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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 Confirmatory Items 7.2.1-1 and 7.2.2.1-3**

Dear Chet:

Enclosed are SSAR markups addressing DFSER Confirmatory Items 7.2.1-1 and 7.2.2.1-3. The pages of IED Figure 7.2-9 and IBD Figure 7.2-10 included in this transmittal are modifications to earlier submittals and the proprietary affidavits under which they were originally issued are applicable to these pages.

Please provide a copy of this transmittal to Jim Stewart.

Sincerely,

Jack Fox

Jack Fox
Advanced Reactor Programs

cc: Norman Fletcher (DOE)
Ali Hekmati (GE)
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JF93-78

Change: NRC PDR 1 Ltr. Encl. D050
ANL Stephanov, E. 1 INP 1 INP

(4) Divisions of Manual Scram Controls

Equipment within a division of manual scram controls includes manual switches, contacts and relays that provide an alternate, diverse, manual means to initiate a scram and air header dump. Each division of manual scram controls interconnects the actuated load power sources to the same division of scram logic circuitry for scram initiation and to both divisions of scram logic circuitry for air header dump initiation.

(5) Divisions of Scram Logic Circuitry

One of the two divisions of scram logic circuitry distributes 120 VAC power to the A solenoids of all HCU's and 125 VDC power to the solenoid of one of the two air header dump valves. The other division of scram logic circuitry distributes 120 VAC power to the B solenoids of all HCU's and 125 VDC power to the solenoid of the other air header dump valve. The HCU's and air header dump valves themselves are not a part of the RPS.

The arrangement of equipment groups within the RPS from sensors to trip actuators is shown in Figure 7.2-2.

7.2.1.1.4.2 Initiating Circuits

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

(a) NMS monitored conditions exceed acceptable limits
(b) High Reactor Pressure
(c) Low Reactor Water Level (Level 3)
(d) High Drywell Pressure
(e) Main Steam Line Isolation
(f) Low Control Rod Drive Charging Header Pressure
(g) High Main Steam Line Radiation
(h) ~~High Seismic Activity~~ Deleted
(i) Turbine Stop Valve Closed
(j) Turbine Control Valve Fast Closure
(k) Operator initiated Manual Scram

CI 7.2.1-1

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 (a), and PRRM (g) and TB-trips (e and g), all of ~~these~~ the other 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. The TB-trips (e and g) are provided through hardwired connections.

CI 7.2.2.1-3

(1) Neutron Monitoring System (NMS)

CI 7.2.2.1-3

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 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 (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 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.

CI 7.2.1-1

(5) ~~Other Systems~~ Deleted

(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 a detected by separate valve stem position switches on each of the four turbine stop valves. Each position switch provides bistable output through ~~the EMS~~ hard-wired connections 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

CI 7.2.2.1-3

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~~

hard-wired connections
~~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.

CI 7.2.2.1-3

hard-wired connections

(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 a hard-wired connection ~~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.

CI 7.2.2.1-3

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 7.2-10. 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 channels at the same time. Once a bypass of one sensor channel has been established, bypasses of any of the remaining three sensor channels are inhibited.

A channel sensors bypass in any channel will bypass all trip initiating input signals except those trip signals received from the NMS.

(2) Division Trip Logic Unit Bypass

A separate, manual, keylock switch in each of the four divisions provides means to bypass that divisions trip unit output to the scram logic. The effect of the division trip logic bypass is to reduce the scram logic to a coincidence of two out of three tripped divisions. Interlocks between the four division trip logic bypasses prevent bypass of any two or more division trip logics at the same time. Once a bypass of one division of trip logic has been established, bypasses of any of the remaining three division trip logics are inhibited.

(3) MSL Isolation Special Bypass (Figure 7.2-4)

A separate, manual, keylock switch associated with each of the four sensor channels provides means to bypass the MSL isolation trip output signal from the sensor channel to all four divisions of trip logic. This bypass permits continued plant operation while any one MSL is isolated without causing a half scram condition. The effect of the MSL isolation special bypass is to reduce the MSL isolation trip function in all four divisions of trip logic to a coincidence of two out of three sensor channel MSL isolation trips. Interlocks between the four divisions of trip logic prevent MSL isolation special bypass in any

conjunction with the pressure relief system is adequate to preclude over-pressurizing the nuclear system, the turbine control valve fast-closure scram provides additional margin to the nuclear system pressure limit. The turbine control valve fast-closure scram setting is selected to provide timely indication of control valve fast closure.

(6) Main Steamline Isolation

The main steamline isolation valve closure can result in a significant addition of positive reactivity to the core as nuclear system pressure rises. The main steamline isolation scram setting is selected to give the earliest positive indication of main steamline isolation without inducing spurious scrams.

(7) Low Charging Pressure to Rod hydraulic Control Unit Accumulators

The RC hydraulic system normally supplies charging water at sufficient pressure to charge all scram accumulators of the individual rod hydraulic control units (RHCUs) to pressure values that will assure adequate control rod scram insertion rates during a full reactor trip or scram. A low charging water pressure is indicative of the potential inability to maintain the scram accumulators pressurized. A reactor trip is initiated after a specified time delay, before the charging water pressure drops to a value that could eventually result in slower than normal scram speed control rod insertion.

(8) Drywell High Pressure

High pressure inside the drywell may indicate a break in the reactor coolant pressure boundary. It is prudent to scram the reactor in such a situation to minimize the possibility of fuel damage and to reduce energy transfer from the core to the coolant. The drywell high pressure scram setting is selected to be as low as possible without inducing spurious scrams.

(9) Main Steamline High Radiation

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.

CI 7.2.1-1

(10) ~~High Seismic Activity~~

Since high seismic activity is a source of potential damage to the plant, a reactor trip is initiated upon indication of such high seismic activity. There is one trip signal associated with each of the four RPS instrument channels.

7.2.1.1.8 Containment Electrical Penetration Assignment

Electrical containment penetrations are assigned to the protection systems on a four- division basis (Subsections 7.2.1.1.4.1 and 4.6).

Each penetration is provided with a NEMA-4 enclosure box on each end providing continuation of the metal wire ways (Subsection 7.2.1.1.4.6).

7.2.1.1.9 Cable Spreading Area Description

The cable spreading areas adjacent to the control room are termed cable rooms and electrical equipment rooms. A description of the separation criteria used in these rooms is in Section 8.3. Cable routing through the cable rooms is shown on raceway plans by reference in Section 6.7.

7.2.1.1.10 Main Control Room Area

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

The SSLC logic cabinets, which contain the RPS, for Divisions I, II, III, and IV include a vertical board for each division. The vertical boards contain digital and solid state discrete and integrated circuits used to condition signals transferred to the SSLC from the essential multiplex system (EMS). 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 nonsafety 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, or throughout the plant.

CI 7.2.2.1-3

The principal console contains the reactor mode switch, the RPS manual scram push button switches, the RPS scram reset switches and the bypass switches for the low RCS accumulator charging pressure.

7.2.1.1.12 Test Methods that Enhance RPS Reliability

Surveillance testing is performed periodically on the RPS during operation. This testing includes sensor calibration, response-time testing, trip channel actuation, and trip time measurement with simulated inputs to individual trip modules and sensors. The sensor channels can be checked during operation by comparison of the associated control room displays on other channels of the same variable. Fault-detection diagnostic testing is not being used to satisfy tech spec requirements for surveillance.

7.2.1.1.13 Interlock Circuits to Inhibit Rod Motion

Interlocks between the RPS and RC&IS inhibit rod withdrawal when the CRD charging pressure trip bypass switch is in the "BYPASS" position. These interlocks assure that no rods can be withdrawn when conditions are such that the RPS cannot re-insert rods if necessary.

7.2.1.1.14 Support Cooling System and HVAC Systems Descriptions

The cooling (ventilating) systems important for proper operation of RPS equipment are described in Section 9.4.

7.2.1.2 Design Bases

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

(1) Conditions

Generating station conditions requiring RPS protective actions are defined in the Technical Specifications, Chapter 16.

(2) Variables

The generating station variables which are monitored cover the protective action conditions that are identified in Subsection 7.2.1.2.1.

(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, Paragraph 3.3).

(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 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 in Chapter 16, Technical Specifications. The margin includes the maximum allowable accuracy error, sensor response times, and sensor setpoint drift.

same protective function are independent and physically separated to accomplish the decoupling of the effects of unsafe environmental factors, electric transients and physical accident consequences and to reduce the likelihood of interactions between channels during maintenance operations or in the event of channel malfunctions.

(7) Control and Protection System Interaction (Paragraph 4.7)

The channels for the RPS trip variables are electrically isolated and physically separated from the plant control systems in compliance with this design requirement.

Multiple redundant sensors and channels assure that no single failure can prevent protective action.

Multiple failures resulting from a single credible event could cause a control system action (closure of the turbine stop or control valves) resulting in a condition requiring protective action and concurrent prevention of operation of a portion of the RPS (scram signal from the turbine stop or control valves (see Subsection 7.2.1.1.4.2(4). The reactor vessel high-pressure and high-power trips provide diverse protection for this event.

(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:

(a) reactor vessel low water level trip;

(b) main steamline high radiation trip;

(c) neutron monitoring (APRM) system trip

(i) neutron flux trip and

(ii) simulated thermal power;

(d) neutron monitoring (SRNM) system trip;

(i) neutron flux trip;

(ii) short neutron flux period; and

(iii) channel inoperative;

(e) drywell high pressure trip; and

(f) reactor vessel high pressure trip

Other variables, which could affect the RPS scram function itself, are thus monitored to induce scram directly. These are:

(g) low charging pressure to rod HCU accumulators

(h) high seismic activity. CI 7.2.1-1

The detection of main steamline isolation valve position and turbine stop valve position is an appropriate variable for the reactor protection system. The desired variable is loss of the reactor heat sink; however, isolation or stop valve closure is the logical variable to inform that the steam path has been blocked between the reactor and the heat sink.

Due to the normal throttling action of the turbine control valves with changes in the plant power level, measurement of control valve position is not an appropriate variable from which to infer the desired variable, which is rapid loss of the reactor heat sink. Consequently, a measurement related to control valve closure rate is necessary.

Protection system design practice has discouraged use of rate-sensing devices for protective purposes. In this instance, it was determined that detection of hydraulic actuator operation would be a more positive means of determining fast closure of the control valves.

Loss of hydraulic pressure in the electrohydraulic control (EHC) oil lines which initiates fast closure of the control valves is monitored. These measurements provide indication that fast closure of the control valves is imminent.

This measurement is adequate and is a proper variable for the protective function, taking into consideration the reliability of the chosen sensors

Table 7.2-1

REACTOR PROTECTION SYSTEM INSTRUMENTATION SPECIFICATIONS

Reactor vessel high pressure	0-1500 psig	Pressure-transmitter/ trip module
Drywell high pressure	0-5 psig	Pressure-transmitter/ trip module
Reactor vessel low water level 3	0-135 inches H_20	Level-transmitter/ trip module
Low charging pressure to rod HCU accumulators	0-2500 psig	Pressure transmitter/ trip module
Turbine stop valve closure	Fully open to fully closed	Position switch
Turbine control valve fast closure	0-1600 psig Fully open to fully closed	Pressure-switch Position switch
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	$1\text{-}10^6$ mR/hr	Gamma detector
CI 7.2.1-1 High seismic activity		
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 seismic activity	12

CI 7.2.1-1

[1] In all modes except RUN

[2] Four limit switches on FASV and four oil pressure switches