ken Scarola (Technical Adviser for I&C Design)**
  - ✓ Senior Technical Manager
  - ✓ MHI Nuclear Energy System, Inc.

Meeting Objective

- **Identify proposed licensing process for US-APWR Digital I&C System design**
  - ✓ Areas for use of DAC in the US-APWR
  - ✓ Topical Reports, contents and submittal schedules
  - ✓ Additional documentation plans
    - During DC phase
    - During COL phase
    - During ITAAC phase
- **Provide discussion of Key Technical Issues related to US-APWR Digital I&C System design**
- **Obtain early NRC feedback on licensing plan and Key Technical Issues**

Note) Acronyms are listed at the end of the presentation.

Agenda

Part 1:

Overview of US-APWR Digital I&C Design and Licensing Process

- US-APWR I&C system design overview
- MHI I&C system development history
- Planned DAC
- Planned Topical Reports

Part 2:

Key Technical Issues Discussion

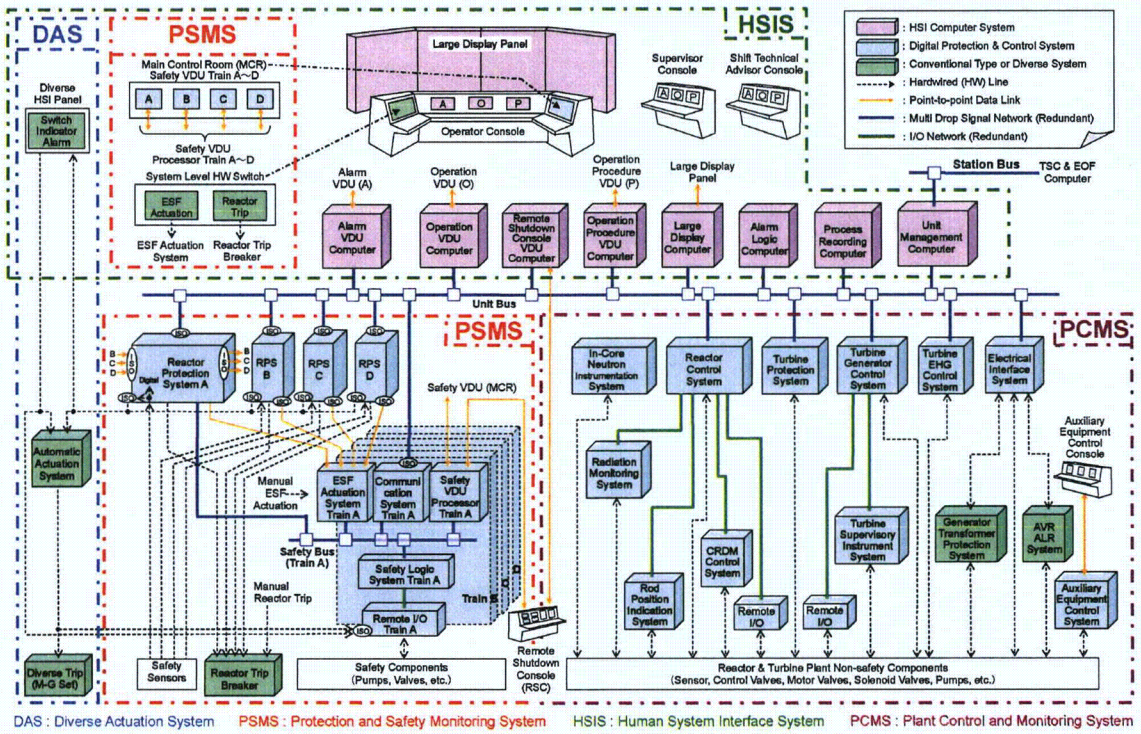
Summary

Part 1:
Overview of US-APWR Digital I&C Design and Licensing Process

Overall I&C System Architecture

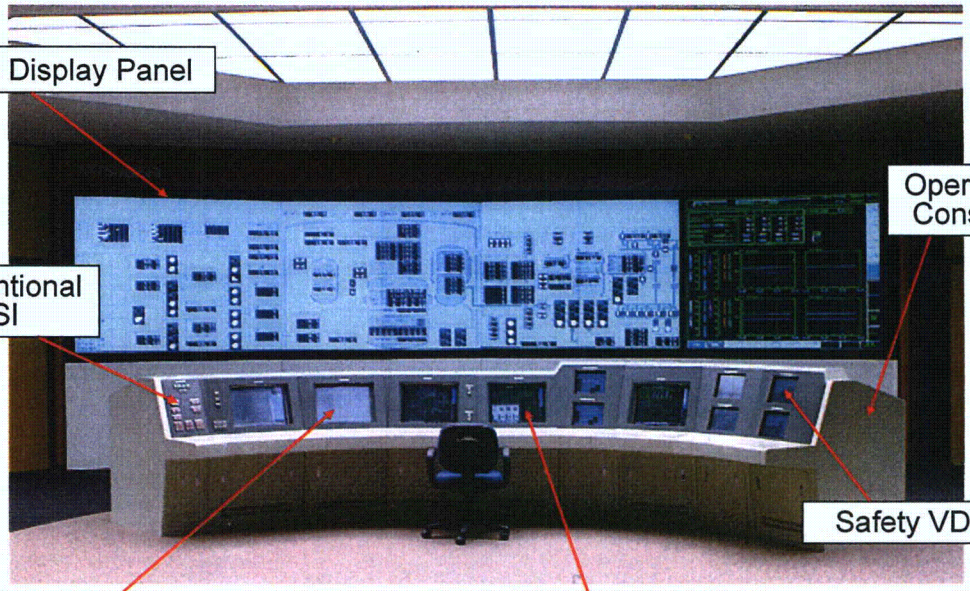
- Microprocessor based digital technology for most plant I&C
- Complete four train redundancy for safety I&C
- Distributed architecture for non-safety I&C with redundancy
- Fully computerized Main Control Room
- Fully multiplexed and duplicated signal transmission networks from local areas to I&C equipment rooms and Main Control Room
- Common digital platform for the Safety and Non-safety I&C. Diverse Actuation System based on a different technology

Overall I&C System Architecture

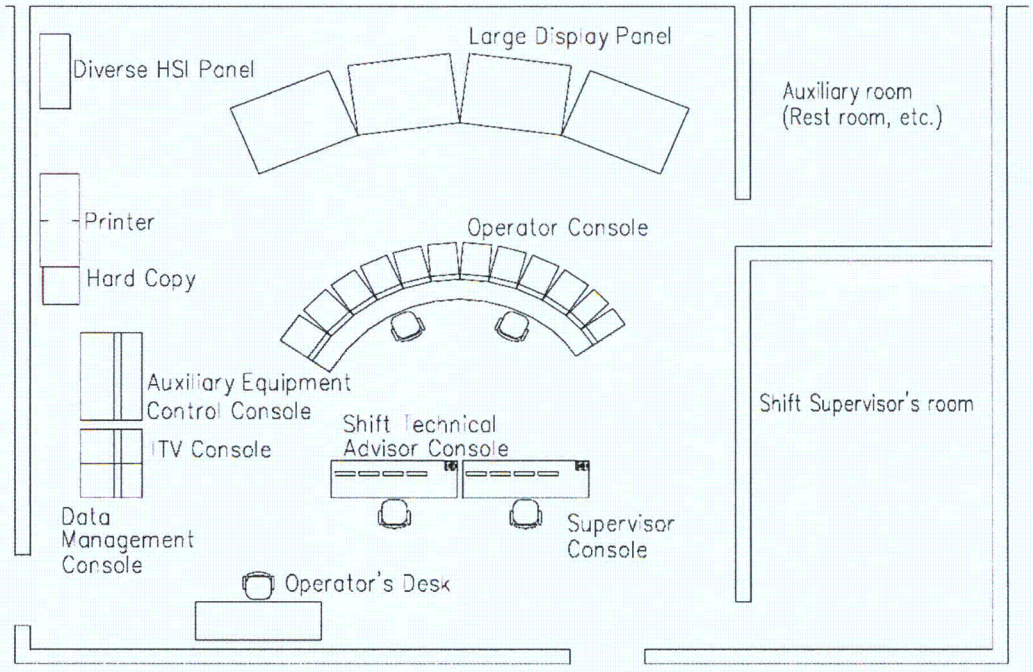


HSI System Architecture

Computerized Main Control Room



MCR Layout (Example)



History of MHI Digital Application

➢ Digital Platform Non-safety Application History

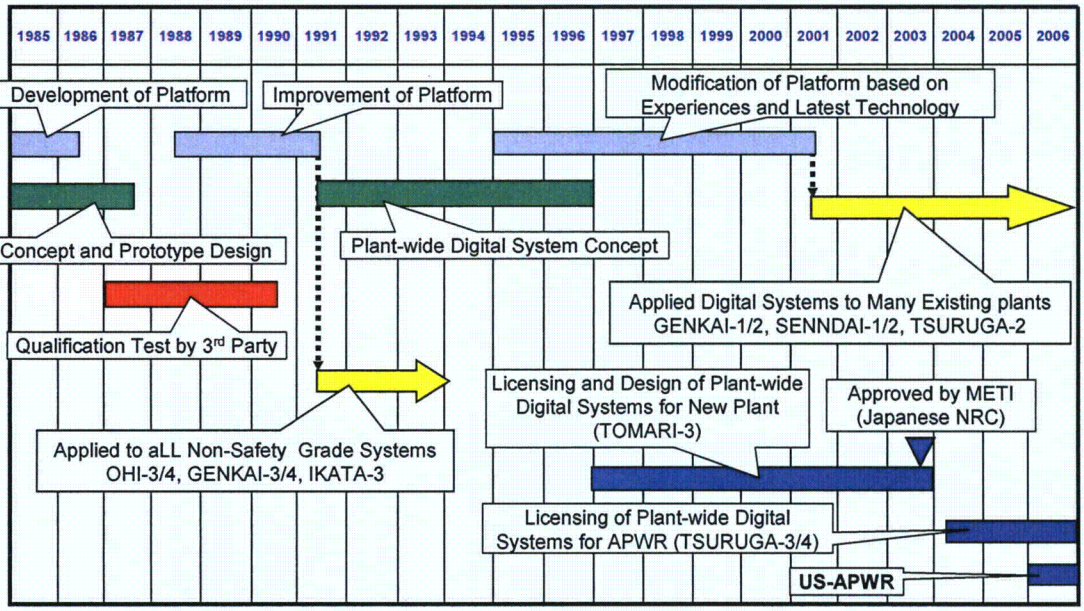
- ✓ Platform development began in 1985 with long term goal of safety applications
- ✓ First installation for non-safety in 1991
- ✓ Platform was developed in compliance with US standards
- ✓ Average 10 years operation for five operating plants
- ✓ Applied to all non-safety I&C, 50 applications per plant
- ✓ Over 20 million hours total operating experience
- ✓ No system malfunction caused by S/W or H/W failure

➢ Current application for Reactor Protection and ESF Actuation System in Japan

- ✓ Tomari #3 (Under construction, C/O 2009)
- ✓ Tsuruga #3/4 (APWR) (Under licensing, C/O 2015)
- ✓ Ikata #1/2 (Digital Upgrade 2009)
- ✓ Takahama #1/2/3/4 (Digital Upgrade 2009 – 2012)
- ✓ Ohi #1/2/3/4 (Digital Upgrade 2009 – 2013)

Note: Above RPS/ESFAS basic architecture are same as US-APWR

History of MHI Digital Application



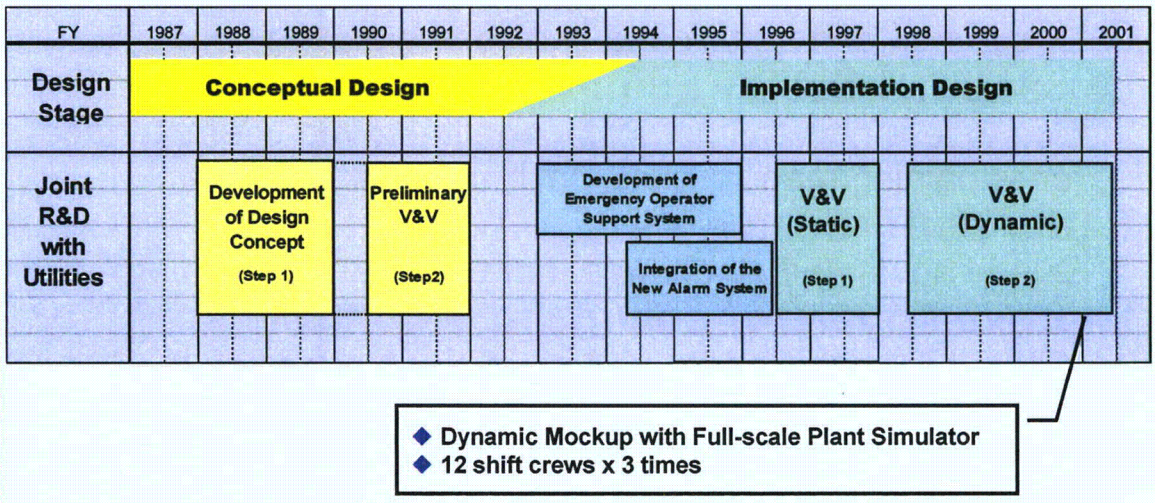
Mitsubishi digital systems and platform have been developed in compliance with US codes and standards

Development of Computerized MCR

- **Dynamic V&V of Computerized Main Control Room (MCR) with Japanese Operators**
  - ✓ Development began in 1987
  - ✓ V&V tests (3 times) with Japanese PWR utilities shift operators (from12 sites) 1998-2001
    - Full-Scale Simulator
    - Performance Check
    - Review and Comment
  - ✓ Established Standard Design Specification
- **Current applications in Japan**
  - ✓ Tomari #3 (Under construction, C/O 2009)
  - ✓ Tsuruga #3/4 (APWR) (Under licensing, C/O 2015)
  - ✓ Ikata #1/2 (Modernization 2009)

Development of Computerized MCR

- **Step by step approach for design process and V&V**
- **V&V by plant operators using Full-scale Simulator**



QA programs for I&C/HSI design

- **All Aspect of the I&C and HSI design are under MHI's Nuclear QA program:**
  - ✓ Generic platform hardware and software, including initial development, V&V, qualification and life cycle management
  - ✓ Plant specific hardware manufacture and configuration control
  - ✓ Application software development, V&V and configuration control
  - ✓ Equipment and software are expected to be turned over to the plant owner's QA program after plant commissioning
  - ✓ Life cycle management for error reporting and corrective actions
  - ✓ QA program equivalence to 10CFR50 Appendix B and 10CFR21 will be discussed later
- **Software QA Program**
  - ✓ Software QA program complies with US standards (IEEE-7.4.3.2-2003 and related IEEE standards)
    - Software Life Cycle Process (SLCP)
    - Independent Verification and Validation (V&V)
    - Configuration Management (CM)

Key Goals & Benefits of Digital I&C

- **Higher availability**
  - ✓ Due to continuous self-testing, additional redundancy and shorter MTTR
- **Higher accuracy**
  - ✓ Due to non-drift nature and self-compensation
- **Lower potential for human error**
  - ✓ Due to less human interaction and improved user interface for remaining manual tests, calibrations and repair
- **Better performance**
  - ✓ Due to advanced algorithms (not practical with analog)
- **Improved operator command & control capability**
  - ✓ Without increasing potential for human performance error
  - ✓ Due to increased automation and improved user interface
- **Reduction of maintenance workload & resources**
  - ✓ Based on standardized design

Licensing Process Overview

- MHI Digital I&C and HSI systems are applicable to New Plants and Operating Plants
- Significant design detail is available based on digital applications in Japan
- Design Detail will be described in the US-APWR DCD
- Minimum use of DAC for US-APWR DCD
- Topical Reports for key technical areas are planned to facilitate early interaction with the NRC staff
  - A) Digital Platform
  - B) Safety I&C System Design Process and Description
  - C) Defense-in-Depth and Diversity
  - D) HFE Process and HSI System Design
- These Topical Reports will be referenced in the US-APWR DCD and are expected to be referenced in future LARs for operating plant digital upgrades
- MHI actively participates in all aspects of the NEI Digital I&C/HFE WG and all related NRC meetings

A) Digital Platform

Topical Report

Contents

- ✓ Equipment and software description, including engineering tools
- ✓ Qualification criteria, reliability and accuracy data
- ✓ Software development process, including V&V process
- ✓ Equipment qualification program summary report
- ✓ System Life Cycle Process
- ✓ Equipment Reliability

Planned Submittal Date

- ✓ February 2007 (An EMC qualification report conforming to requirements of R.G. 1.180 rev.1 will be supplied to supplement this TR in July 2007)

A) Digital Platform

Subsequent Documentation

- **DCD Tier 1**
  - ✓ Extract key performance and qualification attributes from Topical Report
- **DCD Tier 2**
  - ✓ Will reference Topical Report as acceptable platform
- **COL**
  - ✓ No additional information
- **ITAAC**
  - ✓ Will ensure Conformance to qualification and life cycle requirements

B) Safety I&C System Design Process & Description

Topical Report

- **Contents**
  - ✓ System description
  - ✓ Design basis and conformance to safety criteria
  - ✓ Application software and system design process
  - ✓ Requirements and methods for reliability, response time, accuracy, seismic, EMC and fire protection analysis
  - ✓ FMEA
  - ✓ Life cycle process
- **Planned Submittal Date**
  - ✓ February 2007

B) Safety I&C System Design Process & Description

Subsequent Documentation

- **DCD Tier 1**
  - ✓ Extract Topical Report (TR) high level system descriptions and design process descriptions
- **DCD Tier 2**
  - ✓ Extract TR descriptions for SRP format, reference TR for additional details
- **COL (Design detail for compliance with DAC)**
  - ✓ Software design process documentation, including detailed safety functions and V&V
  - ✓ Set-points calculations
- **ITAAC**
  - ✓ Function, performance and qualification conformance

C) Defense-in-Depth and Diversity

Topical Report

- **Contents**
  - ✓ CMF effects in digital platform
  - ✓ DAS description, quality and reliability
  - ✓ Diversity assessment
  - ✓ Coping strategy and acceptance criteria for each DBA
  - ✓ Typical example of coping analysis
  - ✓ Commitment to acceptance criteria or additional DAS functions
- **Planned Submittal Date**
  - ✓ March 2007

C) Defense-in-Depth and Diversity

Subsequent Documentation

- **DCD Tier 1**
  - ✓ Extract Topical Report (TR) high level descriptions of DAS functions and diversity attributes
- **DCD Tier 2**
  - ✓ Extract TR descriptions and analysis for SRP format, reference TR for additional details
  - ✓ Coping analysis results for all DBAs
- **COL**
  - ✓ No additional information
- **ITAAC**
  - ✓ Function and quality conformance

D) HFE Process & HSI System Design

Topical Report

- **Contents**
  - ✓ HSI system design description, including basic designs for displays, alarms, controls, procedures and navigation (Safety and Non-safety)
  - ✓ Design basis for Minimum Inventory
  - ✓ Design basis for operator staffing
  - ✓ HFE design process, including Verification & Validation (V&V) plan for US operators
- **Planned Submittal Date**
  - ✓ March 2007

D) HFE Process & HSI System Design

Subsequent Documentation

- **DCD Tier 1**
  - ✓ Extract Topical Report (TR) high level system descriptions and design process descriptions
- **DCD Tier 2**
  - ✓ Extract summaries for HFE Program Plans, reference TR for details
- **COL (Design detail for compliance with DAC)**
  - ✓ US operator V&V summary report
  - ✓ Plant specific operator staffing basis
  - ✓ Design process documentation, including detail display designs and computer based procedures
- **ITAAC**
  - ✓ Conformance to final NUREG-0711 HFE program elements, including validation, training and human performance monitoring

DAC Process Summary

- **DAC will be used in the US-APWR DCD only for the following limited area**
  - ✓ Digital Safety Systems
    - Application software engineering, including detailed functions & logic designs, V&V and life cycle management
    - Set-point determination
  - ✓ Computerized HSI Systems
    - Detailed display designs, including alarms and soft controls
    - Detailed design of computer based procedures
    - Verification and Validation with US operators
    - Training and Human Performance Monitoring
- **Detail Design for compliance with above DAC will be described in COLA, either directly or via reference to new Topical Reports**

Licensing Process Summary

System	Design Area	DC Phase	COL Phase
Safety System - Reactor Trip - ESF - Safe Shutdown - Safety Display - Safety Interlock	System Description	DD & TR	N/A
	Design Bases	DD & TR	N/A
	Functional Design	DD & TR	N/A
	Analysis	DD & TR	N/A
	Application Software	DAC	DD & TR
	Set-point Calculations	DAC	DD & TR
HSI System - Safety HSI - Non-safety HSI - HFE Process	System Description	DD & TR	N/A
	Design Bases	DD & TR	N/A
	HFE Design Process	DD & TR	N/A
	Detail Display Design	DAC	DD & TR
	US Operator V&V	DAC	DD & TR
Digital Platform for Safety System		DD & TR	N/A
Defense-in-Depth and Diversity		DD & TR	N/A

DD: Detail Design, TR: Topical Report, N/A: Nothing Additional

Key Technical Issues Overview

Key Technical Issues for Digital I&C Application in USA

a. Multi-channel Operator Stations
b. Operator Staffing
c. Operation under Degraded Conditions
d. Integrated RPS and ESFAS with Functional Diversity
e. Spurious Actuation in D3 Analysis
f. Credit for Leak Detection in D3 Analysis
g. Output Modules (Priority Logic Modules Common to Safety Logic System and DAS)
h. Control System Failure Modes
i. Tech Spec Surveillance
j. Bypassed or Out-of-service
k. Minimum Inventory
l. Computer Based Procedures
m. Hardware & Software Architecture of Digital Platform

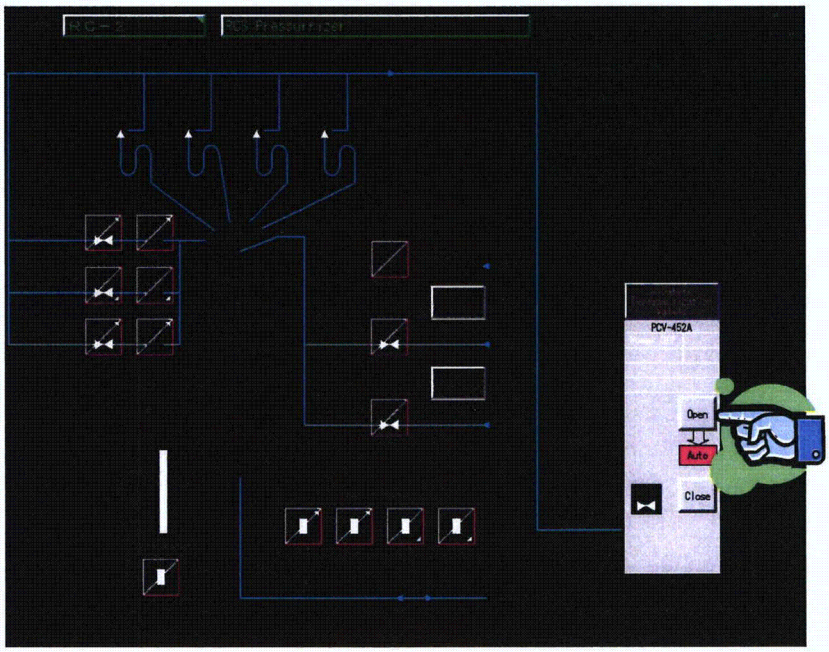
Part 2:
Key Technical Issues Discussion

a. Multi-Channel Operator Station

- Safety operator stations are used for control of all safety systems/components
- Non-safety operator stations are used for control of all non-safety and safety systems/components
- Benefit of common HSI (Multi-Channel Operator Station)
  - ✓ Single operator execution of procedures, simplifying task coordination
  - ✓ Computer based procedures with embedded soft controls

a. Multi-Channel Operator Station

- Safety and Non-safety components can be operated from Same Screen



a. Multi-Channel Operator Station

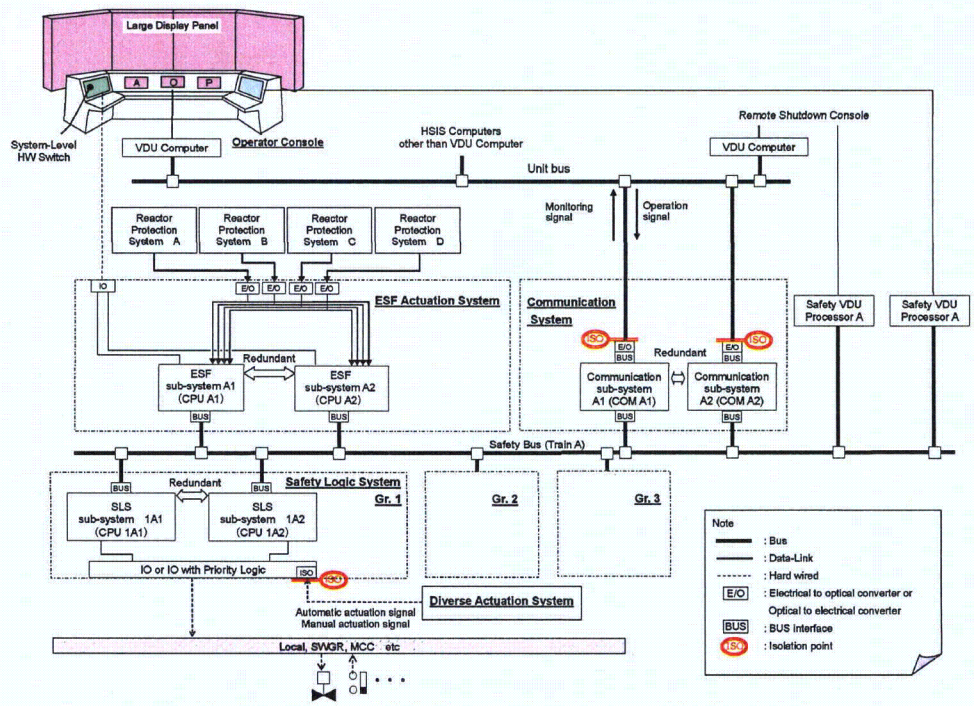
Platform and Safety System TR will demonstrate acceptable Non-safety to Safety Communications

- **Electrical independence:**
  - ✓ Fiber Optics & Optical Device (O/E E/O Transformer)
- **Data processing independence:**
  - ✓ Separate communication modules with no handshaking ensures deterministic asynchronous processing of safety logic functions
- **No ability to transfer unpredicted data:**
  - ✓ No file transfer capability in safety system
  - ✓ Predefined communication data sets will be used to reject unknown data

a. Multi-Channel Operator Station

- **No ability to alter safety software:**
  - ✓ Capability for software download is hardware enabled only during bypassed or out of service conditions
- **Additional protection against cyber threats**
  - ✓ Administrative controls for safety & non-safety systems
  - ✓ One-way communication to uncontrolled systems
- **Acceptable safety function performance:**
  - ✓ Logic in Class 1E system blocks non-safety signals (e.g. priority for automatic ESFAS signals & manual operator actions from safety HSI)
- **Failures of non-safety systems are bounded by safety analysis:**
  - ✓ For worst case erroneous/spurious non-safety data sets during all plant modes (e.g. non-safety failure commanding spurious opening of PORV)

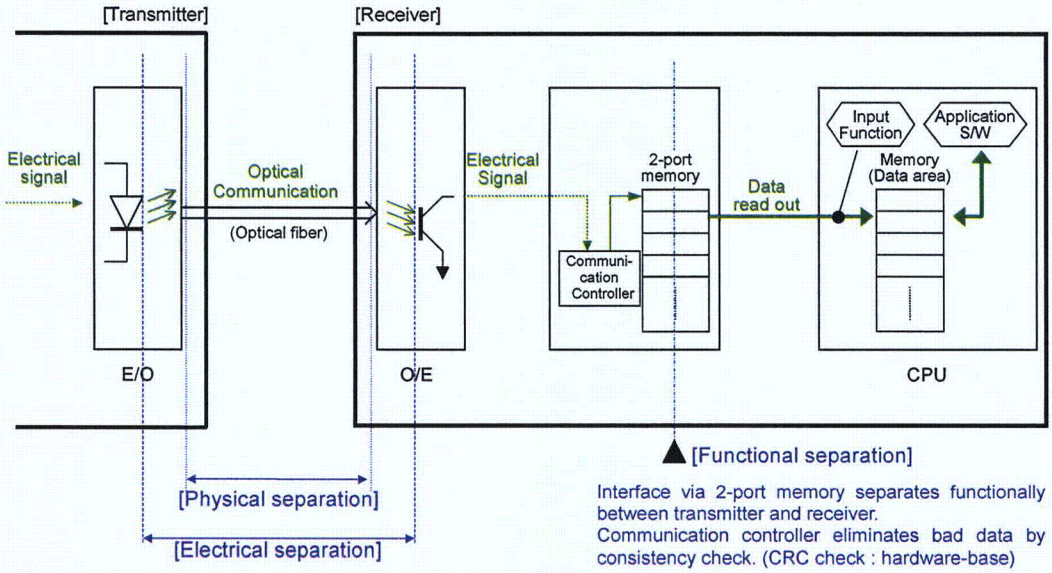
a. Multi-Channel Operator Station



Configuration of Engineered Safety Features Actuation System and Safety Logic System

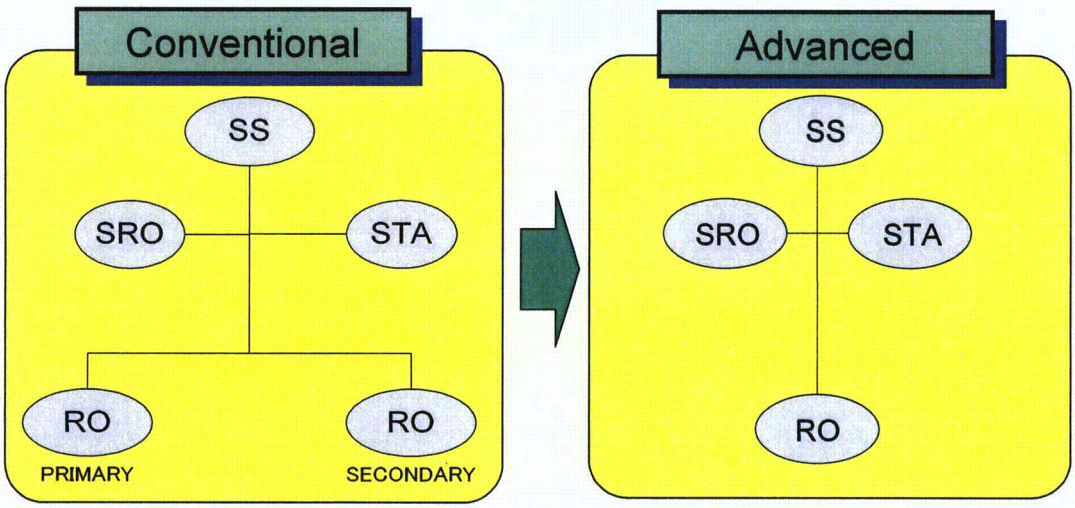
a. Multi-Channel Operator Station

- Separation in Communication (Data Network/Link)
  - ✓ **Applicable between Non-safety to Safety communication**
  - ✓ **Applicable between Inter train communication**



Interface via 2-port memory separates functionally between transmitter and receiver.
Communication controller eliminates bad data by consistency check. (CRC check : hardware-base)

b. Operator Staffing



- Necessary number of Reactor Operators (RO) is reduced from 2 to 1 by reduction of Workload for Operation
- Minimum staff complies with 10 CFR 50.54(m)

b. Operator Staffing

- HSI design will accommodate continuous operation by one or two Reactor Operators
- Validation will focus on worst case one operator conditions
- If human performance concerns are specifically identified for two operator situations, validation will encompass both staffing conditions
- COLA will identify actual plant staffing

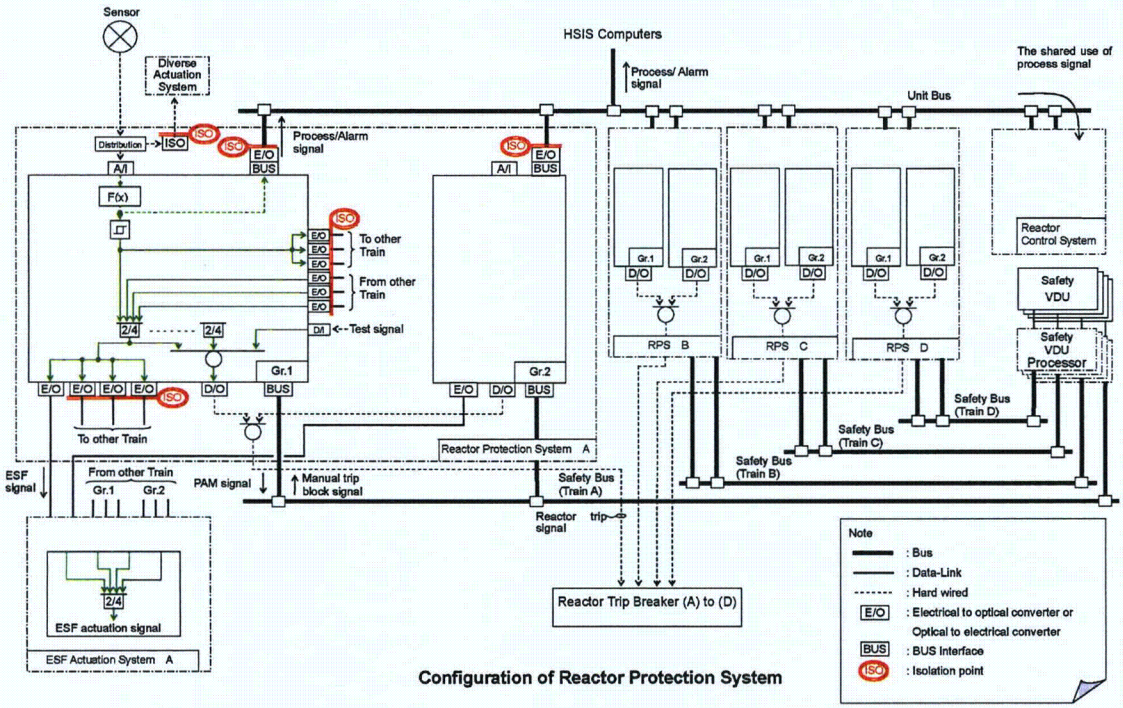
c. Operation under Degraded Conditions

- HFE program will demonstrate safe operation during the following failure conditions
  - ✓ Loss of all Non-safety I&C/HSI:
    - DBA management and safe shutdown using only Safety I&C/HSI
  - ✓ Loss of all safety and Non-safety I&C/HSI (CMF):
    - Coping for each DBA using DAS
  - ✓ Loss of all Non-safety HSI and data communication:
    - Continued stable operation and safe shutdown using Safety I&C/HSI, and Non-safety I&C (without inter-subsystem communication)
      Note: Safe shutdown can be achieved by only Safety I&C/HSI
- These degraded conditions will be included in the HFE analysis & HFE V&V program

d. Integrated RPS & ESFAS

- Functional diversity is provided within RPS and ESFAS for each DBA through two separate subsystems in each train
- PRA shows significant benefit for functional diversity
- RPS bistable and coincidence voting functions are also used for ESFAS
- Therefore RPS and ESFAS functions are integrated within each subsystem
- PRA shows minimal benefit for RPS/ESFAS separation
- Integration benefit is less hardware, therefore reduced maintenance and potential for human error
- Defense-in-Depth and Diversity (D3) coping analysis shows acceptable results for RPS/ESFAS integration

d. Integrated RPS & ESFAS



Configuration of Reactor Protection System

e. Spurious Actuation in D3 Analysis

- **D3 (Defense-in-Depth and Diversity) coping analysis considers CMFs that result in fail-as-is condition for RPS/ESFAS/PCMS coincident with each DBA**
- **D3 coping analysis does not consider CMFs that result in fail-deenergized or spurious actuation coincident with DBA, because Topical Report will demonstrate that:**
  - ✓ Fixed cyclical processing and extensive software QA, including independent V&V, precludes CMF induced by any changing input conditions during DBA
  - ✓ Therefore CMF is not induced by DBA, but rather by an undetected hidden defect
  - ✓ A hidden defect which is undetectable between test intervals may still exist when a DBA occurs
  - ✓ A hidden defect that results in fail-deenergized or spurious actuation is immediately detectable. Therefore it can be corrected prior to a DBA occurrence

f. Credit for Leak Detection in D3 Analysis

- **DAS includes diverse leak measurement sensors, processing and display**
- **D3 TR credits diverse leak detection which allows operators to detect and mitigate the leak even if safety systems are failed due to undetected CMF (this is consistent with BTP-19 and System 80+ DCD)**

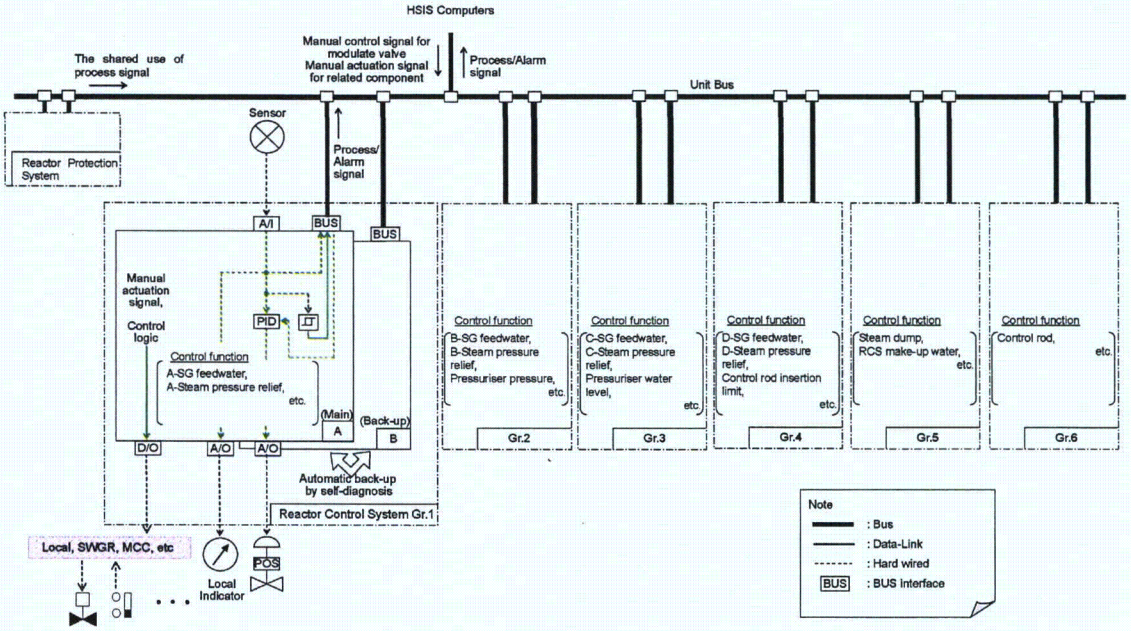
g. Common Output Modules

- **Output Modules are common to Safety Logic System and Diverse Actuation System**
- **DAS outputs interface to plant components via Output Modules of Safety Logic System**
- **Benefit is that module provides a single power switching interface to plant component, therefore less hardware and maintenance**
- **Output Modules are credited for:**
  - ✓ BTP-19 coping analysis and Position 4
  - ✓ 10CFR50.62 ATWS
- **Platform TR will demonstrate:**
  - ✓ SLS/DAS electrical and communication independence
  - ✓ Safe state priority logic
  - ✓ No potential for module CMF by using proven, simple and fully testable hardware

h. Control System Failure Modes

- **Non-safety control functions are partitioned in multiple redundant controllers to limit the effects of failures**
- **Safety analysis considers the following failures for a single redundant controller pair:**
  - ✓ Main controller failure and failed switchover to back-up controller
  - ✓ Failure of output device
  - ✓ Failure resulting in malfunction of control system (e.g. excess feed demand)
- **Failure resulting in fail-active operation for functions in multiple controllers is not possible due to independence of controllers**
- **Failure resulting in multiple spurious commands from a Non-safety VDU is not possible since:**
  - ✓ it requires a series of specific successive failures in multiple software blocks
  - ✓ it can be rejected by self-diagnostic functions of controllers

h. Control System Failure Modes



Configuration of Reactor Control System

i. Tech Spec Surveillance

- **Platform TR will describe test coverage for self-diagnostics, including memory check**
- **System TR will describe Tech Spec surveillance:**
  - ✓ Confirmation of continuous self-diagnostic execution
  - ✓ Additional manual tests for functions not covered by self-test (e.g. output interface to plant components), with self-test overlap
  - ✓ Transmitter calibration with overlap to digital side of A/D converters
- **Surveillance intervals are determined by reliability and drift data (ITAAC confirmation required)**
- **Response time and functional logic is tested only during system validation**
- **Failures that effect response time or logic are detectable through tests described above**

j. Bypassed or Out-of-Service Conditions

- **US-APWR includes four trains from sensors to actuated device with complete electrical separation and independence**
- **With one train bypassed or out of service:**
  - ✓ Conformance to single failure criteria is still maintained
  - ✓ PRA goals for CDF and LERF are achieved
- **LCO is not expected with one train bypassed or out of service**
  - ✓ Except for return to service after return to power mode change (consistent with other four channel plants)
- **LCO is expected for two or more trains bypassed or out of service**

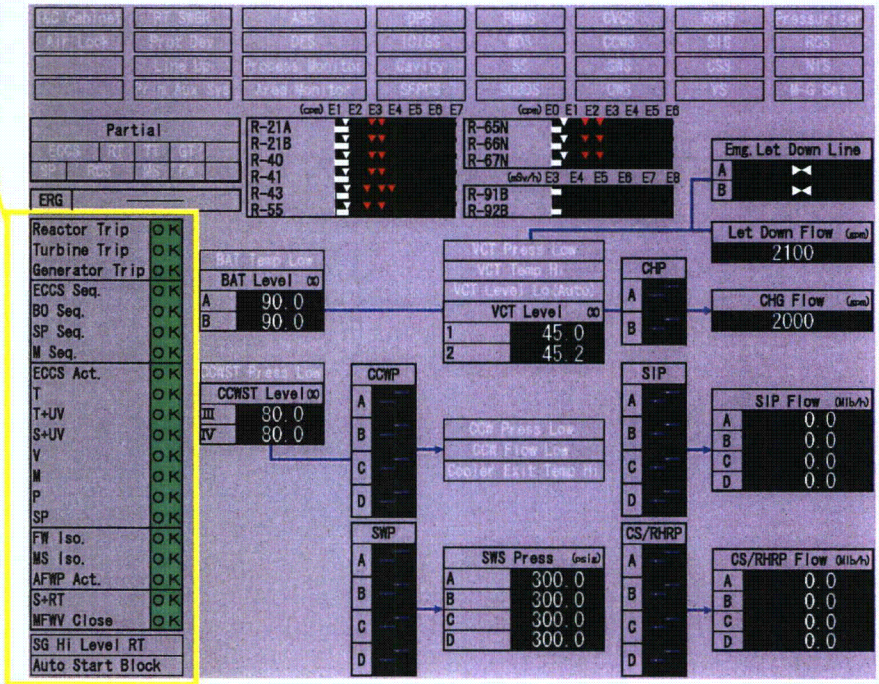
k. Minimum Inventory

- **Spatially Dedicated Continuously Visible (SDCV) HSI (LDP: Large Display Panel)**
  - ✓ Reactor tripped status (all rods in)
  - ✓ ESFAS component actuation status (system level)
  - ✓ Critical safety functions status (top level SPDS)
  - ✓ Safety system performance monitoring
  - ✓ RG1.97 Category 1 variables
  - ✓ SDCV Alarms Required in NUREG-0700
- **SDCV HSI (Conventional Hard-wired)**
  - ✓ Bypassed or inoperable status indicator (train level) required by R.G. 1.47
  - ✓ System level RPS & ESFAS actuation switch required by R.G. 1.62 (Class 1E)
  - ✓ Note there are no immediate manual actions credited in the safety analysis (i.e. no Category 1A parameters)
- **Class 1E HSI (Safety VDU)**
  - ✓ RG1.97 Category 1 variables
  - ✓ Controls for credited safety success paths in EOP for accident mitigation and safe shutdown

k. Minimum Inventory (Example)

- One of Large Display Panel Fixed Display Area

Safety system performance monitoring



I. Computer Based Procedures

- Operating procedures are provided by computer but are the same as current paper based procedures
- Text based procedures display links to relevant display pages and links to soft controls
- Design grade of the computer based procedures is the same as SPDS (i.e. Important to Safety, not Safety Critical)
- Procedure change process will be consistent with current paper procedures;
  - ✓ a design change process will not be invoked

m. Digital Platform (Major Features)

➢ Simple Design

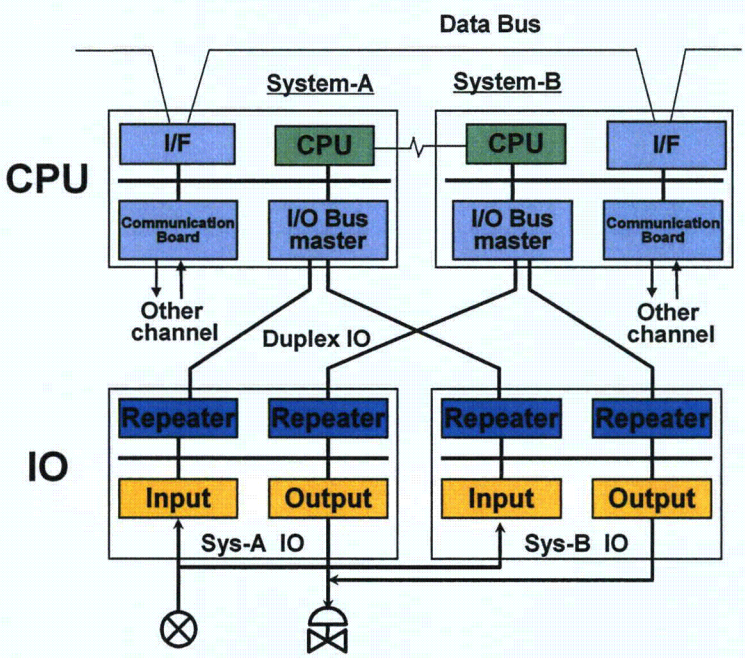
- ✓ Modular and Structured Architecture
- ✓ Single Task execution
- ✓ Cyclical Processing with No Interrupt
- ✓ Exhaustive Tests at Object Code Level (Black Box Test, White Box Test)

➢ Quality Assurance and Control

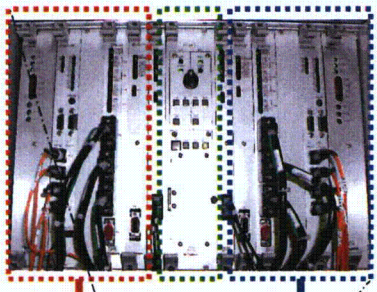
- ✓ Design specifically for Nuclear Applications
- ✓ Under control of Nuclear QA/QC
- ✓ Fully owned and life cycle management by MHI

m. Digital Platform (Major Components)

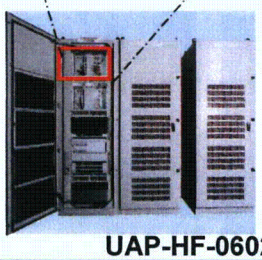
➢ Platform controller configuration



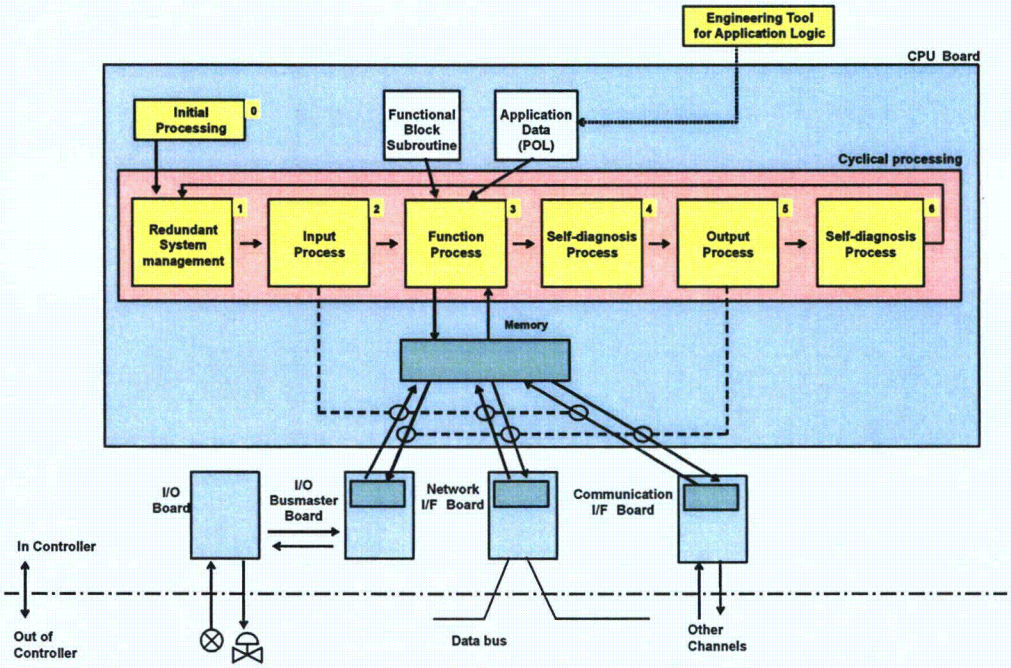
CPU Board Chassis



A-CPU B-CPU



m. Digital Platform (Processing Overview)



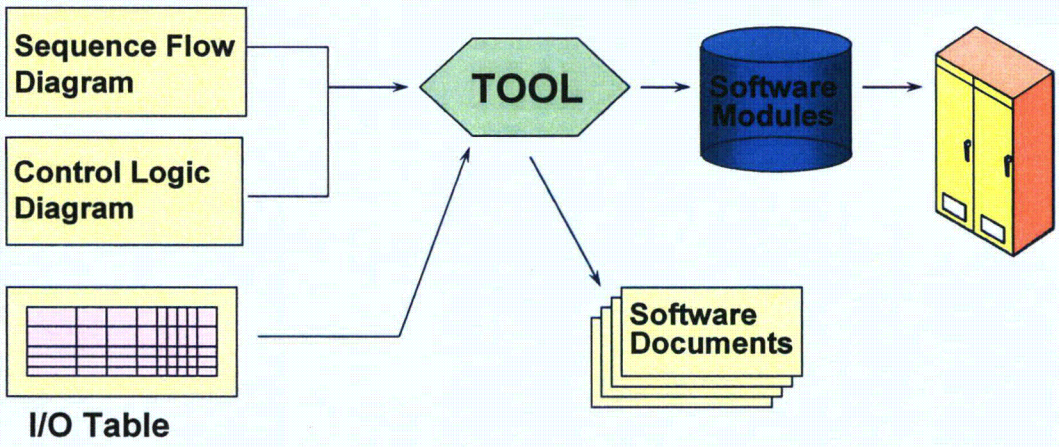
m. Digital Platform (Software Tool)

➢ Software Tool for Engineering function

Automatic Generation of Control Software from Graphic Diagrams

Design Documents

Automatic Generation of Software

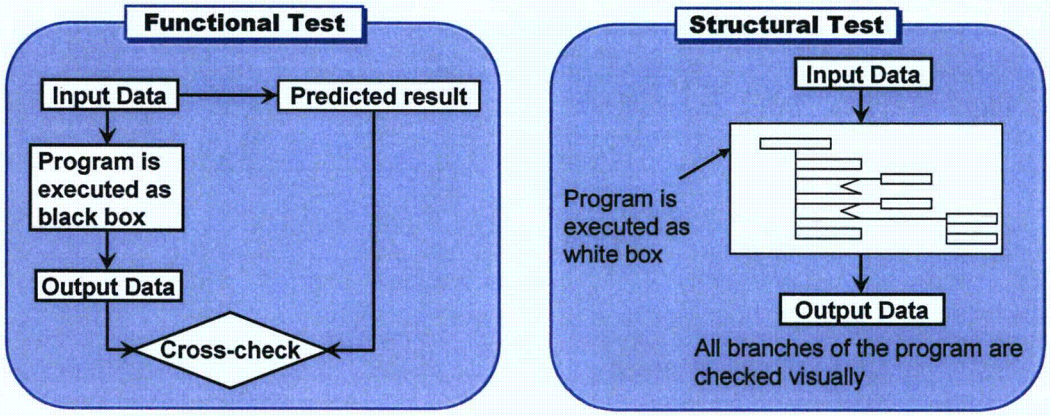


m. Digital Platform (Software Development)

➢ Software Development Process

✓ Verify Base Software and POL software Package

- Static Test (Analyzing) — Source Code Review, Code Audit
- Dynamic Test — Functional (Black Box) Testing, Structural (White Box) Testing



Summary

Topical Report Contents

- Topical Reports describe detail design of Key Technical Issues

Key Technical Issues	TR-A	TR-B	TR-C	TR-D
Multi-channel Operator Stations	✓	✓		✓
Operator Staffing				✓
Operation under Degraded Conditions				✓
Integrated RPS and ESFAS with Functional Diversity		✓	✓	
Spurious Actuation in D3 Analysis			✓	
Credit for Leak Detection in D3 Analysis		✓	✓	
Output Modules	✓	✓		
Control System Failure Modes		✓	✓	
Tech Spec Surveillance		✓		✓
Bypassed or Out-of-service		✓		✓
Minimum Inventory				✓
Computer Based Procedures				✓
Hardware & Software Architecture of Digital Platform	✓			

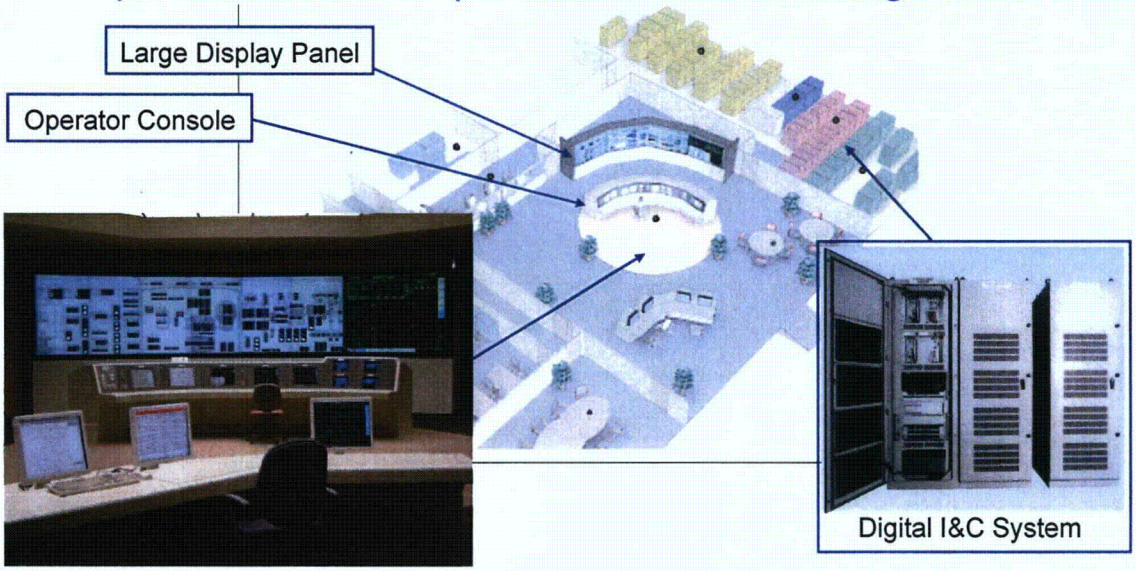
TR-A: Digital Platform, TR-B: Safety I&C System Design Process and Description
TR-C: Defense-in-Depth and Diversity, TR-D: HFE Process and HSI System Design

Summary

- Topical Reports will address key technical issues that are likely to require in depth review by the NRC
- MHI seeks early and frequent interaction to explain how MHI addresses key issues in order to avoid delay in the Review Process
- MHI has proposed two technical meetings, two months after Topical Reports submittals:
  - ✓ Digital Platform and Safety System Design: April 2007
  - ✓ D3 and HSI Design: May 2007
- Additional technical meetings to address issues in more detail can be held should the NRC so request or deem desirable
- MHI is prepared to interact with the NRC at a detail level to ensure DAC is minimized
- MHI invites the NRC to visit MHI's facilities in Japan to better understand Mitsubishi fully digitalized I&C

Mitsubishi Digital I&C Facility

- We have full-scale Digital I&C test and training facility
- Guest personnel can become familiar with architecture, performance and operation of Mitsubishi Digital I&C



Acronyms

✓ ATWS	Anticipated Transient Without Scram
✓ C/O	Commercial Operation
✓ CDF	Core Damage Frequency
✓ CMF	Common Mode Failure
✓ D3	Defense in Depth and Diversity
✓ DAC	Design Acceptance Criteria
✓ DAS	Diverse Actuation System
✓ DBA	Design Basis Accidents
✓ EMC	Electromagnetic Compatibility
✓ EOP	Emergency Operating Procedure
✓ E/O	Electrical to Optical Converter
✓ FMEA	Failure Mode Effect Analysis
✓ HFE	Human Factor Engineering
✓ HSI	Human System Interface
✓ ITV	In-containment Television
✓ LAR	License Amendment Request
✓ LCO	Limiting Condition for Operation
✓ LDP	Large Display Panel
✓ LERF	Large Early Release Frequency
✓ MCR	Main Control Room
✓ MTTR	Mean Time To Repair
✓ O/E	Optical to Electrical Converter
✓ PCMS	Plant Control and Monitoring System
✓ POL	Problem Oriented Language
✓ PORV	Power Operated Relief Valve
✓ PRA	Probabilistic Risk Analysis
✓ RO	Reactor Operator
✓ RPS	Reactor Protection System
✓ SDCV	Spatially Dedicated Continuously Visible
✓ SLCP	Software Life Cycle Process
✓ SLS	Safety Logic System
✓ SPDS	Safety Parameter Display System
✓ SRO	Senior Reactor Operator
✓ SS	Shift Supervisor
✓ STA	Shift Technical Advisor
✓ TR	Topical Report
✓ V&V	Verification and Validation
✓ VDU	Video Display Unit