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LICENSING TOPICAL REPORT

SAFETY SYSTEM LOGIC AND CONTROL REACTOR TRIP AND ISOLATION FUNCTION (SSLC/RTIF) – HARDWARE AND SOFTWARE SPECIFICATION

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1 Scope

The Safety System Logic and Control (SSLC) is the assembly of all equipment that implements the control and interlock functions of the ABWR's safety related systems. The SSLC is divided in two separate segments:

1. The equipment that implements the Reactor Trip and Isolation Functions (RTIF)

2. The equipment that implements the Engineered Safety Features (ESF)

This document defines the hardware and software requirements for the SSLC/RTIF by either inclusion of the requirements herein or by specific reference to associated documents listed in Section 2 of this specification. The requirements that apply to the SSLC ESF are contained in the SSLC ESF Hardware and Software Specification (SSLC ESF HSS) [2.1.2(12)].

The SSLC/RTIF equipment implements the functions of the following safety systems:

1. The Reactor Protection System (RPS) (C71)

   The SSLC/RTIF equipment performs all RPS functions as described in the RPS SDD [2.1.1(5)] and defined in the RPS LD [2.1.2(7)].

2. The Leak Detection and Isolation System (LDI) (C73)

   The SSLC/RTIF equipment performs the LDI functions that are required for the Main Steamline Isolation Valve (MSIV) Closure as described in the LDI SDD [2.1.1(6)] and defined in the LDI LD[2.1.2(8)].

3. The Main Steam System (MS) (B21)

   The SSLC/RTIF equipment performs the part of the MS functions that are required for the MSIV Closure as described in the MS SDD [2.1.1(7)] and defined in the MS LD[2.1.2(9)].

4. The SSLC (C74)

   The SSLC/RTIF equipment performs the following SSLC functions as described in the SSLC SDD [2.1.1(8)] and defined in the SSLC LD [2.1.2(10)]:

a. Anticipated Transient Without Scram (ATWS) Logic Functions of the SSLC.

b. Suppression Pool Temperature Monitoring (SPTM) Functions of the SSLC.

c. RTIF Bypass Functions of the SSLC.

d. RTIF Surveillance and Test Functions of the SSLC.

5. The Multiplexing System (MUX) (H23)

   The SSLC/RTIF equipment includes the safety related Remote Multiplexing Units (RMUs) that are dedicated to the RTIF applications as defined in the MUX SDD [2.1.1(9)].

2 Applicable Documents

2.1 Supporting and Supplemental Documents

2.1.1 Supporting Documents

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2.1.2 Supplemental Documents

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2.2 Codes and Standards

The system level codes and standards applicable to the reactor trip and isolation functions are cited in the RPS SDD [2.1.1(5)], LDI SDD [2.1.1(6)], and MS SDD [2.1.1(7)]. The codes and standards applicable to the SSLC and MUX are cited in the SSLC SDD [2.1.1(8)], and MUX SDD [2.1.1(9)].

The codes and standards applicable to the software required by the SSLC/RTIF equipment are cited in the ABWR DCIS Software Management Plan (SMP) and the documents that are invoked by the SMP [2.1.2(1)].

The codes and standards listed in this section are sources of the system level design requirements applicable to the SSLC/RTIF. This Hardware Software Specification (HSS) is in compliance with those requirements to the extent applicable. Requirements included in these standards are to be used in conjunction with this HSS only where specifically referenced in this HSS.

2.2.1 Institute of Electronic and Electrical Engineers (IEEE)

1. IEEE-603, Criteria for Safety Systems for Nuclear Power Generating Stations (satisfying the provisions of IEEE-279, Criteria for Protection Systems for Nuclear Power Generating Stations).

2. IEEE-323, Standard for Qualification of Class 1E Equipment for Nuclear Power Generating Stations.

3. IEEE-344, Recommended Practices for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations.

4. IEEE-338, Standard Criteria for the Periodic Testing of Nuclear Power Generating Station Class 1E Power and Protection Systems.

5. IEEE-379, Standard Application of the Single-Failure Criterion to Nuclear Power Generating Stations Safety Systems.

6. IEEE-383, Standard for Type Test of Class IE Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations.

7. IEEE-384, Standard Criteria for Independence of Class 1E Equipment and Circuits.

8. IEEE-1050, Guide for Instrumentation and Control Equipment Grounding in Generating Stations.

9. ANS/IEEE-ANS-7-4.3.2-1993, Standard Criteria for Digital Computers Used in Safety Systems of Nuclear Power Generation Stations.

2.2.2 Military Standards

1. MIL STD 217F, Reliability Prediction Of Electronic Equipment

2.3 Regulations and Regulatory Requirements

The system level regulations and regulatory requirements applicable to the reactor trip and isolation functions are cited in the RPS SDD [2.1.1(5)], LDI SDD [2.1.1(6)], and MS SDD [2.1.1(7)]. The regulations and regulatory requirements applicable to the SSLC and MUX are cited in the SSLC SDD [2.1.1(8)], and MUX SDD [2.1.1(9)].

The regulations and regulatory requirements applicable to the software required by the SSLC/RTIF equipment are cited in the ABWR DCIS Software Management Plan (SMP) and the documents that are invoked by the SMP.

The regulations and regulatory requirements listed in this section are sources of the system level design requirements applicable to the SSLC/RTIF. This Hardware Software Specification (HSS) is in compliance with those requirements to the extent applicable.

2.3.1 U.S Nuclear Regulatory Commission (NRC) Regulations

1. 10CFR50.55a (h)/IEEE 603-1991, "Criteria for Safety Systems for Nuclear Power Generating Stations". This HSS complies with the changes to paragraph (h) of 10CFR part 50.55a "Codes and Standards". The US NRC SECY-98-294, dated December 18, 1998 states that IEEE 279-1971 has been withdrawn by IEEE and has been superseded by IEEE-603-1991 which includes the criteria in IEEE 279-1971 and also includes guidelines for design of digital systems.

2. 10CFR50 Appendix A, General Design Criteria (GDC). The GDCs that are applicable to the SSLC RTIF equipment are specified in the RPS SDD [2.1.1(5)], LDI SDD [2.1.1(6)], and SSLC SDD [2.1.1(8)].

2.3.2 U.S. NRC Regulatory Guides

1. Regulatory Guide 1.22, Periodic Testing of Protection System Actuation Functions/IEEE 279.

2. Regulatory Guide 1.47, Bypassed and Inoperable Status Indication for Nuclear Power Plant Safety Systems.

3. Regulatory Guide 1.53, Application of the Single-Failure Criterion to Nuclear Power plant Protection Systems/IEEE 379.

4. Regulatory Guide 1.62, Manual Initiation Of Protection Actions/IEEE 279.

5. Regulatory Guide 1.75, Physical Independence of Electric Systems/IEEE 384.

6. Regulatory Guide 1.118, Periodic Testing of Electric Power and Protection System/IEEE 338.

7. Regulatory Guide 1.152 Criteria for Digital Computers in Safety Systems of Nuclear Power Plants.

8. Regulatory Guide 1.153, Criteria for Power Instrumentation, and Control Portions of Safety Systems/IEEE 603.

3 SSLC/RTIF Equipment Overview

This HSS covers the following equipment:

1. Four divisional RMU cabinets located in the reactor building dedicated to the RTIF applications (referred to as RTIF RMUs). Each cabinet is designed to house the following equipment:

   a. The RMU

   b. The Signal Isolation Unit

   c. The RTIF RMU Local Display Unit

   d. The RTIF RMU cabinet Power Supply and Power Distribution

2. Four SSLC/RTIF divisional cabinets located in the Main Control Room Back Panels (MCRB) area. Each cabinet is designed to house the following equipment:

   a. The Digital Trip Module (DTM)

   b. The Trip Logic Unit (TLU)

   c. The Bypass Unit (BPU)

   d. The RPS Output Logic Unit (RPS OLU)

   e. The MSIV Output Logic Unit (MSIV OLU)

   f. The RPS Power Distribution Logic Unit (RPS PDLU) (in Divisions II and III only)

g. The RPS Load Driver (RPS LD) Assembly (in Divisions II and III only)

h. The RPS Backup Scram Assembly (in Divisions II and III only)

i. The Inboard MSIV LD Assembly (in Divisions I and II only)

j. The Outboard MSIV LD Assembly (in Divisions I and II only)

k. The MSIV Test LD Assembly (in Divisions I and II only)

l. The ATWS Logic Processor

m. The Communication Interface Module (CIM)

n. The Analog Trip Module (ATM)

o. The Standby Liquid Control (SLC) Logic Processor (Divisions I and II)

p. The Diverse High Pressure Core Flooder (HPCF) Unit (Division III only).

q. The RTIF Local Display Unit

r. The RTIF cabinet Power Supply and Power Distribution

RTIF SSLC Manual Controls and Indications mounted on the Main Control Room Panel (MCRP). [[

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Figure 1 shows the general architecture of the four divisions of the RTIF with the main components and interfaces.

3.1 RTIF RMU Cabinets

3.1.1 RMU

One RMU is required in each of the four divisional RMU Cabinets.

1. The inputs to the RMU of each division consist of the following:

   a. Signals from divisional sensors monitoring the plant parameters dedicated for the RTIF applications. Each sensor is hardwired to the RMU cabinet of the corresponding division.

   b. Signals from divisional sensors monitoring the plant parameters shared by the RTIF, ESF Remote Shutdown, and post accident monitoring applications. [[

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3. The output signals from the RMU of each division consist of the following:

   a. The sensor signals and the calculated suppression pool bulk average water temperature value are sent to the DTM of the same division.

   b. The calculated suppression pool bulk average water temperature value is transmitted to the RTIF CIM of the same division (for ESF application).

   c. The RMU signals required for the local display are sent to the local display unit in the same RMU cabinet.

3.1.2 RTIF RMU Cabinet Signal Isolation Unit

One Signal Isolation Unit is required in each of the four divisional RMU cabinets located in the reactor building.[[

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3.1.3 RTIF RMU Cabinet Local Display Unit

One local display unit is required in each of the four divisional RMU Cabinets located in the reactor building. [[

]]

3.2 The SSLC/RTIF Cabinets

3.2.1 RTIF DTMs

One DTM is required in each of the four divisional SSLC/RTIF cabinets to be used for both the RPS (C71) and the LDI (C73) MSIV closure functions.

1. The input signals to the DTM in each division consist of the following:

   a. Signals from the turbine building sensors that are hardwired directly to the DTM.

   b. Sensor signals from the RTIF RMU of the same division.

   c. Input signals from the corresponding division of NMS.

2. The DTM of each division performs the following functions:

   a. Acquires the required sensor data for the monitored parameters.

   b. Performs the trip determination based on the setpoint comparison.

   c. Generates a protective action initiation signal if a monitored parameter exceeds the setpoint limit.

3. The output signals from the DTM of each division consist of the following:

   a. The trip status of every monitored parameter to the TLU of all four divisions.

   b. The monitored parameters trip status alarms required for the non-safety related PCS (C91) (via the RTIF CIM and MVD).

   c. The monitored parameters trip status alarms required for the safety related FDs (via the RTIF CIM and the ESF CIM).

Trip signals to the non-safety related RCIS.[[

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3.2.2 RTIF TLUs

One TLU is required in each of the four divisional SSLC/RTIF cabinets to be used for both the RPS (C71) and the LDI (C73) MSIV closure functions.

1. The input signals to the TLU of each division consist of the following:

   a. The monitored parameters trip signals from the DTM of all four divisions.

   b. The trip signals from the corresponding division of NMS.

   c. Manual bypass signals from the BPU of all four divisions.

   d. Manual controls (operator commands) from the MCRP.

2. The TLU of each division performs the following functions:

   a. Acquires the trip signal for every monitored parameter required by the RPS and MSIV closure function.

   b. Performs the reactor mode switch position exclusionary logic.

   c. Performs an exclusionary logic for the manual bypass input signals.

   d. Performs the required interlock between the Channel Of Sensors Bypass and the MSL Isolation Special Bypass input signals.

e. Performs a three-out-of-four voting of the DTM "not trip" status signals for each monitored parameter.

f. Generates the "RPS Division Auto Scram" and the "MSIV Division Auto Isolation" based on the results of the two-out-of-four voting, Manual Bypass, and the required interlocks.

3. The output signals from the TLU of each division consist of the following:

a. The "RPS Division Auto Scram" signal is sent to the RPS OLU of the same division.

The "MSIV Division Auto Isolation" signal is sent to the MSIV OLU of the same division.[[

]]

3.2.3 RTIF BPUs

One BPU is required in each of the four divisional SSLC/RTIF cabinets to be used for the required manual bypasses of the SSLC/RTIF.

1. The input signals to the BPU of each division consist of the following:

   a. Manual Bypass signal from the RTIF Channel-Of-Sensors Bypass Switch on the MCRP.

   b. Manual Bypass signal from the RTIF Division-Out-Of-Service Bypass (TLU output bypass) Switch on the MCRP.

   c. Manual Bypass signal from the MSL Isolation Special Bypass Switch on the MCRP.

   d. Manual Bypass signal from the ATWS Logic Output Bypass Switch on the MCRP.

2. The RTIF BPU of each division accomplishes the following functions:

   a. Acquires the Channel-Of-Sensors Bypass, Division-Out-Of-Service Bypass (TLU output bypass), MSL Isolation Special Bypass, and ATWS Logic Output Bypass from the SSLC/RTIF bypass switches on the MCRP ("reads" the switch position).

   b. Reformats the bypass signals as necessary and transmits bypass switch status to affected RTIF equipment.

3. The output signals from the BPU of each division consist of the following:

   a. The Channel-Of-Sensors Bypass to the TLU of all four divisions.

   b. The Division-Out-Of-Service Bypass (TLU Output Bypass) to the OLU of all four divisions.

   c. The MSL Isolation Special Bypass to the TLU of all four divisions.

   d. The ATWS Logic Output Bypass to the ATWS logic processors of all four divisions.

3.2.4 RPS OLUs

One OLU is required in each of the four divisional SSLC/RTIF cabinets to be used for RPS (referred to as RPS OLU). [[

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3.2.5 MSIV OLUs

One OLU is required in each of the four divisional SSLC/RTIF cabinets to be used for MSIV closure functions (referred to as MSIV OLU).[[

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3.2.6 RPS PDLUs

One RPS PDLU is required in each of the SSLC/RTIF Divisions II and III cabinets. Each RPS PDLU contains the corresponding division of the RPS manual scram circuits.[[

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3.2.7 RPS LD Assemblies

One RPS LD Assembly is required in each of the SSLC/RTIF Divisions II and III cabinets. Each RPS LD Assembly contains the corresponding division of the RPS scram groups circuits. [[

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3.2.8 RPS Backup Scram Assembly

One RPS Backup Scram Assembly is required in each of the SSLC/RTIF Divisions II and III cabinets. Each Unit contains the corresponding division of the RPS backup scram circuits. [[

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3.2.9 Inboard MSIV LD Assemblies

One Inboard MSIV LD Assembly is required in each of the SSLC/RTIF Divisions I and II cabinets. [[

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3.2.10 Outboard MSIV LD Assemblies

One Outboard MSIV LD Assembly is required in each of the SSLC/RTIF Divisions I and II cabinets. [[

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3.2.11 MSIV Test LD Assemblies

One MSIV Test LD Assembly is required in each of the SSLC/RTIF Divisions I and II cabinets.
[[

]]

3.2.12 RTIF CIMs

One CIM is required in each of the four divisional SSLC/RTIF cabinets.

1. The input signals to the CIM of each division consist of the following:

   The alarms and display signals generated in the RTIF equipment of the same division.

2. The CIM of each division performs the following functions:

   a. Transmits the alarms and display signals generated in the RTIF equipment to the safety related FDs via the ESF CIM.

   b. Performs functions necessary to support RTIF equipment input/output functions.

   c. Performs surveillance functions of the RTIF equipment.

3. The output signals from the CIM of each division consist of the following:

   a. The alarm and display signals generated in the RTIF equipment.

3.2.13 ATMs

One ATM is required in each of the four divisional SSLC/RTIF cabinets.[[

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3.2.14 ATWS Logic Processor

One ATWS logic processor is required in each of the four divisional SSLC/RTIF cabinets to be used for the safety related ATWS mitigation functions of the SSLC (C74). [[

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3.2.15 SLC Logic Processor

One SLC Logic Processor is required in each of the SSLC/RTIF Divisions I and II cabinets. The RTIF Cabinet in Divisions I and II will provide mounting location, the required power , and I/O wiring for the SLC logic processors. [[

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3.2.16 Diverse HPCF Unit

One Diverse HPCF Unit is required in the SSLC/RTIF Division III cabinet. The RTIF Cabinet in Division III will provide mounting location, the required power, and I/O wiring for the Diverse HPCF Unit. [[

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3.2.17 RTIF Local Display Unit

One Local Display Unit is required in each of the four divisional SSLC/RTIF cabinets.[[

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3.3 RTIF Manual Controls On The MCRP

The SSLC/RTIF equipment requires Manual Controls on the Main Control Console (MCC), and the Wide Display Panel (WDP) of the MCRP. Tables 2, 3, 4, and 5 (collectively) provide a complete listing of the RTIF manual controls on the MCRP. [[

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3.4 RTIF Indications Displays and Alarms On The MCRP

The SSLC/RTIF signals to be alarmed and displayed on the MCRP are specified on the RPS LD [2.1.2(7)], LDI LD [2.1.2(8)], MS LD [2.1.2(9)], and SSLC LD [2.1.2(10)]. The MCRP drawings [2.1.2(2)] show the physical attributes of the SSLC/RTIF required fixed-position indications and displays on the MCRP (MCC and WDP).

3.5 RPS Single HCU Scram Test Panel

The SSLC/RTIF equipment requires one RPS Single HCU Scram Test Panel located in the MCRB Area. This panel is comprised of four bays corresponding with Scram Group 1, Group 2, Group 3, and Group 4. The single HCU scram test panel provides the capability to test the performance and operability of each individual HCU separately (one at a time) during the reactor operation.[[

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3.6 RPS Scram Solenoid Fuse Panels

The SSLC/RTIF equipment requires eight RPS Scram Solenoid Fuse panels located in the Reactor Building. Each of the four scram groups is divided in two (of approximately equal

number of HCUs) and use one of the eight scram solenoid fuse panels to distribute the power to the solenoids of each individual HCU.[[

]]

4 The SSLC/RTIF Equipment Requirements

4.1 General Requirements

This section contains the necessary hardware and software design requirements including specific functional requirements of the RTIF components. The RPS and SSLC SDDs shall be referenced for the definitions of RTIF systems and applicable general requirements.

4.1.1 Safety Related Classification Of the SSLC/RTIF

The SSLC/RTIF equipment listed in Section 3 of this HSS shall be designed to perform the safety related functions required by RPS(C71), LDI (C73), MS(B21), and SSLC (C74).

The RPS trip functions, MSIV isolation functions, and the ATWS initiation functions are classified as safety related functions. Any function or subfunction required to accomplish these safety related functions are also classified as safety related. Any subfunction that is required to accomplish one or more of these safety related functions must be treated as safety related function to the extent that it must not fail in such a manner to interfere with or disable a safety related function.

All SSLC/RTIF equipment are classified as class 1E, and shall be designed according to class 1E requirements. For any isolated function which has no impact or relation to the performance of safety-related function, such as certain information display function, this isolated function is not

required to be designed to class 1E requirement. However, it must be fully demonstrated that such function and its equipment are fully separated from the class 1E equipment and shall not interface or impact the class 1E function. IEEE 7.4.3.2-1993 shall be referenced for related requirements [2.2.1(9)].

4.1.2 Hardware and Software Allocation

The RPS LD [2.1.2(7)], LDI LD [2.1.2(8)], MS LD [2.1.2(9)], SSLC LD [2.1.2(10)], and SLC LD [2.1.2(11)] define the functions to be accomplished by the software and hardware.

4.1.2.1 Allocation of the RTIF Hardwired Logic

The SSLC/RTIF required hardwired logic functions shall be implemented in the equipment listed as follows:

1. RPS logic functions in the RPS OLUs
2. MSIV Closure logic in the MSIV OLUs
3. RPS Manual Scram Circuit in the PDLU
4. RPS Scram Group Circuits in the RPS LD Assemblies
5. RPS Backup Scram Circuits in the Backup Scram Assembly
6. MSIV Closure Output Logic in the MSIV LD Assemblies
7. SSLC Bypass Functions in the BPUs
8. SSLC ATWS Mitigation Functions in the ATWS Logic Processor
9. RTIF Logic Functions in the ATM
10. RPS Scram Group Circuits in the Single HCU Scram Test Panel
11. RPS Scram Group Circuits in the Scram Solenoid Fuse Panels

The specific requirements for each equipment item are identified in the applicable requirements in Section 4.3 of this HSS.

4.1.2.2 Allocation Of The RTIF Software-Based Logic

The SSLC/RTIF required software-based logic functions shall be implemented in the equipment listed as follows:

1. Signal Distribution and Logic Functions in the RTIF RMU

2. RPS and MSIV Closure logic in the DTM

3. RPS and MSIV Closure logic in the TLU

4. Signal interface functions and the Surveillance Test functions performed via the CIM

5. Display Generation Functions in the RMU and RTIF Cabinets Local Display Unit

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4.1.3 RTIF Equipment General Hardware Requirements

1. The RTIF Equipment shall be designed to comply with safety related class 1E requirements, and comply with requirements specified in IEEE-308, IEEE-323, IEEE-384, IEEE 7.4.3.2-1993, and other related regulations including Reg. Guide 1.32, Reg. Guide 1.89, etc. in Section 2.2 and 2.3.

2. A performance specification and/or requirement document shall be prepared for each of the RTIF equipment and reviewed following relevant engineering procedures.

3. Modularity: All equipment shall be modular in design to facilitate calibration, maintenance, repair and replacement. [[

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4. All safety-related equipment shall be designed for convection cooling and for operation within specified limits without the use of fans. [[

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5. Operating Power: All components shall be capable of continuous operation without degradation of performance when operating from specified line voltages. [[

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The RTIF equipment shall be micro processor-based wherever applicable[[

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7. Equipment interface requirements:

   a. A user interface capability shall be provided whenever applicable and needed for the specific RTIF equipment, together with a key lock switch to

provide the necessary security protection for data entry and for selection of the available operating modes.

b. The interface shall be substantiated by display hardware, with enough space for character/graphic display, necessary set of pushbuttons or keys and audible device, if applicable. [[

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c. If the display functions contain no data entry capability and are not part of or do not support safety-related function, it is not required to be qualified as class 1E, provided it shall have complete separation (mechanically, electrically, and communication-wise) with the safety related equipment, based on the guideline of IEEE 7.4.3.2-1993 [2.2.1(9)].

The user interface shall have enough memory space[[

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The display shall in general meet US NUREG-0700 as applicable.

e. It is permissible to turn the display off when there are no conditions present, which require operator/user attention, provided that such action will not affect or interfere with any performance or process logic function of the RTIF equipment itself.

Trip and alarm: Data entry for trip and alarm setpoints shall be allowed, where applicable, at the interface of the equipment. [[

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4.1.4 RTIF Equipment General Software Requirements

1. The required software for the SSLC/RTIF equipment shall be developed in accordance with the requirements of Section 5 of this HSS.

2. Programs and data shall be prepared using an established assembly and/or higher level language. [[

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3. The operating system software shall control the timing and scheduling of the various tasks to be performed by the CPU. [[

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4. The application software shall provide the features required to satisfy system functional requirements. [[

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5. Software shall be modular in structure and shall employ structured programming construction.

6. The self-test and calibration software shall determine failures of any replaceable module within the system, to the extent feasible. [[

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7. The user interface programs shall enable simple interactive operation of the instrument front panel as applicable. Menu-driven software shall allow the user to perform troubleshooting, set and calibrate parameters and obtain all specified system data. [[

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8. The applicable data sampling rates and the time requirements for data throughput shall be based on the overall system performance requirements, including those specified in the SSLC SDD [2.1.1(8)].

Security. Means shall be provided to prevent unauthorized alternation to system software after installation. [[

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10. Password. A feature shall be incorporated such that when the key lock switch is in the inoperative mode, the user shall be required to enter a password before being able to change parameters. [[

11. Help system. [[

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4.1.5 RTIF Equipment Initialization Requirements

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4.1.6 RTIF Equipment Behavior on Loss of Power or Loss of Inputs

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4.1.7 RTIF Equipment Communications Requirements

4.1.7.1 Communications Interfaces

1. The communications interfaces shall be designed in accordance with the requirements of the RPS LD [2.1.2(7)], LDI LD [2.1.2(8)], MS LD [2.1.2(9)], SSLC LD [2.1.2(10)], the MUX Data Flow Diagram [2.1.2(4)], the Signal I/O List [2.1.2(3)], and any additional communication requirements identified in Table 1c or Section 4.3 of this HSS. [[

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2. The fiber optic control signals shall be dynamic with specific signal frequencies or patterns that indicate either tripped, not-tripped, or fault condition.

   The fiber optic bypass signals shall be dynamic with specific signal frequencies or patterns that indicate either bypassed, not-bypassed, or fault condition.[[

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4.1.7.2 Data Communications

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4.1.8 Response Time, Drift and Accuracy Requirements

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4.1.9 Reliability and Maintenance Requirements

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4.1.10 RTIF Equipment Surveillance Requirements

As a means of assuring that the system meets availability requirements, the SSLC/RTIF safety systems must be periodically tested as a proper functionality check of the hardware and software. In order to satisfy this requirement, the RTIF equipment is designed to support a combination of automatic/periodic internal self-tests, operator initiated semi-automatic tests and manual tests that provide for complete testing of all hardware and software required to perform the safety related functions.

4.1.10.1 Self-Test Requirements

A self-test system shall be provided in the SSLC/RTIF. The term "self-test" is applied to those test features, which occur automatically without user intervention. The primary purpose of the automatic self-test is to simplify and reduce the frequency of manual surveillance activities while still meeting the availability requirements of the SSLC/RTIF. The self-test accomplishes this objective primarily by reducing the time to detect hardware failures, and by reducing the time to repair failures by aiding the determination of the location of the failure. The specific scope of the testing and tests performed is to be determined as part of the equipment design subject to the requirements included in this HSS. [[

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4.1.10.2 RTIF Equipment Manual and Semi-Automatic Surveillance Requirements

Manual and semi-automatic surveillance capability shall be provided in the SSLC/RTIF. Semi-automatic test means limited interaction with a technician (user) is required in performing the test. The primary purpose of the manual and semi-automatic surveillance is to supplement the automatic self-test coverage to allow detection of all hardware failures that could impact a safety related function, and to provide calibration capability for RTIF equipment items that require calibration to meet the system requirements. [[

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4.1.11 Equipment Qualification Requirements

4.1.11.1 Environmental Qualification Requirements

The RTIF cabinets in the MCRB, the RTIF components on the MCRP, and the RPS Single HCU Scram Test Panel in the MCRB are all located in controlled-environment safety related area. The main control room is cooled by the CBHV [2.1.1(14)]. [[

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4.1.11.2 EMI Qualification Requirements

All SSLC/RTIF equipment shall be designed to minimize both susceptibility to and generation of electromagnetic interference (EMI). [[

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4.1.11.3 Seismic Qualification Requirements

RTIF equipment shall be seismically qualified for its installed locations according to the criteria and response spectra found in Safety Related Control Panels-Standard Equipment Requirements [2.1.2(5)]. All RTIF equipment is classified as Seismic Category 1 and Class 1E.

4.1.12 Other Requirements

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4.2 RTIF RMU Requirements

4.2.1 RTIF RMU

4.2.1.1 Inputs

The RPS (C71), MS (B21), CMS (T62), CRD (C12), and RBHV (T41) systems will provide the sensors to monitor the parameters and processes that are required for the SSLC/RTIF. The RMU shall receive and process analog and discrete inputs defined as RMU inputs Tables 1a and 1b, respectively, and Figures 3 and 4 (for inputs shared with non-RTIF functions). [[

]]

4.2.1.2 RTIF RMU Logic Functions and Processing

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]]

4.2.1.3 RTIF RMU Outputs

[[

]]

4.2.2 Signal Isolation Unit Requirements

4.2.2.1 Inputs

The Signal Isolation Unit (SIU) shall receive analog inputs (shared sensors of reactor water level and reactor pressure) defined in Table 1a and shown in Figures 3 and 4.

4.2.2.2 Signal Isolation Unit Functions

The Signal Isolation Unit shall receive the inputs and provide electrically identical, independent outputs for each input signal. [[

]]

4.2.2.3 Signal Isolation Unit Outputs

The Signal Isolation Unit shall provide analog outputs (shared sensors of reactor water level and reactor pressure) in Table 1d and shown in Figures 3 and 4. [[

]]

4.2.3 RTIF RMU Local Display Unit Requirements

4.2.3.1 RTIF RMU Local Display Unit Inputs

The RTIF RMU Local Display Unit shall receive inputs from the RTIF RMU (and the user) as necessary to perform the functions defined in Subsection 4.2.3.2. The specific inputs required shall be established as part of the equipment design process.

4.2.3.2 RTIF RMU Local Display Unit Logic Functions and Processing

The RTIF RMU Local Display Unit shall provide the RMU related data, displays, and maintenance interface necessary to meet the surveillance requirements in Section 4.1.10, including calibrations where applicable, and to perform fault diagnostics and isolation necessary to maintain and repair RMU equipment. [[

]]

4.2.3.3 RTIF RMU Local Display Unit Outputs

The RTIF RMU Local Display Unit shall provide outputs to the user and the RTIF RMU as necessary to perform the functions defined in Subsection 4.2.3.2. [[

]]

4.2.4 RTIF RMU Cabinet Power Supply and Power Distribution Requirements

Each of the four divisional RMU Cabinets shall receive three different power sources:

1. The Vital AC Power (VAC) (R13)
2. The Instrument and Control Power Supply (ICP) (R14)
3. The Lighting and Servicing Power Supply (LSP) (R15)

[[

]]

4.2.5 RTIF RMU Cabinet Design

The RMU cabinet fabrication and wiring design shall meet the requirements in the Safety Related Control Panels – Standard Equipment Requirements [2.1.2(5)].

4.3 The SSLC/RTIF Cabinets Requirements

4.3.1 RTIF DTM Requirements

4.3.1.1 RTIF DTM Inputs

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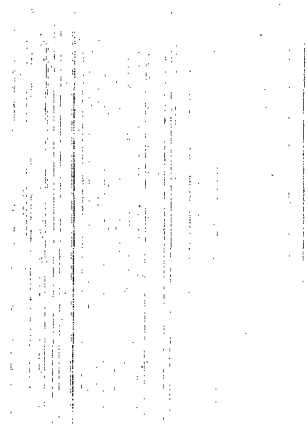
4.3.1.2 RTIF DTM Logic Functions and Processing

[[



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4.3.1.3 RTIF DTM Outputs

[[

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4.3.2 RTIF TLU Requirements

4.3.2.1 RTIF TLU Inputs

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4.3.2.2 RTIF TLU Logic Functions and Processing

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4.3.2.3 RTIF TLU Outputs

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4.3.3 RTIF BPU Requirements

4.3.3.1 RTIF BPU Inputs

The BPU shall receive inputs from RTIF operator bypass input switches (from MCRP) as defined in Table 5. [[

]]

4.3.3.2 RTIF BPU Functions

The BPU shall provide the interface between the operator controlled MCRP mounted bypass switches (Table 5) and the RTIF equipment required to implement the related system logic as defined on the SSLC LD [2.1.2(10)] and RPS LD [2.1.2(7)]. [[

]]

4.3.3.3 RTIF BPU Outputs

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4.3.4 RPS OLU Requirements

4.3.4.1 RPS OLU Inputs

Each RPS OLU shall receive input signals required to perform the RPS OLU Functions (Subsection 4.3.4.2) and to provide the RPS OLU Outputs (Subsection 4.3.4.3). [[

]]

4.3.4.2 RPS OLU Logic Functions and Processing

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4.3.4.3 RPS OLU Outputs

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4.3.5 MSIV OLU Requirements

4.3.5.1 MSIV OLU Inputs

Each MSIV OLU shall receive input signals required to perform the MSIV OLU Functions (Subsection 4.3.5.2) and to provide the MSIV OLU Outputs (Subsection 4.3.5.3). [[

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4.3.5.2 MSIV OLU Logic Functions and Processing

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4.3.5.3 MSIV OLU Outputs

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4.3.6 RPS PDLU Requirements

4.3.6.1 RPS PDLU Inputs

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4.3.6.2 RPS PDLU Logic Functions and Processing

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4.3.6.3 RPS PDLU Outputs

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4.3.7 RPS LD Assembly Requirements

4.3.7.1 RPS LD Assembly Inputs

Each of the two RPS LD Assemblies, one each in Divisions II and III, shall receive input signals required to perform the RPS LD Assembly Functions (Subsection 4.3.7.2) and to provide the RPS LD Assembly Outputs (Subsection 4.3.7.3). [[

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4.3.7.2 RPS LD Assembly Logic Functions and Processing

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4.3.7.3 RPS LD Assembly Outputs

[[

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4.3.8 RPS Backup Scram Assembly Requirements

4.3.8.1 RPS Backup Assembly Unit Inputs

Each of the two RPS Backup Scram Assemblies, one each in Divisions II and III, shall receive input signals required to perform the RPS Backup Scram Assembly Functions (Subsection 4.3.7.2) and to provide the RPS Backup Scram Assembly Outputs (Subsection 4.3.7.3). [[

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4.3.8.2 RPS Backup Scram Assembly Logic Functions and Processing

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4.3.8.3 RPS Backup Scram Assembly Outputs

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4.3.9 Inboard MSIV LD Assembly Requirements

4.3.9.1 Inboard MSIV LD Assembly Inputs

Each of the two Inboard MSIV LD Assemblies, one each in Divisions I and II, shall receive input signals required to perform the Inboard MSIV LD Assembly Functions (Subsection 4.3.9.2) and to provide the Inboard MSIV LD Assembly Outputs (Subsection 4.3.9.3). [[

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4.3.9.2 Inboard MSIV LD Assembly Logic Functions and Processing

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4.3.9.3 Inboard MSIV LD Assembly Outputs

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4.3.10 Outboard MSIV LD Assembly Requirements

4.3.10.1 Outboard MSIV LD Assembly Inputs

Each of the two Outboard MSIV LD Assemblies, one each in Divisions I and II, shall receive input signals required to perform the Outboard MSIV LD Assembly Functions (Subsection 4.3.10.2) and to provide the Outboard MSIV LD Assembly Outputs (Subsection 4.3.10.3). [[

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4.3.10.2 Outboard MSIV LD Assembly Logic Functions and Processing

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4.3.10.3 Outboard MSIV LD Assembly Outputs

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4.3.11 MSIV Test LD Assembly Requirements

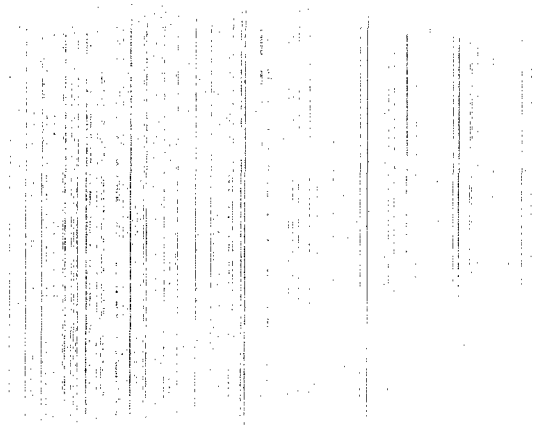
4.3.11.1 MSIV Test LD Assembly Inputs

Each of the two MSIV Test LD Assemblies, one each in Divisions I and II, shall receive input signals required to perform the MSIV Test LD Assembly Functions (Subsection 4.3.11.2) and to provide the MSIV test LD Assembly Outputs (Subsection 4.3.11.3). [[

]]

4.3.11.2 MSIV Test LD Assembly Logic Functions and Processing

[[



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4.3.11.3 MSIV Test LD Assembly Outputs

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4.3.12 RTIF CIM Requirements

4.3.12.1 RTIF CIM Inputs

Each CIM, one each in RTIF divisional cabinet, shall receive input signals required to perform the CIM Functions (Subsection 4.3.12.2) and to provide the CIM Outputs (Subsection 4.3.12.3).
[[

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4.3.12.2 RTIF CIM Logic Functions and Processing

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4.3.12.3 RTIF CIM Outputs

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4.3.13 ATM Requirements

4.3.13.1 ATM Inputs

Each of the four ATMs, one each in each division, shall receive input signals required to perform the ATM Functions (Subsection 4.3.13.2) and to provide the ATM Outputs (Subsection 4.3.13.3). [[

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4.3.13.2 ATM Logic Functions and Processing

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4.3.13.3 ATM Outputs

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4.3.14 ATWS Logic Processor Requirements

4.3.14.1 ATWS Logic Processor Inputs

Each of the four ATWS Logic Processors, one each in each division, shall receive input signals required to perform the ATWS Logic Processor Functions (Subsection 4.3.14.2) and to provide the ATWS Logic Processor Outputs (Subsection 4.3.14.3). [[

]]

4.3.14.2 ATWS Logic Processor Logic Functions and Processing

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4.3.14.3 ATWS Logic Processor Outputs

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4.3.15 RTIF Local Display Unit Requirements

4.3.15.1 RTIF Local Display Unit Inputs

The RTIF Local Display Unit shall receive inputs from the RTIF Cabinet equipment as necessary to perform the functions defined in Subsection 4.3.15.2. The specific inputs required shall be established based on the requirements from 4.3.1 and 4.3.14 and the applicable RPS, MS, LDI, and SSLC LDs, as part of the equipment design process.

4.3.15.2 RTIF Local Display Unit Logic Functions and Processing

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]]

4.3.15.3 RTIF Local Display Unit Outputs

The RTIF Local Display Unit shall provide outputs to the user and to the other RTIF Cabinet equipment as necessary to perform the functions defined in Subsection 4.3.15.2. The specific

outputs required shall be established based on the requirements from 4.3.1 and 4.3.14 and the applicable RPS, LDI, MS, and SSLC LDs, as part of the equipment design process.

4.3.16 RTIF Cabinet Power Supply and Power Distribution Requirements

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4.3.17 SLC Logic Processor Requirements

Each of the four SSLC/RTIF Panels shall include the provision for mounting and power requirements for the SLC Logic Processor. The SLC HSS [2.1.2(13)] specifies the requirements for the SLC Logic Processors.

4.3.18 Diverse HPCF Manual Start Unit Requirements

The SSLC/RTIF Division III Panel shall include the provision for mounting and power requirements for the Diverse HPCF Unit. The SSLC ESF HSS [2.1.2(12)] specifies the requirements for the Diverse HPCF Manual Start Unit.

4.3.19 RTIF Cabinet General Fabrication Requirements

The RTIF cabinet fabrication and wiring design shall meet the requirements in the Safety Related Control Panels – Standard Equipment Requirements [2.1.2(5)].

4.4 RTIF MCRP Manual Controls Requirements

RTIF manual controls shall be provided for mounting on either the Main Control Console (MCC) or the Wide Display Panel (WDP) (both considered to be part of the MCRP) as defined in Tables 2, 3, 4 and 5. The manual controls shall have the physical attributes shown on the Main Control Room Panels (MCRP) [2.1.2(2)] document, and shall include the functional attributes necessary to meet the requirements of the RPS LD [2.1.2(7)], LDI LD [2.1.2(8)], SSLC LD [2.1.2(10)], or MS LD [2.1.2(9)], as applicable. [[

]]

Reactor Mode Switch [[

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Auto-Scram Test Switch [[

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MSIV TLU Auto-Trip Test Switch [[

CRD Charging Pressure Bypass Switch [[

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RTIF Channel-Of-Sensors Bypass Switch [[

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RTIF Division-out-of-Service Bypass Switch [[

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RTIF Special MSLI Trip Bypass Switch [[

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ATWS Logic Output Bypass Switch [[

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Parallel Load Driver Test Switch (RPS) [[

]]

Manual Divisional Trip Switch [[

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Trip Reset Switch [[

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Parallel Load Driver Test Switch (MSIV) [[

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Inboard MSIV Test Close Switch [[

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Outboard MSIV Test Close Switch [[

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Inboard MSIV Auto/Open - Close Switch [[

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Outboard MSIV Auto/Open - Close Switch [[

Manual MSL Isolation Initiation Switch [[

]]

Manual/Auto MSL Isolation Reset Switch [[

Manual Scram Switch [[

]]

RPS Manual Scram Reset Switch [[

Reactor-Mode-Switch-In-Shutdown-Scram Bypass Switch [[

4.5 RTIF MCRP Indications, Displays and Alarms Requirements

RTIF indications, alarms and displays shall be provided for mounting on either the Main Control Console (MCC) or the Wide Display Panel (WDP) (both considered to be part of the MCRP). The indications, alarms and displays shall have the physical attributes shown on the Main Control Room Panels (MCRP) [2.1.2(2)] document, and shall include the functional attributes necessary to meet the requirements of the RPS LD [2.1.2(7)], LDI LD [2.1.2(8)], SSLC LD [2.1.2(10)], or MS LD [2.1.2(9)], as applicable. [[

4.6 RPS Single HCU Scram Test Panel Requirements

The RPS Single HCU Scram Panel requirements are stated below. For specific detailed information, refer to the RPS Single HCU Scram Test Panel Purchase Specification [2.1.2(17)].

4.6.1 RPS Single HCU Scram Test Panel Inputs

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4.6.2 RPS Single HCU Scram Test Panel Functions

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4.6.3 RPS Single HCU Scram Test Panel Outputs

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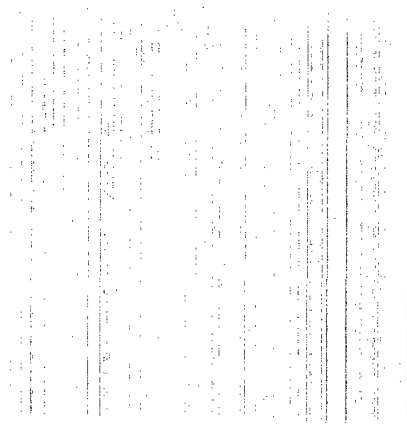

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4.6.4 Fabrication Requirements

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4.7 RPS Scram Solenoid Fuse Panels Requirements

The RPS Scram Solenoid Fuse Panels requirements are stated below. For specific detailed information, refer to the RPS Scram Solenoid Fuse Panels Purchase Specification [2.1.2(18)].

4.7.1 RPS Scram Solenoid Fuse Panels Inputs

Each of the two sections of the eight RPS Scram Solenoid Fuse Panels shall receive from the RPS Single HCU Scram Test Panel the 120 VAC switched power (switched by the RPS Load Drivers) to one of the scram solenoids ("A" or "B") for one of the scram groups, and the corresponding "return" circuits for those solenoids.

4.7.2 RPS Scram Solenoid Fuse Panels Functions

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4.7.3 RPS Scram Solenoid Fuse Panels Outputs

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4.7.4 Fabrication Requirements

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5 The SSLC/RTIF Equipment Design Verification and Validation (V&V) Requirements

The design process for the SSLC/RTIF Equipment shall include structured V&V activities including verification reviews of design documents, "white box" testing of hardware and software, and "black box" testing of integrated hardware and software components of the design. This section specifies the requirements for those activities.

5.1 Design Process

A structured design process shall be established to control the design of the RTIF equipment, both hardware and software. That process shall meet the requirements of the ABWR DCIS SMP [2.1.2(1)]. [[

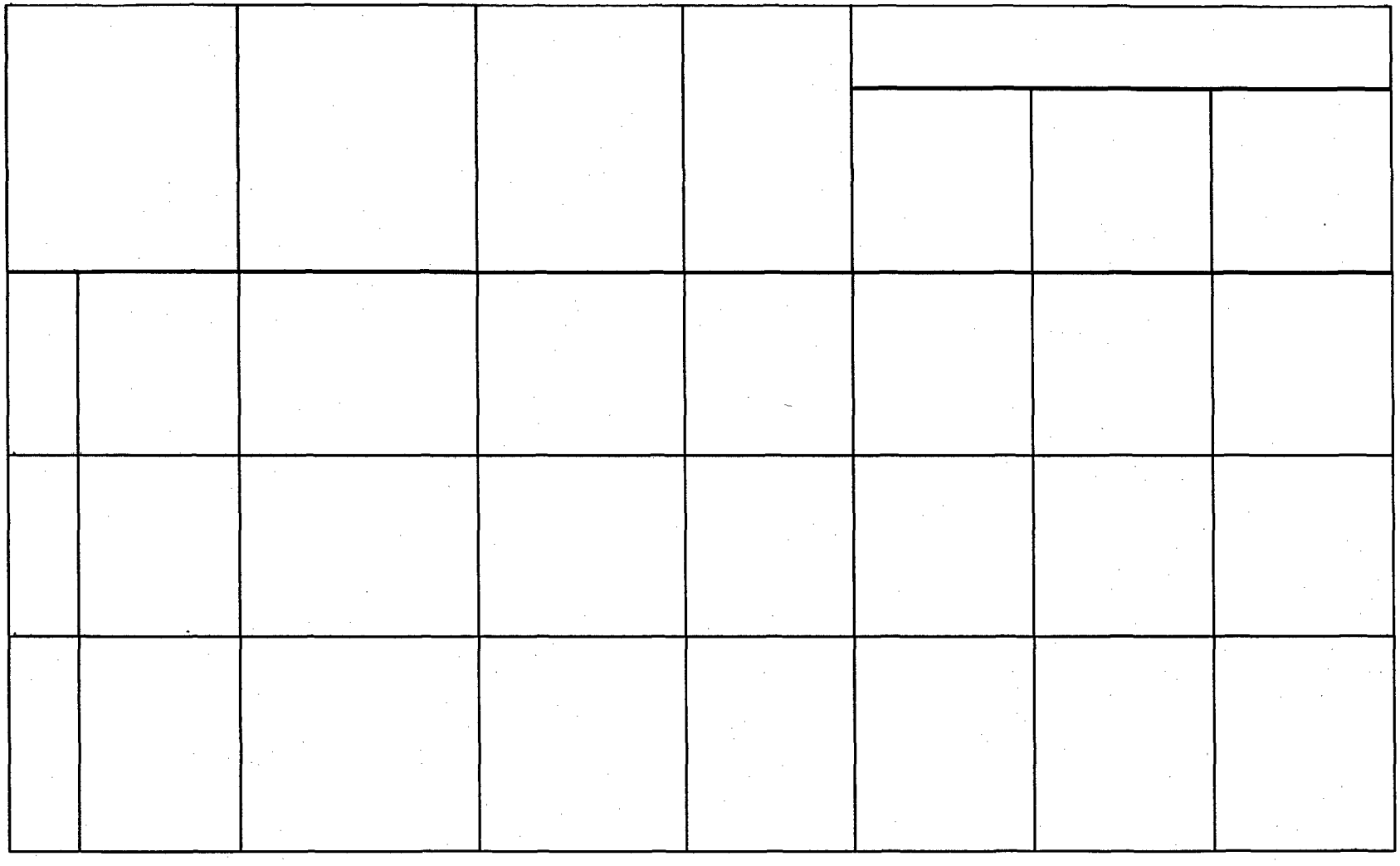
]]

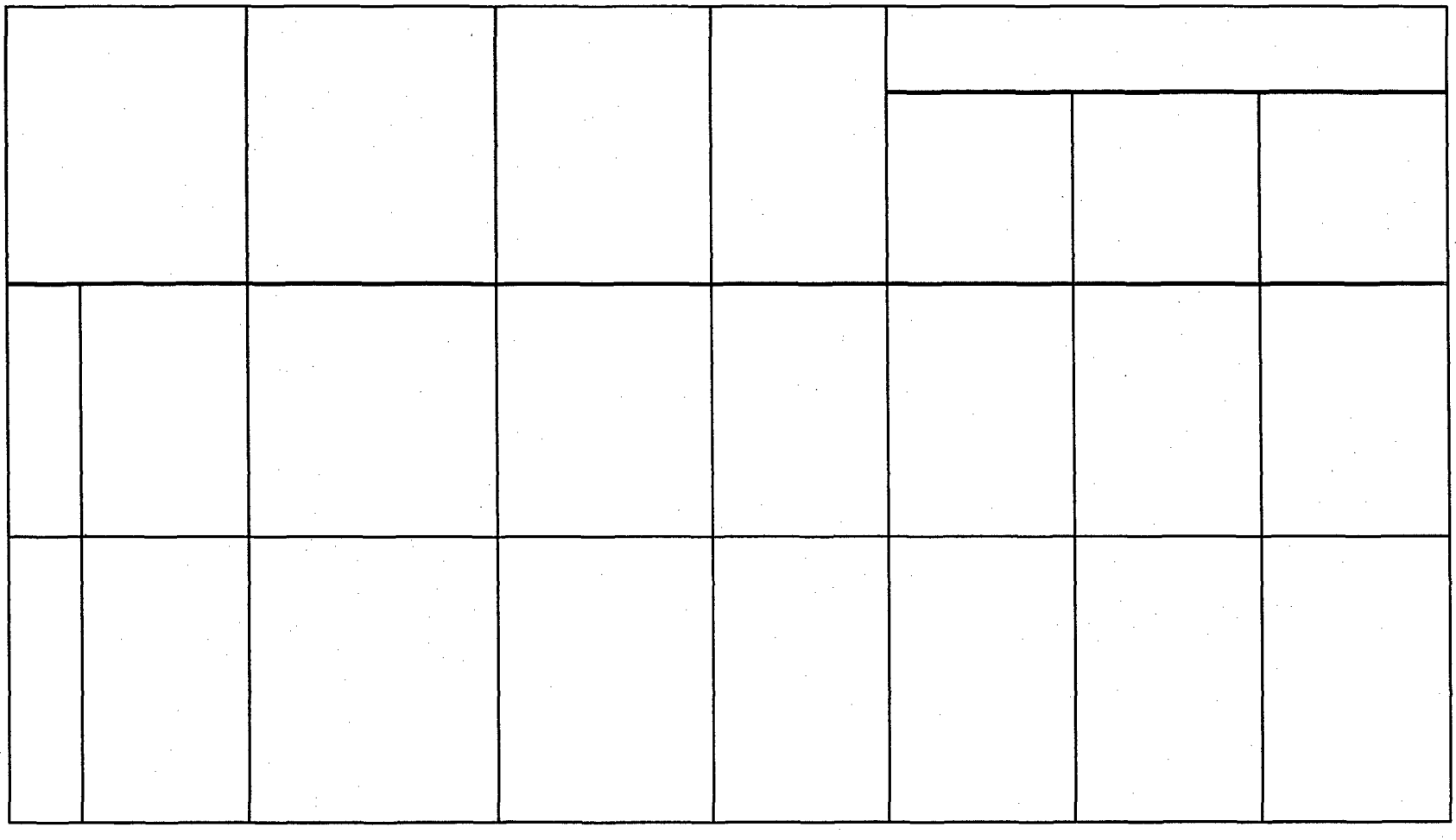
5.2 Acceptance Criteria

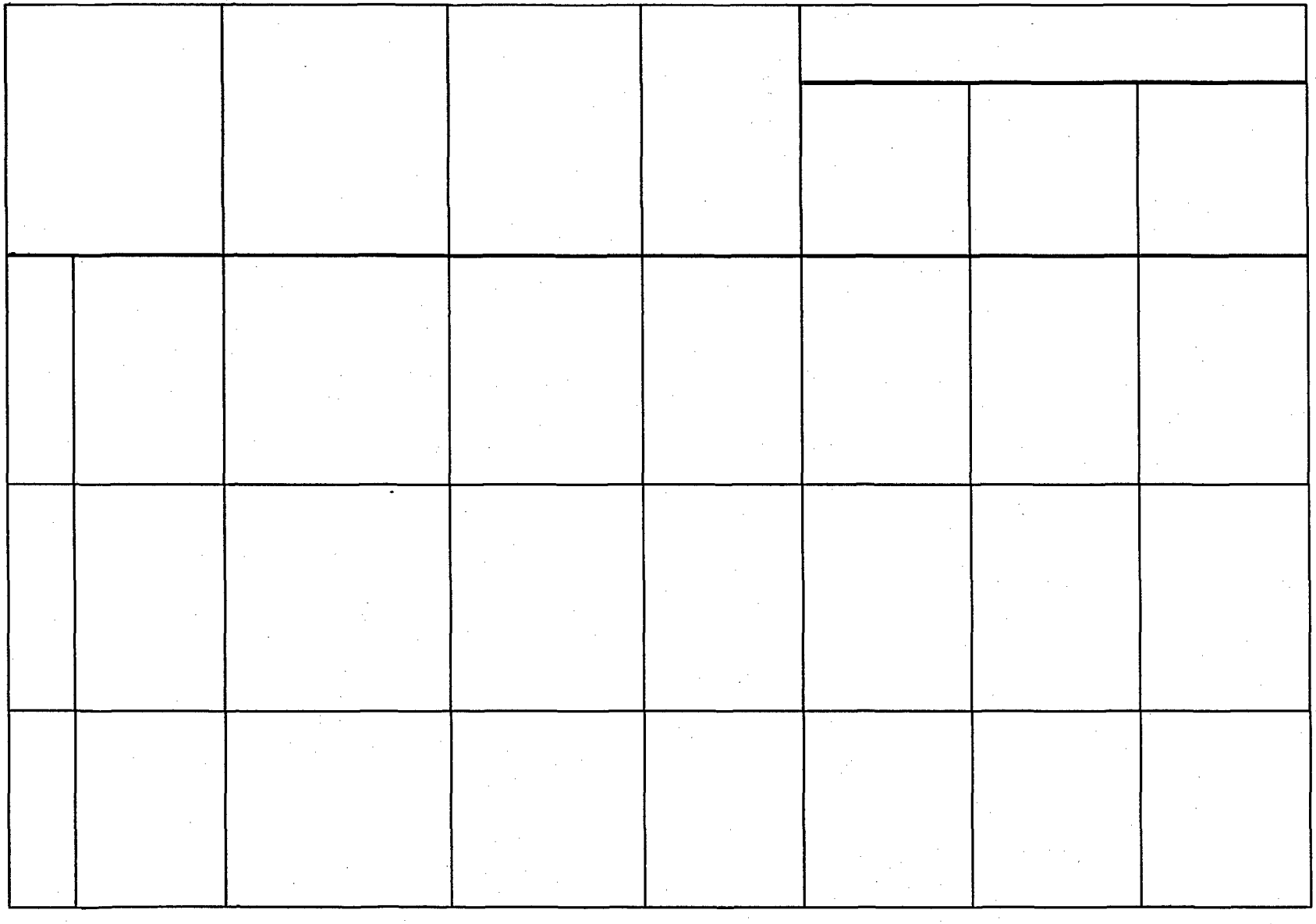
The combined verification, "white box", and "black box" testing shall demonstrate that the final design meets all functional, performance and interface requirements defined in this HSS. [[

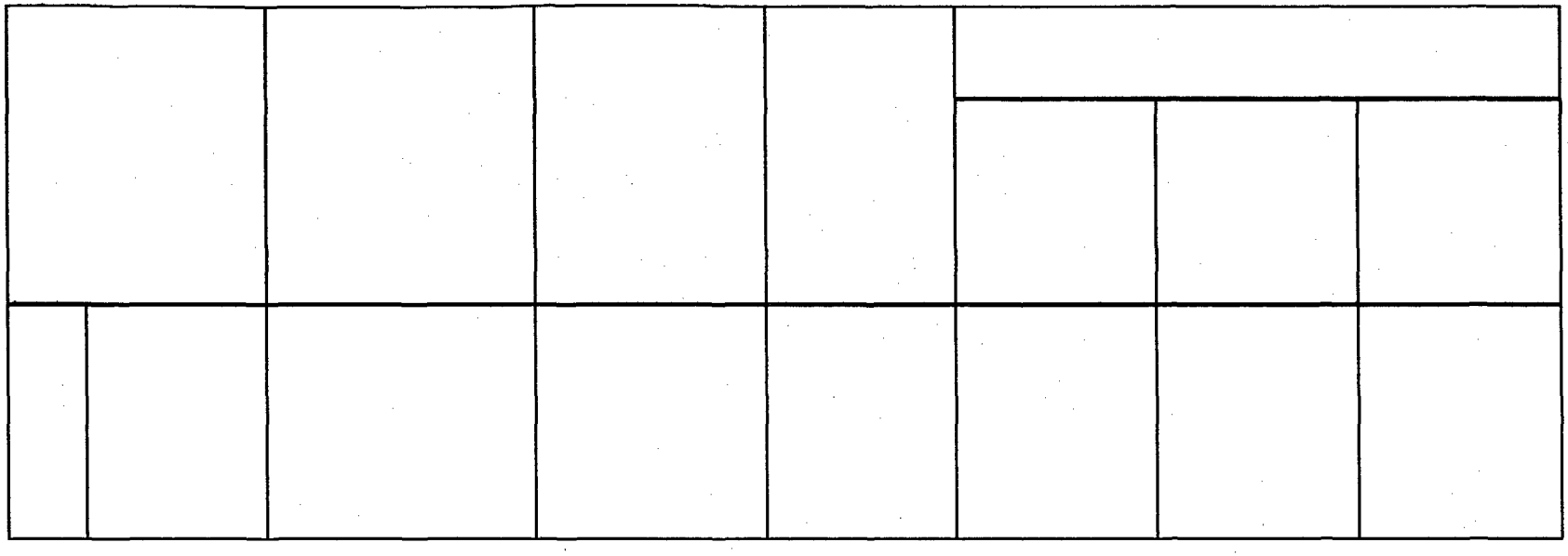
Table 1a RTIF Analog Sensor Inputs

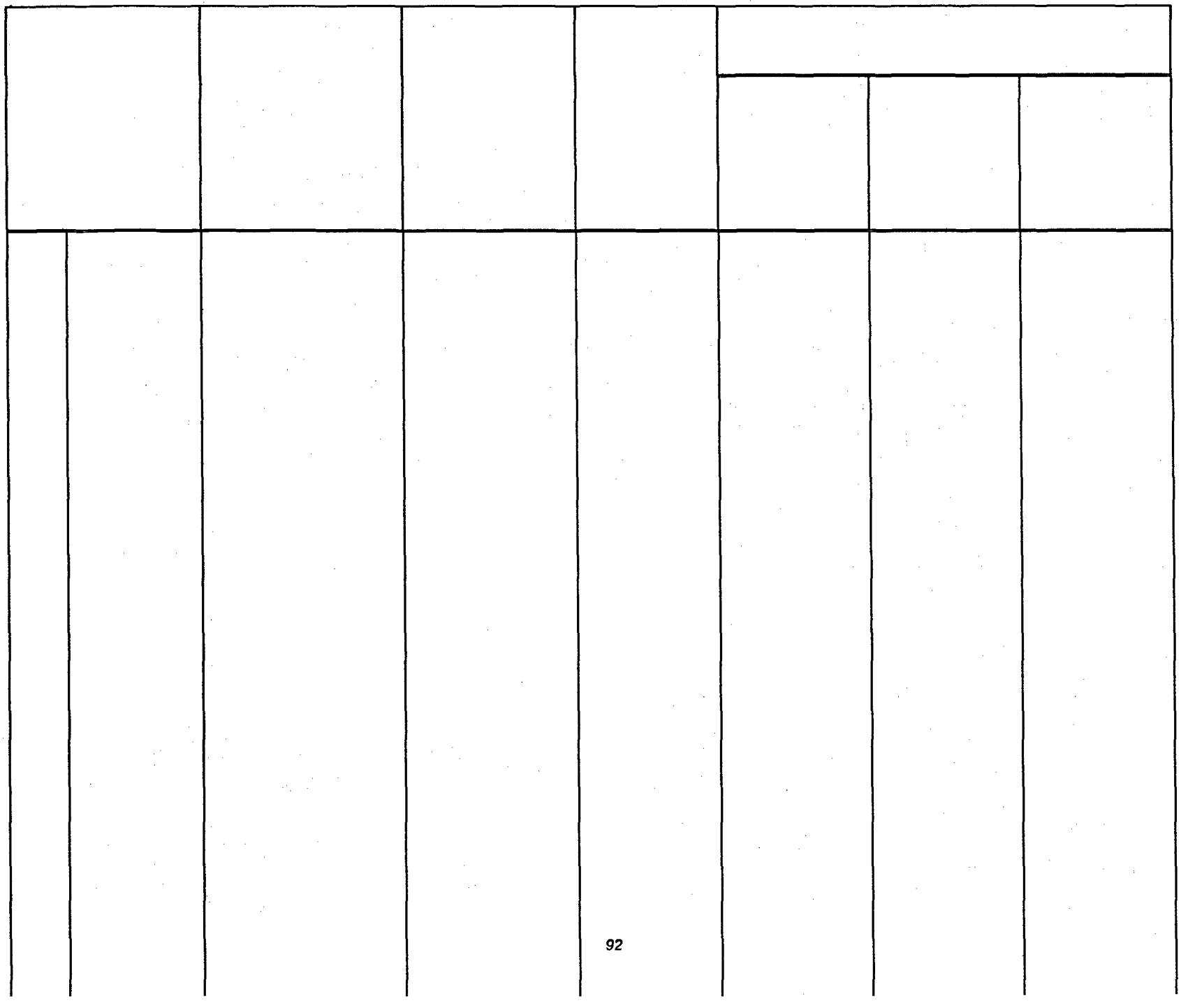
[[							











7.]]

Table 1b RTIF Discrete Inputs

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5.]]

Table 1c RTIF External Multiplexed Communication Links

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Table 1d RTIF Discrete and Analog Electrical Outputs

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Table 2 RPS Operator Interfaces - Hard Inputs

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Table 3 LDI Operator Interfaces - Hard Inputs

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Table 4 MS Operator Interfaces - Hard Inputs

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Table 5 SSLC Operator Interfaces - Hard Inputs

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Table 6 The RPS Logic Function Blocks

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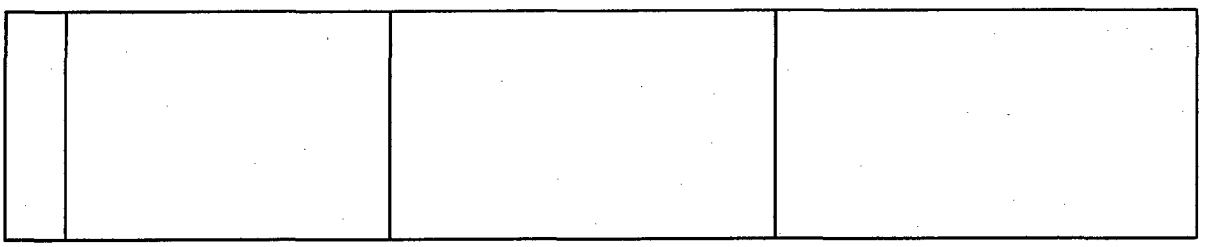

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Table 7 The LDI Logic Function Blocks

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Table 8 The MS Logic Function Blocks

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Table 9 The SSLC Logic Function Blocks

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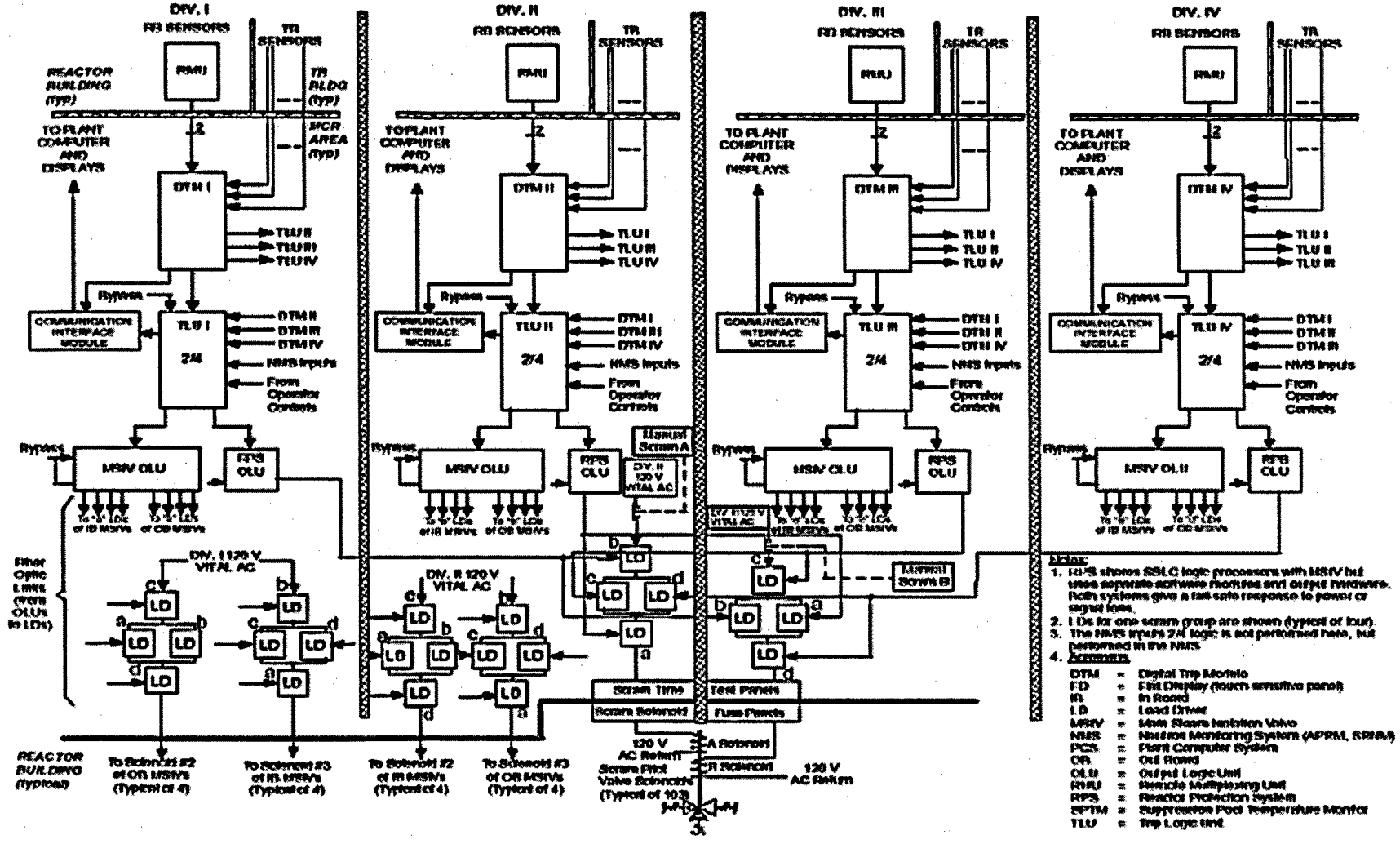
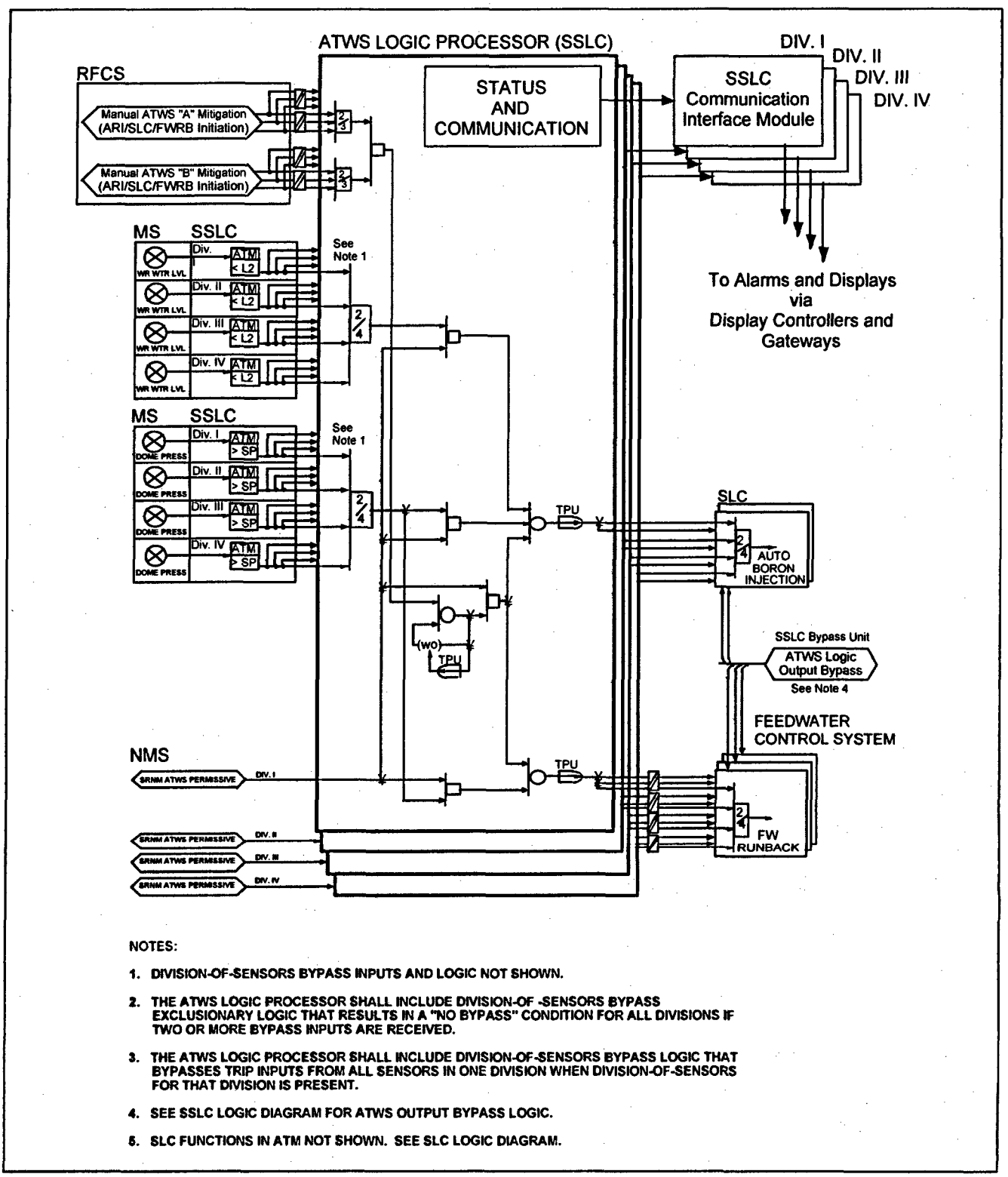


Figure 1 RPS/MSIV Architecture



NOTES:

1. DIVISION-OF-SENSORS BYPASS INPUTS AND LOGIC NOT SHOWN.
2. THE ATWS LOGIC PROCESSOR SHALL INCLUDE DIVISION-OF -SENSORS BYPASS EXCLUSIONARY LOGIC THAT RESULTS IN A "NO BYPASS" CONDITION FOR ALL DIVISIONS IF TWO OR MORE BYPASS INPUTS ARE RECEIVED.
3. THE ATWS LOGIC PROCESSOR SHALL INCLUDE DIVISION-OF-SENSORS BYPASS LOGIC THAT BYPASSES TRIP INPUTS FROM ALL SENSORS IN ONE DIVISION WHEN DIVISION-OF-SENSORS FOR THAT DIVISION IS PRESENT.
4. SEE SSLC LOGIC DIAGRAM FOR ATWS OUTPUT BYPASS LOGIC.
5. SLC FUNCTIONS IN ATM NOT SHOWN. SEE SLC LOGIC DIAGRAM.

Figure 2 ATWS Mitigation Logic

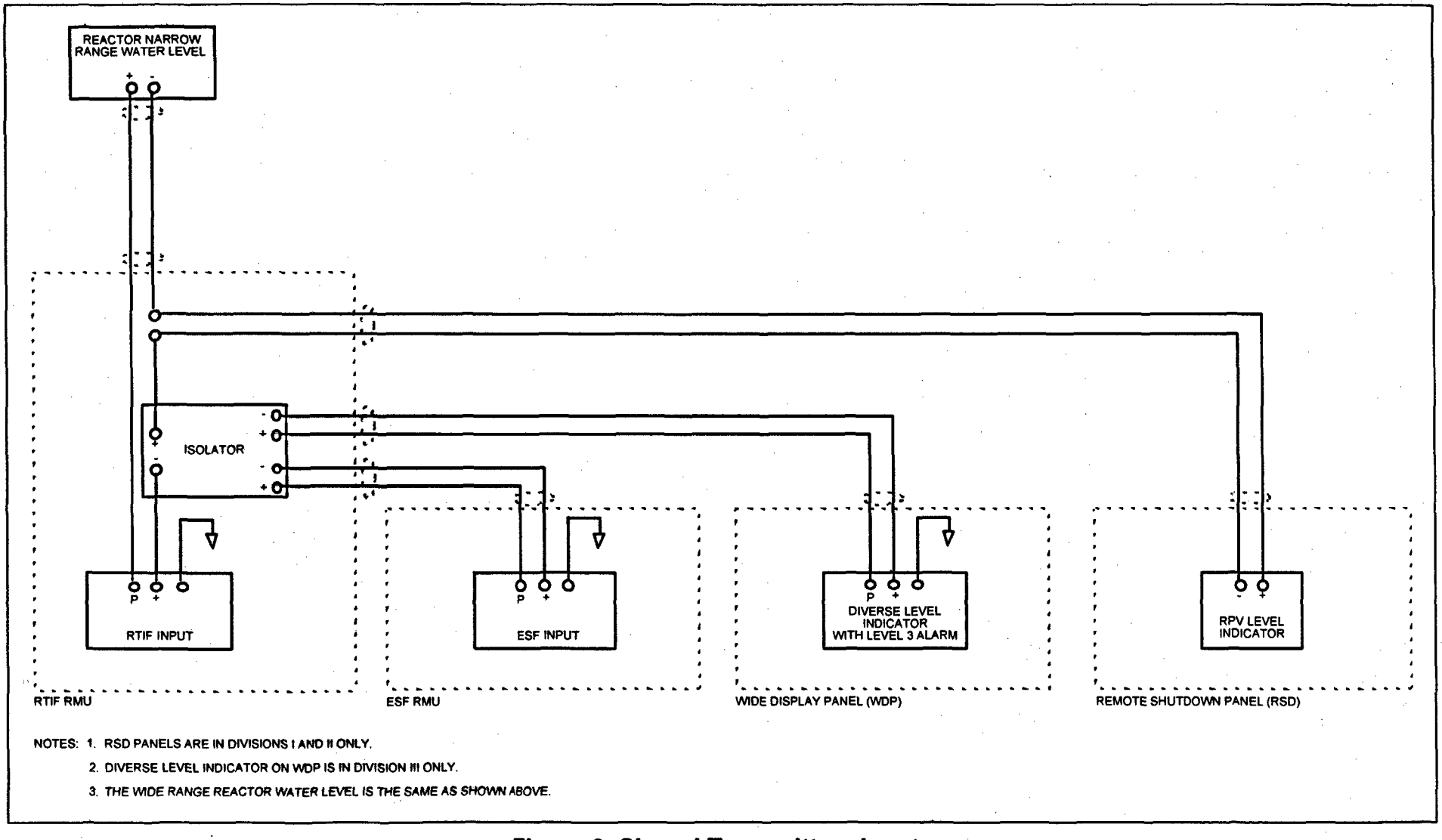


Figure 3 Shared Transmitters Inputs

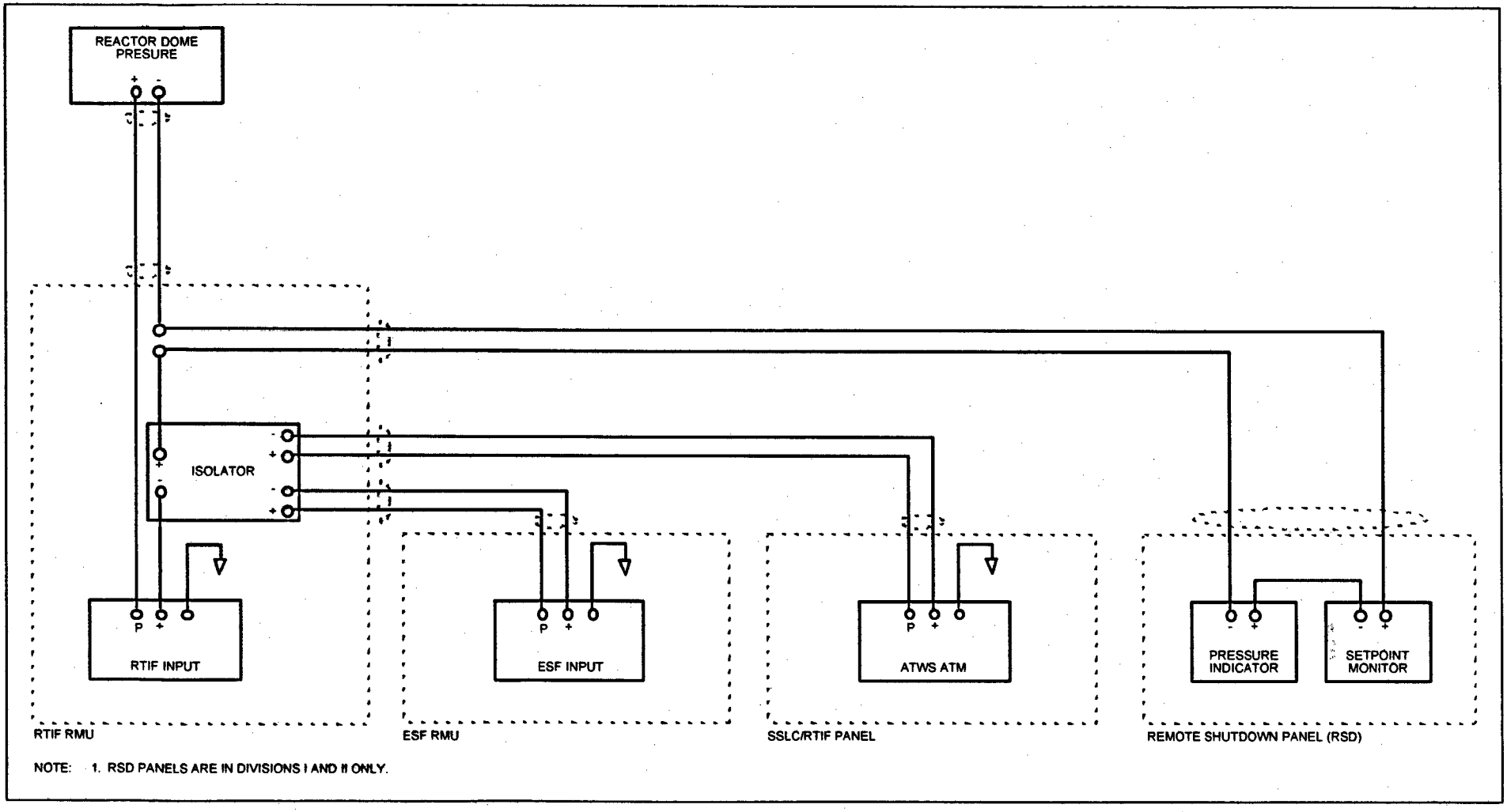


Figure 4 Shared Transmitters Inputs