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B 3.1.3 Control Rod Block Instrumentation

BASES

TRO

The Control Rod Block Instrumentation is a portion of the Reactor Manual Control System (RMCS), which upon receipt of input signals from other systems and subsystems, inhibits movement or selection of control rods (Reference 1). The purpose of the Control Rod Block function is to avoid conditions that would require Reactor Protection System (RPS) action if allowed to proceed.

The specific Functions associated with the TRM Control Rod Block Instrumentation are identified in Table 3.1.3-1 and are discussed below.

1. Average Power Range Monitors (APRM)
2. Source Range Monitors (SRM)
3. Intermediate Range Monitors (IRM)

The same grouping of neutron monitoring equipment (SRM and IRM) that is used in the RPS is also used in the rod block circuitry. Half of the total monitors (SRM and IRM) provide inputs to one of the two RMCS rod block logic circuits and the remaining half provide inputs to the other RMCS rod block circuit.

Reference APRM Flux level input to the RMCS is through the rod block monitor. A signal from one of the four redundant APRM channels supplies a reference signal for one of the RBM channels and a signal from another of the APRM channels supplies the reference signal to the second RBM channel. The RBM interfaces to the RMCS to determine rod selection conditions.

The APRM rod block settings are varied as a function of Reactor Coolant System (RCS) recirculation flow. The settings are selected so that all the neutron monitoring rod blocks are sufficient to avoid an RPS action. Mechanical switches in the SRM and IRM detector drive systems provide the position signals used to indicate that a detector is not fully inserted.

The SRM minimum count rate Allowable Value is discussed in the TS Bases for SR 3.3.1.2.4.

4. Scram Discharge Volume Water Level - High

Scram Discharge Volume Water Level – High signals are provided as inputs into both rod block logic circuits. Both rod block logic circuits sense when the high water level scram trip for the Scram Discharge Volume is bypassed. The rod block from Scram Discharge Volume Water Level – High comes from one of two float type level switches installed in each of two scram discharge instrument volumes. The second float switch in each instrument volume provides a control room annunciation of increasing level below the level at which a rod block occurs.

(continued)

B 3.1.3 Control Rod Block Instrumentation

BASES

TRO (continued)

5. RCS Recirculation Flow

The recirculation flow system consists of four separate transmitters on each of two recirculation loops (eight total). The transmitter output signal from one flow channel is routed to one of four APRM channels. Each APRM processes and sums the transmitters signals. Each APRM then sends its total flow signal to both RBMs. Each RBM then compares the four flows and issues Alarms based on user entered values. Both RBM channels are identical, but are configured to support either RBM channel A or channel B.

With the NUMAC PRNMS system, the Upscale flow function is performed within the APRM and sent on to the reactor manual control system. Flow comparison is performed within the RBM but is processed as an alarm only since the RBM rod block functions are power and not flow dependent. Recirculation flow inputs for system 'inop' functions are processed as part of the APRM 'Upscale/Inop' function.

ACTIONS

The ACTIONS are defined to ensure proper corrective measures are taken in response to the inoperable components.

TRS

The TRSs are performed at the specified Frequency to ensure that the Control Rod Block Function is maintained OPERABLE.

TRS 3.1.3.1, TRS 3.1.3.2, TRS 3.1.3.3, TRS 3.1.3.4, TRS 3.1.3.5, TRS 3.1.3.6, and TRS 3.1.3.7

Control Rod Block Instrumentation surveillances are performed consistent with the Bases for the comparable channels in LCO 3.3.1.1 and LCO 3.3.1.2.

(continued)

B 3.1.3 Control Rod Block Instrumentation

BASES (continued)

REFERENCE

1. FSAR Section 7.7.1
2. NEDC-32410P-A, "Nuclear Measurement Analysis and Control Power Range Neutron Monitor (NUMAC PRNM) Retrofit Plus Option III Stability Trip Function"

B 3.3.9 OPRM Instrumentation

BASES

TRO

The OPRM system configuration governs its operation in accordance with the licensing analysis. Several configuration parameters are intrinsic to the trip function safety setpoint bases or provide settings for defense-in-depth algorithm features that are not assumed in the basis for the protection system safety analysis (Reference 2, Reference 3).

Each of the setting values may be used as the process setpoint or device setting without further adjustment for uncertainties.

Setpoints and Settings Bases

TOL(ε) Period Tolerance

The specified range of values for the period tolerance has been demonstrated to provide continuous confirmations upon transition from stable reactor operation to a growing reactor instability. A range of values is provided to allow system tuning to avoid spurious alarms on period confirmations. Limiting the setpoint adjustment range provides assurance that the Period Based Detection Algorithm will provide sufficient confirmations for a growing instability.

f_c Conditioning Filter Cutoff Frequency

The specified value for the Conditioning Filter Cutoff Frequency has been demonstrated to provide continuous confirmations upon transition from stable reactor operation to a growing reactor instability. Setting minimizes impact on signal amplitude and provides assurance that the Period Based Detection Algorithm will provide sufficient confirmations for a growing instability.

Tmin Oscillation Period Lower Time Limit

Tmax Oscillation Period Upper Time Limit

The Oscillation Period Time Limit parameters establish the range of detectable oscillation periods of OPRM cell signals for signal oscillations associated with reactor core thermal-hydraulic instability.

(continued)

B 3.3.9 OPRM Instrumentation

BASES

TRO (continued)

$LPRM_{min}$

This value determines the availability and resulting sensitivity of cells in the reactor core in the event of LPRM channel failures. The minimum LPRM per cell parameter is an assumption of the OPRM trip setpoint (Sp) basis calculation.

Amplitude and Growth Rate Based Algorithm Parameters

S1	Peak Threshold Setpoint/ABA & GRBA
S2	Valley Threshold Setpoint/ABA & GRBA
Smax	Amplitude Trip Setpoint/ABA
DR3	Growth Rate Factor Setpoint/GRBA

These parameters calibrate the Amplitude and Growth Rate Based Algorithm, described in References 2 and 3, which provides an OPRM trip output to the Reactor Protection System. The OPRM design and licensing basis takes no credit for the Amplitude and Growth Rate Based Algorithm. The algorithm is provided as a defense-in-depth feature in the event of unanticipated power oscillations. These Amplitude and Growth Rate Based Algorithm Parameters are considered sufficient to provide backup protection and to avoid spurious trips by maximizing margin to expected operating conditions and transients.

ACTIONS

The required actions assure that the system settings that support the Period Based Algorithm setpoint analysis, and those parameters that define the Amplitude and Growth Rate Based Algorithm are returned in a timely manner to the values assumed in the analysis (Reference 2, Reference 3) or that the affected channel is declared inoperable and the applicable Required Action of LCO 3.3.1.1 is then entered, or an alternate method to detect and suppress thermal hydraulic instability oscillations is employed.

(continued)

B 3.3.9 OPRM Instrumentation

BASES

ACTIONS (continued)

Note 1 has been provided to modify the ACTIONS related to affected OPRM channels. Technical Specification Section 1.3, Completion Times, specifies that once a Condition has been entered, subsequent divisions, subsystems, components, or variables expressed in the Condition discovered to be inoperable or not within limits will not result in separate entry into the Condition. Technical Specification Section 1.3 also specifies that Required Actions of the Condition continue to apply for each additional failure, with Completion Times based on initial entry into the Condition. However, the Required Actions for affected OPRM channels provide appropriate compensatory measures. As such, a Note has been provided that allows separate Condition entry for each affected OPRM channel.

B.1

Several parameter settings are essential for the proper operation of the OPRM period-based trip algorithm. The permissible values of Period Confirmation Tolerance, Averaging Filter time constant, Conditioning Filter Cutoff Frequency, and minimum operable LPRM per cell parameters are limited by the setpoint basis calculations and system transient response analysis. The Minimum and Maximum Oscillation Period settings limit the algorithm window to the cell signal resonances that can be associated with unstable thermal-hydraulic conditions.

Because the ability of the OPRM channel to perform its safety function is affected by these parameter settings, the affected OPRM channel must be considered inoperable when these conditions are not met.

Operability is evaluated for each inoperable channel and Required Actions taken in accordance with LCO 3.3.1.1.

C.1

The design objective for the Amplitude and Growth Rate Based Algorithms is to provide automatic action to limit the size of these unanticipated oscillations, thereby preventing fuel cladding damage. Several parameter settings define the function of the Amplitude and Growth Rate Based Algorithm. The OPRM design and licensing basis takes no credit for the Amplitude and Growth Rate Based Algorithm, which is provided as a defense-in-depth feature in the event of unanticipated oscillations.

(continued)

B 3.3.9 OPRM Instrumentation

BASES

ACTIONS

C.1 (continued)

Because the ability of the OPRM channel to perform its safety function is not affected by these parameter settings, the affected OPRM channel need not be immediately considered inoperable when these conditions are not met. These parameters are to be maintained for conformance with the licensing requirement of a defense-in-depth feature in addition to the licensed OPRM trip function. This is corrected by returning the parameters to conformance within 120 days of identification.

Since the Amplitude and Growth Rate Based parameters affect only the defense-in-depth response within each channel, failure to maintain the proper parameters in the channel affects only the operability of that channel.

D.1

This Action is to be taken if the Period Based Detection Algorithm trip function is not available in accordance with LCO 3.3.1.1, and initiation of an alternate method to Detect and Suppress thermal hydraulic instability oscillations is required by the referenced LCO Required Actions. The applicable Conditions are entered as required.

E.1

As directed from Required Action D.1, this Action provides preemptive protection through Power/Flow Map operating restrictions.

When operating in Region I of the Power / Flow map specified in the COLR, or when operating in Region II of the Power / Flow map specified in the COLR with less than 50% of the required LPRM upscale alarms OPERABLE, the potential for thermal-hydraulic oscillations is greatly increased and sufficient margin may not be available for operator response to suppress potential thermal-hydraulic oscillations. Therefore, the reactor mode switch must be immediately placed in the shutdown position. Action is taken immediately to place the plant in a condition where any potential for thermal-hydraulic instabilities will be terminated.

Identification of which LPRMs are Upscale can be determined by a number of methods in the control room. The most commonly used method is visual and audible observance of the LPRM Upscale Annunciator and Alarm followed with identification of the individual LPRMs feeding the annunciation/alarm. Identification of individual LPRM Upscale is possible by observance of the various Operator display assemblies and control panel monitors including PICSY.

(continued)

B 3.3.9 OPRM Instrumentation

BASES

ACTIONS (continued)

F.1

As directed from Required Action D.1, this Action provides guidance for Operator action in response to thermal-hydraulic instability oscillations.

When operating in Region II of the Power/Flow map specified in the COLR immediate response is necessary when there are indications that thermal hydraulic oscillations are occurring as defined in the CONDITION.

LPRM upscale alarms are required to detect reactor core thermal-hydraulic instability events. The criteria for determining which LPRM upscale alarms are required is based on assignment of these alarms to designated core zones. These core zones consist of the level A, B, and C alarms in 4 or 5 adjacent LPRM strings. The number and location of LPRM strings in each zone assure that with 50% or more of the associated LPRM upscale alarms OPERABLE sufficient monitoring capability is available to detect core wide and regional oscillations. Operating plant instability data is used to determine the specific LPRM strings assigned to each zone.

Identification of which LPRMs are Upscale can be determined by a number of methods in the control room. The most commonly used method is visual and audible observance of the LPRM Upscale Annunciator and Alarm followed with identification of the individual LPRMs feeding the annunciation/ alarm. Identification of individual LPRM Upscale is possible by observance of the various Operator display assemblies and control panel monitors including PICSY.

G.1

As directed from Required Action D.1, this Action provides guidance for Operator action in response to operation in conditions that may lead to thermal-hydraulic instability oscillations.

When operating in Region II of the Power/Flow map specified in the COLR, the potential for thermal-hydraulic oscillations is increased and sufficient margin may not be available for operator response to suppress potential thermal-hydraulic oscillations. Therefore, action must be initiated immediately to restore operation outside of Regions II of the Power/Flow map specified in the COLR. This can be accomplished by either decreasing THERMAL POWER with control rod insertion or increasing core flow by increasing recirculation pump speed. The starting of a recirculation pump will not be used as a means to exit the excluded Regions because the starting of a recirculation pump with the plant operating above the 80% rod line is prohibited due to potential instability problems.

(continued)

B 3.3.9 OPRM Instrumentation

BASES

ACTIONS (continued)

H.1

The LPRMs provide a capability to monitor power in selected locations of the reactor core. The LPRM Upscale Alarm Instrumentation provides information concerning local power oscillations. Condition F requires a reactor scram when operating in Region II of the Power/Flow map specified in the COLR with indications that thermal hydraulic oscillations are occurring. The number and location of LPRM strings in each zone assures that with 50% or more of the associated LPRM upscale alarms OPERABLE any power oscillations which could occur would be detected and proper actions can be taken.

Identification of which LPRMs are Upscale can be determined by a number of methods in the control room. The most commonly used method is visual and audible observance of the LPRM Upscale Annunciator and Alarm followed with identification of the individual LPRMs feeding the annunciation/ alarm. Identification of individual LPRM Upscale is possible by observance of the various Operator display assemblies and control panel monitors including PICSY.

A sign is posted in the Control Room to ensure that plant operators are aware of the system condition if a plant transient results in the plant entering into the instability region.

TRS

TRS 3.3.9.1

Required only when the OPRM trip function is not available, this TRS ensures the combination of core flow and THERMAL POWER are within required limits to prevent uncontrolled thermal hydraulic oscillations by ensuring the recirculation loops are within the limits established by the Power / Flow map specified in the COLR. At low recirculation flows and high reactor power, the reactor exhibits increased susceptibility to thermal-hydraulic instability. The Power / Flow map specified in the COLR is based on guidance provided in References 7, 8, and 9 which also provided the guidance on how to respond to operation in these conditions. The 24 hour Frequency is based on operating experience and the operator's inherent knowledge of the current reactor status, including significant changes in THERMAL POWER and core flow to ensure the requirements are constantly met.

TRS 3.3.9.2

This TRS is to be performed at the specified Frequency to ensure that the LPRM Upscale Alarm Instrumentation are maintained OPERABLE.

(continued)

B 3.3.9 OPRM Instrumentation

BASES

TRS (continued)

TRS 3.3.9.3

The parameter setpoint verification surveillance compares the desired settings and setpoints to the values contained in the processor memory. This surveillance is required to assure that the settings are maintained in accordance with the setpoint analysis. The frequency is based on the OPRM CALIBRATION frequency per SR 3.3.1.1.18.

REFERENCES

1. NEDO-31960-A, BWROG Long Term Solution Licensing Methodology
2. NEDO-31960-A, Supp. 1, BWROG Long Term Solution Licensing Methodology
3. NEDO-32465-A, BWROG Reactor Stability Detect and Suppress Solutions Licensing Basis Methodology and Reload Applications
4. Deleted.
5. Generic Letter 94-02, Long-Term Solutions and Upgrade Of Interim Operating Recommendations for Thermal-Hydraulic Instabilities in Boiling Water Reactors
6. LCO 3.3.1.1, Reactor Protection System (RPS) Instrumentation
7. GE Service Information Letter No. 380, "BWR Core Thermal Hydraulic Stability," Revision 1, February 10, 1984.
8. Letter, L. A. England to M. J. Virgilio, "BWR Owner's Group Guidelines for Stability Interim Corrective Action," June 6, 1994.
9. EMF-CC-074(P)(A), Volume 4, Revision 0, "BWR Stability Analysis: Assessment of STAIF with Input from MICROBURN-B2," November 1999.
10. NEDC-32410P-A, "Nuclear Measurement Analysis and Control Power Range Neutron Monitor (NUMAC PRNM) Retrofit Plus Option III Stability Trip Function"

B 3.10.2 Shutdown Margin Test RPS Instrumentation

BASES

TRO

Prior to demonstration of adequate shutdown margin, neutron monitoring system trips provide a level of defense-in-depth to assure that the reactor will be maintained sufficiently subcritical to preclude inadvertent criticality in the shutdown condition. The intent of the requirement is to ensure that the protection system coincident trip logics are removed if a rod has been withdrawn and shutdown margin has not been demonstrated.

With the shorting links removed, the trip function is in the non-coincident mode, such that all trip channels go to both trip systems, effectively producing one trip system. For the NUMAC PRNMS, only the 2-Out-of-4 Voter logic provides trip inputs to RPS. Therefore, when the "shorting links" are removed, the Minimum OPERABLE Channels Per Trip system is four 2-Out-of-4 Voters, and 6 IRM Neutron Flux High or Inop. Two SRM channels are required, one in, and one near, the affected core quadrant undergoing shutdown margin testing.

ACTIONS

The Actions are defined to ensure that defense-in-depth protection against inadvertent core criticality is provided during initial startup with a new full core; CORE ALTERATIONS (i.e. - control rod withdrawals) are prohibited, and withdrawn rods are inserted, to assure a subcritical core. The Conditions cover inoperable instrument channels and failure to remove the shorting links. These Actions are consistent with the non-coincident logic.

(continued)

B 3.10.2 Shutdown Margin Test RPS Instrumentation

BASES (continued)

TRS	The TRSs listed provide for the proper channel surveillances for the SRM trip that assure the trip function operates per design when needed. TRS 3.10.2.1 provides assurance that the SRM monitoring function that drives the RPS function remains OPERABLE. The IRM and APRM surveillances are properly defined for MODE 5 OPERABILITY in LCO 3.3.1.1. TRS 3.10.2.2 assures that the shorting links are removed prior to and during MODE 5 Shutdown Margin demonstrations per LCO 3.1.1. TRS 3.10.2.4 assures that the resulting RPS trip logic performs as designed with the shorting links removed.
REFERENCES	1. LCO 3.1.1 2. LCO 3.3.1.1