GE Nuclear Energy

General Electric Company
175 Curtner Avenue, San Jose, CA 95125

April 30, 1993

Docket No. STN 52-001

Chet Poslusny, Senior Project Manager
Standardization Project Directorate
Associate Directorate for Advanced Reactors
and License Renewal
Office of the Nuclear Reactor Regulation

Subject: Submittal Supporting Accelerated ABWR Review Schedule - **DFSER Chapter 7 Outstanding Item**

Dear Chet:

Enclosed are SSAR markups addressing the following outstanding items:

Open Item	Confirmatory Items
7.2.6-1	7.2.1-3
7.2.6-2	7.2.2.2-1
7.2.6-4	7.2.2.5-1
7.2-8-~~2~~1	7.2.8-2
7.7.1.15-2	7.2.8-3
	7.2.8-5
	7.3.2.-1
	7.4.1.4-1

Please provide a copy of this transmittal to Jim Stewart.

Sincerely,

Jack Fox

Jack Fox
Advanced Reactor Programs

cc: Norman Fletcher (DOE)
Barry Simon (GE)

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CLOSURE OF ABWR Draft FSER OPEN AND CONFIRMATORY ITEMS

The following DFSER open item, No. 7.1.3.3-1, while not on the list of items to be included in this submittal, has been added because it is referenced as the source of closure documentation in several of the other DFSER open and confirmatory items.

DFSER No. 7.1.3.3-1 (OPEN)

ISSUE

a. Development and review of generic ITAAC and DAC, including computer (software development and setpoint methodology).
b. One channel SSLC prototype.
c. SSLC Tier 1 design description, ITAAC/DAC.
d. ITAAC for setpoints will require a plant-specific analysis in accordance with RG 1.105.
e. Commitment to RG 1.152 and ANSI/IEEE ANS-7-4.3.2 not sufficient

CLOSURE

A new document, Tier 1 Design Certification Material for Instrumentation and Control, ITAAC Section 3.4, has been prepared. The outline of the basic structure of this document was submitted to the NRC for placement on the docket on March 26, 1993. Completed sections on equipment qualification (EQ) and setpoint methodology were submitted the latter part of April. A complete version of the total document will be submitted by the latter part of May.

This document takes an integrated software and hardware approach to safety-related I&C development and also discusses non-safety-related aspects of software development. The document combines material previously developed for ITAAC and DAC (SSLC, software development, and electromagnetic compatibility) with new sections covering setpoint methodology and equipment qualification. The Tier 1 material for software development, setpoint methodology and EQ is supported by Tier 2 commitments to specific methods and standards (incorporated into the SSAR as Appendix 7B).

DFSER No. 7.2.1-3 (CNFM)

ISSUE

Revise SSAR text and figures to indicate that turbine inputs to SSLC are not multiplexed.

CLOSURE

a. SSAR Section 7.2 revised (see attachment).
b. Marked-up figures are attached: Figures 7.2-2, 7.2-9a, 7.2-9b. Additional changes shown are hardwired MSIV position switches and deletion of seismic acceleration sensors (not applicable to domestic ABWR design).

DFSER No. 7.2.2.2-1 (CNFM)

ISSUE

a. Revise Figure 7.A.2-1 in Appendix 7A to show direct hardwired inputs into DTM.
b. Revise SSAR to reflect accurate listing of sensors that use EMS.

CLOSURE

a. Revised Figure 7.A.2-1 is attached, showing hardwired inputs.
b. Revised listing of EMS sensors (April 1993) is attached.

DFSER No. 7.2.2.5-1 (CNFM)

ISSUE

a. All STS equipment will be qualified as part of SSLC.
b. STS for all safety systems other than SSLC must also be Class 1E.

CLOSURE

The shaded paragraph after the following paragraph in SSAR Section 7A.7 is added:

All programmable digital equipment utilized for safety-related functions are qualified in accordance with safety criteria and with the safety system design basis with which they interface.

Self-test or self-diagnostic features of this equipment, whether implemented in hardware or software, are considered an integral part of the design and, as such, are qualified to Class 1E standards.

DFSER No. 7.2.6-1 (OPEN)

ISSUE

a. Common-mode failure potential of ABWR software.
b. GE to complete review of LLNL diversity study.

CLOSURE

GE's position continues to be that the very low common-mode failure probability of the simple ABWR protection system software, in conjunction with a design basis accident, is adequately backed up by system level diversity inherent in the plant design. GE believes that the hardware and software development, test, and qualification methodologies and acceptance criteria presented in the I&C Design Certification Material (see reply to DFSER No. 7.1.3.3-1) will result in a highly reliable protection system. Specifically for RPS, however, there are several alternate diverse or hardwired methods of scram outside of the software logic, including ARI, manual scram, and ATWS mitigation, as presently discussed in the SSAR.

See the following item, DFSER No. 7.2.6-2, for the specific closure of this issue.

DFSER No. 7.2.6-2 (OPEN)

ISSUE

a. Diversity and defense-in-depth (lack of design details).
b. Chapter 15 analyses completed by GE; stated that GE design has adequate defense-in-depth and diversity; staff should consider probability of events and allow credit for use of RSS.

CLOSURE

GE's initial analysis of Chapter 15 accidents took credit for feedwater control being available to the operator for makeup after complete common-mode failure of SSLC or the essential multiplexing system. A succeeding analysis was prepared at NRC request taking credit only for availability of CRD flow and one condensate pump for operator action. Following submittal of this analysis on February 26, 1993, additional studies were requested by NRC staff to bound the time available for operator response to each of the accident conditions considered previously, also assuming the same equipment availability. These studies are in process and will be submitted in early May. The results of these studies will close this issue.

DFSER No. 7.2.6-4 (OPEN)

ISSUE

Simplicity of SSLC and EMS software; GE to provide supporting analyses.

CLOSURE

At this stage of safety-related I&C development there will always be a question of software reliability no matter how simple the proposed software is shown to be, mainly because of the common-mode failure issue. However, as a result of the LLNL common-mode failure study and other discussions with NRC staff, GE has committed to the following plan:

a. Produce an integrated hardware/software development program as described in the I&C Design Certification Material submittal (DFSER No. 7.1.3.3-1)
b. Commit to provide a set of hardwired displays and controls (DFSER No. 7.2.6.-3)
c. Complete the common-mode failure analyses (DFSER No. 7.2.6-2), which support the inherent diversity provided by both the safety-related and non-safety-related systems.

Thus, GE believes that additional analyses of software simplicity are no longer relevant and will be of no benefit in closing this issue; the DFSER items mentioned above will close this issue.

DFSER No. 7.2.8-1

ISSUE

a. Software metrics to be used to track error rates during software development (COL).
b. Software metric commitment to be included in Tier 1 ITAAC (CNFM).
c. Commitment to software safety hazards analysis, sneak circuit analysis, timing analyses (OPEN).

CLOSURE

a. COL action item for software metrics to be included as Section 7A.8 in Appendix 7A of SSAR.
b. Confirmatory commitment for software metrics included in I&C Design Certification Material discussed in DFSER No. 7.1.3.3-1. Tier 2 material for SSAR (Appendix 7B) also submitted.
c. These commitments should also be a COL action item for the same reasons as item a.; i.e., technology in these areas will change over time and must be specified by the final software vendor at the time of software design. These items will be included in Section 7A.8 of Appendix A. A general commitment to special analyses for safety-critical software is made in the Tier 1 I&C Design Certification Material discussed in DFSER No. 7.1.3.3-1.

DFSER No. 7.2.8-2 (CNFM)

ISSUE

Commercial dedication of software in safety systems

CLOSURE

This issue is resolved in the SSAR in Appendix 7B, the Tier 2 material developed to support the I&C DCM (see DFSER No. 7.1.3.3-1) by a commitment to the proposed ANSI/IEEE standard P 7-4.3.2, "Standard Criteria for Digital Computers Used in Safety Systems of Nuclear Power Generation Stations," that will replace ANSI/IEEE-ANS-7-4.3.2-1982, "Application Criteria for Digital Computers in Safety Systems for Nuclear Facilities." The proposed standard covers commercial dedication of third-party software and the use of commercial software tools for safety-related applications.

As stated in the proposed standard, the dedication process requires the inclusion of the requirements that the commercial software shall meet in the verification and validation (V&V) and configuration management plans. The requirements shall address the similarity of the nuclear and non nuclear applications. Additionally, the requirements shall describe the aspects of the commercial software which demonstrated that the software has the high quality required. Both complete software designs and partial designs (operating systems) are covered by the dedication process.

Also as stated in the proposed standard, commercial software development tools become part of the software configuration management process, and are controlled by, but are not formally certified through, the V&V program. These tools can include, but are not limited to, compilers, debuggers, software documentation programs, and testing tools. The software tools are not required to be verified and validated as safety software. A tool will be indirectly verified, first by prior knowledge of its extensive usage in operational industrial applications, and, second, through the formal verification process, where the results of code generation are checked by an independent team of reviewers against design requirements and performance specifications at each stage of software development. Eventually, testing of the integrated software and hardware combination is performed as part of the final validation process.

DFSER No. 7.2.8-3 (CNFM)

ISSUE

Report errors in commercial tools to end user (to be included in ITAAC/DAC).

CLOSURE

Commitment has been included in I&C DCM discussed in DFSER No. 7.1.3.3-1.

DFSER No. 7.2.8-5 (CNFM)

ISSUE

a. Commit to maintain temperature rise of 15 °C (27 °F) in SSLC equipment.
b. State qualification temperature margin for SSLC equipment in SSAR.

CLOSURE

a. The response to RAI 420.92 (SSAR Amendment 9, page 20.3-242) is revised as follows:

   "... a thermal analysis will be performed at the circuit board, instrument and panel design stages. The heat release by internal panel components shall not raise the internal temperature of a panel to greater than 15 °C (27 °F) above external ambient temperature of the equipment room for electronic components within a chassis or within any printed circuit card file structure. Convective cooling ..."

b. While GE has agreed to state the limits on internal panel temperatures in the SSAR (see item a. above), GE believes that, for equipment qualification, only a commitment to the temperature margin required by IEEE-323 is required in the SSAR. While GE has shown that its safety-related, microprocessor-based equipment is tested at temperatures far beyond the guaranteed maximum operating temperature, the exact requirement should be determined after analyses are performed at the time of actual design and after the equipment to be used has been selected. GE has already committed in the SSAR to perform thermal analyses at the circuit board, instrument, and panel level, and to take other steps as necessary to ensure proper equipment operation at the stated maximum temperature of 50 °C (122 °F). Note that we have also committed to the use of low power semiconductor technologies and low stress design techniques. The possible occurrence, stated in the DFSER, of local hot spots in new digital chip designs is a concern of the vendor who must design and qualify the design to the functional specifications. The integration and validation testing and the equipment qualification program described in the I&C Design Certification Material (see DFSER No. 7.1.3.3-1) is designed to uncover such design problems.

   The response to RAI 420.92 (SSAR Amendment 9, page 20.3-242) is revised as follows:

   "... shall include adequate margin to ensure that this condition can be met under extreme conditions. The minimum margin shall be as stated in IEEE-323, Section 6.3.1.5. Additional margin will be determined by thermal analysis of the installed equipment area."

DFSER No. 7.3.2-1 (CNFM)

ISSUE

Resolve discrepancy between use of term auxiliary supporting features for part of the safety system logic unit (SLU) function shown in Figure 1 of the EMS/SSLC Interface Requirements Specification and the use of only the term SLU in the SSAR and Tier 1 descriptions.

CLOSURE

An early alternative considered for SSLC design was the strict separation of primary ESF functions (i.e., ECCS and LDS) and auxiliary supporting features (e.g., Diesel Generator, Flammability Control System, Reactor Service Water) by using separate instrument channels within a division. However, because there are interfaces between the primary systems and auxiliary supporting systems, a different allocation of system functions was applied in the final design, where functions are primarily separated by whether they are used to support high pressure or low pressure injection features of ECCS. The term SLU is used correctly in the SSAR and Tier 1 descriptions. The figure and text of EMS/SSLC Interface Requirements Specification, 23A6327 (MPL A32-4080) will be changed at the next revision to eliminate all uses of the terms auxiliary supporting features (ASF) and auxiliary supporting features logic unit (ALU).

DFSER No. 7.4.1.4-1 (CNFM)

ISSUE

Clarify in SSAR that Remote Shutdown System is totally separate and independent from SSLC and the Essential Multiplexing System (EMS).

CLOSURE

Section 7.4.1.4.4(1) of the SSAR is revised as follows:

> "... Actuation of the transfer devices interrupts the connection to the RMUs and transfers control to the remote shutdown system. Transfer of control completely isolates all functions of SSLC and EMS from RSS. The analog, hardwired instrument loops of RSS directly operate the actuated devices under manual control of the operator at the RSS panels. Displays at the RSS also give direct hardwired indication to the operator from the sensors. All necessary power supply circuits ..."

DFSER No. 7.7.1.15-2

ISSUE

EMI sensitivity of safety computer systems to plant communications equipment to be in ITAAC.

CLOSURE:

A commitment to a test program for checking sensitivity of safety-related computer components to communication transmitters and receivers is included in the I&C DCM discussed in DFSER No. 7.1.3.3-1. The SSAR, in Section 7A.2 of Appendix 7A, contains a commitment to use ANSI/IEEE C37.90.2-1987, "IEEE Trial-Use Standard, Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers," to develop this test program.

RESPONSE TO DFSER 7.2.1-3

7.2.1.1.4 RPS Equipment Design

The RPS is designed to provide reliable single-failure-proof capability to automatically or manually initiate a reactor scram while maintaining protection against unnecessary scrams resulting from single failures. This is accomplished through the combination of fail-safe equipment design and redundant two-out-of-four and one-out-of-two-twice scram logic arrangement. All equipment within the RPS is designed to fail into a trip initiating state on loss of power or input signal. In conjunction with this, trip initiating logic signals to and within the RPS are asserted low whereas trip bypass logic signals and trip bypass permissive logic signals are asserted high.

7.2.1.1.4.1 General RPS Equipment

The RPS equipment is divided into four redundant divisions of sensor (instrument) channels, trip logics and trip actuators, and two divisions of manual scram controls and scram logic circuitry. The sensor channels, divisions of trip logics, divisions of trip actuators and associated portions of the divisions of scram logic circuitry together constitute the RPS scram and air header dump (back-up scram) automatic initiation logic. The divisions of manual scram controls and associated portions of the divisions of scram logic circuitry together constitute the RPS scram and air header dump manual initiation logic. The automatic and manual scram initiation logics are independent of each other. RPS equipment arrangement is shown in Figure 7.2-2.

(1) Sensor Channels

Equipment within a sensor channel includes primarily sensors (transducers or switches), multiplexers and digital trip modules (DTM's). The sensors within each channel monitor plant variables discussed in Section 7.2.1.1.4.2 and send either analog or discrete output to remote multiplexer units (RMS's) within the associated division of essential multiplexing system (EMS). Each division of EMS performs analog to digital conversion on analog signals and sends the digital or digitized analog output values of all monitored variables to the DTM within the associated RPS sensor channel. The DTM in each sensor channel compares individual monitored variable values with trip setpoint values and for each variable sends a separate, discrete (trip/no trip) output signal to all four divisions of trip logics. Because of the location of the monitored processes some sensor signals are hardwired directly to the DTM. All equipment within a sensor channel is powered from the same division of class 1E power source. However, different pieces of equipment may be powered from separate DC power supplies. Within a sensor channel sensors themselves may belong to the RPS or may be components of another system. Signal conditioning and distribution performed by the RMU's is a function of the EMS and is discussed in Section 7A.2.

(2) High Reactor Pressure

(3) Low Reactor Water Level (Level 3)

(4) High Drywell Pressure

(5) Main Steam Line Isolation

(6) Low Control Rod Drive Charging Header Pressure

(7) High Main Steam Line Radiation

~~(8) High Seismic Activity~~

(9) Turbine Stop Valve Closed

(10) Turbine Control Valve Fast Closure

(11) Operator initiated Manual Scram

Signals from the Turbine Building

The systems and equipment that provide trip and scram initiating inputs to the RPS for these conditions are discussed in the following subsections. With the exception of the NMS and PRRM, all of these systems provide sensor outputs through the EMS. Analog to digital conversion of these sensor output values is done by EMS equipment. NMS and PRRM trip signals are provided directly to the RPS by NMS and PRRM trip logic units.

and the MSIV position switches,

Sensor signals from the Turbine Building are hardwired directly to the DTM.

(1) Neutron Monitoring System (NMS)

Each of the four divisions of neutron monitoring system (NMS) equipment provides separate, isolated, bistable source range monitor (SRNM) trip and average power range monitor (APRM) trip signals to all four divisions of RPS trip logics (Figure 7.2-5).

(a) SRNM Trip Signals

The SRNM's of the NMS provide trip signals to the RPS to cover the range of plant operation from source range through start-up range to about ten percent of reactor rated power. Three conditions monitored as a function of the NMS comprise the SRNM trip logic output to the RPS. These conditions are upscale, short period and SRNM inoperative. The specific condition within the NMS that caused the SRNM trip output is not detectable within the RPS.

(b) APRM Trip Signals

The APRM's of the NMS provide trip signals to the RPS to cover the range of plant operation from a few percent to greater than reactor

rated power. Four conditions monitored as a function the NMS comprise the APRM trip logic output to the RPS. These conditions are high neutron flux, high simulated thermal power, APRM inoperative and reactor internal pump trip. The specific condition within the NMS that caused the APRM trip output is not detectable within the RPS.

(2) Nuclear Boiler System (NB) (Figure 7.2-6)

(a) Reactor Pressure

Reactor pressure is measured at four physically separated locations by locally mounted pressure transducers. Each transducer is on a separate instrument line and provides analog equivalent output through the EMS to the DTM in one of four RPS sensor channels. The pressure transducers and instrument lines are components of the NB.

(b) Reactor Water Level

Reactor water level is measured at four physically separated locations by locally mounted level (differential pressure) transducers. Each transducer is on a separate pair of instrument lines and provides analog equivalent output through the EMS to the DTM in one of the four RPS sensor channels. The level transducers and instrument lines are components of the NB.

(c) Drywell Pressure

Drywell pressure is measured at four physically separated locations by locally mounted pressure transducers. Each transducer is on a separate instrument line and provides analog equivalent output through the EMS to the DTM in one of the four RPS sensor channels of the NB.

(d) Main Steam Line Isolation (Figure 7.2-4)

Each of the four main steam lines can be isolated by closing either the inboard or the outboard isolation valve. Separate position switches on both of the isolation valves of one of the main steam lines provide bistable output ~~through the EMS~~ hardwired to the DTM in one of the four RPS sensor channels. Each main steam line is associated with a different RPS sensor channel. The main steam line isolation valves and position switches are components of the NB.

(3) Control Rod Drive (CRD) System (Figure7.2-6)

(a) CRD Charging Header Pressure CRD charging header pressure is measured at four physically separated locations by locally mounted

pressure transducers. Each transducer is on a separate instrument line and provides analog equivalent output through the EMS to the DTM in one of the four RPS sensor channels. The pressure transducers and instrument lines are components of the CRD system.

(4) Process Radiation Monitoring System (PRRM) (Figure 7.2-6)

(a) Main Steam Line Radiation

Main steam line radiation is measured by four separate radiation monitors. Each monitor is positioned to measure gamma radiation in all four main steam lines. The PRRM then provides a separate bistable output to the DTM in each of the four RPS sensor channels. The radiation monitors and associated equipment that determine whether or not main steam line radiation is within acceptable limits are components of the PRRM.

(5) Other Systems

(a) Seismic Activity (Figure 7.2-7)

Seismic activity is detected by four separate sets of three acceleration switches. Each set of switches provides reactor building bottom horizontal acceleration, bottom vertical acceleration and top horizontal acceleration bistable output through the EMS to the DTM in one of four RPS sensor channels.

(6) Reactor Protection System (Figure 7.2-3)

(a) Turbine Stop Valve Closure

Turbine stop valve closure is detected by separate valve stem position switches on each of the four turbine stop valves. Each position switch provides bistable output ~~through the EMS~~ to the DTM in one of the four RPS sensor channels. The turbine stop valves are components of main turbine, however the position switches are components of the RPS.

(b) Turbine Control Valve Fast Closure

Two separate conditions monitored by the RPS are indicative of turbine control valve fast closure. These conditions are fast acting solenoid valve closure and low hydraulic trip system oil pressure. Fast acting solenoid valve closure is detected by separate switches on each of the four valves. Each position switch provides bistable output ~~through the EMS~~ to the DTM in one of the four RPS sensor channels. Low hydraulic trip system oil pressure is detected by separate pressure switches on each of the four

turbine control valve hydraulic mechanisms. Each pressure switch provides bistable output ~~through the EMS~~ to the DTM in one of the four RPS sensor channels. The fast acting solenoid valves and turbine control valve hydraulic mechanisms are components of the main turbine, however the position and pressure switches are components of the RPS.

(c) Manual Scram

Two manual scram switches and the reactor mode switch provide the means to manually initiate a reactor scram independent of conditions within the sensor channels, divisions of trip logics and divisions of trip actuators. Each manual scram switch is associated with one of the two divisions of actuated load power.

In addition to the scram initiating variables monitored by the RPS, one bypass initiating variable is also monitored.

(d) Turbine First Stage Pressure

Turbine first stage pressure is measured at four physically separated locations by locally mounted pressure transducers. Each pressure transducer is on a separate instrument line and provides analog equivalent output ~~through the EMS~~ to the DTM in one of the four sensor channels. Within the RPS divisions of trip logics this variable forms a bypass component of the turbine stop valve and turbine control valve closure trip logic.

7.2.1.1.4.3 RPS Logic

The combination of division trip, scram, reset and bypass logic that make up the overall RPS logic is shown in Figure 21.7.2-2. Each division trip logic receives trip inputs from all four sensor channels and NMS divisions and provides a sealed-in trip output to the scram logic when the same trip condition exists in any two or more sensor channels or NMS divisions. At the division trip logic level various trips and trip initiating conditions can be bypassed as described in the following subsections. The scram logic will initiate a reactor scram when a trip condition exists in any two or more division trip logics. At the scram logic level no bypasses are possible.

(1) Channel Sensors Bypass

A separate, manual, keylock switch in each of the four divisions provides means to bypass the collective trip outputs of the associated sensor channel. The effect of the channel sensors bypass is to reduce all four division trips to a coincidence of two out of three tripped sensor channels. Interlocks between the four divisions of trip logic prevent bypass of any two or more sensor

A high reactor pressure trip will occur in each division of trip logic when reactor pressure is above the trip setpoint in any two or more unbypassed sensor channels. There are no operating bypasses associated with this trip function.

Low Reactor Water Level Trip (Figure 7.2-6)

A low reactor water level trip will occur in each division of trip logic when reactor water level is below the trip setpoint in any two or more unbypassed sensor channels. There are no operating bypasses associated with this trip function.

High Drywell Pressure Trip (Figure 7.2-6)

A high drywell pressure trip will occur in each division of trip logic when drywell pressure is above the trip setpoint in any two or more unbypassed sensor channels. There are no operating bypasses associated with this trip function.

High Main Steam Line Radiation Trip (Figure 7.2-6)

A high main steam line radiation trip will occur in each division of trip logic when a main steam line radiation trip condition exists in any two or more unbypassed sensor channels. There are no operating bypasses associated with this trip function.

Reactor Building High Seismic Activity Trip (Figure 7.2-7)

A high seismic activity trip will occur in each division of trip logic when either reactor building bottom horizontal or vertical acceleration or building top horizontal acceleration is high in any two or more unbypassed sensor channels. There are no operating bypasses associated with this trip function.

(5) Manual Scram

A sealed-in manual scram of all HCU's and associated control rods will occur when both manual scram pushbuttons are armed and depressed or when the reactor mode switch is placed in the shutdown position. Depressing only one armed scram pushbutton will result in a sealed-in half scram (de-energization of one division of actuated loads). The scram initiating input received from the mode switch shutdown contacts is automatically bypassed after a sufficient time delay (10 sec) to allow for scram seal-in and full insertion of all control rods.

A separate, manual, pushbutton switch in each of the four divisions provides means to manually trip all trip actuators in that division. This sealed-in division manual trip is equivalent to a sealed-in automatic trip from the same division of trip logic. An alternative manual scram can be accomplished by depressing any two or more of the four division manual trip pushbuttons.

(6) Reset Logic

A single, manual, three position, toggle switch provides means to reset the manual scram seal-in circuitry in both divisions of manual scram controls. If either of the manual scram pushbuttons is still depressed when a reset is attempted, the reset will not have any effect.

A separate, manual pushbutton associated with each division of trip actuators provides means to reset the seal-in at the input of all trip actuators in the same division. If the conditions that caused the division trip have not cleared when a reset is attempted, the reset will not have any effect. After a single division trip, reset is possible immediately; however, if a full scram has occurred, reset is inhibited for 10 seconds to allow sufficient time for scram completion.

As a consequence of a full scram the CRD charging header pressure will drop below the trip setpoint resulting in a trip initiating input to all four divisions of trip logic. While this condition exists reset of the manual scram circuitry is possible; however, the four divisions of trip logic cannot be reset until the CRD charging pressure trip is manually bypassed in all four divisions and all other trip initiating conditions have cleared.

7.2.1.1.4.4 Redundancy and Diversity

Instrument sensing lines from the reactor vessel are routed through the drywell and terminate inside the containment. Instruments mounted on instrument racks in the four quadrants of the reactor building sense reactor vessel pressure and water level from this piping. Valve position switches are mounted on valves from which position information is required. The sensors for RPS signals from equipment in the turbine building are mounted locally. The four battery-powered inverters and divisional 120-VAC power suppliers for the SSLC and RPS are located in an area where they can be serviced during reactor operation. Sensor signals (via the multiplex network), and power cables are routed to four SSLC cabinets (in which RPS components are located) in the divisional electrical compartments. One logic cabinet is used for each division.

except those from the Turbine Building mounted and MSIV position switches

The redundancy portions of the RPS have physically separated sensor taps, sensing lines, sensors, sensor rack locations, cable routing, and termination in four separate panels in the control room. By the use of four or more separate redundant sensors for each RPS variable with separate redundant logic and wiring, the RPS system has been

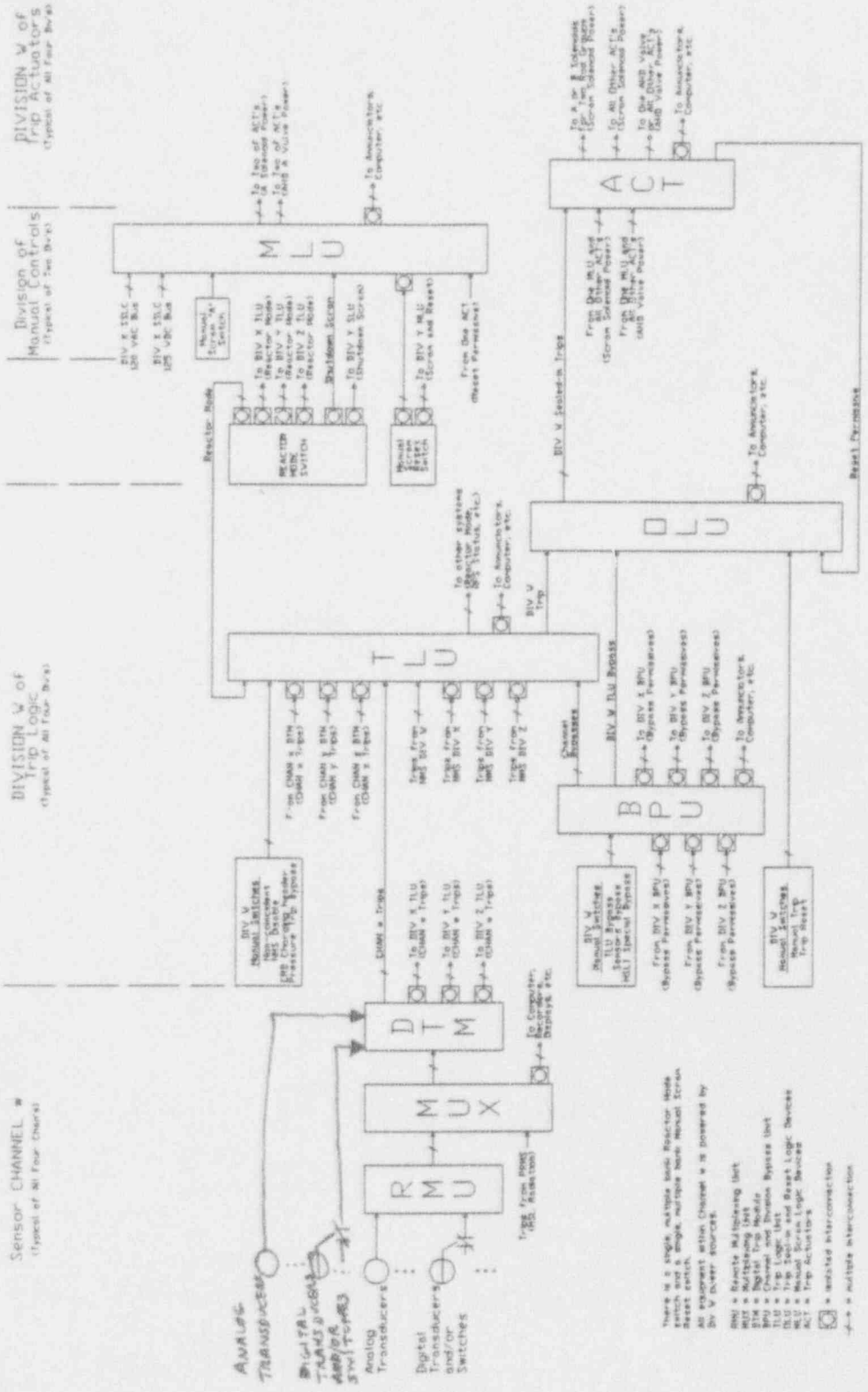


Figure 7.2-2 REACTOR PROTECTION SYSTEM EQUIPMENT ARRANGEMENT
(From sensors through trip actuators)

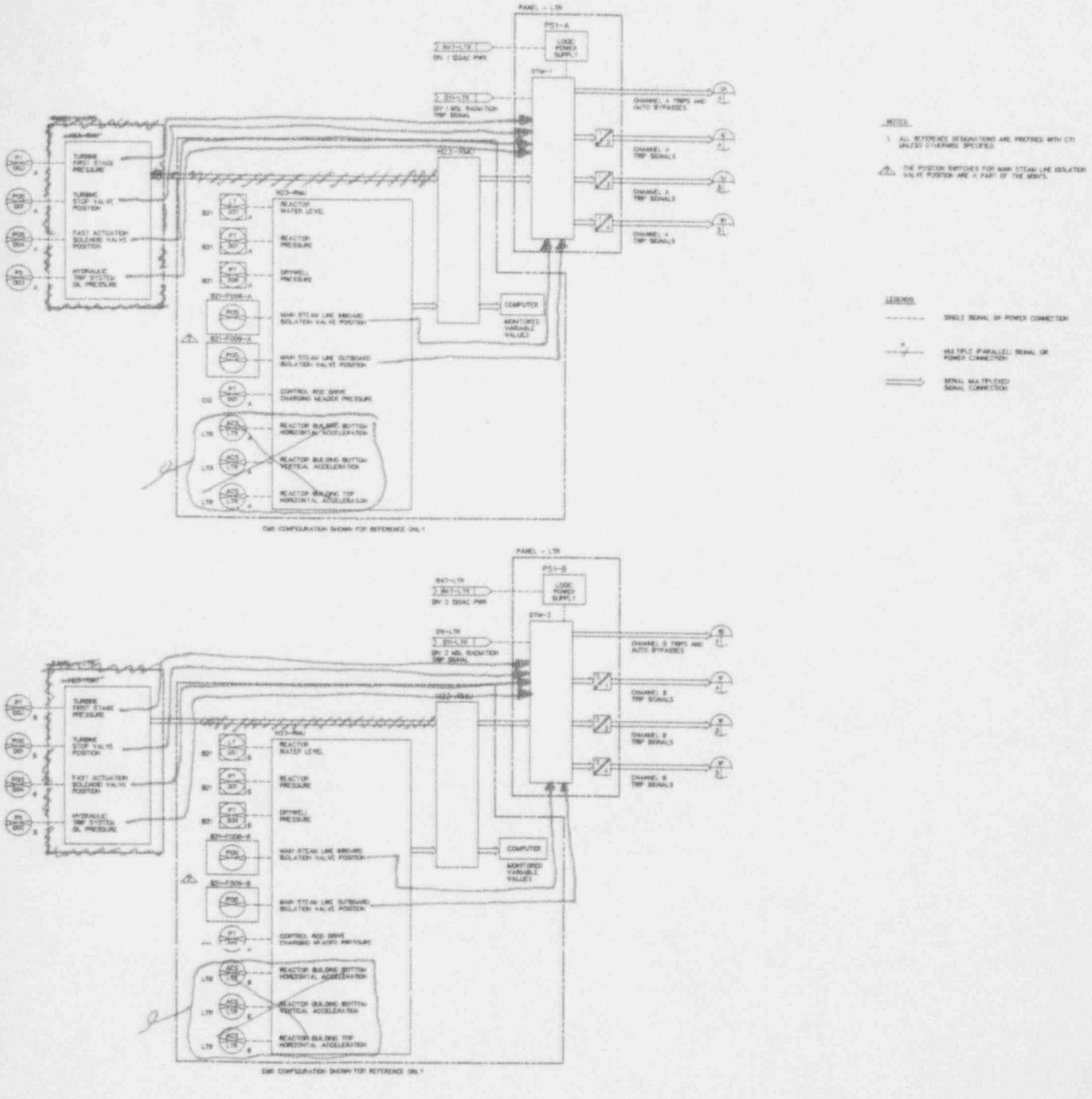
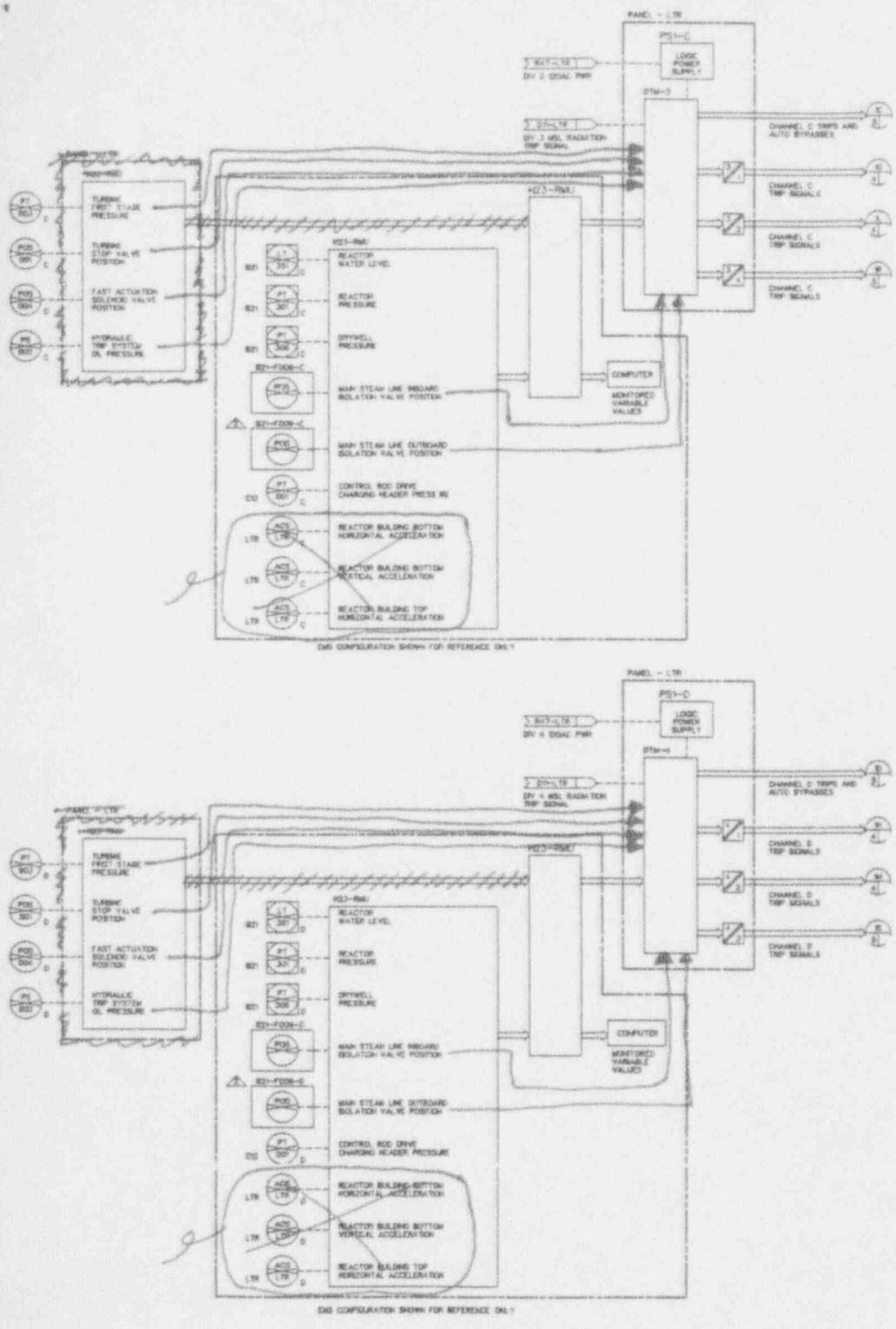


Figure 7.2–9a REACTOR PROTECTION SYSTEM IED – S

RESPONSE TO DFSER 7.2.1-3



89-070-02

Figure 7.2–9b REACTOR PROTECTION SYSTEM IED – SHEET 2

RESPONSE TO OFSER 7.2.1-3

7A.2 MULTIPLEXING SYSTEMS

NRC Request (1): Provide a complete list of components (pumps, valves, etc.) whose actuation, interlock, or status indication is dependent on the proper operation of each Class 1E multiplexer.

Response (1): The list (as of February 1989) is provided as Table 7A.2-1. It was obtained by extraction from the multiplexer I/O database which reflects information available on the current system P&ID and IBD drawings.

Note: A revised list (as of April 1993) is now replaces the February 1989 list as Table 7A.2-1.

NRC Request (2): For the components cited above, describe the means of remote or local control (other than by cutting wires or jumpering) that may be employed should the multiplexer fail.

Response (2): All Class-1E multiplex hardware is designed to meet the single failure criteria. Systems which employ such hardware have redundant channels such that no single failure of any MUX unit could jeopardize any safety system action. In addition, local control is provided, via the remote shutdown system, to bring the reactor to shutdown conditions in event of multiple safety system failures or evacuation of the control room. The remote shutdown system is hard-wired and therefore provides diversity to the MUX interfaces.

NRC Request (3): Describe the multiplexer pre-operational test program.

Response (3): The pre-operational test program will test the multiplexers concurrently with instrumentation and control functional loop checks. As each input to a remote multiplexing unit (RMU) is simulated using a suitable input device the required outputs shall be verified c[illegible] this manner all hardware and software are confirmed concurrently.

Equipment verifications of the individual multiplexing units are performed at the factory and typically include detailed component level tests which require special test apparatus and technical expertise. Any malfunctions not found during factory testing will be detected during pre-operational tests of instrument loops.

Testing shall include instrument loop checks, calibration verification tests and response time verification tests as described in ANSI/IEEE Standard 338. If possible, the entire instrument loop shall be tested from sensor to output device(s). Otherwise, suitable input devices shall be used to simulate process inputs and the system outputs verified to be acceptable.

In addition to the testing described above, tests shall be developed to verify system redundancy and electrical independence.

NRC Request (4): Describe the test and/or hardware features employed to demonstrate fault tolerance to electromagnetic interference.

Response (4): One major deterrence to electromagnetic interference (EMI) in the multiplexing system is the use of fiber optic data links as the transmission medium. Optical fiber, being a non-electrical medium, has the inherent properties of immunity to electrical noise (EMI, RFI, and lightning), point-to-point electrical isolation, and the absence of conventional transmission line effects. Fiber optic multiplexing is also unaffected by the radiated noise from high voltage conductors, by high frequency motor control drives, and by transient switching pulses from electromagnetic contactors or other switching devices.

However, the electrical-to-optical interface at the transmitting and receiving ends must still be addressed to ensure complete immunity to EMI. The control equipment containing the electrical circuitry use standard techniques for shielding, grounding, and filtering and are mounted in grounded equipment panels provided with separate instrument ground busses. Panel location, particularly in local areas, is carefully chosen to minimize noise effects from adjacent sources. The use of fiber optic cables ensures that current-carrying ground loops will not exist between the control room and local areas.

The use of redundancy provides the other major deterrence to EMI effects. The safety-related multiplexing system uses redundant optical channels within each separated electrical division. The

LIST OF EQUIPMENT INTERFACE WITH ESSENTIAL MUX SIGNALS
(In order of device - reading top to bottom)

DEVICE	DIV	DESCRIPTION
B21-F003A	1	AO CHECK VALVE
B21-F003B	2	AO CHECK VALVE
B21-F008A	1	MO GLOBE VALVE (MSIV)
B21-F008A	2	MO GLOBE VALVE (MSIV)
B21-F008B	1	MO GLOBE VALVE (MSIV)
B21-F008B	2	MO GLOBE VALVE (MSIV)
B21-F008C	1	MO GLOBE VALVE (MSIV)
B21-F008C	2	MO GLOBE VALVE (MSIV)
B21-F008D	1	MO GLOBE VALVE (MSIV)
B21-F008D	2	MO GLOBE VALVE (MSIV)
B21-F009A	1	MO GLOBE VALVE (MSIV)
B21-F009A	2	MO GLOBE VALVE (MSIV)
B21-F009B	1	MO GLOBE VALVE (MSIV)
B21-F009B	2	MO GLOBE VALVE (MSIV)
B21-F009C	1	MO GLOBE VALVE (MSIV)
B21-F009C	2	MO GLOBE VALVE (MSIV)
B21-F009D	1	MO GLOBE VALVE (MSIV)
B21-F009D	2	MO GLOBE VALVE (MSIV)
B21-F010A	1	SRV/ADS VALVE
B21-F010A	2	SRV/ADS VALVE
B21-F010A	3	SRV/ADS VALVE
B21-F010B	3	SAFETY RELIEF VALVE
B21-F010C	1	SRV/ADS VALVE
B21-F010C	2	SRV/ADS VALVE
B21-F010D	1	SAFETY RELIEF VALVE
B21-F010E	2	SAFETY RELIEF VALVE
B21-F010F	1	SRV/ADS VALVE
B21-F010F	2	SRV/ADS VALVE
B21-F010G	1	SAFETY RELIEF VALVE
B21-F010H	1	SRV/ADS VALVE
B21-F010H	2	SRV/ADS VALVE
B21-F010H	3	SRV/ADS VALVE
B21-F010J	2	SAFETY RELIEF VALVE
B21-F010K	1	SAFETY RELIEF VALVE
B21-F010L	1	SRV/ADS VALVE
B21-F010L	2	SRV/ADS VALVE
B21-F010L	3	SRV/ADS VALVE
B21-F010M	3	SAFETY RELIEF VALVE
B21-F010N	1	SRV/ADS VALVE
B21-F010N	2	SRV/ADS VALVE
B21-F010P	1	SAFETY RELIEF VALVE
B21-F010R	1	SRV/ADS VALVE
B21-F010R	2	SRV/ADS VALVE
B21-F010S	2	SAFETY RELIEF VALVE
B21-F010T	1	SRV/ADS VALVE
B21-F010T	2	SRV/ADS VALVE
B21-F010U	3	SAFETY RELIEF VALVE
B21-F011	1	MO GATE VALVE
B21-F012	2	MO GATE VALVE
B21-F018	1	MO GLOBE VALVE
B21-F019	1	MO GLOBE VALVE
B21-F020	1	MO GLOBE VALVE
B21-F516	1	MO GLOBE VALVE
B21-LT001A	1	LEVEL TRANSMITTER
B21-LT001B	2	LEVEL TRANSMITTER
B21-LT001C	3	LEVEL TRANSMITTER
B21-LT001D	4	LEVEL TRANSMITTER
B21-LT002A	1	LEVEL TRANSMITTER
B21-LT002B	2	LEVEL TRANSMITTER
B21-LT002C	3	LEVEL TRANSMITTER
B21-LT003A	1	LEVEL TRANSMITTER
B21-LT003B	2	LEVEL TRANSMITTER
B21-LT003C	3	LEVEL TRANSMITTER
B21-LT003D	4	LEVEL TRANSMITTER
B21-LT003E	1	LEVEL TRANSMITTER
B21-LT003F	2	LEVEL TRANSMITTER
B21-LT003G	3	LEVEL TRANSMITTER
B21-LT003H	4	LEVEL TRANSMITTER
B21-LT006A	1	LEVEL TRANSMITTER
B21-LT006B	2	LEVEL TRANSMITTER
B21-POSA3I	1	POSITION SWITCH
B21-POSA3O	1	POSITION SWITCH
B21-POSB1I	2	POSITION SWITCH
B21-POSB1O	2	POSITION SWITCH
B21-POSB2I	2	POSITION SWITCH
B21-POSB2O	2	POSITION SWITCH
B21-POSB3I	2	POSITION SWITCH
B21-POSB3O	2	POSITION SWITCH
B21-POSC1I	3	POSITION SWITCH
B21-POSC1O	3	POSITION SWITCH
B21-POSC2I	3	POSITION SWITCH
B21-POSC2O	3	POSITION SWITCH
B21-POSC3I	3	POSITION SWITCH
B21-POSC3O	3	POSITION SWITCH
B21-POSD1I	4	POSITION SWITCH
B21-POSD1O	4	POSITION SWITCH
B21-POSD2I	4	POSITION SWITCH
B21-POSD2O	4	POSITION SWITCH
B21-POSD3I	4	POSITION SWITCH
B21-POSD3O	4	POSITION SWITCH
B21-POT011A	3	POSITION TRANSMITTER
B21-POT011B	3	POSITION TRANSMITTER
B21-POT011C	2	POSITION TRANSMITTER
B21-POT011D	1	POSITION TRANSMITTER
B21-POT011E	2	POSITION TRANSMITTER
B21-POT011F	1	POSITION TRANSMITTER
B21-POT011G	1	POSITION TRANSMITTER
B21-POT011H	3	POSITION TRANSMITTER
B21-POT011J	2	POSITION TRANSMITTER
B21-POT011K	1	POSITION TRANSMITTER

LIST OF EQUIPMENT INTERFACE WITH ESSENTIAL MUX SIGNALS
(In order of device - reading top to bottom)

DEVICE	DIV	DESCRIPTION
B21-POT011L	3	POSITION TRANSMITTER
B21-POT011M	3	POSITION TRANSMITTER
B21-POT011N	2	POSITION TRANSMITTER
B21-POT011P	1	POSITION TRANSMITTER
B21-POT011R	2	POSITION TRANSMITTER
B21-POT011S	2	POSITION TRANSMITTER
B21-POT011T	1	POSITION TRANSMITTER
B21-POT011U	3	POSITION TRANSMITTER
B21-PT007A	1	PRESS TRANSMITTER
B21-PT007B	2	PRESS TRANSMITTER
B21-PT007C	3	PRESS TRANSMITTER
B21-PT007D	4	PRESS TRANSMITTER
B21-PT008A	1	PRESS TRANSMITTER
B21-PT008B	2	PRESS TRANSMITTER
B21-PT008C	3	PRESS TRANSMITTER
B21-PT009	1	PRESS TRANSMITTER
B21-PT025A	1	PRESS TRANSMITTER
B21-PT025B	2	PRESS TRANSMITTER
B21-PT025C	3	PRESS TRANSMITTER
B21-PT025D	4	PRESS TRANSMITTER
B21-PT028A	1	PRESS TRANSMITTER
B21-PT028B	2	PRESS TRANSMITTER
B21-PT028C	3	PRESS TRANSMITTER
B21-PT028D	4	PRESS TRANSMITTER
B21-PT301A	1	PRESS TRANSMITTER
B21-PT301B	2	PRESS TRANSMITTER
B21-PT301C	3	PRESS TRANSMITTER
B21-PT301D	4	PRESS TRANSMITTER
B21-TE012A	1	TEMP ELEMENT
B21-TE012B	2	TEMP ELEMENT
B21-TE012C	3	TEMP ELEMENT
B21-TE013A	1	TEMP ELEMENT
B21-TE013B	2	TEMP ELEMENT
B21-TE013C	3	TEMP ELEMENT
B21-TE014A	1	TEMP ELEMENT
B21-TE014B	2	TEMP ELEMENT
B21-TE014C	3	TEMP ELEMENT
B21-TE019A	1	TEMP ELEMENT
B21-TE019B	2	TEMP ELEMENT
B21-TE020A	1	TEMP ELEMENT
B21-TE020B	2	TEMP ELEMENT
B21-TE021A	1	TEMP ELEMENT
B21-TE021B	2	TEMP ELEMENT
B21-TE022A	1	TEMP ELEMENT
B21-TE022B	2	TEMP ELEMENT
B21-TE023A	1	TEMP ELEMENT
B21-TE023B	2	TEMP ELEMENT
B21-TE024A	1	TEMP ELEMENT
B21-TE024B	2	TEMP ELEMENT
C12-D005001	1	FMCRD 34-63 A QUAD
C12-D005001	2	FMCRD 34-63 A QUAD
C12-D005002	1	FMCRD 54-59 A QUAD
C12-D005002	2	FMCRD 54-59 A QUAD
C12-D005003	1	FMCRD 38-19 C QUAD
C12-D005003	2	FMCRD 38-19 C QUAD
C12-D005004	1	FMCRD 50-59 A QUAD
C12-D005004	2	FMCRD 50-59 A QUAD
C12-D005005	1	FMCRD 38-35 A QUAD
C12-D005005	2	FMCRD 38-35 A QUAD
C12-D005006	1	FMCRD 54-35 C QUAD
C12-D005006	2	FMCRD 54-35 C QUAD
C12-D005007	1	FMCRD 34-23 C QUAD
C12-D005007	2	FMCRD 34-23 C QUAD
C12-D005008	1	FMCRD 50-55 A QUAD
C12-D005008	2	FMCRD 50-55 A QUAD
C12-D005009	1	FMCRD 62-47 A QUAD
C12-D005009	2	FMCRD 62-47 A QUAD
C12-D005010	1	FMCRD 38-31 C QUAD
C12-D005010	2	FMCRD 38-31 C QUAD
C12-D005011	1	FMCRD 58-35 C QUAD
C12-D005011	2	FMCRD 58-35 C QUAD
C12-D005012	1	FMCRD 58-47 A QUAD
C12-D005012	2	FMCRD 58-47 A QUAD
C12-D005013	1	FMCRD 42-27 C QUAD
C12-D005013	2	FMCRD 42-27 C QUAD
C12-D005014	1	FMCRD 54-47 A QUAD
C12-D005014	2	FMCRD 54-47 A QUAD
C12-D005015	1	FMCRD 46-63 A QUAD
C12-D005015	2	FMCRD 46-63 A QUAD
C12-D005016	1	FMCRD 50-51 A QUAD
C12-D005016	2	FMCRD 50-51 A QUAD
C12-D005017	1	FMCRD 46-59 A QUAD
C12-D005017	2	FMCRD 46-59 A QUAD
C12-D005018	1	FMCRD 42-23 C QUAD
C12-D005018	2	FMCRD 42-23 C QUAD
C12-D005019	1	FMCRD 38-27 C QUAD
C12-D005019	2	FMCRD 38-27 C QUAD
C12-D005020	1	FMCRD 38-55 A QUAD
C12-D005020	2	FMCRD 38-55 A QUAD
C12-D005021	1	FMCRD 34-67 A QUAD
C12-D005021	2	FMCRD 34-67 A QUAD
C12-D005022	1	FMCRD 26-07 B QUAD
C12-D005022	2	FMCRD 26-07 B QUAD
C12-D005023	1	FMCRD 38-03 C QUAD
C12-D005023	2	FMCRD 38-03 C QUAD
C12-D005024	1	FMCRD 10-43 D QUAD
C12-D005024	2	FMCRD 10-43 D QUAD
C12-D005025	1	FMCRD 42-35 A QUAD
C12-D005025	2	FMCRD 42-35 A QUAD
C12-D005026	1	FMCRD 14-11 B QUAD

LIST OF EQUIPMENT INTERFACE WITH ESSENTIAL MUX SIGNALS
(In order of device - reading top to bottom)

DEVICE	DIV	DESCRIPTION
C12-D005026	2	FMCRD 14-11 B QUAD
C12-D005027	1	FMCRD 54-51 A QUAD
C12-D005027	2	FMCRD 54-51 A QUAD
C12-D005028	1	FMCRD 34-39 D QUAD
C12-D005028	2	FMCRD 34-39 D QUAD
C12-D005029	1	FMCRD 34-19 C QUAD
C12-D005029	2	FMCRD 34-19 C QUAD
C12-D005030	1	FMCRD 10-19 B QUAD
C12-D005030	2	FMCRD 10-19 B QUAD
C12-D005031	1	FMCRD 30-23 B QUAD
C12-D005031	2	FMCRD 30-23 B QUAD
C12-D005032	1	FMCRD 22-47 D QUAD
C12-D005032	2	FMCRD 22-47 D QUAD
C12-D005033	1	FMCRD 54-31 C QUAD
C12-D005033	2	FMCRD 54-31 C QUAD
C12-D005034	1	FMCRD 06-47 D QUAD
C12-D005034	2	FMCRD 06-47 D QUAD
C12-D005035	1	FMCRD 22-19 B QUAD
C12-D005035	2	FMCRD 22-19 B QUAD
C12-D005036	1	FMCRD 34-43 D QUAD
C12-D005036	2	FMCRD 34-43 D QUAD
C12-D005037	1	FMCRD 50-31 C QUAD
C12-D005037	2	FMCRD 50-31 C QUAD
C12-D005038	1	FMCRD 42-19 C QUAD
C12-D005038	2	FMCRD 42-19 C QUAD
C12-D005039	1	FMCRD 30-19 B QUAD
C12-D005039	2	FMCRD 30-19 B QUAD
C12-D005040	1	FMCRD 38-67 A QUAD
C12-D005040	2	FMCRD 38-67 A QUAD
C12-D005041	1	FMCRD 46-47 A QUAD
C12-D005041	2	FMCRD 46-47 A QUAD
C12-D005042	1	FMCRD 42-59 A QUAD
C12-D005042	2	FMCRD 42-59 A QUAD
C12-D005043	1	FMCRD 26-39 D QUAD
C12-D005043	2	FMCRD 26-39 D QUAD
C12-D005044	1	FMCRD 42-11 C QUAD
C12-D005044	2	FMCRD 42-11 C QUAD
C12-D005045	1	FMCRD 46-15 C QUAD
C12-D005045	2	FMCRD 46-15 C QUAD
C12-D005046	1	FMCRD 34-31 C QUAD
C12-D005046	2	FMCRD 34-31 C QUAD
C12-D005047	1	FMCRD 10-15 B QUAD
C12-D005047	2	FMCRD 10-15 B QUAD
C12-D005048	1	FMCRD 46-35 A QUAD
C12-D005048	2	FMCRD 46-35 A QUAD
C12-D005049	1	FMCRD 46-19 C QUAD
C12-D005049	2	FMCRD 46-19 C QUAD
C12-D005050	1	FMCRD 58-27 C QUAD
C12-D005050	2	FMCRD 58-27 C QUAD
C12-D005051	1	FMCRD 26-15 B QUAD
C12-D005051	2	FMCRD 26-15 B QUAD
C12-D005052	1	FMCRD 54-19 C QUAD
C12-D005052	2	FMCRD 54-19 C QUAD
C12-D005053	1	FMCRD 50-23 C QUAD
C12-D005053	2	FMCRD 50-23 C QUAD
C12-D005054	1	FMCRD 66-35 C QUAD
C12-D005054	2	FMCRD 66-35 C QUAD
C12-D005055	1	FMCRD 06-39 D QUAD
C12-D005055	2	FMCRD 06-39 D QUAD
C12-D005056	1	FMCRD 66-39 A QUAD
C12-D005056	2	FMCRD 66-39 A QUAD
C12-D005057	1	FMCRD 06-31 B QUAD
C12-D005057	2	FMCRD 06-31 B QUAD
C12-D005058	1	FMCRD 58-51 A QUAD
C12-D005058	2	FMCRD 58-51 A QUAD
C12-D005059	1	FMCRD 58-23 C QUAD
C12-D005059	2	FMCRD 58-23 C QUAD
C12-D005060	1	FMCRD 34-27 C QUAD
C12-D005060	2	FMCRD 34-27 C QUAD
C12-D005061	1	FMCRD 22-27 B QUAD
C12-D005061	2	FMCRD 22-27 B QUAD
C12-D005062	1	FMCRD 50-43 A QUAD
C12-D005062	2	FMCRD 50-43 A QUAD
C12-D005063	1	FMCRD 38-51 A QUAD
C12-D005063	2	FMCRD 38-51 A QUAD
C12-D005064	1	FMCRD 58-31 C QUAD
C12-D005064	2	FMCRD 58-31 C QUAD
C12-D005065	1	FMCRD 14-27 B QUAD
C12-D005065	2	FMCRD 14-27 B QUAD
C12-D005066	1	FMCRD 50-47 A QUAD
C12-D005066	2	FMCRD 50-47 A QUAD
C12-D005067	1	FMCRD 38-47 A QUAD
C12-D005067	2	FMCRD 38-47 A QUAD
C12-D005068	1	FMCRD 46-55 A QUAD
C12-D005068	2	FMCRD 46-55 A QUAD
C12-D005069	1	FMCRD 26-27 B QUAD
C12-D005069	2	FMCRD 26-27 B QUAD
C12-D005070	1	FMCRD 58-55 A QUAD
C12-D005070	2	FMCRD 58-55 A QUAD
C12-D005071	1	FMCRD 58-39 A QUAD
C12-D005071	2	FMCRD 58-39 A QUAD
C12-D005072	1	FMCRD 38-11 C QUAD
C12-D005072	2	FMCRD 38-11 C QUAD
C12-D005073	1	FMCRD 42-31 C QUAD
C12-D005073	2	FMCRD 42-31 C QUAD
C12-D005074	1	FMCRD 26-11 B QUAD
C12-D005074	2	FMCRD 26-11 B QUAD
C12-D005075	1	FMCRD 50-15 C QUAD
C12-D005075	2	FMCRD 50-15 C QUAD
C12-D005076	1	FMCRD 34-15 B QUAD

LIST OF EQUIPMENT INTERFACE WITH ESSENTIAL MUX SIGNALS
(In order of device - reading top to bottom)

DEVICE	DIV	DESCRIPTION
C12-D005076	2	FMCRD 34-15 B QUAD
C12-D005077	1	FMCRD 38-43 A QUAD
C12-D005077	2	FMCRD 38-43 A QUAD
C12-D005078	1	FMCRD 22-43 D QUAD
C12-D005078	2	FMCRD 22-43 D QUAD
C12-D005079	1	FMCRD 58-43 A QUAD
C12-D005079	2	FMCRD 58-43 A QUAD
C12-D005080	1	FMCRD 14-59 D QUAD
C12-D005080	2	FMCRD 14-59 D QUAD
C12-D005081	1	FMCRD 42-15 C QUAD
C12-D005081	2	FMCRD 42-15 C QUAD
C12-D005082	1	FMCRD 18-23 B QUAD
C12-D005082	2	FMCRD 18-23 B QUAD
C12-D005083	1	FMCRD 42-43 A QUAD
C12-D005083	2	FMCRD 42-43 A QUAD
C12-D005084	1	FMCRD 06-35 D QUAD
C12-D005084	2	FMCRD 06-35 D QUAD
C12-D005085	1	FMCRD 42-51 A QUAD
C12-D005085	2	FMCRD 42-51 A QUAD
C12-D005086	1	FMCRD 18-59 D QUAD
C12-D005086	2	FMCRD 18-59 D QUAD
C12-D005087	1	FMCRD 42-07 C QUAD
C12-D005087	2	FMCRD 42-07 C QUAD
C12-D005088	1	FMCRD 14-43 D QUAD
C12-D005088	2	FMCRD 14-43 D QUAD
C12-D005089	1	FMCRD 18-35 D QUAD
C12-D005089	2	FMCRD 18-35 D QUAD
C12-D005090	1	FMCRD 26-31 B QUAD
C12-D005090	2	FMCRD 26-31 B QUAD
C12-D005091	1	FMCRD 46-51 A QUAD
C12-D005091	2	FMCRD 46-51 A QUAD
C12-D005092	1	FMCRD 22-11 B QUAD
C12-D005092	2	FMCRD 22-11 B QUAD
C12-D005093	1	FMCRD 22-55 D QUAD
C12-D005093	2	FMCRD 22-55 D QUAD
C12-D005094	1	FMCRD 22-59 D QUAD
C12-D005094	2	FMCRD 22-59 D QUAD
C12-D005095	1	FMCRD 26-63 D QUAD
C12-D005095	2	FMCRD 26-63 D QUAD
C12-D005096	1	FMCRD 14-23 B QUAD
C12-D005096	2	FMCRD 14-23 B QUAD
C12-D005097	1	FMCRD 22-35 B QUAD
C12-D005097	2	FMCRD 22-35 B QUAD
C12-D005098	1	FMCRD 30-27 B QUAD
C12-D005098	2	FMCRD 30-27 B QUAD
C12-D005099	1	FMCRD 34-11 B QUAD
C12-D005099	2	FMCRD 34-11 B QUAD
C12-D005100	1	FMCRD 18-47 D QUAD
C12-D005100	2	FMCRD 18-47 D QUAD
C12-D005101	1	FMCRD 62-23 C QUAD
C12-D005101	2	FMCRD 62-23 C QUAD
C12-D005102	1	FMCRD 10-51 D QUAD
C12-D005102	2	FMCRD 10-51 D QUAD
C12-D005103	1	FMCRD 34-51 D QUAD
C12-D005103	2	FMCRD 34-51 D QUAD
C12-D005104	1	FMCRD 14-47 D QUAD
C12-D005104	2	FMCRD 14-47 D QUAD
C12-D005105	1	FMCRD 62-27 C QUAD
C12-D005105	2	FMCRD 62-27 C QUAD
C12-D005106	1	FMCRD 26-55 D QUAD
C12-D005106	2	FMCRD 26-55 D QUAD
C12-D005107	1	FMCRD 30-03 B QUAD
C12-D005107	2	FMCRD 30-03 B QUAD
C12-D005108	1	FMCRD 10-47 D QUAD
C12-D005108	2	FMCRD 10-47 D QUAD
C12-D005109	1	FMCRD 10-39 D QUAD
C12-D005109	2	FMCRD 10-39 D QUAD
C12-D005110	1	FMCRD 26-35 B QUAD
C12-D005110	2	FMCRD 26-35 B QUAD
C12-D005111	1	FMCRD 22-07 B QUAD
C12-D005111	2	FMCRD 22-07 B QUAD
C12-D005112	1	FMCRD 46-39 A QUAD
C12-D005112	2	FMCRD 46-39 A QUAD
C12-D005113	1	FMCRD 38-63 A QUAD
C12-D005113	2	FMCRD 38-63 A QUAD
C12-D005114	1	FMCRD 34-59 A QUAD
C12-D005114	2	FMCRD 34-59 A QUAD
C12-D005115	1	FMCRD 30-43 D QUAD
C12-D005115	2	FMCRD 30-43 D QUAD
C12-D005116	1	FMCRD 62-35 C QUAD
C12-D005116	2	FMCRD 62-35 C QUAD
C12-D005117	1	FMCRD 22-39 D QUAD
C12-D005117	2	FMCRD 22-39 D QUAD
C12-D005118	1	FMCRD 42-63 A QUAD
C12-D005118	2	FMCRD 42-63 A QUAD
C12-D005119	1	FMCRD 46-11 C QUAD
C12-D005119	2	FMCRD 46-11 C QUAD
C12-D005120	1	FMCRD 46-27 C QUAD
C12-D005120	2	FMCRD 46-27 C QUAD
C12-D005121	1	FMCRD 30-35 B QUAD
C12-D005121	2	FMCRD 30-35 B QUAD
C12-D005122	1	FMCRD 38-07 C QUAD
C12-D005122	2	FMCRD 38-07 C QUAD
C12-D005123	1	FMCRD 18-27 B QUAD
C12-D005123	2	FMCRD 18-27 B QUAD
C12-D005124	1	FMCRD 42-47 A QUAD
C12-D005124	2	FMCRD 42-47 A QUAD
C12-D005125	1	FMCRD 34-07 B QUAD
C12-D005125	2	FMCRD 34-07 B QUAD
C12-D005126	1	FMCRD 62-31 C QUAD

LIST OF EQUIPMENT INTERFACE WITH ESSENTIAL MUX SIGNALS
(In order of device - reading top to bottom)

DEVICE	DIV	DESCRIPTION
C12-D005126	2	FMCRD 62-31 C QUAD
C12-D005127	1	FMCRD 06-23 B QUAD
C12-D005127	2	FMCRD 06-23 B QUAD
C12-D005128	1	FMCRD 46-31 C QUAD
C12-D005128	2	FMCRD 46-31 C QUAD
C12-D005129	1	FMCRD 10-31 B QUAD
C12-D005129	2	FMCRD 10-31 B QUAD
C12-D005130	1	FMCRD 62-43 A QUAD
C12-D005130	2	FMCRD 62-43 A QUAD
C12-D005131	1	FMCRD 30-55 D QUAD
C12-D005131	2	FMCRD 30-55 D QUAD
C12-D005132	1	FMCRD 26-43 D QUAD
C12-D005132	2	FMCRD 26-43 D QUAD
C12-D005133	1	FMCRD 14-35 D QUAD
C12-D005133	2	FMCRD 14-35 D QUAD
C12-D005134	1	FMCRD 30-47 D QUAD
C12-D005134	2	FMCRD 30-47 D QUAD
C12-D005135	1	FMCRD 14-15 B QUAD
C12-D005135	2	FMCRD 14-15 B QUAD
C12-D005136	1	FMCRD 18-31 B QUAD
C12-D005136	2	FMCRD 18-31 B QUAD
C12-D005137	1	FMCRD 30-51 D QUAD
C12-D005137	2	FMCRD 30-51 D QUAD
C12-D005138	1	FMCRD 66-31 C QUAD
C12-D005138	2	FMCRD 66-31 C QUAD
C12-D005139	1	FMCRD 30-15 B QUAD
C12-D005139	2	FMCRD 30-15 B QUAD
C12-D005140	1	FMCRD 50-19 C QUAD
C12-D005140	2	FMCRD 50-19 C QUAD
C12-D005141	1	FMCRD 02-35 D QUAD
C12-D005141	2	FMCRD 02-35 D QUAD
C12-D005142	1	FMCRD 46-43 A QUAD
C12-D005142	2	FMCRD 46-43 A QUAD
C12-D005143	1	FMCRD 26-19 B QUAD
C12-D005143	2	FMCRD 26-19 B QUAD
C12-D005144	1	FMCRD 18-15 B QUAD
C12-D005144	2	FMCRD 18-15 B QUAD
C12-D005145	1	FMCRD 06-43 D QUAD
C12-D005145	2	FMCRD 06-43 D QUAD
C12-D005146	1	FMCRD 30-59 D QUAD
C12-D005146	2	FMCRD 30-59 D QUAD
C12-D005147	1	FMCRD 18-43 D QUAD
C12-D005147	2	FMCRD 18-43 D QUAD
C12-D005148	1	FMCRD 38-59 A QUAD
C12-D005148	2	FMCRD 38-59 A QUAD
C12-D005149	1	FMCRD 22-15 B QUAD
C12-D005149	2	FMCRD 22-15 B QUAD
C12-D005150	1	FMCRD 54-27 C QUAD
C12-D005150	2	FMCRD 54-27 C QUAD
C12-D005151	1	FMCRD 26-51 D QUAD
C12-D005151	2	FMCRD 26-51 D QUAD
C12-D005152	1	FMCRD 10-35 D QUAD
C12-D005152	2	FMCRD 10-35 D QUAD
C12-D005153	1	FMCRD 30-07 B QUAD
C12-D005153	2	FMCRD 30-07 B QUAD
C12-D005154	1	FMCRD 30-31 B QUAD
C12-D005154	2	FMCRD 30-31 B QUAD
C12-D005155	1	FMCRD 18-51 D QUAD
C12-D005155	2	FMCRD 18-51 D QUAD
C12-D005156	1	FMCRD 18-39 D QUAD
C12-D005156	2	FMCRD 18-39 D QUAD
C12-D005157	1	FMCRD 14-55 D QUAD
C12-D005157	2	FMCRD 14-55 D QUAD
C12-D005158	1	FMCRD 30-39 D QUAD
C12-D005158	2	FMCRD 30-39 D QUAD
C12-D005159	1	FMCRD 30-11 B QUAD
C12-D005159	2	FMCRD 30-11 B QUAD
C12-D005160	1	FMCRD 26-23 B QUAD
C12-D005160	2	FMCRD 26-23 B QUAD
C12-D005161	1	FMCRD 18-55 D QUAD
C12-D005161	2	FMCRD 18-55 D QUAD
C12-D005162	1	FMCRD 18-11 B QUAD
C12-D005162	2	FMCRD 18-11 B QUAD
C12-D005163	1	FMCRD 14-51 D QUAD
C12-D005163	2	FMCRD 14-51 D QUAD
C12-D005164	1	FMCRD 18-19 B QUAD
C12-D005164	2	FMCRD 18-19 B QUAD
C12-D005165	1	FMCRD 10-23 B QUAD
C12-D005165	2	FMCRD 10-23 B QUAD
C12-D005166	1	FMCRD 02-31 B QUAD
C12-D005166	2	FMCRD 02-31 B QUAD
C12-D005167	1	FMCRD 34-35 B QUAD
C12-D005167	2	FMCRD 34-35 B QUAD
C12-D005168	1	FMCRD 54-43 A QUAD
C12-D005168	2	FMCRD 54-43 A QUAD
C12-D005169	1	FMCRD 06-27 B QUAD
C12-D005169	2	FMCRD 06-27 B QUAD
C12-D005170	1	FMCRD 54-39 A QUAD
C12-D005170	2	FMCRD 54-39 A QUAD
C12-D005171	1	FMCRD 10-55 D QUAD
C12-D005171	2	FMCRD 10-55 D QUAD
C12-D005172	1	FMCRD 38-23 C QUAD
C12-D005172	2	FMCRD 38-23 C QUAD
C12-D005173	1	FMCRD 22-63 D QUAD
C12-D005173	2	FMCRD 22-63 D QUAD
C12-D005174	1	FMCRD 42-39 A QUAD
C12-D005174	2	FMCRD 42-39 A QUAD
C12-D005175	1	FMCRD 34-03 B QUAD
C12-D005175	2	FMCRD 34-03 B QUAD
C12-D005176	1	FMCRD 10-27 B QUAD

LIST OF EQUIPMENT INTERFACE WITH ESSENTIAL MUX SIGNALS
(In order of device - reading top to bottom)

DEVICE	DIV	DESCRIPTION
C12-D005176	2	FMCRD 10-27 B QUAD
C12-D005177	1	FMCRD 30-67 D QUAD
C12-D005177	2	FMCRD 30-67 D QUAD
C12-D005178	1	FMCRD 46-23 C QUAD
C12-D005178	2	FMCRD 46-23 C QUAD
C12-D005179	1	FMCRD 02-39 D QUAD
C12-D005179	2	FMCRD 02-39 D QUAD
C12-D005180	1	FMCRD 14-31 B QUAD
C12-D005180	2	FMCRD 14-31 B QUAD
C12-D005181	1	FMCRD 14-39 D QUAD
C12-D005181	2	FMCRD 14-39 D QUAD
C12-D005182	1	FMCRD 22-31 B QUAD
C12-D005182	2	FMCRD 22-31 B QUAD
C12-D005183	1	FMCRD 62-39 A QUAD
C12-D005183	2	FMCRD 62-39 A QUAD
C12-D005184	1	FMCRD 34-47 D QUAD
C12-D005184	2	FMCRD 34-47 D QUAD
C12-D005185	1	FMCRD 58-19 C QUAD
C12-D005185	2	FMCRD 58-19 C QUAD
C12-D005186	1	FMCRD 22-51 D QUAD
C12-D005186	2	FMCRD 22-51 D QUAD
C12-D005187	1	FMCRD 50-35 C QUAD
C12-D005187	2	FMCRD 50-35 C QUAD
C12-D005188	1	FMCRD 54-11 C QUAD
C12-D005188	2	FMCRD 54-11 C QUAD
C12-D005189	1	FMCRD 38-15 C QUAD
C12-D005189	2	FMCRD 38-15 C QUAD
C12-D005190	1	FMCRD 42-55 A QUAD
C12-D005190	2	FMCRD 42-55 A QUAD
C12-D005191	1	FMCRD 38-39 A QUAD
C12-D005191	2	FMCRD 38-39 A QUAD
C12-D005192	1	FMCRD 54-23 C QUAD
C12-D005192	2	FMCRD 54-23 C QUAD
C12-D005193	1	FMCRD 50-39 A QUAD
C12-D005193	2	FMCRD 50-39 A QUAD
C12-D005194	1	FMCRD 26-47 D QUAD
C12-D005194	2	FMCRD 26-47 D QUAD
C12-D005195	1	FMCRD 46-07 C QUAD
C12-D005195	2	FMCRD 46-07 C QUAD
C12-D005196	1	FMCRD 22-23 B QUAD
C12-D005196	2	FMCRD 22-23 B QUAD
C12-D005197	1	FMCRD 54-15 C QUAD
C12-D005197	2	FMCRD 54-15 C QUAD
C12-D005198	1	FMCRD 34-55 A QUAD
C12-D005198	2	FMCRD 34-55 A QUAD
C12-D005199	1	FMCRD 50-11 C QUAD
C12-D005199	2	FMCRD 50-11 C QUAD
C12-D005200	1	FMCRD 26-59 D QUAD
C12-D005200	2	FMCRD 26-59 D QUAD
C12-D005201	1	FMCRD 58-15 C QUAD
C12-D005201	2	FMCRD 58-15 C QUAD
C12-D005202	1	FMCRD 50-27 C QUAD
C12-D005202	2	FMCRD 50-27 C QUAD
C12-D005203	1	FMCRD 14-19 B QUAD
C12-D005203	2	FMCRD 14-19 B QUAD
C12-D005204	1	FMCRD 54-55 A QUAD
C12-D005204	2	FMCRD 54-55 A QUAD
C12-D005205	1	FMCRD 30-63 D QUAD
C12-D005205	2	FMCRD 30-63 D QUAD
C12-F041	1	SO VALVE
C12-F042	2	SO VALVE
C12-F043	2	AO VALVE
C12-F044	2	AO VALVE
C12-F047	1	AO VALVE
C12-F048A	1	AO VALVE
C12-F048B	2	AO VALVE
C12-F049A	1	AO VALVE
C12-F049B	2	AO VALVE
C12-PT011A	1	PRESS TRANSMITTER
C12-PT011B	2	PRESS TRANSMITTER
C12-PT011C	3	PRESS TRANSMITTER
C12-PT011D	4	PRESS TRANSMITTER
E11-C001A	1	RHR PUMP
E11-C001B	2	RHR PUMP
E11-C001C	3	RHR PUMP
E11-C002A	1	SEAL WATER PUMP
E11-C002B	2	SEAL WATER PUMP
E11-C002C	3	SEAL WATER PUMP
E11-F001A	1	MO GATE VALVE
E11-F001B	2	MO GATE VALVE
E11-F001C	3	MO GATE VALVE
E11-F004A	1	MO GLOBE VALVE
E11-F004B	2	MO GLOBE VALVE
E11-F004C	3	MO GLOBE VALVE
E11-F005A	1	MO GATE VALVE
E11-F005B	2	MO GATE VALVE
E11-F005C	3	MO GATE VALVE
E11-F006A	1	AO CHECK VALVE
E11-F006B	2	AO CHECK VALVE
E11-F006C	3	AO CHECK VALVE
E11-F007B	2	MAN OPER GATE VALVE
E11-F007C	3	MAN OPER GATE VALVE
E11-F008A	1	MO GATE VALVE
E11-F008B	2	MO GATE VALVE
E11-F008C	3	MO GATE VALVE
E11-F009A	1	MAN OPER GATE VALVE
E11-F009B	2	MAN OPER GATE VALVE
E11-F009C	3	MAN OPER GATE VALVE
E11-F010A	1	MO GATE VALVE
E11-F010B	2	MO GATE VALVE

LIST OF EQUIPMENT INTERFACE WITH ESSENTIAL MUX SIGNALS
(In order of device - reading top to bottom)

DEVICE	DIV	DESCRIPTION
E11-F010C	3	MO GATE VALVE
E11-F011A	2	MO GATE VALVE (RHR ISOL)
E11-F011B	3	MO GATE VALVE (RHR ISOL)
E11-F011C	1	MO GATE VALVE (RHR ISOL)
E11-F012A	1	MO GATE VALVE
E11-F012B	2	MO GATE VALVE
E11-F012C	3	MO GATE VALVE
E11-F013A	1	MO GLOBE VALVE
E11-F013B	2	MO GLOBE VALVE
E11-F013C	3	MO GLOBE VALVE
E11-F014B	2	MO GATE VALVE
E11-F014C	3	MO GATE VALVE
E11-F015B	2	MO GATE VALVE
E11-F015C	3	MO GATE VALVE
E11-F017B	2	MO GLOBE VALVE
E11-F017C	3	MO GLOBE VALVE
E11-F018B	2	MO GATE VALVE
E11-F018C	3	MO GATE VALVE
E11-F019B	2	MO GATE VALVE
E11-F019C	3	MO GATE VALVE
E11-F021A	1	MO GATE VALVE
E11-F021B	2	MO GATE VALVE
E11-F021C	3	MO GATE VALVE
E11-F029A	1	MO GLOBE VALVE
E11-F029B	2	MO GLOBE VALVE
E11-F029C	3	MO GLOBE VALVE
E11-F030A	1	MO GATE VALVE
E11-F030B	2	MO GATE VALVE
E11-F030C	3	MO GATE VALVE
E11-F031A	1	MO GLOBE VALVE
E11-F031B	2	MO GLOBE VALVE
E11-F031C	3	MO GLOBE VALVE
E11-F036A	1	AO GLOBE VALVE
E11-F036B	2	AO GLOBE VALVE
E11-F036C	3	AO GLOBE VALVE
E11-F043A	1	SO VALVE
E11-F043B	2	SO VALVE
E11-F043C	3	SO VALVE
E11-F044A	1	SO VALVE
E11-F044B	2	SO VALVE
E11-F044C	3	SO VALVE
E11-F045A	1	MO GLOBE VALVE
E11-F046A	1	MO GATE VALVE
E11-FT008A1	1	FLOW TRANSMITTER
E11-FT008A2	1	FLOW TRANSMITTER
E11-FT008B1	2	FLOW TRANSMITTER
E11-FT008B2	2	FLOW TRANSMITTER
E11-FT008C1	3	FLOW TRANSMITTER
E11-FT008C2	3	FLOW TRANSMITTER
E11-FT012B	2 *	FLOW TRANSMITTER

DEVICE	DIV	DESCRIPTION
E11-POT303A	1	POSITION TRANSMITTER
E11-POT303B	2	POSITION TRANSMITTER
E11-POT303C	3	POSITION TRANSMITTER
E11-PT004A	1	PRESS TRANSMITTER
E11-PT004B	2	PRESS TRANSMITTER
E11-PT004C	3	PRESS TRANSMITTER
E11-PT004E	1	PRESS TRANSMITTER
E11-PT004F	2	PRESS TRANSMITTER
E11-PT004G	3	PRESS TRANSMITTER
E11-PT005A	1 *	PRESS TRANSMITTER
E11-PT005B	2 *	PRESS TRANSMITTER
E11-PT005C	3 *	PRESS TRANSMITTER
E11-PT009A	1	PRESS TRANSMITTER
E11-PT009B	2	PRESS TRANSMITTER
E11-PT009C	3	PRESS TRANSMITTER
E22-C001B	2	PUMP
E22-C001C	3	PUMP
E22-F001B	2	MO GATE VALVE
E22-F001C	3	MO GATE VALVE
E22-F003B	2	MO GATE VALVE
E22-F003C	3	MO GATE VALVE
E22-F004B	2	AIR OP CHECK VALVE
E22-F004C	3	AIR OP CHECK VALVE
E22-F005B	2	MAN OPER GATE VALVE
E22-F005C	3	MAN OPER GATE VALVE
E22-F006B	2	MO GLOBE VALVE
E22-F006C	3	MO GLOBE VALVE
E22-F008B	2	MO GLOBE VALVE
E22-F008C	3	MO GLOBE VALVE
E22-F009B	2	MO GLOBE VALVE
E22-F009C	3	MO GLOBE VALVE
E22-F010B	2	MO GATE VALVE
E22-F010C	3	MO GATE VALVE
E22-F019B	2	EQUALIZING VALVE
E22-F019C	3	EQUALIZING VALVE
E22-FT008B1	2	FLOW TRANSMITTER
E22-FT008B2	2	FLOW TRANSMITTER
E22-FT008C1	3	FLOW TRANSMITTER
E22-FT008C2	3	FLOW TRANSMITTER
E22-PT003B	2	PRESSURE TRANSMITTER
E22-PT003C	3	PRESSURE TRANSMITTER
E22-PT006A	2	PRESSURE TRANSMITTER
E22-PT006C	3	PRESSURE TRANSMITTER
E22-PT006F	2	PRESSURE TRANSMITTER
E22-PT006G	3	PRESSURE TRANSMITTER
E22-PT007B	2	PRESSURE TRANSMITTER
E22-PT007C	3	PRESSURE TRANSMITTER
E31-DPT006A	1	DIFF PRESS TRANSMITTER
E31-DPT006B	2	DIFF PRESS TRANSMITTER
E31-DPT006C	3	DIFF PRESS TRANSMITTER

*denotes change from previous version

LIST OF EQUIPMENT INTERFACE WITH ESSENTIAL MUX SIGNALS
(In order of device - reading top to bottom)

DEVICE	DIV	DESCRIPTION
E31-DPT006D	4	DIFF PRESS TRANSMITTER
E31-DPT013A	1	DIFF PRESS TRANSMITTER
E31-DPT013B	2	DIFF PRESS TRANSMITTER
E31-DPT013C	3	DIFF PRESS TRANSMITTER
E31-DPT013D	4	DIFF PRESS TRANSMITTER
E31-DPT014A	1	DIFF PRESS TRANSMITTER
E31-DPT014B	2	DIFF PRESS TRANSMITTER
E31-DPT014C	3	DIFF PRESS TRANSMITTER
E31-DPT014D	4	DIFF PRESS TRANSMITTER
E31-DPT015A	1	DIFF PRESS TRANSMITTER
E31-DPT015B	2	DIFF PRESS TRANSMITTER
E31-DPT015C	3	DIFF PRESS TRANSMITTER
E31-DPT015D	4	DIFF PRESS TRANSMITTER
E31-DPT016A	1	DIFF PRESS TRANS
E31-DPT016B	2	DIFF PRESS TRANS
E31-DPT016C	3	DIFF PRESS TRANS
E31-DPT016D	4	DIFF PRESS TRANS
E31-DPT016E	1	DIFF PRESS TRANS
E31-DPT016F	2	DIFF PRESS TRANS
E31-DPT016G	3	DIFF PRESS TRANS
E31-DPT016H	4	DIFF PRESS TRANS
E31-DPT016J	1	DIFF PRESS TRANS
E31-DPT016K	2	DIFF PRESS TRANS
E31-DPT016L	3	DIFF PRESS TRANS
E31-DPT016M	4	DIFF PRESS TRANS
E31-DPT016N	1	DIFF PRESS TRANS
E31-DPT016P	2	DIFF PRESS TRANS
E31-DPT016R	3	DIFF PRESS TRANS
E31-DPT016S	4	DIFF PRESS TRANS
E31-F002	1	A O SOLENOID VALVE (OB)
E31-F003	2	A O SOLENOID VALVE (1B)
E31-F004	2	A O SOLENOID VALVE
E31-F005	1	A O SOLENOID VALVE
E31-PT007A	1	PRESS TRANSMITTER
E31-PT007B	2	PRESS TRANSMITTER
E31-PT007C	3	PRESS TRANSMITTER
E31-PT007D	4	PRESS TRANSMITTER
E31-TE005A	1	TEMP ELEMENT
E31-TE005B	2	TEMP ELEMENT
E31-TE005C	3	TEMP ELEMENT
E31-TE005D	4	TEMP ELEMENT
E31-TE008A	1	TEMP ELEMENT
E31-TE008B	2	TEMP ELEMENT
E31-TE008C	3	TEMP ELEMENT
E31-TE008D	4	TEMP ELEMENT
E31-TE008E	1	TEMP ELEMENT
E31-TE008F	2	TEMP ELEMENT
E31-TE008G	3	TEMP ELEMENT
E31-TE008H	4	TEMP ELEMENT
E31-TE008J	1	TEMP ELEMENT
E31-TE008K	2	TEMP ELEMENT
E31-TE008L	3	TEMP ELEMENT
E31-TE008M	4	TEMP ELEMENT
E31-TE009A	1	TEMP ELEMENT
E31-TE009B	2	TEMP ELEMENT
E31-TE009C	3	TEMP ELEMENT
E31-TE009D	4	TEMP ELEMENT
E31-TE009E	1	TEMP ELEMENT
E31-TE009F	2	TEMP ELEMENT
E31-TE009G	3	TEMP ELEMENT
E31-TE009H	4	TEMP ELEMENT
E31-TE009J	1	TEMP ELEMENT
E31-TE009K	2	TEMP ELEMENT
E31-TE009L	3	TEMP ELEMENT
E31-TE009M	4	TEMP ELEMENT
E31-TE010A	1	TEMP ELEMENT
E31-TE010B	2	TEMP ELEMENT
E31-TE010C	3	TEMP ELEMENT
E31-TE010D	4	TEMP ELEMENT
E31-TE011A	1	TEMP ELEMENT
E31-TE011B	2	TEMP ELEMENT
E31-TE011C	3	TEMP ELEMENT
E31-TE011D	4	TEMP ELEMENT
E31-TE012A	1	TEMP ELEMENT
E31-TE012B	2	TEMP ELEMENT
E31-TE012C	3	TEMP ELEMENT
E31-TE012D	4	TEMP ELEMENT
E31-TE018A	1	TEMP ELEMENT
E31-TE019A	1	TEMP ELEMENT
E31-TE020A	1	TEMP ELEMENT
E31-TE020B	2	TEMP ELEMENT
E31-TE020C	3	TEMP ELEMENT
E31-TE020D	4	TEMP ELEMENT
E31-TE021A	1	MSL TEMP SENSORS
E31-TE021B	2	MSL TEMP SENSORS
E31-TE021C	3	MSL TEMP SENSORS
E31-TE021D	4	MSL TEMP SENSORS
E31-TE022A	1	TEMP ELEMENT
E31-TE022B	2	TEMP ELEMENT
E31-TE022C	3	TEMP ELEMENT
E31-TE022D	4	TEMP ELEMENT
E31-TE023A	1	TEMP ELEMENT
E31-TE023B	2	TEMP ELEMENT
E31-TE023C	3	TEMP ELEMENT
E31-TE023D	4	TEMP ELEMENT
E31-TE024A	1	TEMP ELEMENT
E31-TE024B	2	TEMP ELEMENT
E31-TE024C	3	TEMP ELEMENT
E31-TE024D	4	TEMP ELEMENT
E31-TE025A	1	TEMP ELEMENT

LIST OF EQUIPMENT INTERFACE WITH ESSENTIAL MUX SIGNALS
(In order of device - reading top to bottom)

DEVICE	DIV	DESCRIPTION
E31-TE025B	2	TEMP ELEMENT
E31-TE025C	3	TEMP ELEMENT
E31-TE025D	4	TEMP ELEMENT
E31-TE026A	1	TEMP ELEMENT
E31-TE026B	2	TEMP ELEMENT
E31-TE026C	3	TEMP ELEMENT
E31-TE026D	4	TEMP ELEMENT
E31-TE027A	1	TEMP ELEMENT
E31-TE027B	2	TEMP ELEMENT
E31-TE027C	3	TEMP ELEMENT
E31-TE027D	4	TEMP ELEMENT
E31-TE028A	1	TEMP ELEMENT
E31-TE028B	2	TEMP ELEMENT
E31-TE028C	3	TEMP ELEMENT
E31-TE028D	4	TEMP ELEMENT
E31-TE029A	1	TEMP ELEMENT
E31-TE029B	2	TEMP ELEMENT
E31-TE029C	3	TEMP ELEMENT
E31-TE029D	4	TEMP ELEMENT
E31-TE031A	1	TEMP ELEMENT
E31-TE031E	1	TEMP ELEMENT
E31-TE031J	1	TEMP ELEMENT
E31-TE032A	1	TEMP ELEMENT
E31-TE032E	1	TEMP ELEMENT
E31-TE032J	1	TEMP ELEMENT
E31-TE033A	1	TEMP ELEMENT
E31-TE033E	1	TEMP ELEMENT
E31-TE033J	1	TEMP ELEMENT
E31-TE034A	1	TEMP ELEMENT
E31-TE034E	1	TEMP ELEMENT
E31-TE034J	1	TEMP ELEMENT
E51-C002	1	TURBINE
E51-C901*	1	VACUUM PUMP
E51-C902*	1	CONDENSATE PUMP
E51-F001	1	MO GATE VALVE
E51-F004	1	MO GATE VALVE
E51-F005	1	AO CHECK VALVE
E51-F006	1	MO GATE VALVE
E51-F008	1	MO GLOBE VALVE
E51-F009	1	MO GLOBE VALVE
E51-F011	1	MO GLOBE VALVE
E51-F012	1	MO GLOBE VALVE
E51-F026	1	AO GLOBE VALVE
E51-F031	1	SO DIAPHRAM VALVE
E51-F032	1	SO DIAPHRAM VALVE
E51-F035	1	MO GATE VALVE
E51-F036	2	MO GATE VALVE
E51-F037	1	MO GLOBE VALVE
E51-F039	1	MO GATE VALVE
E51-F040	1	AO GLOBE VALVE
E51-F041	1	AO GLOBE VALVE
E51-F045	1	MO GLOBE VALVE
E51-F047	1	MO GATE VALVE
E51-F048	1	MO GLOBE VALVE
E51-F058	1	AO GLOBE VALVE
E51-FT007-1	1	FLOW TRANSMITTER
E51-FT007-2	1	FLOW TRANSMITTER
E51-LS011	1	LEVEL SWITCH
E51-POT901	1	POSITION TRANSMITTER
E51-PT001	1	PRESS TRANSMITTER
E51-PT002	1	PRESS TRANSMITTER
E51-PT005	1	PRESS TRANSMITTER
E51-PT008	1	PRESS TRANSMITTER
E51-PT009	1	PRESS TRANSMITTER
E51-PT013A	1	PRESS TRANSMITTER
E51-PT013E	1	PRESS TRANSMITTER
E51-PT014A	1	PRESS TRANSMITTER
E51-PT014B	2	PRESS TRANSMITTER
E51-PT014E	1	PRESS TRANSMITTER
E51-PT014F	2	PRESS TRANSMITTER
E51-SE997*	1	SPEED ELEMENT
G31-F002	2	MO GATE VALVE
G31-F003	1	MO GATE VALVE
G31-F013	2	MO GATE VALVE
G31-F030	1	MO VALVE
G31-F031	1	MO VALVE
G31-F065	2	AO VALVE
G31-F066	1	AO VALVE
G31-TE006	1 *	TEMP ELEMENT
G41-C001A	1	PUMP
G41-C001B	2	PUMP
G41-F005A	1 *	MO GATE VALVE
G41-F005B	2 *	MO GATE VALVE
G41-F013	1	MO GATE VALVE
G41-F021A	1	MO GLOBE VALVE
G41-F021B	2	MO GLOBE VALVE
G41-F038	1 *	MO GLOBE VALVE
G41-FT006A	1	FLOW TRANSMITTER
G41-FT006B	2	FLOW TRANSMITTER
G41-LT020A	1 *	LEVEL TRANSMITTER
G41-LT020B	2 *	LEVEL TRANSMITTER
G41-PT003A	1	PRESS TRANSMITTER
G41-PT003B	2	PRESS TRANSMITTER
G51-C001	1	PUMP
G51-F001	2	MO GATE VALVE
G51-F004	1	AO VALVE
G51-F006	2	MO GATE VALVE
G51-F007	1	MO GATE VALVE
G51-F020	1	MO GATE VALVE
K11-C001A	1	LCW PUMP - DRYWELL SUMP

LIST OF EQUIPMENT INTERFACE WITH ESSENTIAL MUX SIGNALS
(In order of device - reading top to bottom)

DEVICE	DIV	DESCRIPTION
K11-C001B	2	LCW PUMP - DRYWELL SUMP
K11-C101A	1	HCW PUMP - DRYWELL SUMP
K11-C101B	2	HCW PUMP - DRYWELL SUMP
K11-C102A	1	HCW PUMP FOR SUMP (A)
K11-C102B	2	HCW PUMP FOR SUMP (B)
K11-C102C	3	HCW PUMP FOR SUMP (C)
K11-C102D	1	HCW PUMP FOR SUMP (D)
K11-C102E	2	HCW PUMP FOR SUMP (E)
K11-C102F	1	HCW PUMP FOR SUMP (A)
K11-C102G	2	HCW PUMP FOR SUMP (B)
K11-C102H	3	HCW PUMP FOR SUMP (C)
K11-C102I	1	HCW PUMP FOR SUMP (D)
K11-C102J	2	HCW PUMP FOR SUMP (E)
P13-LT001A	1 *	COND STORAGE POOL LEVEL*
P13-LT001B	2 *	COND STORAGE POOL LEVEL*
P13-LT001C	3 *	COND STORAGE POOL LEVEL*
P13-LT001D	4 *	COND STORAGE POOL LEVEL*
P21-C001A	1	PUMP
P21-C001B	2	PUMP
P21-C001C	3	PUMP
P21-C001E	1	PUMP
P21-C001F	2	PUMP
P21-C001G	3	PUMP
P21-DPS033A	1	DIFF PRESS SWITCH
P21-DPS033B	2	DIFF PRESS SWITCH
P21-DPS033C	3	DIFF PRESS SWITCH
P21-DPS034A	1	DIFF PRESS SWITCH
P21-DPS034B	2	DIFF PRESS SWITCH
P21-DPS034C	3	DIFF PRESS SWITCH
P21-E/P605A	1	E/P CONVERTER
P21-E/P605B	2	E/P CONVERTER
P21-E/P605C	3	E/P CONVERTER
P21-F004A	1	MO GATE VALVE
P21-F004B	2	MO GATE VALVE
P21-F004C	3	MO GATE VALVE
P21-F004E	1	MO GATE VALVE
P21-F004F	2	MO GATE VALVE
P21-F004G	3	MO GATE VALVE
P21-F004J	1	MO GATE VALVE
P21-F004K	2	MO GATE VALVE
P21-F004L	3	MO GATE VALVE
P21-F006A	1	TEMP CONTROL VALVE
P21-F006B	2	TEMP CONTROL VALVE
P21-F006C	3	TEMP CONTROL VALVE
P21-F010A	1	TEMP CONTROL VALVE
P21-F010B	2	TEMP CONTROL VALVE
P21-F010C	3	TEMP CONTROL VALVE
P21-F013A	1	MO GLOBE VALVE
P21-F013B	2	MO GLOBE VALVE
P21-F013C	3	MO GLOBE VALVE
P21-F018A	1 *	MO GLOBE VALVE
P21-F018B	2 *	MO GLOBE VALVE
P21-F018C	3 *	MO GLOBE VALVE
P21-F025A	1	MO GLOBE VALVE
P21-F025B	2	MO GLOBE VALVE
P21-F025C	3	MO GLOBE VALVE
P21-F025E	1	MO GLOBE VALVE
P21-F025F	2	MO GLOBE VALVE
P21-F025G	3	MO GLOBE VALVE
P21-F055A	1	MO GATE VALVE
P21-F055B	2	MO GATE VALVE
P21-F055C	3	MO GATE VALVE
P21-F055E	1	MO GATE VALVE
P21-F055F	2	MO GATE VALVE
P21-F055G	3	MO GATE VALVE
P21-F072A	1	AO VALVE
P21-F072B	2	AO VALVE
P21-F072C	3	AO VALVE
P21-F072E	1	AO VALVE
P21-F072F	2	AO VALVE
P21-F072G	3	AO VALVE
P21-F074A	1	MO GATE VALVE
P21-F074B	2	MO GATE VALVE
P21-F074C	3	MO GATE VALVE
P21-F075A	1	MO GATE VALVE
P21-F075B	1	MO GATE VALVE
P21-F080A	2	MO GATE VALVE
P21-F080B	2	MO GATE VALVE
P21-F081A	1	MO GATE VALVE
P21-F081B	1	MO GATE VALVE
P21-F082A	1	MO GATE VALVE
P21-F082B	2	MO GATE VALVE
P21-F082C	3	MO GATE VALVE
P21-F084A	1	MAN OPER GATE VALVE
P21-F084B	2	MAN OPER GATE VALVE
P21-FT006A	1	FLOW TRANSMITTER
P21-FT006B	2	FLOW TRANSMITTER
P21-FT006C	3	FLOW TRANSMITTER
P21-FT008A	1	FLOW TRANSMITTER
P21-FT008B	2	FLOW TRANSMITTER
P21-FT008C	3	FLOW TRANSMITTER
P21-FT042A	1	FLOW TRANSMITTER
P21-FT042B	2	FLOW TRANSMITTER
P21-FT042C	3	FLOW TRANSMITTER
P21-LS015A	1	LEVEL SWITCH
P21-LS015B	2	LEVEL SWITCH
P21-LS015C	3	LEVEL SWITCH
P21-LT013A	1	LEVEL TRANSMITTER
P21-LT013B	2	LEVEL TRANSMITTER
P21-LT013C	3	LEVEL TRANSMITTER

LIST OF EQUIPMENT INTERFACE WITH ESSENTIAL MUX SIGNALS
(In order of device - reading top to bottom)

DEVICE	DIV	DESCRIPTION
P21-LT014A	1	LEVEL TRANSMITTER
P21-LT014B	2	LEVEL TRANSMITTER
P21-LT014C	3	LEVEL TRANSMITTER
P21-LT014E	1	LEVEL TRANSMITTER
P21-LT014F	2	LEVEL TRANSMITTER
P21-LT014G	3	LEVEL TRANSMITTER
P21-LT014J	1	LEVEL TRANSMITTER
P21-LT014K	2	LEVEL TRANSMITTER
P21-LT014L	3	LEVEL TRANSMITTER
P21-PT004A	1	PRESS TRANSMITTER
P21-PT004B	2	PRESS TRANSMITTER
P21-PT004C	3	PRESS TRANSMITTER
P21-TE005A	1	TEMP ELEMENT
P21-TE005B	2	TEMP ELEMENT
P21-TE005C	3	TEMP ELEMENT
P21-TE009A	1	TEMP ELEMENT
P21-TE009B	2	TEMP ELEMENT
P21-TE009C	3	TEMP ELEMENT
P24-F053	1	MO GATE VALVE
P24-F141	2	MO GATE VALVE
P24-F142	1	MO GATE VALVE
P25 F016A	1	TEMP CONTROL VALVE
P25-C001A	1	HECW PUMP
P25-C001B	2	HECW PUMP
P25-C001C	3	HECW PUMP
P25-C001E	1	HECW PUMP
P25-C001F	2	HECW PUMP
P25-C001G	3	HECW PUMP
P25-D001A	1	REFRIGERATOR
P25-D001B	2	REFRIGERATOR
P25-D001C	3	REFRIGERATOR
P25-D001E	1	REFRIGERATOR
P25-D001F	2	REFRIGERATOR
P25-D001G	3	REFRIGERATOR
P25-DPT007A	1	DIFF PRESS TRANSMITTER
P25-DPT007B	2	DIFF PRESS TRANSMITTER
P25-DPT007C	3	DIFF PRESS TRANSMITTER
P25-F005B	2	TEMP CONTROL VALVE
P25-F005C	3	TEMP CONTROL VALVE
P25-F012A	1	PRESSURE CONTROL VALVE
P25-F012B	2	PRESSURE CONTROL VALVE
P25-F012C	3	PRESSURE CONTROL VALVE
P25-F016B	2	TEMP CONTROL VALVE
P25-F016C	3	TEMP CONTROL VALVE
P25-F022A	1	TEMP CONTROL VALVE
P25-F022B	2	TEMP CONTROL VALVE
P25-F022C	3	TEMP CONTROL VALVE
P25-F040A	1	AO VALVE
P25-F040B	2	AO VALVE
P25-F040C	3	AO VALVE
P25-FIS003A	1	FLOW IND SWITCH
P25-FIS003B	2	FLOW IND SWITCH
P25-FIS003C	3	FLOW IND SWITCH
P25-FIS003E	1	FLOW IND SWITCH
P25-FIS003F	2	FLOW IND SWITCH
P25-FIS003G	3	FLOW IND SWITCH
P25-TE005A	1	TEMP ELEMENT
P25-TE005B	2	TEMP ELEMENT
P25-TE005C	3	TEMP ELEMENT
P41-B001A	1	RCW HT EXCHANGER
P41-B001B	2	RCW HT EXCHANGER
P41-B001C	3	RCW HT EXCHANGER
P41-B001D	1	RCW HT EXCHANGER
P41-B001E	2	RCW HT EXCHANGER
P41-B001F	3	RCW HT EXCHANGER
P41-C001A	1	RSW PUMP
P41-C001B	2	RSW PUMP
P41-C001C	3	RSW PUMP
P41-C001D	1	RSW PUMP
P41-C001E	2	RSW PUMP
P41-C001F	3	RSW PUMP
P41-D001A	1	SE WATER STRAINER
P41-D001B	2	SE WATER STRAINER
P41-D001C	3	SE WATER STRAINER
P41-D001D	1	SE WATER STRAINER
P41-D001E	2	SE WATER STRAINER
P41-D001F	3	SE WATER STRAINER
P41-DPI005A	1	DIFF PRESS INDICATOR
P41-DPI005B	2	DIFF PRESS INDICATOR
P41-DPI005C	3	DIFF PRESS INDICATOR
P41-DPI005D	1	DIFF PRESS INDICATOR
P41-DPI005E	2	DIFF PRESS INDICATOR
P41-DPI005F	3	DIFF PRESS INDICATOR
P41-DPS006A	1	DIFF PRESS SWITCH
P41-DPS006B	2	DIFF PRESS SWITCH
P41-DPS006C	3	DIFF PRESS SWITCH
P41-DPS006D	1	DIFF PRESS SWITCH
P41-DPS006E	2	DIFF PRESS SWITCH
P41-DPS006F	3	DIFF PRESS SWITCH
P41-DPT004A	1	DIFF PRESS TRANS
P41-DPT004B	2	DIFF PRESS TRANS
P41-DPT004C	3	DIFF PRESS TRANS
P41-DPT004D	1	DIFF PRESS TRANS
P41-DPT004E	2	DIFF PRESS TRANS
P41-DPT004F	3	DIFF PRESS TRANS
P41-F003A	1	MO BUTTERFLY VLV
P41-F003B	2	MO BUTTERFLY VLV
P41-F003C	3	MO BUTTERFLY VLV
P41-F003D	1	MO BUTTERFLY VLV
P41-F003E	2	MO BUTTERFLY VLV

LIST OF EQUIPMENT INTERFACE WITH ESSENTIAL MUX SIGNALS
(In order of device - reading top to bottom)

DEVICE	DIV	DESCRIPTION
P41-F003F	3	MO BUTTERFLY VLV
P41-F004A	1	MO BUTTERFLY VLV
P41-F004B	2	MO BUTTERFLY VLV
P41-F004C	3	MO BUTTERFLY VLV
P41-F004D	1	MO BUTTERFLY VLV
P41-F004E	2	MO BUTTERFLY VLV
P41-F004F	3	MO BUTTERFLY VLV
P41-F005A	1	MO BUTTERFLY VLV
P41-F005B	2	MO BUTTERFLY VLV
P41-F005C	3	MO BUTTERFLY VLV
P41-F005D	1	MO BUTTERFLY VLV
P41-F005E	2	MO BUTTERFLY VLV
P41-F005F	3	MO BUTTERFLY VLV
P41-F006A	1	MO BUTTERFLY VLV
P41-F006B	2	MO BUTTERFLY VLV
P41-F006C	3	MO BUTTERFLY VLV
P41-F006D	1	MO BUTTERFLY VLV
P41-F006E	2	MO BUTTERFLY VLV
P41-F006F	3	MO BUTTERFLY VLV
P41-F009A	1	AO GLOBE VALVE
P41-F009B	2	AO GLOBE VALVE
P41-F009C	3	AO GLOBE VALVE
P41-F009D	1	AO GLOBE VALVE
P41-F009E	2	AO GLOBE VALVE
P41-F009F	3	AO GLOBE VALVE
P41-F011A	1	AO GLOBE VALVE
P41-F011B	2	AO GLOBE VALVE
P41-F011C	3	AO GLOBE VALVE
P41-F011D	1	AO GLOBE VALVE
P41-F011E	2	AO GLOBE VALVE
P41-F011F	3	AO GLOBE VALVE
P41-F014A	1	MO BUTTERFLY VLV
P41-F014B	2	MO BUTTERFLY VLV
P41-F014C	3	MO BUTTERFLY VLV
P41-PT003A	1	PRESS TRANSMITTER
P41-PT003B	2	PRESS TRANSMITTER
P41-PT003C	3	PRESS TRANSMITTER
P54-F007	1	MO GLOBE VALVE
P54-F018A	1	MO GLOBE VALVE
P54-F018B	2	MO GLOBE VALVE
P54-F024A	1	MO GLOBE VALVE
P54-F024B	2	MO GLOBE VALVE
P54-F027A	1	MO GLOBE VALVE
P54-F027B	2	MO GLOBE VALVE
P54-PIS005A	1	PRESS IND SWITCH
P54-PIS005B	2	PRESS IND SWITCH
P54-PT006A	1	PRESS TRANSMITTER
P54-PT006B	2	PRESS TRANSMITTER
R24 MCC C10	1	MOTOR CONTROL CENTER
R24 MCC C11	1	MOTOR CONTROL CENTER
R24 MCC C12	1	MOTOR CONTROL CENTER
R24 MCC C13	1	MOTOR CONTROL CENTER
R24 MCC C14	1	MOTOR CONTROL CENTER
R24 MCC C17	1	MOTOR CONTROL CENTER
R24 MCC D10	2	MOTOR CONTROL CENTER
R24 MCC D11	2	MOTOR CONTROL CENTER
R24 MCC D12	2	MOTOR CONTROL CENTER
R24 MCC D14	2	MOTOR CONTROL CENTER
R24 MCC D17	2	MOTOR CONTROL CENTER
R24 MCC E10	3	MOTOR CONTROL CENTER
R24 MCC E11	3	MOTOR CONTROL CENTER
R24 MCC E14	3	MOTOR CONTROL CENTER
R24 MCC E17	3	MOTOR CONTROL CENTER
R42-P005A	1	125 VDC NORM CHARGER
R42-P005B	2	125 VDC NORM CHARGER
R42-P005C	3	125 VDC NORM CHARGER
R42-P005D	4	125 VDC NORM CHARGER
R42-P006A	1	125 VDC NORM CHARGER
R42-P006B	2	125 VDC NORM CHARGER
R42-P006C	3	125 VDC NORM CHARGER
R42-P006D	4	125 VDC NORM CHARGER
R42-P007A	1	125 VDC CNTR DIST BD
R42-P007B	2	125 VDC CNTR DIST BD
R42-P007C	3	125 VDC CNTR DIST BD
R42-P007D	4	125 VDC CNTR DIST BD
R42-P008A	1,2	125 VDC STBY CHARGER
R42-P008B	1,3	125 VDC STBY CHARGER
R43-C201A*	1	COMPRESSOR
R43-C201B*	2	COMPRESSOR
R43-C201C*	3	COMPRESSOR
R43-C202A*	1	COMPRESSOR
R43-C202B*	2	COMPRESSOR
R43-C202C*	3	COMPRESSOR
R43-C401A*	1	LUBE OIL PUMP
R43-C401B*	2	LUBE OIL PUMP
R43-C401C*	3	LUBE OIL PUMP
R43-DPS091A*	1	DIFF PRESS SWITCH
R43-DPS091B*	2	DIFF PRESS SWITCH
R43-DPS091C*	3	DIFF PRESS SWITCH
R43-J001A	1	DIESEL GENERATOR
R43-J001B	2	DIESEL GENERATOR
R43-J001C	3	DIESEL GENERATOR
R43-LIS191A*	1	LEVEL IND SWITCH
R43-LIS191B*	2	LEVEL IND SWITCH
R43-LIS191C*	3	LEVEL IND SWITCH
R43-LS142A*	1	LEVEL SWITCH
R43-LS142B*	2	LEVEL SWITCH
R43-LS142C*	3	LEVEL SWITCH
R43-LS395A*	1	LEVEL SWITCH
R43-LS395B*	2	LEVEL SWITCH

LIST OF EQUIPMENT INTERFACE WITH ESSENTIAL MUX SIGNALS
(In order of device - reading top to bottom)

DEVICE	DIV	DESCRIPTION
R43-LS395C*	3	LEVEL SWITCH
R43-P001A*	1	DG(A) CONTROL PNL (A)
R43-P001B*	2	DG(B) CONTROL PNL (A)
R43-P001C*	3	DG(C) CONTROL PNL (A)
R43-P002A*	1	DG(A) SCT PANEL
R43-P002B*	2	DG(B) SCT PANEL
R43-P002C*	3	DG(C) SCT PANEL
R43-P003A*	1	DG(A) CONTROL PNL (B)
R43-P003B*	2	DG(B) CONTROL PNL (B)
R43-P003C*	3	DG(C) CONTROL PNL (B)
R46-J002A1	1	VITAL DIST PNL A1
R46-J002B1	2	VITAL DIST PNL B1
R46-J002C1	3	VITAL DIST PNL C1
R46-J002D1	4	VITAL DIST PNL D1
R46-P001A	1	VITAL CVCF A
R46-P001B	2	VITAL CVCF B
R46-P001C	3	VITAL CVCF C
R46-P001D	4	VITAL CVCF D
T22-C001A	1	EXHAUST FAN (A)
T22-C001B	2	EXHAUST FAN (B)
T22-C002A	1	PRE SPACE HTR. & FAN (A)
T22-C002B	2	PRE SPACE HTR. & FAN (B)
T22-C003A	1	AFTER HTR. & FAN (A)
T22-C003B	2	AFTER HTR. & FAN (B)
T22-D001A	1	DRYER UNIT (A)
T22-D001B	2	DRYER UNIT (B)
T22-DPT021A	1	DIFF PRESS TRANSMITTER
T22-DPT021B	2	DIFF PRESS TRANSMITTER
T22-DPT021C	1	DIFF PRESS TRANSMITTER
T22-DPT021D	2	DIFF PRESS TRANSMITTER
T22-F001A	1	AO BUTTERFLY VALVE
T22-F001B	2	AO BUTTERFLY VALVE
T22-F002A	1	MO BUTTERFLY VALVE
T22-F002B	2	MO BUTTERFLY VALVE
T22-F004A	1	MO BUTTERFLY VALVE
T22-F004B	2	MO BUTTERFLY VALVE
T22-F005A*	1	MO BUTTERFLY VALVE
T22-F005B*	2	MO BUTTERFLY VALVE
T22-FT018A	1	FLOW TRANSMITTER
T22-FT018B	2	FLOW TRANSMITTER
T22-H001A1	1	PRE SPACE HEATER
T22-H001A2	1	PRE SPACE HEATER
T22-H001A3	1	AFTER SPACE HEATER
T22-H001A4	1	AFTER SPACE HEATER
T22-H001B1	2	PRE SPACE HEATER
T22-H001B2	2	PRE SPACE HEATER
T22-H001B3	2	AFTER SPACE HEATER
T22-H001B4	2	AFTER SPACE HEATER
T22-LS004A	1	LEVEL SWITCH
T22-LS004B	2	LEVEL SWITCH
T22-LS019A	1	LEVEL SWITCH
T22-LS019B	2	LEVEL SWITCH
T22-ME011A	1	MOISTURE ELEMENT
T22-ME011B	2	MOISTURE ELEMENT
T22-ME011C	3	MOISTURE ELEMENT
T22-ME011D	4	MOISTURE ELEMENT
T22-MT011A	1	MOISTURE TRANSMITTER
T22-MT011B	2	MOISTURE TRANSMITTER
T22-MT011C	3	MOISTURE TRANSMITTER
T22-MT011D	4	MOISTURE TRANSMITTER
T22-POE001A	1	POSITION ELEMENT
T22-POE001B	2	POSITION ELEMENT
T22-TE002A	1	TEMP ELEMENT
T22-TE002B	2	TEMP ELEMENT
T22-TE010A	1	TEMP ELEMENT
T22-TE010B	2	TEMP ELEMENT
T22-TE013A	1	TEMP ELEMENT
T22-TE013B	2	TEMP ELEMENT
T22-TE014A	1	TEMP ELEMENT
T22-TE014B	2	TEMP ELEMENT
T22-TE016A	1	TEMP ELEMENT
T22-TE016B	2	TEMP ELEMENT
T22-TS005A	1	TEMP SWITCH
T22-TS005B	2	TEMP SWITCH
T22-TS009A	1	TEMP SWITCH
T22-TS009B	2	TEMP SWITCH
T22-TS013A	1 *	TEMP SWITCH
T22-TS013B	2	TEMP SWITCH
T22-TS015A	1	TEMP ELEMENT
T22-TS015B	2	TEMP ELEMENT
T31-F001	1	AO VALVE
T31-F002	2	AO VALVE
T31-F003	2	AO VALVE
T31-F004	2	AO VALVE
T31-F005	2	AO VALVE
T31-F006	2	AO VALVE
T31-F007	2	AO VALVE
T31-F008	1	AO VALVE
T31-F009	1	AO VALVE
T31-F025	1	AO VALVE
T31-F039	1	AO VALVE
T31-F040	2	AO VALVE
T31-F041	2	AO VALVE
T31-F720A	2	SO VALVE
T31-F720B	2	SO VALVE
T31-F731	1	SO VALVE
T31-F733A	1	SO VALVE
T31-F733B	1	SO VALVE
T31-F735A	1	SO VALVE
T31-F735B	2	SO VALVE

LIST OF EQUIPMENT INTERFACE WITH ESSENTIAL MUX SIGNALS
(In order of device - reading top to bottom)

DEVICE	DIV	DESCRIPTION
T31-F735C	3	SO VALVE
T31-F735D	4	SO VALVE
T31-F737A	1	SO VALVE
T31-F737B	1	SO VALVE
T31-F739A	1	SO VALVE
T31-F739B	2	SO VALVE
T31-F739C	3	SO VALVE
T31-F739D	4	SO VALVE
T31-F741A	1	SO VALVE
T31-F741B	2	SO VALVE
T31-F741C	3	SO VALVE
T31-F741D	4	SO VALVE
T31-F743A	1	SO VALVE
T31-F743B	2	SO VALVE
T31-F745A	1	SO VALVE
T31-F745B	2	SO VALVE
T31-F801A	1	SO VALVE
T31-F801B	2	SO VALVE
T31-F803A	1	SO VALVE
T31-F803B	2	SO VALVE
T31-F805A	1	SO VALVE
T31-F805B	2	SO VALVE
T31-LT058A	1	LEVEL TRANSMITTER
T31-LT058B	2	LEVEL TRANSMITTER
T31-LT058C	3	LEVEL TRANSMITTER
T31-LT058D	4	LEVEL TRANSMITTER
T31-LT059A	1	LEVEL TRANSMITTER
T31-LT059B	2	LEVEL TRANSMITTER
T31-LT100A	1	LEVEL TRANSMITTER
T31-LT100B	2	LEVEL TRANSMITTER
T49-C001A	3	BLOWER
T49-C001B	2	BLOWER
T49-D002A*	3	HEATER
T49-D002B*	2	HEATER
T49-F001A	3	MO GATE VALVE
T49-F001B	2	MO GATE VALVE
T49-F002A	3	MO GATE VALVE
T49-F002B	2	MO GATE VALVE
T49-F003A	3	MO GLOBE VALVE
T49-F003B	2	MO GLOBE VALVE
T49-F004A	3	MO GLOBE VALVE
T49-F004B	2	MO GLOBE VALVE
T49-F006A	3	MO GATE VALVE
T49-F006B	2	MO GATE VALVE
T49-F007A	3	MO GATE VALVE
T49-F007B	2	MO GATE VALVE
T49-F008A	1 *	MO GATE VALVE
T49-F008B	2 *	MO GATE VALVE
T49-F009A	3	MAN OPER GLOBE VALVE
T49-F009B	2	MAN OPER GLOBE VALVE

DEVICE	DIV	DESCRIPTION
T49-F010A	3	MO GLOBE VALVE
T49-F010B	2	MO GLOBE VALVE
T49-F013A	3	MAN OPER GATE VALVE
T49-F013B	2	MAN OPER GATE VALVE
T49-F014A	3	MAN OPER GATE VALVE
T49-F014B	2	MAN OPER GATE VALVE
T49-FT002A	3	FLOW TRANSMITTER
T49-FT002B	2	FLOW TRANSMITTER
T49-FT004A	3	FLOW TRANSMITTER
T49-FT004B	2	FLOW TRANSMITTER
T49-PT003A	3	PRESS TRANSMITTER
T49-PT003B	2	PRESS TRANSMITTER
T49-TE001A	3	TEMP ELEMENT
T49-TE001B	2	TEMP ELEMENT
T49-TE005A	3	TEMP ELEMENT
T49-TE005B	2	TEMP ELEMENT
T49-TE006A**	3	TEMP ELEMENT
T49-TE006B**	2	TEMP ELEMENT
T49-TE007A**	3	TEMP ELEMENT
T49-TE007B**	2	TEMP ELEMENT
T49-TE008A**	3	TEMP ELEMENT
T49-TE008B**	2	TEMP ELEMENT
T49-TE009A**	3	TEMP ELEMENT
T49-TE009B**	2	TEMP ELEMENT
T49-TE010A**	3	TEMP ELEMENT
T49-TE010B**	2	TEMP ELEMENT
T49-TE011A	3	TEMP ELEMENT
T49-TE011B	2	TEMP ELEMENT
T53-TE001A	1 *	TEMPERATURE ELEMENT
T53-TE001B	2 *	TEMPERATURE ELEMENT
T53-TE001E	1 *	TEMPERATURE ELEMENT
T53-TE001F	2 *	TEMPERATURE ELEMENT
T53-TE001J	1 *	TEMPERATURE ELEMENT
T53-TE001K	2 *	TEMPERATURE ELEMENT
T53-TE001N	1 *	TEMPERATURE ELEMENT
T53-TE001P	2 *	TEMPERATURE ELEMENT
T53-TE002A	1 *	TEMPERATURE ELEMENT
T53-TE002B	2 *	TEMPERATURE ELEMENT
T53-TE002E	1 *	TEMPERATURE ELEMENT
T53-TE002F	2 *	TEMPERATURE ELEMENT
T53-TE002J	1 *	TEMPERATURE ELEMENT
T53-TE002K	2 *	TEMPERATURE ELEMENT
T53-TE002N	1 *	TEMPERATURE ELEMENT
T53-TE002P	2 *	TEMPERATURE ELEMENT
T53-TE003A	1 *	TEMPERATURE ELEMENT
T53-TE003B	2 *	TEMPERATURE ELEMENT
T53-TE003E	1 *	TEMPERATURE ELEMENT
T53-TE003F	2 *	TEMPERATURE ELEMENT
T53-TE003J	1 *	TEMPERATURE ELEMENT
T53-TE003K	2 *	TEMPERATURE ELEMENT

LIST OF EQUIPMENT INTERFACE WITH ESSENTIAL MUX SIGNALS
(In order of device - reading top to bottom)

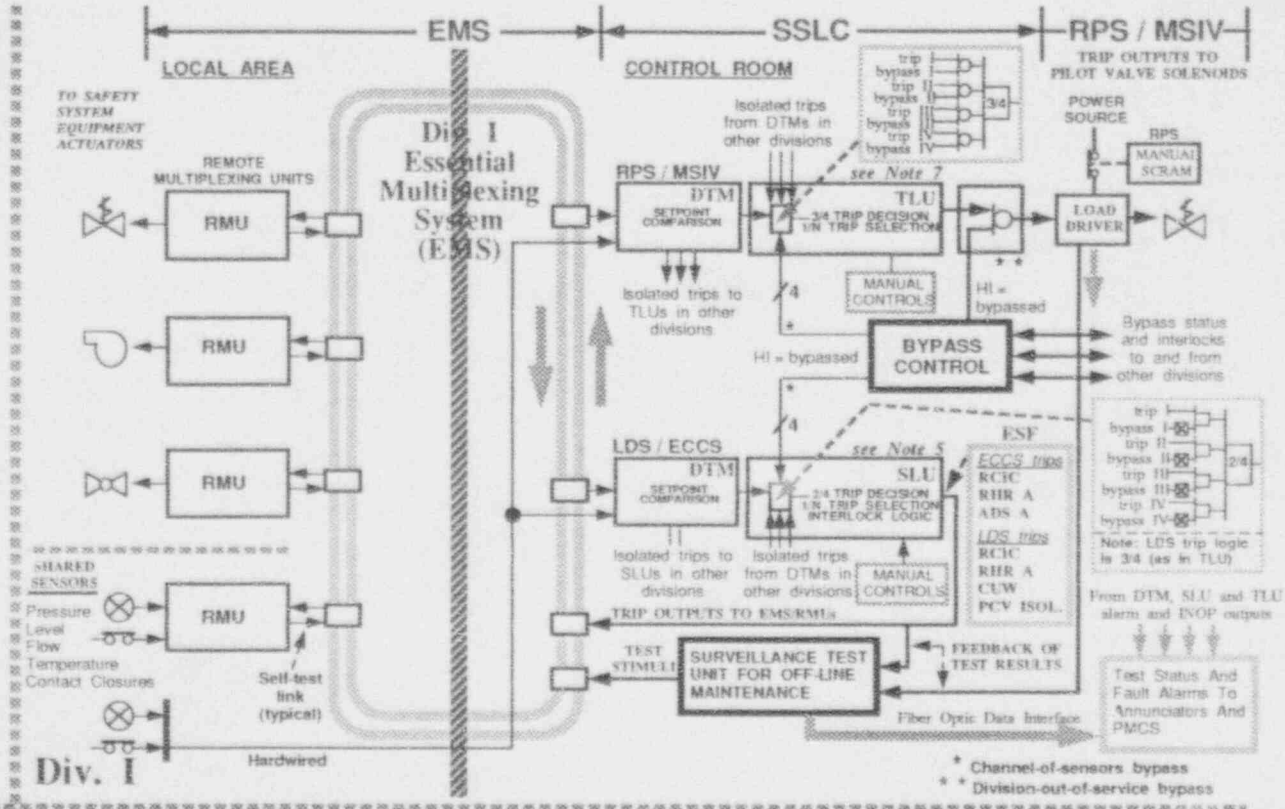
DEVICE	DIV	DESCRIPTION
T53-TE003M	1 *	TEMPERATURE ELEMENT
T53-TE003P	2 *	TEMPERATURE ELEMENT
T53-TE004A	1 *	TEMPERATURE ELEMENT
T53-TE004B	2 *	TEMPERATURE ELEMENT
T53-TE004E	1 *	TEMPERATURE ELEMENT
T53-TE004F	2 *	TEMPERATURE ELEMENT
T53-TE004J	1 *	TEMPERATURE ELEMENT
T53-TE004K	2 *	TEMPERATURE ELEMENT
T53-TE004M	1 *	TEMPERATURE ELEMENT
T53-TE004P	2 *	TEMPERATURE ELEMENT
T53-TE005A	1 *	TEMPERATURE ELEMENT
T53-TE005B	2 *	TEMPERATURE ELEMENT
T53-TE005E	1 *	TEMPERATURE ELEMENT
T53-TE005F	2 *	TEMPERATURE ELEMENT
T53-TE005J	1 *	TEMPERATURE ELEMENT
T53-TE005K	2 *	TEMPERATURE ELEMENT
T53-TE005M	1 *	TEMPERATURE ELEMENT
T53-TE005P	2 *	TEMPERATURE ELEMENT
T53-TE006A	1 *	TEMPERATURE ELEMENT
T53-TE006B	2 *	TEMPERATURE ELEMENT
T53-TE006E	1 *	TEMPERATURE ELEMENT
T53-TE006F	2 *	TEMPERATURE ELEMENT
T53-TE006J	1 *	TEMPERATURE ELEMENT
T53-TE006K	2 *	TEMPERATURE ELEMENT
T53-TE006M	1 *	TEMPERATURE ELEMENT
T53-TE006P	2 *	TEMPERATURE ELEMENT
U41-C201A	1	DG(A) SUPPLY FAN (A)
U41-C201B	1	DG(A) SUPPLY FAN (B)
U41-C202A	1	DG(A) EXHAUST FAN (A)
U41-C202B	1	DG(A) EXHAUST FAN (B)
U41-C203A	1	DG(A) EMER SUPP FAN (A)
U41-C203B	1	DG(A) EMER SUPP FAN (B)
U41-C204A	2	DG(B) SUPPLY FAN (A)
U41-C204B	2	DG(B) SUPPLY FAN (B)
U41-C205A	2	DG(B) EXHAUST FAN (A)
U41-C205B	2	DG(B) EXHAUST FAN (B)
U41-C206A	2	DG(B) EMER SUPP FAN (A)
U41-C206B	2	DG(B) EMER SUPP FAN (B)
U41-C207A	3	DG(C) SUPPLY FAN (A)
U41-C207B	3	DG(C) SUPPLY FAN (B)
U41-C208A	3	DG(C) EXHAUST FAN (A)
U41-C208B	3	DG(C) EXHAUST FAN (B)
U41-C209A	3	DG(C) EMER SUPP FAN (A)
U41-C209B	3	DG(C) EMER SUPP FAN (B)
U41-C503A	1	ELEC EQ SUPPLY FAN (A)
U41-C503B	2	ELEC EQ SUPPLY FAN (B)
U41-C601B	2	MCR SUPPLY FAN (B)
U41-C601C	3	MCR SUPPLY FAN (C)
U41-C601F	2	MCR SUPPLY FAN (F)
U41-C601G	3	MCR SUPPLY FAN (G)
U41-C602B	2	MCR EXHAUST FAN (B)
U41-C602C	3	MCR EXHAUST FAN (C)
U41-C602F	2	MCR EXHAUST FAN (F)
U41-C602G	3	MCR EXHAUST FAN (G)
U41-C603B	2	MCR RECIRC SUPP FAN (B)
U41-C603C	3	MCR RECIRC SUPP FAN (C)
U41-C603F	2	MCR RECIRC SUPP FAN (F)
U41-C603G	3	MCR RECIRC SUPP FAN (G)
U41-C604A	1	EMER EQ FAN(A) ZONE(A)
U41-C604E	1	EMER EQ FAN(B) ZONE(A)
U41-C605A	1	EM EQ EX FAN(A) ZONE(A)
U41-C605E	1	EM EQ EX FAN(B) ZONE(A)
U41-C606B	2	EMER EQ FAN(A) ZONE(B)
U41-C606F	2	EMER EQ FAN(B) ZONE(B)
U41-C607B	2	EM EQ EX FAN(A) ZONE(B)
U41-C607F	2	EM EQ EX FAN(B) ZONE(B)
U41-C608C	3	EMER EQ FAN(A) ZONE(C)
U41-C608G	3	EMER EQ FAN (B) ZONE(C)
U41-C609C	3	EM EQ EX FAN(A) ZONE(C)
U41-C609G	3	EM EQ EX FAN(B) ZONE(C)
U41-D101	1	RCIC PUMP ROOM HVH
U41-D102	3	HPCF PUMP (C) ROOM HVH
U41-D103	1	RHR PUMP (A) ROOM HVH
U41-D104	3	RHR PUMP (C) ROOM HVH
U41-D105	2	RHR PUMP (B) ROOM HVH
U41-D106	2	HPCF PUMP (B) ROOM HVH
U41-D107	3	FCS ROOM (A) HVH
U41-D108	2	FCS ROOM (B) HVH
U41-D109	1	FPC PUMP (A) ROOM HVH
U41-D110	2	FPC PUMP (B) ROOM HVH
U41-D111	1	SGTS ROOM HVH (A)
U41-D112	2	SGTS ROOM HVH (B)
U41-D113	1	CAMS (A) ROOM HVH
U41-D114	2	CAMS (B) ROOM HVH
U41-F001A	1	AO VLV - R/A SUP ISO VLV
U41-F001B	2	AO VLV - R/A SUP ISO VLV
U41-F002A	1	AO VLV - R/A EXH ISO (A)
U41-F002B	2	AO VLV - R/A EXH ISO (B)
U41-F003A	1	AO VALVE
U41-F003B	2	AO VALVE
U41-F004A	1	AO VALVE
U41-F004B	2	AO VALVE
U41-F005A	1	AO VALVE
U41-F005B	2	AO VALVE
U41-F090A*	1	AO VLV - CAMS RM EXH
U41-F090B*	2	AO VLV - CAMS RM EXH
U41-F091A*	1	AO VLV - CAMS RM SUPPLY
U41-F091B*	2	AO VLV - CAMS RM SUPPLY
U41-TE052	1	TEMP ELEMENT
U41-TE056	2	TEMP ELEMENT

LIST OF EQUIPMENT INTERFACE WITH ESSENTIAL MUX SIGNALS
(In order of device - reading top to bottom)

DEVICE	DIV	DESCRIPTION
U41-TE060	3	TEMP ELEMENT
U41-TE071A	1	TEMP ELEMENT
U41-TE071B	2	TEMP ELEMENT
U41-TE071C	3	TEMP ELEMENT
U41-TE072A	1	TEMP ELEMENT
U41-TE072B	2	TEMP ELEMENT
U41-TE072C	3	TEMP ELEMENT
U41-TE103C	3	TEMP ELEMENT
U41-TE103G	3	TEMP ELEMENT
U41-TE104B	2	TEMP ELEMENT
U41-TE104F	2	TEMP ELEMENT
U41-TE111	1	TEMP ELEMENT
U41-TE114	2	TEMP ELEMENT
U41-TE117	3	TEMP ELEMENT
U41-TISC52	3	TEMP IND SW EMER EXH
U41-TISC53	2	TEMP IND SW EMER EXH
U41-TISC54	1	TEMP IND SW EMER EXH

RESPONSE TO DFSER 7.2.2.2-1

Notes:
1. THIS SIMPLIFIED DIAGRAM SHOWS THE BASIC ARRANGEMENT OF THE ABWR SHARED SENSOR, TIME-MULTIPLEXED, PLANT PROTECTION SYSTEM, USING STORED-PROGRAM COMPUTERS TO DETERMINE THE DECISION FOR SAFETY ACTION.
2. Essential Multiplexing System, which is independent of SSLC, is shown for REFERENCE ONLY and represents one possible configuration. As an example, a bi-directional, dual redundant ring is illustrated. This system can automatically reconfigure after a node or cable failure to maintain availability of remaining functions.
3. RMUs shown are typical; actual quantity of RMUs and number of inputs and outputs per RMU will be determined during detailed design stage.
4. DTM, SLU and TLU functions shown are performed by microprocessors under software program control; the exact number and location of these functions will be determined during further detailed design. The functions shown represent the minimum separation of tasks between RPS and ESF to ensure independence and high system availability.
5. To provide fault-tolerance, the LDS/ECCS SLU may be made redundant (for example, dual with 2/2 voting or triple with 2/3 voting) to prevent inadvertent ECCS initiation.
6. RPS and MSIV outputs are shown hardwired to the load drivers due to time constraints for trip action.
7. "3/4" coincidence trip is "fail-safe 2/4"; i.e., two or more normally high inputs must trip low for the normally high output to trip low. Three or more high inputs maintain a high output.



Same equipment as Div. I except no SLU is required. (No ESF in Div. IV.)

Div. IV | Div. I

Div. II | Div. III

Same equipment as Div. I except ECCS trip outputs are:
- HPCF B
- RHR B
- ADS B

and LDS trip outputs are:
- RCIC isolation
- RHR B isolation
- CUW isolation
- PCV isolation

Same equipment as Div. I except ECCS trip outputs are:
- HPCF C
- RHR C

and LDS trip outputs are:
- RHR C isolation

Glossary:
- DTM - Digital Trip Module
- ESF - Engineered Safety Features
- PMCS - Performance Monitoring Control System
- RMU - Remote Multiplexing Unit
- SLU - Safety System Logic Unit
- TLU - Trip Logic Unit

Figure 7A.2-1 SAFETY SYSTEM LOGIC AND CONTROL (SSLC)

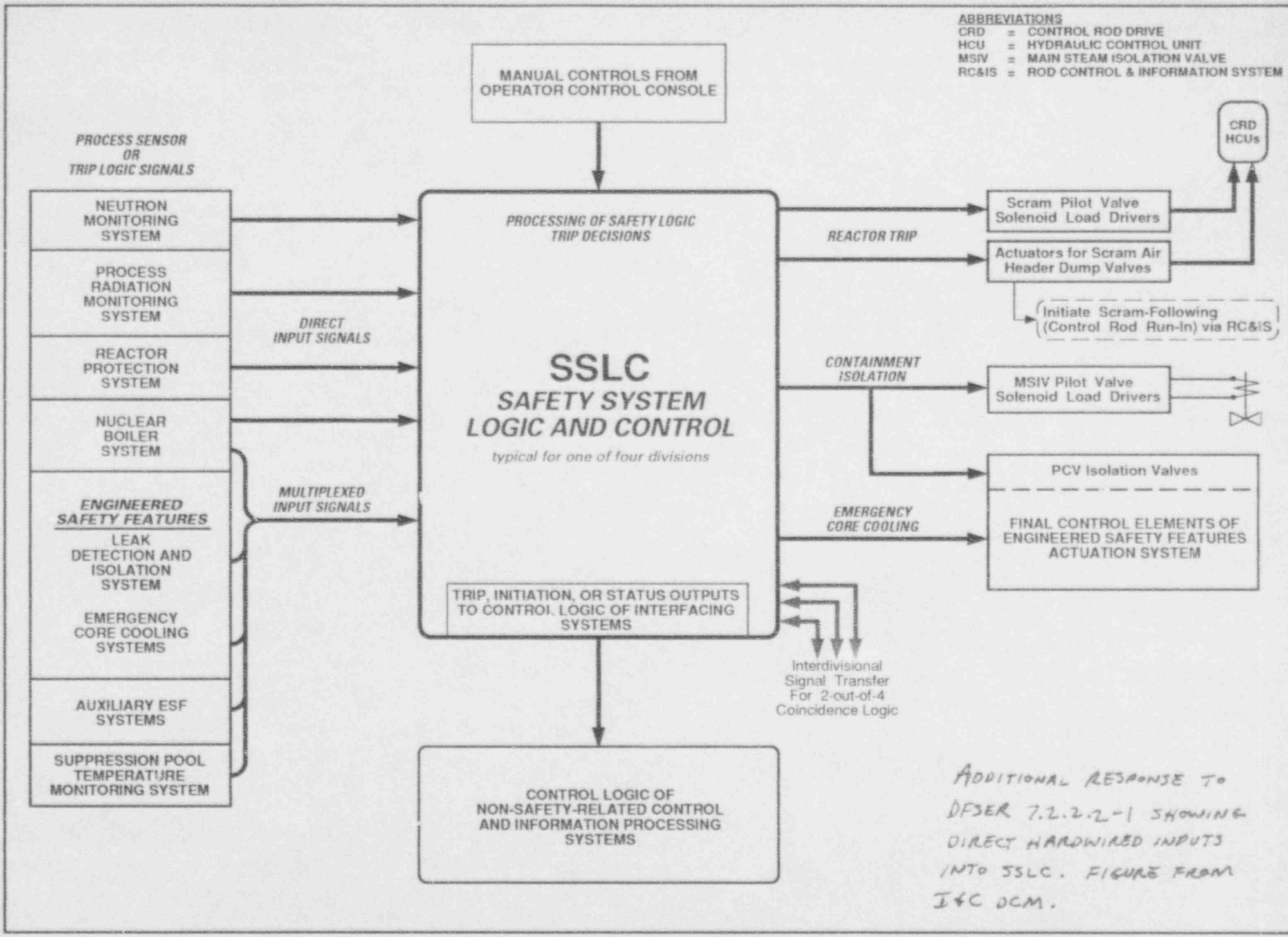
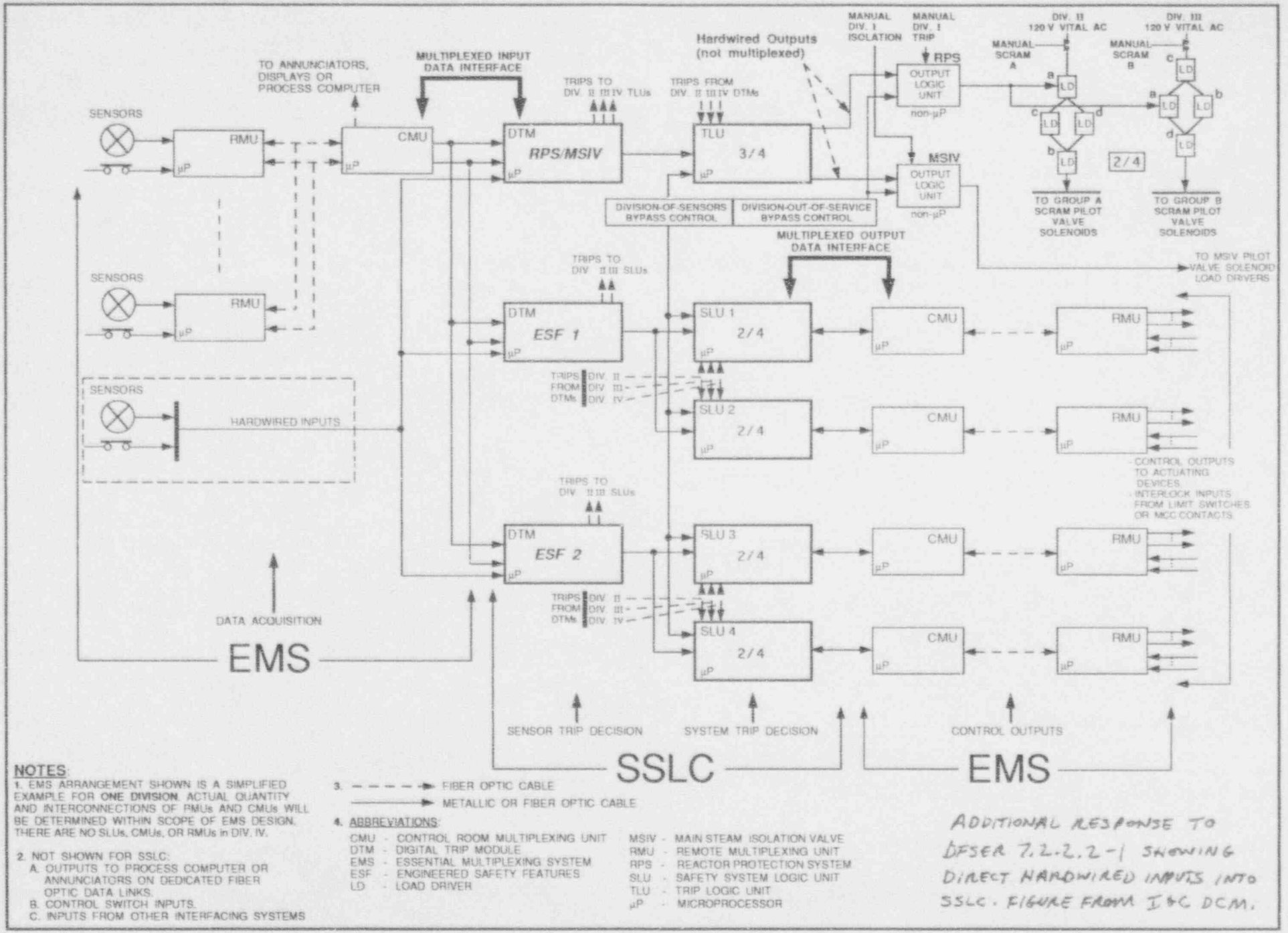


Figure 3.4a Safety System Logic and Control (SSLC) Interface Diagram



NOTES:

1. EMS ARRANGEMENT SHOWN IS A SIMPLIFIED EXAMPLE FOR **ONE DIVISION**. ACTUAL QUANTITY AND INTERCONNECTIONS OF RMUs AND CMUs WILL BE DETERMINED WITHIN SCOPE OF EMS DESIGN. THERE ARE NO SLUs, CMUs, OR RMUs in DIV. IV.
2. NOT SHOWN FOR SSLC:
   A. OUTPUTS TO PROCESS COMPUTER OR ANNUNCIATORS ON DEDICATED FIBER OPTIC DATA LINKS.
   B. CONTROL SWITCH INPUTS.
   C. INPUTS FROM OTHER INTERFACING SYSTEMS
3. - - - - → FIBER OPTIC CABLE
   ——→ METALLIC OR FIBER OPTIC CABLE
4. ABBREVIATIONS:

CMU	CONTROL ROOM MULTIPLEXING UNIT	MSIV	MAIN STEAM ISOLATION VALVE
DTM	DIGITAL TRIP MODULE	RMU	REMOTE MULTIPLEXING UNIT
EMS	ESSENTIAL MULTIPLEXING SYSTEM	RPS	REACTOR PROTECTION SYSTEM
ESF	ENGINEERED SAFETY FEATURES	SLU	SAFETY SYSTEM LOGIC UNIT
LD	LOAD DRIVER	TLU	TRIP LOGIC UNIT
		µP	MICROPROCESSOR

ADDITIONAL RESPONSE TO DFSER 7.2.2.2-1 SHOWING DIRECT HARDWIRED INPUTS INTO SSLC. FIGURE FROM I&C DCM.

Figure 3.4b SAFETY SYSTEM LOGIC & CONTROL BLOCK DIAGRAM

7A.7 RESPONSES TO SUBSECTIONS 7A.5 & 7A.6; COMPUTER HARDWARE AND SOFTWARE

Items 7A.5(1) and 7A.5(2):

Criteria and guidelines stated in ANSI/IEEE-ANS-7.4.3.2, as endorsed by Regulatory Guide 1.152, have been used as a basis for design procedures established for programmable digital equipment.

All programmable digital equipment utilized for safety-related functions are qualified in accordance with safety criteria and with the safety system design basis with which they interface.

A structured, engineered approach to the development of both hardware and software is implemented to assure that the design proceeds along the lines of the requirement specifications and has traceable documentation.

Verification and validation (V&V) includes the establishment of test and evaluation criteria, the development of test and evaluation procedures, the testing of the integrated hardware and software, and the installation of the hardware and software in the field.

In accordance with the step-by-step verification process, design reviews are performed at the system functional and performance requirements specification/task analysis and allocation of functions level, the hardware design and the software design level, the test and evaluation criteria and procedures level, and the personnel requirements and operating/maintenance plan level. Such reviews are conducted by knowledgeable and experienced system engineers, software engineers, hardware engineers, etc., who are not directly responsible for the design, but who may be from the same organization.

Figure 7A.7-1 illustrates the structure utilized for ABWR control and instrumentation system design which incorporates subject guidelines.

Items 7A.5(3) and 7A.6(2):

NUREG-0308, "Safety Evaluation Report - Arkansas Nuclear 1, Unit 2" was reviewed and generally found to be not applicable to the BWR/ABWR reactor design philosophy.

The NUREG discusses a "core protection calculator system (CPCS)" which is designed to provide reactor protection for two conditions: (1) low local departure from nucleate boiling ratio (DNBR), and (2) high local linear power density.

For condition (1), "DNBR" is associated with PWRs and is not applicable to BWRs. For condition (2), power density is determined via the neutron monitoring system (NMS), similar to methods used in operating BWRs. (See Subsection 7.6.1.1 for discussion of the NMS.)

The ABWR design of the reactor protection system utilizes microprocessor technology for logic decisions based on analog input from various sensors. This philosophy is much the same as that of GESSAR II and the Clinton BWR, except in those designs, solid-state CMOS accepted digital signals from analog trip modules (ATM). In the ABWR design, the microprocessors perform the functions of both the CMOS and the ATM.

The important distinction is that the ABWR uses a modern form of digital computer device (i.e., microprocessors) for the same reasons relays and solid-state devices were used in earlier designs (i.e., making simple logic decisions); not for making complex calculations for which protective action is dependent.

Items 7A.5(4) and 7A.6(4):

The guidelines of NUREG-0493 have been used to perform analysis of several possible different configurations of the safety system logic and control (SSLC) network. Analyses have been performed at the system design level to assure adequate defense-in-depth and/or diversity principles were incorporated at acceptable cost. It is recognized that such requirements are in addition to positions on safety-related protection systems (such as the single failure criterion) taken previously in other Regulatory Guides.

In order to reduce plant construction costs and simplify maintenance operation, the ABWR protection sytems are designed with a "shared

If self-test or self-diagnostic features of this equipment, whether implemented in hardware or software, are considered an integral part of the design, and, as such, are qualified to Class 1E standards.

Output Voltage - 2 kV to 16.5 kV
Polarity - positive
Energy Storage Capacitor - 150 pF plus or minus 10%
Discharge Resistor - 150 ohms plus or minus 5%
Charging Resistor - 100 Megohms plus or minus 10%
Rise time of discharge current - 5 ns plus or minus 30% at 4 KV
Operating Modes - (1) up to 20 discharges per second for approximately 5 seconds per test; (2) also single pulses with at least 1 sec between succesive discharges.

Acceptance criterion shall be no misoperation during or after test.

QUESTION 420.92

The application of high technology semiconductor materials and related technologies to computing devices has resulted in high current densities in some portions of equipment used in non-nuclear applications. This type of equipment may be used for the ABWR.

Identify how these higher current densities, which can result in localized high heat spots, will be considered in the design described by Section 7.0. (7)

RESPONSE 420.92

Computing devices used for ABWR instrumentation are designed to utilize the lowest power components available for the task. Technologies such as CMOS and low power Schottky, including high speed and advanced versions, will be the standard device types used for all functions, including the microprocessor. The emphasis is on low stress design; when these components are operated within their voltage and current ratings and at their specified clock frequency, no unusual heat stresses will occur within the semiconductor materials. As much as possible, all components shall be of the high reliability type or adequately screened and burned-in to ensure high reliability.

The only likely areas of high current density will be in the power semiconductors of solid-state load drivers. The effects of these localized high spots will be mitigated by proper heat sinking and ventilation of the local area, following the component vendor's recommendations. High power devices will be physically separated as much as possible from lower power circuitry.

To ensure that adequate compensation for heat rise is incorporated into the design, a thermal analysis will be performed at the circuit board, instrument and panel design stages. Convective cooling is assumed; cooling fans, particularly for safety-related equipment, are not recommended for mounting within instruments or panels. However, if fans are used to increase reliability of equipment located in high density panels or high temperature areas, no credit shall be taken for forced-air cooling in the thermal analyses. Since it is intended that all computerized instrumentation will be installed in the Main Control Room or in other areas with similar environmental conditions, adequate HVAC will generally be available for proper heat transfer. In case of loss of HVAC, the instrumentation is designed for operation to an ambient temperature of 122 degrees F (50 degrees C). Environmental qualification testing of safety-related equipment shall include adequate margin to ensure that this condition can be met under extreme conditions. The minimum margin shall be as stated in IEEE-323, Section 6.3.1.5. Additional margin will be determined by thermal analysis of the installed equipment area.

All I&C designs shall meet the environmental criteria stated in the following ABWR requirements documents listed in Section 1.1.3:

(1) BWR Requirements - Equipment Environmental Interface Data,

(2) Environmental Quality Requirements for Safety Grade Equipment.

The heat release by internal panel components shall not raise the internal temperature of a panel to greater than 15 °C (27 °F) above external ambient temperature of the equipment room for electronic components within a chassis or within any printed circuit card file structure.

RESPONSE TO DFSER 7.4.1.4-1

(4) Manual operation of the relief valves will cool the reactor and reduce its pressure at a controlled rate until reactor pressure becomes so low that HPCF system operation is discontinued.

(5) The RHR system will then be operated in the shutdown cooling mode using the RHR system heat exchanger in the reactor water circuit to bring the reactor to the cold low pressure condition.

7.4.1.4.4 Remote Shutdown Capability Controls and Instrumentation–Equipment, Panels, and Displays

(1) **Main Control Room**–Remote Shutdown Capability Interconnection Design Considerations

Some of the existing systems used for normal reactor shutdown operations are also utilized in the remote shutdown capability to shut down the reactor from outside the main control room. The functions needed for remote shutdown control are provided with manual transfer devices which override controls from the main control room and transfer the controls to the remote shutdown control. Control and process sensor signals are interrupted by the transfer devices at the hardwired, analog loop. Sensor signals which interface with the remote shutdown system are routed from the sensor, through the transfer devices on the remote shutdown panels, and then to the multiplexing system remote multiplexing units (RMUs) for transmission to the main control room. Similary, control signals from the main control room are routed from the RMUs, through the remote shutdown transfer devices, and then to the interfacing system equipment. Actuation of the transfer devices interrupts the connection to the RMUs and transfers control to the remote shutdown system. All necessary power supply circuits are also transferred to other sources. Remote shutdown control is not possible without actuation of the transfer devices. Operation of the transfer devices causes an alarm in the main control room. The remote shutdown control panels are located outside the main control room. Access to this point is administratively and procedurally controlled.

Instrumentation and controls located on the remote shutdown control panels are shown in instrument and electrical diagram Figure 21.7.4-2a.

Transfer of control completely isolates all functions of SSLC and EMS from RSS. The analog, hardwired instrument loops of RSS directly operate the actuated devices under manual control of the operator at the RSS panels. Displays at the RSS also give direct hardwired indication to the operator from the sensors.

RESPONSE TO OFSER 7.2.8-2 and 7.2.8-3

Tier 2 Material to be added as Appendix 7B of SSAR Chapter 7

7B. Implementation Requirements for Hardware/Software Development

This section defines the requirements to be met by the hardware and software development implementation activities that are to be made available for review by the NRC. The hardware and software development-related acceptance criteria which are established through rule-making (refer to section 3.4, Instrumentation and Control, of the Tier 1 design certification material for the GE ABWR design) are defined such that there exists a direct correspondence between the acceptance criteria entries and requirements imposed herein on those design activities whose results are to be made available for the NRC conformance reviews. Those requirements presented in Table 7B.1 which correspond to individual Tier 1 acceptance criteria are specifically identified. Therefore, satisfaction of those specific requirements shall result in full compliance with the Design Commitment and the corresponding Acceptance Criteria presented in the Tier 1 (rule-making) design certification material established for Instrumentation and Control.

Table 7B.1 Software Development

A. Software Management Plan

(Satisfaction of the requirements presented herein shall result in the creation of a Software Management Plan which is in full compliance with the Acceptance Criteria for Item 5 presented in Table 3.4 of the Tier 1 design certification material for the GE ABWR design.)

1. The Software Management Plan shall define:

   a. the organization and responsibilities for development of the software design; the procedures to be used in the software development; the interrelationships between software design activities; and the methods for conducting software safety analyses.

      Within the defined scope and content of the Software Management Plan, accepted methods and procedures for the above activities are presented in the following documents:

      (i) IEEE 730-1984, Standard for Software Quality Assurance Plans, Section 3.4
      (ii) ASME NQA2a, Part 2.7, Quality Assurance Requirements of Computer Software for Nuclear Facility Application
      (iii) ANSI/IEEE-ANS-7-4.3.2-1982, Application Criteria for Digital Computers in Safety Systems for Nuclear Facilities (to be replaced by the issued version of P 7-4.3.2, "Standard Criteria for Digital Computers Used in Safety Systems of Nuclear Power Generation Stations")
      (iv) IEC 880-1986, Software for computers in the safety systems of nuclear power stations, Section 3.1
      (v) IEEE *(draft H)*-1992, Standard for Software Safety Plans
      (vi) IEEE 1012-1986, Standard for Software Verification and Validation Plans, Section 3.5
      (vii) IEEE 830-1984, Guide to Software Requirements Specifications, Section 5
      (viii) IEEE 1042-1987, Guide to Software Configuration Management

      Note that within the set of documents listed above, differences may exist regarding specific methods and criteria applicable to the Software Management Plan. In situations where such differences exist, all of the methods and criteria presented within those documents are considered to be equally appropriate and valid and, therefore, any of the above listed documents may be selected as the basis for elements of the SMP.

   b. that the software safety analyses to be conducted for safety-related software applications shall:

      (i) identify software requirements having safety-related implications

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(ii) document th identified safety-critical software requirements in the software requirements specification for the design
(iii) incorporate in to the software design the safety-critical software functions specified in the software requirements specification
(iv) identify in the coding and test of the developed software, those software modules which are safety-critical
(v) evaluate the performance of the developed safety-critical software modules when operated within the constraints imposed by the established system requirements, software design, and computer hardware requirements
(vi) evaluate software interfaces of safety-critical software modules
(vii) perform equipment integration and validation testing that demonstrate that safety-related functions identified in the design input requirements are operational.

c. the software engineering process, which is composed of the following life-cycle phases:

(i) Planning
(ii) Design Definition
(iii) Software Design
(iv) Software Coding
(v) Integration
(vi) Validation
(vii) Change control

d. the Planning phase design activities, which shall address the following system design requirements and software development plans:

(i) Software Management Plan
(ii) Software Configuration Management Plan
(iii) Verification and Validation Plan
(iv) Equipment design requirements
(v) Safety analysis of design requirements
(vi) disposition of design and/or documentation nonconformances identified during this phase

e. the Design Definition phase design activities, which shall address the development of the following implementing equipment design and configuration requirements:

(i) equipment schematic
(ii) equipment hardware and software performance specification
(iii) equipment user's manual
(iv) data communications protocol
(v) safety analysis of the developed design definition
(vi) disposition of design and/or documentation nonconformances identified during this phase

f. the Software Design phase, which shall address the design of the software architecture and program structure elements, and the definition of software module functions:

   (i) Software Design Specification
   (ii) safety analysis of the software design
   (iii) disposition of design and/or documentation nonconformances identified during this phase

g. the Software Coding phase, which shall address the following software coding and testing activities of individual software modules:

   (i) software source code
   (ii) software module test reports
   (iii) safety analysis of the software coding
   (iv) disposition of nonconformances identified in this phase's design documentation and test results

h. the Integration phase, which shall address the following equipment testing activities that evaluates the performance of the software when installed in hardware prototypical of that defined in the Design Definition phase:

   (i) integration test reports
   (ii) safety analysis of the integration test results
   (iii) disposition of nonconformances identified in this phase's design documentation and test results

i. the Validation phase, which comprises the development and implementation of the following documented test plans and procedures:

   (i) validation test plans and procedures
   (ii) validation test reports
   (iii) description of as-tested software
   (iv) safety analysis of the validation test results
   (v) disposition of nonconformances identified in this phase's design documentation and test results
   (vi) software change control procedures, and

j. the Change Control phase, which begins with the completion of validation testing, and addresses changes to previously validated software and the implementation of the established software change control procedures.

B. Configuration Management Plan

(Satisfaction of the requirements presented herein shall result in the creation of a Software Management Plan which is in full compliance with the Acceptance Criteria for Item 6 presented in Table 3.4 of the Tier 1 design certification material for the GE ABWR design.)

1. The Configuration Management Plan shall define:

   a. the specific product or system scope to which it is applicable, the organizational responsibilities for software configuration management, and methods to be applied to:

      (i) identify design interfaces
      (ii) produce software design documentation
      (iii) process changes to design interface documentation and software design documentation
      (iv) process corrective actions to resolve deviations identified in software design and design documentation, including notification to end user of errors discovered in software development tools or other software
      (v) maintain status of design interface documentation and developed software design documentation
      (vi) designate and control software revision status. Such methods shall require that software code listings present direct indication of the software code revision status

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      Within the defined scope and content of the Configuration Management Plan, accepted methods and procedures for the above activities are presented in the following documents:

      (i) IEEE 1042-1987, Guide to Software Configuration Management
      (ii) IEEE 828-1983, Standard for Software Configuration Management Plans
      (iii) ANSI/IEEE-ANS-7-4.3.2-1982, Application Criteria for Digital Computers in Safety Systems for Nuclear Facilities (to be replaced by the issued version of P 7-4.3.2, "Standard Criteria for Digital Computers Used in Safety Systems of Nuclear Power Generation Stations")
      (iv) IEC 880-1986, Software for computers in the safety systems of nuclear power stations

      Note that within the set of documents listed above, differences may exist regarding specific methods and criteria applicable to the Configuration Management Plan. In situations that such differences exist, all of the methods and criteria presented within those documents are considered to be equally appropriate and valid and, therefore, any of the above listed documents may be selected as the basis for elements of the CMP.

b. methods for, and the sequencing of, reviews to evaluate the compliance of software design activities with the requirements of the CMP.

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c. the configuration management of tools (such as compilers) and software development procedures.

d. methods for the dedication of commerical software for safety-related usage

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e. methods for tracking error rates during software development, such as the use of software metrics

f. the methods for design record collection and retention.

C. Verification and Validation Plan

(Satisfaction of the requirements presented herein shall result in the creation of a Verification and Validation Plan which is in full compliance with the Acceptance Criteria for Item 7 presented in Table 3.4 of the Tier 1 design certification material for the GE ABWR design.)

1. The Verification and Validation Plan shall define:

   a. that baseline reviews of the software development process are to be conducted during each phase of the software development life cycle and the scope and methods to be used in the baseline reviews to evaluate the implemented design, design documentation, and compliance with the requirements of the Software Management Plan and Configuration Management Plan.

      Within the defined scope and content of the Verification and Validation Plan, accepted methods and procedures for the above activities are presented in the following documents:

      (i) IEEE 1012-1986, Standard for Software Verification and Validation Plans
      (ii) ANSI/IEEE-ANS-7-4.3.2-1982, Application Criteria for Digital Computers in Safety Systems for Nuclear Facilities (to be replaced by the issued version of P 7-4.3.2, "Standard Criteria for Digital Computers Used in Safety Systems of Nuclear Power Generation Stations")
      (iii) IEC 880-1986, Software for computers in the safety systems of nuclear power stations

      Note that within the set of documents listed above, differences may exist regarding specific methods and criteria applicable to the Verification and Validation Plan. In situations that such differences exist, all of the methods and criteria presented within those documents are considered

to be equally appropriate and valid and, therefore, any of the above listed documents may be selected as the basis for elements of the V&VP.

b. that verification shall be performed as a controlled and documented evaluation of the conformity of the developed design to the documented design requirements at each phase of baseline review.

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c. that the use of commercial software and commercial development tools for safety-related applications is a controlled and documented procedure

d. that validation shall be performed through controlled and documented testing of the developed software that demonstrates compliance of the software with the software requirements specifications.

e. that for safety-related software, verification reviews and validation testing are to be conducted by personnel who are knowledgeable in the technologies and methods used in the design, but who did not develop the software design to be reviewed and tested.

f. that for safety-related software, design verification reviews shall be conducted as part of the baseline reviews of the design material developed during the Planning through Integration phases of the software development life-cycle (as defined in Criterion 1b, above), and that validation testing shall be conducted as part of the baseline review of the Validation phase of the software development life-cycle.

g. that validation testing shall be conducted per a documented test plan and procedure.

h. that for non-safety-related software development, verification and validation shall be performed through design reviews conducted as part of the baseline reviews completed at the end of the phases in the software development life cycle. These design reviews shall be performed by personnel knowledgeable in the technologies and methods used in the design development.

i. the products which shall result from the baseline reviews conducted at each phase of the software development life-cycle; and that the defined products of the baseline reviews and the V&V Plan shall be documented and maintained under configuration management.

j. the methods for identification, closure, and documentation of design and/or design documentation nonconformances.

k. that the software development is not complete until the specified verification and validation activities are complete and design documentation is consistent with the developed software.

D. Completion of Software Development

(Satisfaction of the requirements presented herein shall result in the documented completion of the software development process which is in full compliance with the Acceptance Criteria for Item 8 presented in Table 3.4 of the Tier 1 design certification material for the GE ABWR design.)

Software development has been completed as defined in the SMP, CMP, and V&VP.

THE ATTACHED SHEETS FROM THE

I&C DESIGN CERTIFICATION MATERIAL

DESCRIBED IN DFSER No. 7.1.3.3-1 ARE

MARKED TO REFERENCE THE DFSER NUMBER

FOR WHICH THE RESPONSE IS GIVEN

Table 3.4: Instrumentation and Control

Inspections, Tests, Analyses and Acceptance Criteria

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
Hardware/Software Development 5. A Software Management Plan (SMP) shall be instituted which establishes that software for embedded control hardware shall be developed, designed, evaluated, and documented per a design development process that addresses, for safety-related software, software safety issues at each defined phase of the software development. The SMP shall state that the output of each defined phase shall be documents that define the current state of that design phase and the design input for the next design phase.	5. The Software Management Plan shall be reviewed.	5. The Software Management Plan shall define: a. the organization and responsibilities for development of the software design; the procedures to be used in the software development; the interrelationships between software design activities; and the methods for conducting software safety analyses. b. that the software safety analyses to be conducted for safety-related software applications shall: (i) identify software requirements having safety-related implications (ii) document the identified safety-critical software requirements in the software requirements specification for the design (iii) incorporate in to the software design the safety-critical software functions specified in the software requirements specification (iv) identify in the coding and test of the developed software, those software modules which are safety-critical (v) evaluate the performance of the developed safety-critical software modules when operated within the

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Table 3.4: Instrumentation and Control

Inspections, Tests, Analyses and Acceptance Criteria

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
Hardware/Software Development		
5. (continued)	5. (continued)	5. b. (continued)

constraints imposed by the established system requirements, software design, and computer hardware requirements

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(vi) evaluate software interfaces of safety-critical software modules

(vii) perform equipment integration and validation testing that demonstrate that safety-related functions identified in the design input requirements are operational.

c. the software engineering process, which is composed of the following life-cycle phases:

(i) Planning
(ii) Design Definition
(iii) Software Design
(iv) Software Coding
(v) Integration
(vi) Validation
(vii) Change control

d. the Planning phase design activities, which shall address the following system design requirements and software development plans:

Table 3.4: Instrumentation and Control

Inspections, Tests, Analyses and Acceptance Criteria

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
Hardware/Software Development		
6. A Configuration Management Plan (CMP) shall be instituted which establishes the methods for maintaining, throughout the software design process, the design documentation, procedures, evaluated software, and the resultant as-installed software.	6. The Configuration Management Plan shall be reviewed.	6. The Configuration Management Plan shall define: a. the specific product or system scope to which it is applicable. b. the organizational responsibilities for software configuration management. c. methods to be applied to: (i) identify design interfaces (ii) produce software design documentation (iii) process changes to design interface documentation and software design documentation (iv) process corrective actions to resolve deviations identified in software design and design documentation, including notification to end user of errors discovered in software development tools or other software (v) maintain status of design interface documentation and developed software design documentation

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Table 3.4: Instrumentation and Control

Inspections, Tests, Analyses and Acceptance Criteria

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
Hardware/Software Development		
6. (continued)	6. (continued)	6. c. (continued) (vi) designate and control software revision status. Such methods shall require that software code listings present direct indication of the software code revision status. d. methods for, and the sequencing of, reviews to evaluate the compliance of software design activities with the requirements of the CMP. e. the configuration management of tools (such as compilers) and software development procedures. f. methods for the dedication of commercial software for safety-related usage. g. methods for tracking error rates during software development, such as the use of software metrics h. the methods for design record collection and retention.

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Table 3.4: Instrumentation and Control

Inspections, Tests, Analyses and Acceptance Criteria

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
Hardware/Software Development		
7. A Verification and Validation Plan (V&VP) shall be developed which establishes that developed software shall be subjected to structured and documented verification reviews and validation testing, including testing of the software integrated into the target hardware.	7. The Verification and Validation Plan shall be reviewed.	7. The Verification and Validation Plan shall define: a. that baseline reviews of the software development process are to be conducted during each phase of the software development life cycle. b. the scope and methods to be used in the baseline reviews to evaluate the implemented design, design documentation, and compliance with the requirements of the Software Management Plan and Configuration Management Plan. c. the requirements for use of commercial software and commercial development tools for safety-related applications and that such use is a controlled and documented procedure d. that verification shall be performed as a controlled and documented evaluation of the conformity of the developed design to the documented design requirements at each phase of baseline review.

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Table 3.4: Instrumentation and Control

Inspections, Tests, Analyses and Acceptance Criteria

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
Electromagnetic Compatibility 9. (continued)	9. (continued)	9. (continued) d. Test results that show the component or system is qualified for its application and remains qualified after being subjected to the range of normal and abnormal test conditions specified above. The plan establishes separate test regimes for each element of EMC, using the following approaches: a. EMI and RFI Protection. An EMC compliance plan for each component or system identified in the design commitment includes tests to ensure that equipment performs its functions in the presence of the specified EMI/RFI electrical noise environment, including the low range of the EMI spectrum, without equipment damage, spurious actuation, or inhibition of functions. As part of the pre-operational test program, the EMC compliance plan calls for each system to be subjected to EMI/RFI testing. Tests cover potential EMI and RFI susceptibility over four different paths: (1) Power feed lines (2) Input signal lines (3) Output signal lines (4) Radiation

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Table 3.4: Instrumentation and Control

Inspections, Tests, Analyses and Acceptance Criteria

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
Electromagnetic Compatibility		
9. (continued)	9. (continued)	9. (continued)

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- The test program includes sensitivity of components identified in the design commitment to radiation from plant communication transmitters and receivers

b. ESD Protection. An EMC compliance plan for each component or system identified in the design commitment includes tests to ensure that equipment performs its functions in the presence of the specified ESD environment without equipment damage, spurious actuation, or inhibition of functions.

The plan is structured on the basis that ESD protection is confirmed by factory tests that determine the susceptibility of instrumentation and control equipment to electrostatic discharges.

The EMC compliance plan includes standards, conventions, design considerations, and test procedures to ensure ESD protection of the plant instrumentation and control equipment.

The plan requires test documentation confirming that , for each component tested, the following conditions have been met: