## 7.2 Reactor Protection (Trip) System (RPS)—Instrumentation and Controls

The information in this section of the reference ABWR DCD, including all subsections, tables and figures, is incorporated by reference with the following departures and supplements.

STD DEP T1 2.2-1 (Tables 7.2-1, 7.2-2, Figures 7.2-9, 7.2-10)

STD DEP T1 2.3-1 (Table 7.2-1, 7.2-2, Figures 7.2-3, 7.2-6, 7.2-9, 7.2-10)

STD DEP T1 3.4-1 (Figures 7.2-9, 7.2-10)

STD DEP 1.8-1

STD DEP 7.1-1

STD DEP 7.2-1 (Figure 7.2-5, 7.2-9, 7.2-10)

STD DEP 7.2-2

STD DEP 7.2-3

STD DEP 7.2-4

STD DEP 7.2-6 (Table 7.2-1)

STD DEP Admin

### 7.2.1 Description

#### 7.2.1.1 System Description

##### 7.2.1.1.1 RPS Identification

STD DEP T1 3.4-1

*The Reactor Protection System (RPS) is the overall complex of instrument channels, trip logics, trip actuators and scram logic circuitry that initiate rapid insertion of control rods (scram) to shut down the reactor. The RPS also establishes reactor operating modes and provides status and control signals to other systems and annunciators. To accomplish its overall function, the RPS interfaces with the ~~Essential Multiplexing System~~,* Essential Communication Function of the RTIS*, Neutron Monitoring System, ~~Process Radiation Monitoring System~~, Control Rod Drive System, Rod Control and Information System, Reactor Recirculation Control System, ~~Process Computer System~~,* Plant Computer Function*, Nuclear Boiler System and other plant systems and equipment. These interfaces are discussed in detail in the following subsections. The RPS IED is provided as Figure 7.2-9. The RPS IBD is provided as Figure 7.2-10.*

### 7.2.1.1.4 RPS Equipment Design

The following standard supplement addresses design-related information originally provided in Chapter 20 of the reference ABWR DCD.

The RPS design will utilize proven technology to ensure that a sufficient failure rate history is available to support reliability goals.

### 7.2.1.1.4.1 General RPS Equipment

STD DEP T1 3.4-1

STD DEP 7.2-1

STD DEP 7.2-2

STD DEP Admin

*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 (backup 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~~* data communication equipment *and digital ~~trip modules (DTMs)~~* trip units (DTUs)*. The sensors within each channel monitor plant variables (Subsection 7.2.1.1.4.2) send either analog or discrete output to ~~remote multiplexer units (RMUs)~~* Remote Digital Logic Controllers (RDLCs) *within the associated division of ~~Essential Multiplexing System (EMS)~~* data communication*. Each division of the ~~EMS~~* data communication *performs analog-to-digital conversion on analog signals and sends the digital or digitized analog output values of all monitored variables to the ~~DTM~~* DTU *within the associated RPS sensor channel. The ~~DTM~~* DTU *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.*

*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*, including filtering and voltage level conversion for digital systems, *and* signal *distribution* are *performed by the* RDLCs ~~*RMUs is a function of the EMS and is discussed in Section 7A.2*~~.

*(2) Divisions of Trip Logics*

*The TLUs perform automatic scram initiation logic based on reactor operating mode, channel and division trip conditions and bypass conditions. Each TLU receives* ~~*bistable*~~ bypass *input signals from the BPU and various switches in the same division and receives isolated* ~~*bistable*~~ trip *inputs from all four sensor channels* of RPS *and* the corresponding division ~~*divisions*~~ *of the NMS.*

*(3) Divisions of Trip Actuators*

*Normally* ~~*closed*~~ open *relay contacts are arranged in the scram logic circuitry between the air header dump valve solenoids and air header dump valve solenoid 125 VDC power source such that, when in a tripped state (coil* ~~*de-energized*~~ energized*), the relays will cause energization of the air header dump valve solenoids (air header dump initiation). All relays within a division interconnect with relays in all other divisions into two separate two-out-of-four air header dump logic arrangements (Figure 7.2-8).*

## 7.2.1.1.4.2 Initiating Circuits

STD DEP T1 2.3-1

STD DEP T1 3.4-1

STD DEP 7.2-1

STD DEP 7.2-3

STD DEP 7.2-4

STD DEP T1 2.2-1

STD DEP Admin

*The RPS will initiate a reactor scram when any one or more of the following conditions occur or exist within the plant:*

*(7)* ~~*High Main Steamline Radiation*~~ Not Used

*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 (1)* ~~*and PRRM (7)*~~*, and the* ~~*TB trips*~~ TB-trip *(5* ~~*and 7*~~*) all of the building signals (9) and (10), all of the other systems provide sensor outputs through the* ~~*EMS*~~ Data Communication of RPS*. Analog-to-digital conversion of these sensor output values is done by* ~~*EMS*~~ Data Communication of RPS *equipment. NMS* ~~*and PRRM*~~ *trip signals are provided directly to the RPS by NMS* ~~*and PRRM*~~ *trip logic units. The turbine* *building signals 9 and 10 are hardwired to connections in the control building. The ~~TB-trips~~* TB-trip *(5 ~~and 7~~) Is ~~are~~* is *provided through hardwired connections.*

(1) *Neutron Monitoring System (NMS)*

*Each of the four divisions of the NMS equipment provides separate, isolated, ~~bistable~~ SRNM trip and APRM trip signals to ~~all four divisions~~* the corresponding division *of RPS trip logics (Figure 7.2-5).*

(2) *Nuclear Boiler System (NBS) (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~~* data communication of RTIS *to the ~~DTM~~* DTU *in one of four RPS sensor channels. The pressure transducers and instrument lines are components of the NBS.*

(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~~* data communication of RTIS *to the ~~DTM~~* DTU *in one of the four RPS sensor channels. The level transducers and instrument lines are components of the NBS.*

(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~~* data communication of RTIS *to the ~~DTM~~* DTU *in one of the four RPS sensor channels of the NBS.*

(d) *Main Steamline Isolation (Figure 7.2-4)*

*Each of the four main steamlines 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 steamlines provide* contact *~~bistable output~~ outputs ~~through the EMS~~ to the ~~DTM~~* DTU *in one of the four RPS sensor channels. Each main steamline is associated with a different RPS sensor channel. The main steamline isolation valves and position switches are components of the NBS.*

(e) *High Suppression Pool Temperature*

*Suppression pool temperature is measured at ~~four~~ physically separated locations by locally mounted sensors. ~~Each sensor is on a separate instrument line and provides analog equivalent of suppression pool temperature to the EMS which~~,* These sensors are monitored by divisional I/O devices which digitize the signals and*, in turn,* provide *~~provides~~ digitized suppression pool temperature data to the suppression pool monitoring (SPTM) module of SSLC. SSLC, after process and averaging the data, provides trip signal to the corresponding RPS divisional ~~DTM~~* DTU*, when the calculated average temperature exceeds the setpoint.*

*(3) Control Rod Drive (CRD) System (Figure 7.2-6)*

*(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~~* data communication of RTIS *to the ~~DTM~~* DTU *in one of the four RPS sensor channels. The pressure transducers and instrument lines are components of the CRD System.*

*(4) ~~Process Radiation Monitoring (PRM) System (Figure 7.2-6)~~* Not Used

*~~(a) Main Steamline Radiation~~*

*~~Main steamline radiation is measured by four separate radiation monitors. Each monitor is positioned to measure gamma radiation in all four main steamlines. The PRM System 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 steamline radiation is within acceptable limits are components of the PRM System.~~*

*(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 hard-wired connections to the ~~DTM~~* DTU *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*

*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 hard-wired connections to the ~~DTM~~* DTU *in one of the four RPS sensor channels. The 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 or 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~~* Simulated Thermal Power

*~~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 hard-wired connections to the DTM in one of the four sensor channels.~~* Simulated Thermal Power (STP) is calculated by NMS and transmitted via hardwired connections to the DTU. *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

STD DEP 7.2-1

STD DEP T1 2.2-1

STD DEP T1 2.3-1

*(1) Trip Logic and Operating Bypasses*

*Neutron Monitoring System Trips (Figure 7.2-5)*

*~~A coincident~~ An NMS trip will occur in each division of trip logic when ~~any two or more out of four divisions of~~ APRM or SRNM trip signals are received from the NMS. The ~~coincident~~ SRNM trip is automatically bypassed when the reactor is in the run mode. The coincident APRM trip cannot be bypassed.*

*~~A non-coincident NMS trip will occur in each division of trip logic when any single APRM or SRNM trip signal is received from the NMS. The non-coincident NMS trip is automatically bypassed when the reactor is in the run mode. When the reactor is in the shutdown, refuel or startup mode, the non-~~*

~~*coincident NMS trip can be manually bypassed in each division by a separate, manual, keylock non-coincident NMS trip disable switch.*~~

*A turbine stop valve closed trip will occur in each division of trip logic when the turbine stop valve is closed in any two or more unbypassed sensor channels. A turbine control valve fast closure trip will occur in each division of trip logic when either the fast acting solenoid valve is closed or the HTS oil pressure is below the trip setpoint in any two or more unbypassed sensor channels. Both of these trips are automatically bypassed in each division of trip logic when* ~~*turbine first-stage pressure*~~ the simulated thermal power (from NMS) *in the associated sensor channel is below the bypass setpoint. Each division of trip logic sends a separate recirc pump trip initiating signal to the recirc system when these trips occur in the division.*

~~*High Main Steamline Radiation Trip (Figure 7.2-6)*~~

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

## 7.2.1.1.4.4 Redundancy and Diversity

STD DEP T1 3.4-1

*Instrument sensing lines from the reactor vessel are routed through the drywell and terminate outside the primary 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*~~ essential data communication *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.*

## 7.2.1.1.4.6 Separation

STD DEP T1 3.4-1

*Four independent sensor channels monitor the various process variables listed in Subsection 7.2.1.1.4.2. The redundant sensor devices are separated so that no single failure can prevent a scram. The arrangement of RPS sensors mounted in local racks is shown in Figure 7.2-2. Locations for local RPS racks and panels are shown on the instrument location drawings provided in Section 1.7. Divisional separation is also applied to the* ~~*Essential Multiplexing System (EMS)*~~ ~~D~~data ~~C~~communication for RTIS*, which provides data highways for the sensor input to the logic units. Physically separated cabinets are provided for the four scram logics. Fiber optic cable routing* either *from* ~~*remote multiplexing units (RMUs)*~~ ~~remote digital logic controllers (~~RDLCs~~)~~ or directly *to control room equipment is shown in raceway plans provided by reference in Section 1.7. The criteria for separation of sensing lines and sensors are discussed in Section 7.1.*

## 7.2.1.1.6 Operational Considerations

### 7.2.1.1.6.1 Reactor Operator Information

STD DEP T1 3.4-1

*(2) Annunciators*

*Each RPS trip channel input is* ~~*provided to the Containment Cooling System (CCS) annunciator system*~~ annunciated *through isolation devices. Trip logic trips, manual trips, and certain bypasses also signal the annunciator system.*

*(3) Computer Alarms*

*Upon detection of a status change of any of the preselected sequential events contacts, the sequence-of-events log shall be initiated and shall signal the beginning of an event. This log will include both NSSS and BOP inputs. Changes of state received 5 milliseconds or more apart* for BOP systems and approximately 25 milliseconds or more apart for NSSS systems *are sequentially differentiated on the printed log, together with time of occurrence, which shall be printed in hours, minutes, seconds, and milliseconds. Use of the alarm typewriter and computer is not required for plant safety. The printout of trips is particularly useful in routinely verifying the correct operation of pressure, level, and valve position switches as trip points are passed during startup, shutdown, and maintenance operations.*

## 7.2.1.1.7 Setpoints

STD DEP T1 2.3-1

*Instrument ranges are chosen to cover the range of expected conditions for the variable being monitored. Additionally, the range is chosen to provide the necessary accuracy for any required setpoints and to meet the overall accuracy requirements of the channel.*

*(9)* ~~*Main Steamline High Radiation*~~ Not Used

~~*High radiation in the vicinity of the main steamlines may indicate a gross fuel failure in the core. When high radiation is detected near the steamlines, a scram is initiated to limit release of fission products from the fuel. The high radiation trip setting is selected high enough above background radiation levels to avoid spurious scrams yet low enough to promptly detect a gross release of fission products from the fuel. More information on the trip setting is available in Section 7.3.*~~

### 7.2.1.1.10 Main Control Room Area

STD DEP T1 2.2-1

*Virtually all hardware within the RPS design scope is located within the four separate and redundant safety system logic and control (SSLC) cabinets in the main control room, except the instrumentation for monitoring turbine stop valve closure and turbine control valve fast closure~~, and turbine first-stage pressure~~. The panels are mounted on four separate control complex system steel floor sections which, in turn, are installed in the main control room. The major control switches are located on the principal console.*

### 7.2.1.1.11 Control Room Cabinets and Their Contents

STD DEP Admin

STD DEP T1 3.4-1

*The SSLC logic cabinets, ~~which contain~~* containing *the RPS for Divisions I, II, III, and IV~~,~~ include ~~a vertical board~~* input signal interface cards (ISIC) *for each division. The ~~vertical boards~~* ISICs *contain digital and solid-state discrete and integrated circuits used to condition signals transferred to the SSLC ~~from the EMS~~* via data communication for RTIS*. They also contain combinational and sequential logic circuits for the initiation of safety actions and/or alarm annunciation, isolators for electrical and physical separation of circuits used to transmit signals between redundant safety systems or between safety and non-safety systems, and system support circuits such as power supplies, automatic testing circuits, etc. Load drivers with solid-state switching outputs for actuation solenoids, motor control centers, or switchgear may be located in the control room.*

### 7.2.1.2 Design Bases

STD DEP 1.8-1

STD DEP 7.1-1

STD DEP 8.3-1

*Design bases information requested by IEEE-~~279~~*603 *is discussed in the following paragraphs. These IEEE-~~279~~*603 *design bases aspects are considered separately from those more broad and detailed design bases for this system cited in Subsection 7.1.2.2.*

*(3) Sensors*

*A minimum number of LPRMs per APRM are required to provide adequate protective action. This is the only variable that has spatial dependence (IEEE-~~279~~*603*, Paragraph ~~3.3~~*4.6.

*(4) Operational Limits*

*Operational limits for each safety-related variable trip setting are selected with sufficient margin to avoid a spurious scram. It is then verified by analysis that the release of radioactive material following postulated gross failure of the fuel or the reactor coolant pressure boundary is kept within acceptable bounds. Design basis operational limits in ~~Chapter 16~~* the Instrument Setpoint Summary Report *are based on operating experience and constrained by the safety design basis and the safety analyses.*

*(5) Margin Between Operational Limits*

*The margin between operational limits and the limiting conditions of operation (scram) for the Reactor Protection System are described in ~~Chapter 16~~* the Instrument Setpoint Summary Report*. The margin includes the maximum allowable accuracy error, sensor response times, and sensor setpoint drift.*

*(6) Levels Requiring Protective Action*

*Levels requiring protective action are provided in Chapter 16. These levels are design basis setpoints and are at least as limiting as the limiting safety system settings provided in ~~Chapter 16~~* the Instrument Setpoint Summary Report*.*

*(7) Ranges of Energy Supply and Environmental Conditions*

*The RPS 120 VAC power is provided by the four battery-powered inverters, for the SSLC, each with an alternate Class 1E 120 VAC supply. The batteries, which are designed for a two-hour minimum capacity, have sufficient stored energy to ride through switching transients in the switch yards in order to prevent switching transients from causing a scram. The alternate sources of 120V power are provided to each SSLC bus from transformers powered from the ~~6.9 kV~~* 4.16kV *emergency diesel generators. Since there are three diesel generators, the fourth division alternate power originates from the first division diesel.*

### 7.2.2.1 Conformance to Design Bases Requirements

STD DEP T1 2.3-1

STD DEP T1 3.4-1

STD DEP 7.1-1

*(1) Design Bases 7.1.2.2(1)(a)*

*Table 7.2-1 provides a listing of the sensors selected to initiate reactor scrams and delineates the range for each sensor. Setpoints, and accuracy ~~and response time~~ can be found in ~~Chapter 16~~* the Instrument Setpoint Summary Report. Response times are included in the analysis calculation for the design limit. *This information establishes the precision of the RPS variable sensors.*

*(3) Design Basis 7.1.2.2(1)(c)*

*The scram initiated by the main steamline ~~radiation monitoring system~~* isolation valve closure *and reactor vessel low-water level satisfactorily limits the radiological consequences of gross failure of the fuel or RCPB. (Chapter 15 evaluates gross failure of the fuel and RCPB). In no case does the release of radioactive material to the environs result in exposures which exceed the guidelines of applicable published regulations.*

*(5) Design Basis 7.1.2.2(1)(e)*

*The scrams initiated by the NMS drywell pressure, reactor vessel pressure, high suppression pool temperature, reactor vessel water level, turbine stop valve closure, MSIV bypass, and turbine control valve fast closure will prevent fuel damage. The scram setpoints ~~and response time requirements~~ for these variables are identified in ~~Chapter 16 and the~~* the Instrument Setpoint Summary Report and response times are included in the analysis calculation for the design limit; both *have been designed to cover the expected range of magnitude and rates of change during abnormal operational transients without fuel damage. Chapter 15 identifies and evaluates those conditions which threaten fuel integrity. With the selected variables and scram setpoints, adequate core margins are maintained relative to thermal/hydraulic safety limits.*

*(6) RPS Design Basis 7.1.2.2.1(1)(g) through (n)*

*The RPS is designed so that it is only necessary for trip variables to exceed their trip setpoints for sufficient length of time to trip the digital trip ~~modules~~* units *and seal-in the associated trip logic. Once this is accomplished, the scram will go to completion regardless of the state of the variable which initiated the protective action.*

*The ability of the RPS to function properly with a single failure is discussed in Subsection ~~7.2.1.2~~* 7.2.1.1.4.4*.*

*The ability of the RPS to function properly while any one sensor or channel is bypassed or undergoing test or maintenance is discussed in Subsection ~~7.2.1.2~~* 7.2.1.1.4.3*.*

The following standard supplement addresses the licensing requirements from 7.1.2.2(1).

*(9)* Design Basis 7.1.2.2(1)(q), (r) and (s)

Selective automatic and manual operational trip bypasses that permit proper plant operation are provided.

Manual control switches for initiation of reactor scram by plant operator are provided.

Mode switch to allow appropriate operational trips is provided.

### 7.2.2.2.1 Regulatory Guides

STD DEP T1 3.4-1

STD DEP 1.8-1

STD DEP Admin

*(3) Regulatory Guide 1.53—Application of the Single-Failure Criterion to Nuclear Power Plant Protection Systems.*

*Compliance with NRC Regulatory Guide 1.53 is met by specifying, designing, and constructing the Reactor Protection System to meet the single-failure criterion described in Section ~~4.2~~5.1 of IEEE-~~279~~603 (~~Criteria for Protection~~Standard Criteria for Safety Systems for Nuclear Power Generating Stations) and IEEE-379 (Standard Application of the Single-Failure Criterion to Nuclear Power Generating Station Class 1E Systems). Redundant sensors are used and the logic is arranged to ensure that a failure in a sensing element of the decision logic or an actuator will not prevent protective action. Separated channels are employed so that a fault affecting one channel will not prevent the other channels from operating properly. A complete discussion of the RPS power supplies is presented in Subsection 7.2.1.1.*

*(4) Regulatory Guide 1.62—Manual Initiation of Protective Actions.*

*Manual initiation of reactor scram, once initiated, goes to completion as required by IEEE-~~279~~603, ~~Section 4.16~~ Sections 5.2 and 7.3.*

*(5) Regulatory Guide 1.75~~:~~—Physical Independence of Electric Systems*

*The RPS complies with the criteria set forth in IEEE-~~279~~603, Paragraph ~~4.6~~5.6, and Regulatory Guide 1.75, which endorses IEEE-384. Class 1E circuits and Class 1E-associated circuits are identified and separated from redundant and non-Class 1E circuits. Isolation devices are provided in the design where an interface exists between redundant Class 1E divisions and between non-Class 1E and Class 1E or Class 1E-associated circuits. Independence and separation of safety-related systems is discussed in ~~Subections 8.3.1.3 and 8.3.1.4~~ Subsection 8.3.3.6.2.*

*Physical and electrical independence of the instrumentation devices of the system is provided by channel independence for sensors exposed to each process variable. Separate and independent raceways are routed from each device to the respective remote ~~multiplexing units (RMUs)~~ I/O devices. Each channel has a separate and independent control room panel. Trip logic outputs are separated in the same manner as are the channels. Signals* *between redundant RPS divisions are electrically and physically isolated by Class 1E isolators or by fiber optic cables.*

### 7.2.2.2.3.1 IEEE-~~279~~603, ~~Protection~~Standard Criteria for Safety Systems for Nuclear Power Generating Stations

STD DEP T1 2.3-1

STD DEP T1 2.2-1

STD DEP 1.8-1

STD DEP 7.2-1

*The Reactor Protection (trip) System conforms to the requirements of this standard. The following is a detailed discussion of this conformance.*

*(1) General Functional Requirement (~~Paragraph 4.1~~Section 5)*

*(2) Single-Failure Criterion (~~Paragraph4.2~~Section 5.1)*

(3) Quality of Components and Modules (*~~Paragraph 4.3~~Section 5.3)*

*(4) Equipment Qualification (~~Paragraph 4.4~~Section 5.4)*

*(8) Derivation of System Inputs (Paragraph 4.8)*

*The following RPS trip variables are direct measures of a reactor overpressure condition, a reactor overpower condition, a gross fuel damage condition, or abnormal conditions within the reactor coolant pressure boundary:*

*(b)* *~~Main steamline high radiation trip~~* Not Used

*The turbine stop valve closure trip bypass and control valve fast closure trip operating bypass permit continued reactor operation at low-power levels when the turbine stop or control valves are closed. The selection of* *~~turbine first- stage pressure~~* NMS Simulated Thermal Power (STP) *is an appropriate variable for permissive of this bypass function. In the power range of reactor operation, turbine first-stage pressure STP is essentially linear with increasing reactor power. Consequently, this variable provides the desired measurement of power level (i.e., whenever* *~~turbine first- stage pressure~~* STP *is below a specified value, the valve closure trip signals are automatically bypassed).*

*(10) Capability for Test and Calibration (Paragraph 4.10)*

*Most sensors have a provision for actual testing and calibration during reactor operation. The exceptions are defined as follows:*

(b) Not Used ~~Testing of the main steamline high-radiation monitors can be performed during full power operation by cross-comparison of sensors. Calibration of the electronics portion of each channel can be performed during reactor operation by switching in a current source in place of the normal signal from the sensor. Calibration of the sensor itself can be performed during shutdown.~~

*(12) Operating Bypasses (Paragraph 4.12)*

*The following RPS trip variables have no provision for an operating bypass:*

*(a) Reactor vessel low water level trip*

*(b)* ~~*Main steamline high radiation trip*~~ Not Used

*(15) Multiple Setpoints (Paragraph 4.15)**

*The trip setpoint of each SRNM channel is generally fixed. However, there is also the scram initiated by intermediate high neutron flux level corresponding to 5E + 5 counts per second. This is only activated in a noncoincidence scram mode by a switch in the* ~~*RPS SSLC*~~ NMS *cabinet. The conditions under which such trip is to be activated are included in plant operating procedures.*

## 7.2.2.2.4 Conformance to Branch Technical Positions

STD DEP 1.8-1

*(1) BTP-ICSB-26: Requirements for Reactor Protection System Anticipatory Trips*

*All hardware components used to provide trip signals to the RPS ~~is~~are designed in accordance with IEEE-~~279~~603 and ~~is~~are considered safety-related. This includes the sensors for turbine stop valve closure and turbine control valve fast closure even though these are located in the non-seismic Turbine Building. Since reactor high pressure and power trips are diverse to the turbine scram variables, locating the sensors in the turbine enclosure does not compromise the ability of the RPS to provide protection action when required.*

* Includes conformance with BTP ICSB 12.

**Table 7.2-1 Reactor Protection System Instrumentation Specifications**

| | | |
|---|---|---|
| Reactor vessel high pressure | ~~0–10.3~~ **0-10.0** MPa G | Pressure-transmitter/trip module |
| Drywell high pressure | ~~0–0.036 MpaG~~ **34.3-100.0 KPaG** | Pressure-transmitter/trip module |
| Reactor vessel low water Level 3 | ~~0–0.033 MPa G~~**350-500 Cm** | Level-transmitter/trip module |
| Low charging pressure to rod HCU accumulators | ~~0–245.2~~ **0-20.0** MPa G | Pressure transmitter/ trip module |
| Turbine stop valve closure | Fully open to fully closed | Position switch |
| Turbine control valve fast closure | ~~0–10.98~~ **15.00** MPa G | Pressure-~~switch~~ **transmitter/trip module** |
| Main steamline isolation valve closure | Fully open to fully closed | Position-switch |
| Neutron Monitoring System | APRM or SRNM Trip/No Trip | See Section 7.6 |
| ~~Main steamline high radiation~~ | ~~0.01-10$^4$mGy/h~~ | ~~Gamma detector~~ |
| High suppression pool temperature | 4 to 110°C | Temperature-transmitter/trip module |
| ~~Turbine first-stage pressure~~ | | ~~Pressure transmitter/ trip module~~ |

## Table 7.2-2 Channels Required for Functional Performance of RPS

This table shows the number of sensors required for the functional performance of the reactor protection system.

| Channel Description | # Sensors |
|---|---|
| Neutron Monitoring System (APRM) | 4 |
| Neutron Monitoring System (SRNM)[1] | 10 |
| Nuclear System high pressure | 4 |
| Drywell high pressure | 4 |
| Reactor vessel low level | 4 |
| Low charging pressure to rod hydraulic control unit accumulator | 4 |
| Main steamline isolation valve position | 8 |
| Turbine stop valve position | 4 |
| Turbine control valve fast closure~~[2]~~ | 8 |
| ~~*Turbine first-stage pressure (bypass channel)*~~ | ~~*4*~~ |
| ~~*Main steamline radiation*~~ | ~~*4*~~ |
| High suppression pool temperature | 64 |

1 In all modes except RUN.
~~2) Four limit switches on FASV and our oil pressure switches.~~

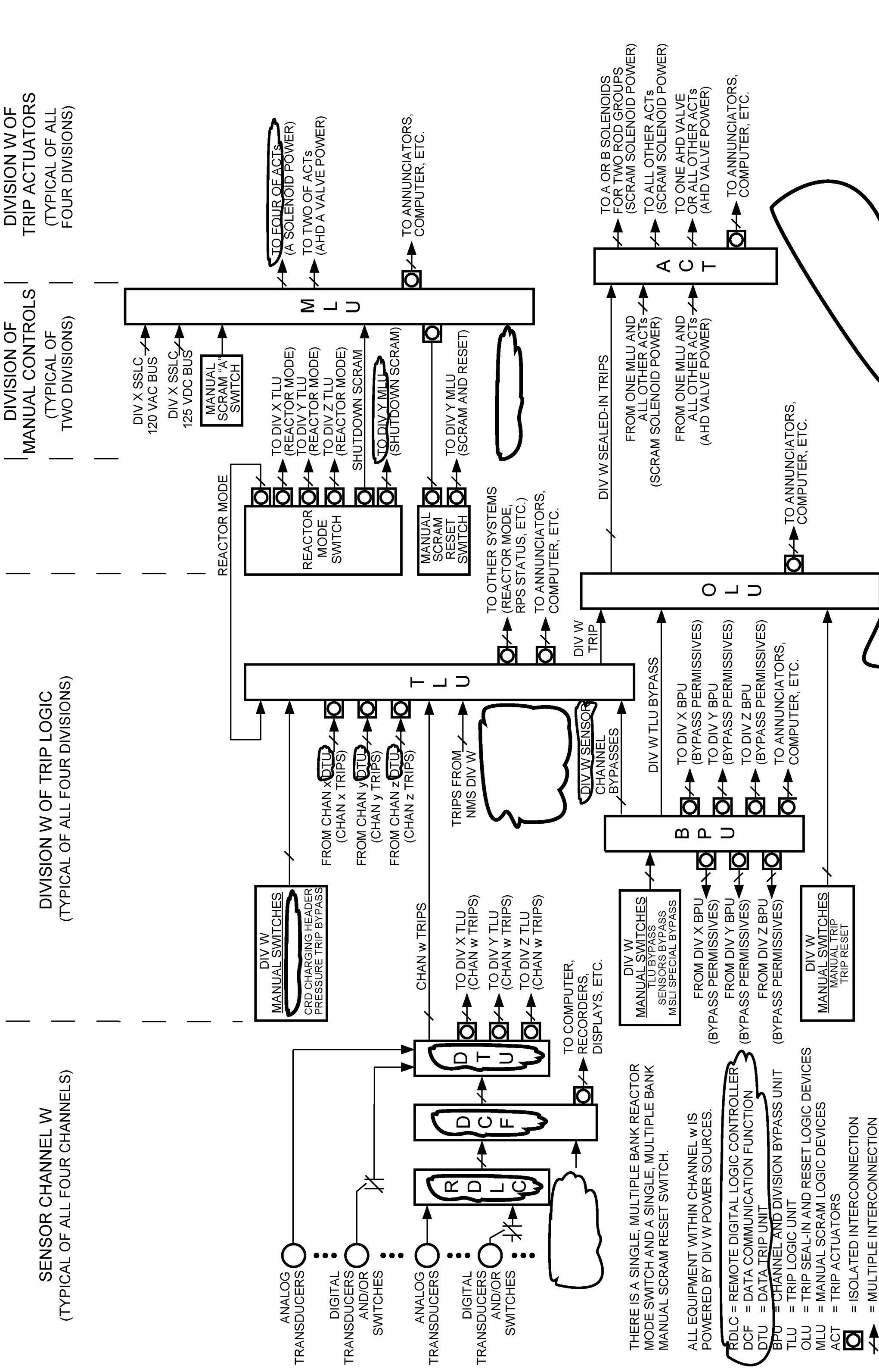
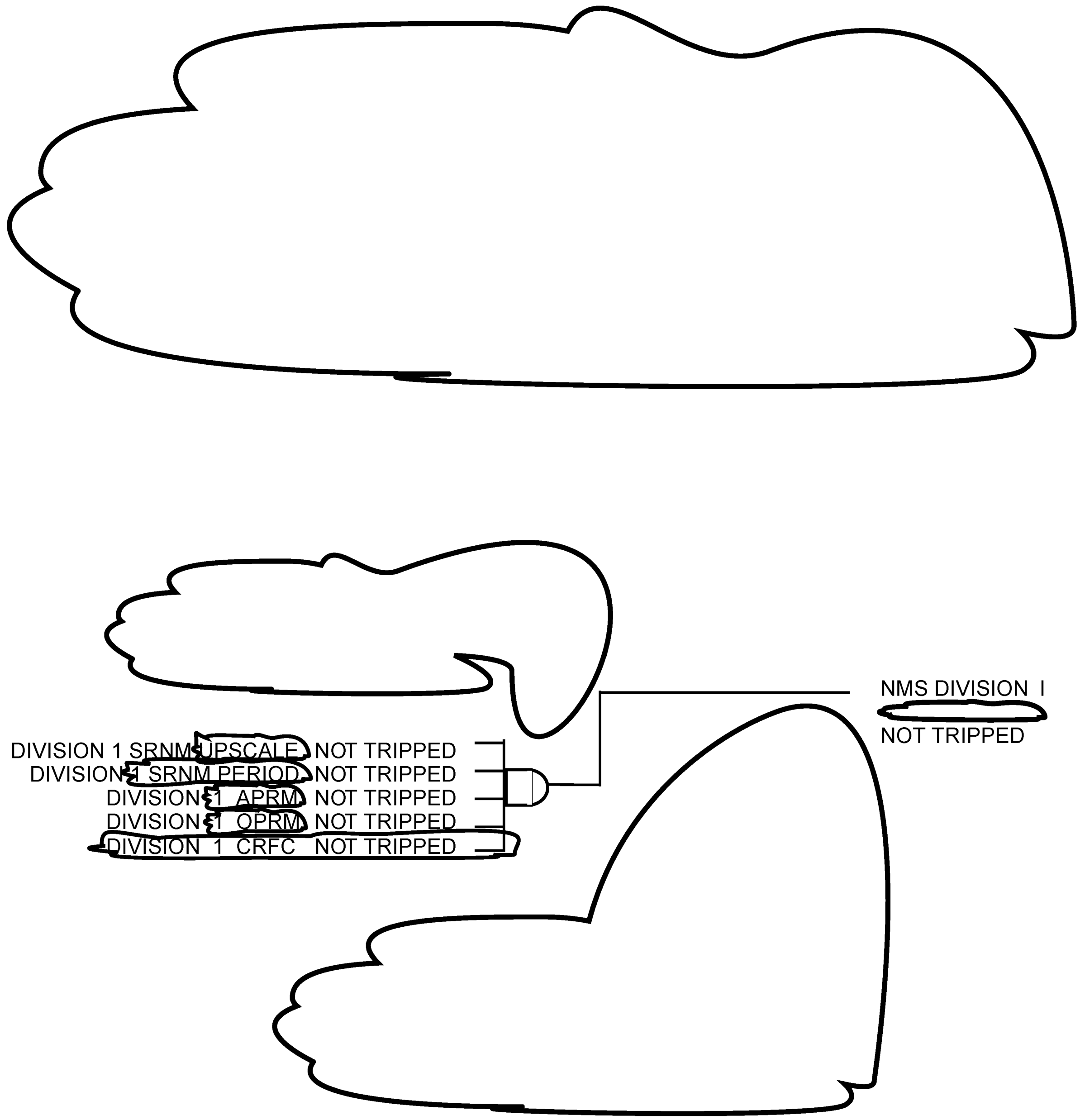



**Figure 7.2-2 Reactor Protection System Equipment Arrangement (From Sensors Through Trip Actuators)**




(TYPICAL OF ALL FOUR DIVISIONS)

**Figure 7.2-5 Division 1 Trip Logic Coincident and Non-Coincident NMS Trips**

The following figures are located in Chapter 21:

- **Figure 7.2-9 (Sheets 1-3, 5, 6)**
- **Figure 7.2-10 (Sheets 1, 2, 11-22, 27-30, 39-42, 47-54, 67, 69, 71)**