LIMITING CONDITIONS FOR OPERATION

3.3 REACTIVITY CONTROL

A. Reactivity Margin - Core Loading

LCO 3.3.A.1

The core loading shall be limited to that which can be made subcritical in the most reactive condition during the OPERATING CYCLE with the strongest OPERABLE control rod in its full-out position and all other OPERABLE rods fully inserted.

APPLICABILITY:

At all times when there is fuel in the reactor vessel.

ACTIONS:

A. LCO 3.3.A.1 cannot be met.

1 Be in HOT SHUTDOWN within 12 hours.

SURVEILLANCE REQUIREMENTS

4.3 REACTIVITY CONTROL

A. Reactivity Margin - Core Loading

SR 4.3.A.1

Sufficient control rods shall be withdrawn following a REFUELING OUTAGE when CORE ALTERATIONS were performed to demonstrate with a margin of 0.25 percent Δk that the core can be made subcritical at any time in the subsequent fuel cycle with the strongest OPERABLE control rod fully withdrawn and all other OPERABLE rods fully inserted.

LIMITING CONDITIONS FOR OPERATION

3.3 REACTIVITY CONTROL (continued)

B. Control Rod Operability

LCO 3.3.B.1

Each control rod shall be OPERABLE.

APPLICABILITY:

RUN and STARTUP MODES; REFUEL MODE when the reactor vessel head is fully tensioned. (See also 3.10.D)

ACTIONS

----------------NOTE--------------------
Separate condition entry is allowed for each control rod.

A. One withdrawn control rod stuck.

-----------------NOTE-----------------
Rod Worth Minimizer (RWM) may be bypassed as allowed by LCO 3.3.F.
----

1 Verify stuck control rod is separated from other inoperable control rods by two or more OPERABLE control rods immediately.

AND

2 Disarm the associated control rod drive (CRD) within 2 hours.

AND

3 Perform SR 4.3.B.1.1 and SR 4.3.B.1.2 for each withdrawn OPERABLE control rod within 24 hours from discovery of condition A concurrent with thermal power greater than the Low Power Setpoint (LPSP) of the RWM.

AND

4 Verify LCO 3.3.A.1 is met within 72 hours.

AND

SURVEILLANCE REQUIREMENTS

4.3 REACTIVITY CONTROL (continued)

B. Control Rod Operability

SR 4.3.B.1.1

---------------------NOTE---------------------
Not required to be performed until 7 days after the control rod is withdrawn and thermal power is greater than the LPSP of the RWM.

Insert each fully withdrawn OPERABLE control rod at least one notch once per 7 days.

SR 4.3.B.1.2

---------------------NOTE---------------------
Not required to be performed until 31 days after the control rod is withdrawn and thermal power is greater than the LPSP of the RWM.

Insert each partially withdrawn OPERABLE control rod at least one notch once per 31 days.

SR 4.3.B.1.3

Verify each withdrawn control rod does not go to the withdrawn overtravel position.

a. Each time the control rod is withdrawn to "full out" position.

AND

b. Prior to declaring control rod OPERABLE after work on control rod or CRD system that could affect coupling.

SR 4.3.B.1.4

Verify each control rod scram time from fully withdrawn to notch position 04 is $\leq$ 7 seconds in accordance with SR 4.3.C.1 or SR 4.3.C.2.

SR 4.3.B.1.5

Determine the position of each control rod once per 24 hours.

LIMITING CONDITIONS FOR OPERATION

3.3 REACTIVITY CONTROL (continued)

B. Control Rod Operability (continued)

LCO 3.3.B.1 (continued)

5 -------------NOTE--------------
Not applicable when thermal power > 20% RTP.

Ensure stuck rod is in compliance with banked position withdrawal sequence (BPWS) within 8 hours.

OR

Verify control rod drop accident limit of 280 cal/gm is not exceeded within 8 hours.

B. Two or more withdrawn control rods stuck.

1 Be in HOT SHUTDOWN within 12 hours.

C. One or more control rods inoperable for reasons other than condition A or B.

1 --------------NOTE-------------
RWM may be bypassed as allowed by LCO 3.3.F.

Fully insert inoperable control rod within 3 hours.

AND

2 Disarm the associated CRD within 4 hours.

SURVEILLANCE REQUIREMENTS

4.3 REACTIVITY CONTROL (continued)

B. Control Rod Operability (continued)

LIMITING CONDITIONS FOR OPERATION

3.3 REACTIVITY CONTROL (continued)

B. Control Rod Operability (continued)

LCO 3.3.B.1 (continued)

D. -------------------NOTE------------------
Not applicable when thermal power > 20% RTP.

Two or more inoperable control rods not in compliance with BPWS and not separated by two or more OPERABLE control rods.

1 Restore compliance with BPWS within 8 hours.

OR

2 Verify control rod drop accident limit of 280 cal/gm is not exceeded within 8 hours.

OR

3 Restore control rod(s) to OPERABLE status within 8 hours.

E. -------------------NOTE------------------
Not applicable when thermal power > 20% RTP.

One or more groups with four or more inoperable control rods.

1 Restore control rod(s) to OPERABLE status within 8 hours.

F. Required action and associated completion time of condition A, C, D, or E not met.

OR

Nine or more control rods inoperable.

1 Be in HOT SHUTDOWN within 12 hours.

SURVEILLANCE REQUIREMENTS

4.3 REACTIVITY CONTROL (continued)

B. Control Rod Operability (continued)

LIMITING CONDITIONS FOR OPERATION

3.3 REACTIVITY CONTROL (continued)

B. Control Rod Operability (continued)

LCO 3.3.B.2

The control rod drive housing support system shall be in place.

APPLICABILITY:

During reactor power operation and when the reactor coolant system is pressurized above atmospheric pressure with fuel in the reactor vessel.

ACTIONS:

A. LCO 3.3.B.2 cannot be met.

1 Be in COLD SHUTDOWN within 24 hours.

SURVEILLANCE REQUIREMENTS

4.3 REACTIVITY CONTROL (continued)

B. Control Rod Operability (continued)

SR 4.3.B.2

The control rod drive housing support system shall be inspected after reassembly and the results of the inspection recorded.

LIMITING CONDITIONS FOR OPERATION

3.3 REACTIVITY CONTROL (continued)

B. Control Rod Operability (continued)

LCO 3.3.B.3

Control rods shall not be withdrawn for startup unless at least two source range channels have an observed count rate equal to or greater than three counts per second.

APPLICABILITY:

Prior to withdrawing control rods for startup.

ACTIONS:

A. LCO 3.3.B.3 cannot be met.

1 Place the mode switch in shutdown immediately.

SURVEILLANCE REQUIREMENTS

4.3 REACTIVITY CONTROL (continued)

B. Control Rod Operability (continued)

SR 4.3.B.3

Prior to control rod withdrawal for startup, verify that at least two source range channels have an observed count rate of at least three counts per second.

LIMITING CONDITIONS FOR OPERATION

3.3 REACTIVITY CONTROL (continued)

C. Scram Insertion Times

LCO 3.3.C

1 Average scram insertion time for all OPERABLE control rods from de-energization of the scram pilot valve solenoids to dropout (DO) of notches 04, 24, 34, and 44 shall be no greater than:

Notch Position	Average Scram Times (seconds)
44 DO	0.508
34 DO	1.252
24 DO	2.016
04 DO	3.578

2 Average scram insertion time for the three fastest OPERABLE control rods in each group of four control rods in all two by two arrays from de-energization of the scram pilot valve solenoids to dropout (DO) of notches 04, 24, 34, and 44 shall be no greater than:

Notch Position	Average Scram Times (seconds)
44 DO	0.538
34 DO	1.327
24 DO	2.137
04 DO	3.793

APPLICABILITY:

RUN and STARTUP MODES; REFUEL MODE when the reactor vessel head is fully tensioned.

ACTIONS:

A. LCO 3.3.C cannot be met.

1 Be in HOT SHUTDOWN within 12 hours.

SURVEILLANCE REQUIREMENTS

4.3 REACTIVITY CONTROL (continued)

C. Scram Insertion Times

SR 4.3.C.1

Following each REFUELING OUTAGE, or after a reactor shutdown that is greater than 120 days, each OPERABLE control rod shall be subjected to scram time tests from the fully withdrawn position. If testing is not accomplished with the nuclear system pressure above 950 psig, the measured scram insertion time shall be extrapolated to reactor pressures above 950 psig using previously determined correlations. Testing of all OPERABLE control rods shall be completed prior to exceeding 40% rated thermal power.

SR 4.3.C.2

Within each 120 days of operation, a minimum of 10% of the control rod drives, on a rotating basis, shall be scram tested as in SR 4.3.C.1. An evaluation shall be completed every 120 days of operation to provide reasonable assurance that proper performance is being maintained.

D. Control Rod Accumulators

LCO 3.3.D

Each control rod scram accumulator shall be OPERABLE.

APPLICABILITY:

RUN and STARTUP MODES; REFUEL MODE when the reactor vessel head is fully tensioned.

ACTIONS:

--------------------NOTE-----------------------

Separate condition entry is allowed for each control rod scram accumulator.

A. Control rod scram accumulator(s) inoperable with reactor steam dome pressure ≥ 950 psig.

1.1 Verify no adjacent OPERABLE control rod has an inoperable scram accumulator within 1 hour.

AND

1.2 Verify no adjacent control rod is electrically disarmed in a non-fully inserted position within 1 hour.

OR

2 Declare the associated control rod inoperable within 1 hour.

B. Control rod scram accumulator(s) inoperable with reactor steam dome pressure < 950 psig or reactor thermal power ≤ 20 % RTP.

1 Restore inoperable accumulator to OPERABLE status within 8 hours.

OR

2 Declare the associated control rod inoperable within 8 hours.

(continued)

D. Control Rod Accumulators

SR 4.3.D

Once a shift, check the status of the pressure and level alarms for each accumulator.

D. Control Rod Accumulators (continued)

LCO 3.3.D (continued)

C. Two or more control rod accumulators inoperable, concurrent with loss of charging water pressure, when reactor steam dome pressure ≥ 950 psig.

1 Restore charging water header pressure within 20 minutes.

AND

2 Restore inoperable accumulator(s) to OPERABLE status within 8 hours.

D. Two or more control rod accumulators inoperable, concurrent with loss of charging water pressure, when reactor steam dome pressure < 950 psig.

1 Verify all control rods associated with inoperable accumulators are fully inserted immediately.

AND

2 Declare the associated control rods inoperable within 1 hour.

E. Required action and associated completion time if C.1 or D.1 not met.

1 -------------NOTE--------------
Not applicable if all inoperable control rod scram accumulators are associated with fully inserted control rods.

Place the reactor mode switch in the shutdown position immediately.

D. Control Rod Accumulators (continued)

E. Reactivity Anomalies

LCO 3.3.E

The reactivity equivalent of the difference between the actual critical rod configuration and the expected configuration shall not exceed 1% ΔK.

APPLICABILITY:

STARTUP AND RUN MODES

ACTIONS:

A. Limit exceeded.

1 Be in HOT SHUTDOWN within 12 hours.

E. Reactivity Anomalies

SR 4.3.E

During startups following REFUELING OUTAGES, the critical rod configurations will be compared to the expected configurations at selected operating conditions. These comparisons will be used as base data for reactivity monitoring during subsequent power operation throughout the fuel cycle. At specific power operating conditions, the critical rod configuration will be compared to the configuration expected based upon appropriately corrected past data. This comparison will be made at least every full power month.

F. Rod Worth Minimizer (RWM)

LCO 3.3.F

The RWM shall be OPERABLE.

APPLICABILITY:

RUN and STARTUP MODES with reactor thermal power ≤ 20 % RTP.

ACTIONS:

A. RWM inoperable during reactor startup.

1 Immediately suspend control rod movement except by scram.

OR

2.1 Immediately verify by administrative methods that startup with RWM inoperable has not been performed in the last 12 months.

AND

2.2 Verify movement of control rods is in compliance with BPWS by a second licensed operator or other qualified member of the technical staff during control rod movement.

B. RWM inoperable during reactor shutdown.

1 Verify movement of control rods is in accordance with BPWS by a second licensed operator or other qualified member of the technical staff during control rod movement.

F. Rod Worth Minimizer (RWM)

SR 4.3.F.1

Perform an INSTRUMENT FUNCTIONAL TEST of the RWM prior to control rod withdrawal for startup or insertion to reduce power below 20%.

SR 4.3.F.2

Verify the RWM automatic bypass setpoint to be > 20% RTP every 24 months.

SR 4.3.F.3

Verify control rod sequences input to the RWM are in conformance with BPWS prior to declaring RWM OPERABLE following loading of sequence into RWM.

LIMITING CONDITIONS FOR OPERATION

3.3 REACTIVITY CONTROL (continued)

G. Scram Discharge Volume

LCO 3.3.G

The scram discharge volume drain & vent valves shall be OPERABLE.

APPLICABILITY:

RUN and STARTUP MODES; REFUEL MODE when the reactor vessel head is fully tensioned.

ACTIONS:

A. Any scram discharge volume drain or vent valves made or found inoperable.

    1 Be in HOT SHUTDOWN within 12 hours.

SURVEILLANCE REQUIREMENTS

4.3 REACTIVITY CONTROL (continued)

G. Scram Discharge Volume

SR 4.3.G.1

Verify scram discharge volume drain and vent valves open at least once per month.

SR 4.3.G.2

Test scram discharge volume drain and vent valves as specified in 4.13. These valves may be closed intermittently for testing under administrative control.

SR 4.3.G.3

During each REFUELING INTERVAL verify the scram discharge volume drain and vent valves.

a Close within 30 seconds after receipt of a reactor scram signal.

AND

b Open when the scram is reset.

LIMITING CONDITIONS FOR OPERATION

3.3 REACTIVITY CONTROL (continued)

H. Rod Pattern Control

LCO 3.3.H

All OPERABLE control rods shall comply with the requirements of the BPWS.

APPLICABILITY:

RUN and STARTUP MODES with reactor thermal power ≤ 20 % RTP.

ACTIONS:

A. One or more OPERABLE control rods not in compliance with BPWS.

1. ------------NOTE-------------
   RWM may be bypassed as allowed by LCO 3.3.F.

   Move associated control rod(s) to correct position within 8 hours.

OR

2. Verify control rod drop accident limit of 280 cal/gm is not exceeded within 8 hours.

OR

3. Declare associated control rod(s) inoperable within 8 hours.

(continued)

SURVEILLANCE REQUIREMENTS

4.3 REACTIVITY CONTROL (continued)

H. Rod Pattern Control

SR 4.3.H

Verify all OPERABLE control rods comply with BPWS every 24 hours.

LIMITING CONDITIONS FOR OPERATION

3.3 REACTIVITY CONTROL (continued)

H. Rod Pattern Control (continued)

LCO 3.3.H (continued)

B. Nine or more OPERABLE control rods not in compliance with BPWS.

1 ------------NOTE-------------
RWM may be bypassed as allowed by LCO 3.3.F.

Immediately suspend withdrawal of control rods.

AND

2 Place the reactor mode switch in the shutdown position within 1 hour.

SURVEILLANCE REQUIREMENTS

4.3 REACTIVITY CONTROL (continued)

H. Rod Pattern Control (continued)

PNPS

TABLE 3.2.F

SURVEILLANCE INSTRUMENTATION

Minimum # of Operable Instrument Channels	Instrument #	Parameter	Type Indication and Range	Notes
2	640-29A & B	Reactor Water Level	Indicator 0-60"	(1) (2) (3)
2	640-25A & B	Reactor Pressure	Indicator 0-1200 psig	(1) (2) (3)
2	TRU-9044 TRU-9045	Drywell Pressure	Recorder 0-80 psia	(1) (2) (3)
2	TRU-9044 TI-9019	Drywell Temperature	Recorder, Indicator 0-400°F	(1) (2) (3)
2	TRU-9045 TI-9018	Suppression Chamber Air Temperature	Recorder, Indicator 0-400°F	(1) (2) (3)
2	LR-5038 LR-5049	Suppression Chamber Water Level	Recorder -7 to +7 inches	(1) (2) (3)
1	NA	Neutron Monitoring	SRM, IRM, LPRM 0 to 100% power	(1) (2) (3) (4)

TABLE 4.2.F

MINIMUM TEST AND CALIBRATION FREQUENCY FOR SURVEILLANCE INSTRUMENTATION

Instrument Channel	Calibration Frequency	Instrument Check
1) Reactor Water Level	Each Refueling Outage	Each Shift
2) Reactor Pressure	Each Refueling Outage	Each Shift
3) Drywell Pressure	Each Refueling Outage	Each Shift
4) Drywell Temperature	Once/6 Months	Each Shift
5) Suppression Chamber Temperature	Once/6 Months	Each Shift
6) Suppression Chamber Water Level	Once/6 Months	Each Shift
7) NA		
8) Neutron Monitoring	(2)	Each Shift
9) Drywell/Torus Differential Pressure	Once/6 Months	Each Shift
10) Drywell Pressure Torus Pressure	Once/6 Months Once/6 Months	Each Shift
11) Safety/Relief Valve Position Indicator (Primary/Secondary)	Each refueling outage	Once each day
12) Safety Valve Position Indicator (Primary/ Secondary)	Each refueling outage	Once each day

3/4.3 REACTIVITY CONTROL

3/4.3.A.1 Reactivity Margin - Core Loading

BASES:

BACKGROUND

Reactivity Margin requirements are specified to ensure:

a. The reactor can be made subcritical from all operating conditions and transients and Design Basis Events;

b. The reactivity transients associated with postulated accident conditions are controllable within acceptable limits; and,

c. The reactor will be maintained sufficiently subcritical to preclude inadvertent criticality in the shutdown condition.

These requirements are satisfied by the control rods, which compensate for the reactivity effects of the fuel and water temperature changes experienced during all operating conditions.

APPLICABLE SAFETY ANALYSES

The control rod drop accident (CRDA) analysis (References 1, 2, and 3) assumes the core is subcritical with the highest worth control rod withdrawn. Typically, the first control rod withdrawn has a very high reactivity worth and, should the core be critical during the withdrawal of the first control rod, the consequences of a CRDA could exceed the fuel damage limits for a CRDA (see Bases for LCO 3.3.H, "Rod Pattern Control"). Also, reactivity margin is assumed as an initial condition for the control rod removal error during refueling (Reference 4) accident. The analysis of this reactivity insertion event assumes the refueling interlocks are OPERABLE when the reactor is in the refueling mode of operation. These interlocks prevent the withdrawal of more than one control rod from the core during refueling. (Special consideration and requirements for multiple control rod withdrawal during refueling are covered in LCO 3.10.D, "Multiple Control Rod Withdrawal"). The analysis assumes this ACTION is acceptable since the core will be shut down with the highest worth control rod withdrawn, if adequate reactivity margin has been demonstrated.

Prevention or mitigation of reactivity insertion events is necessary to limit energy deposition in the fuel to prevent significant fuel damage, which could result in undue release of radioactivity. Adequate reactivity margin ensures inadvertent criticalities and potential CRDAs involving high worth control rods (namely the first control rod withdrawn) will not cause significant fuel damage during all operations and post accident conditions.

LCO

The core reactivity limitation is a restriction to be applied principally to the design of new fuel which may be loaded in the core or into a

3/4.3 REACTIVITY CONTROL

BASES

particular refueling pattern. Satisfaction of the limitation can only be demonstrated at the time of loading and must be such that it will apply to the entire subsequent fuel cycle. The generalized form is that the reactivity of the core loading will be limited so the core can be made subcritical by at least R + 0.25% Δk at the time of the test, with the strongest control rod fully withdrawn and all others fully inserted. The value of R in % Δk is the maximum amount that shutdown margin is calculated to decrease during the fuel cycle from that at the beginning of the fuel cycle. R must be a positive quantity or zero. A core which contains temporary control or other burnable neutron absorbers may have a reactivity characteristic which increases with core lifetime, goes through a maximum, and then decreases thereafter.

The value of R shall include the potential shutdown margin loss assuming full B_4C settling in all inverted poison tubes present in the core. A new value of R must be determined for each full cycle.

APPLICABILITY

In the STARTUP and RUN MODES, reactivity margin must be provided because subcriticality with the highest worth control rod withdrawn is assumed in the CRDA analysis (References 1, 2, and 3). In the HOT SHUTDOWN and COLD SHUTDOWN MODES, reactivity margin is required to ensure the reactor will be held subcritical with margin for a single withdrawn control rod. Reactivity margin is required in the REFUEL MODE to prevent an open vessel, inadvertent criticality during the withdrawal of a single control rod from a core cell containing one or more fuel assemblies.

ACTIONS

A.1

If the reactivity margin cannot be restored, the plant must be brought to HOT SHUTDOWN within 12 hours, to prevent the potential for further reductions in available reactivity margin (e.g., additional stuck control rods).

SURVEILLANCE REQUIREMENTS

SR 4.3.A.1

3/4.3 REACTIVITY CONTROL

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The 0.25% Δk in the expression R + 0.25% Δk is provided as a finite, demonstrable, subcriticality margin. This margin is demonstrated by full withdrawal of the strongest rod and partial withdrawal of an adjacent rod to a position calculated to insert at least R + 0.25% Δk in reactivity, or by an insequence, xenon-free cold critical measurement to demonstrate at least R + 0.25% Δk in reactivity with the most reactive control rod fully withdrawn. Observation of subcriticality in this ACTION assures subcriticality with not only the strongest rod fully withdrawn, but at least an R + 0.25% Δk margin beyond this.

REFERENCES

1. NEDE-24011-P-A-13-US, "General Electric Application for Reload Fuel", Supplement for United States, S.2.2.3.1.
2. FSAR, Section 14.5.1
3. FSAR, Section R.3.2
4. FSAR, Section R.2.3.4

3/4.3 REACTIVITY CONTROL

3/4.3.B.1 Control Rod Operability

BASES:

BACKGROUND

Control rods are components of the control rod drive (CRD) system, which is the primary reactivity control system for the reactor. In conjunction with the reactor protection system (RPS), the CRD system provides the means for the reliable control of reactivity changes to ensure under conditions of normal operation, including anticipated operational occurrences, that specified acceptable fuel design limits are not exceeded. In addition, the control rods provide the capability to hold the reactor core subcritical under all conditions and to limit the potential amount and rate of reactivity increase caused by a malfunction in the CRD system.

The CRD system consists of 145 locking piston control rod drive mechanisms (CRDMs) and a hydraulic control unit for each drive mechanism. The locking piston type CRDM is a double acting hydraulic piston, which uses condensate water as the operating fluid. Accumulators provide additional energy for a scram. An index tube and piston, coupled to the control rod, are locked at fixed increments by a collet mechanism. The collet fingers engage notches in the index tube to prevent unintentional withdrawal of the control rod, but without restricting insertion.

This Specification, along with LCO 3.3.C, "Scram Insertion Times", and LCO 3.3.D, "Control Rod Accumulators", ensure that the performance of the control rods in the event of a design basis accident (DBA) or transient meets the assumptions used in the safety analyses of References 1, 2, and 3.

APPLICABLE SAFETY ANALYSES

The analytical methods and assumptions used in the evaluations involving control rods are presented in References 1, 2, and 3. The control rods provide the primary means for rapid reactivity control (reactor scram), for maintaining the reactor subcritical, and for limiting the potential effects of reactivity insertion events caused by malfunctions in the CRD System.

The capability to insert the control rods provides assurance that the assumptions for scram reactivity in the DBA and transient analyses are not violated. Since reactivity margin ensures the reactor will be subcritical with the highest worth control rod withdrawn (assumed single failure), the additional failure of a second control rod to insert, if required, could invalidate the demonstrated reactivity margin and potentially limit the ability of the CRD System to hold the reactor subcritical. If the control rod is stuck at an inserted position and becomes decoupled from the CRD, a control rod drop accident

APPLICABLE SAFETY (CRDA) can possibly occur. Therefore, the requirement that all

3/4.3 REACTIVITY CONTROL

BASES

ANALYSES (continued)

control rods be OPERABLE ensures the CRD System can perform its intended function.

The control rods also protect the fuel from damage which could result in release of radioactivity. The limits protected are the "MCPR Safety Limit" (SL 2.1.2), and LCO 3.11.C, "MINIMUM CRITICAL POWER RATIO (MCPR)", LCO 3.11.A, "AVERAGE PLANAR LINEAR HEAT GENERATION RATE (APLHGR)", LCO 3.11.B, "LINEAR HEAT GENERATION RATE (LHGR)", and the fuel damage limit (see Bases for LCO 3.3.H, "Rod Pattern Control") during reactivity insertion events.

The negative reactivity insertion (scram) provided by the CRD system provides the analytical basis for determination of plant thermal limits and provides protection against fuel damage limits during a CRDA.

LCO

The OPERABILITY of an individual control rod is based on a combination of factors, primarily the scram insertion times, the associated control rod scram accumulator status, the control rod coupling integrity, and the ability to determine the control rod position. Accumulator OPERABILITY is addressed by LCO 3.3.D. The associated scram accumulator status for a control rod only affects the scram insertion times; therefore, an inoperable accumulator does not immediately require declaring a control rod inoperable. Although not all control rods are required to be OPERABLE to satisfy the intended reactivity control requirements, strict control over the number and distribution of inoperable control rods is required to satisfy the assumptions of the DBA and transient analyses.

APPLICABILITY

In the RUN and STARTUP MODES, the control rods are assumed to function during a DBA or transient and are therefore required to be OPERABLE in these MODES. In the HOT SHUTDOWN and COLD SHUTDOWN MODES, control rods are not able to be withdrawn since the reactor mode switch is in shutdown and a control rod block is applied. This provides adequate requirements for control rod OPERABILITY during these conditions. CTS 3/4.10, "CORE ALTERATIONS", provides requirements to ensure that core reactivity is within the capability of the control rods and to prevent criticality during refueling conditions.

ACTIONS

A.1, A.2, A.3, and A.4

A control rod is considered stuck if it will not insert by either CRD drive water or scram pressure. With a fully inserted control rod stuck, no actions are required as long as the control rod remains fully inserted. The required ACTIONS are modified by a note, which allows the rod worth minimizer (RWM) to be bypassed if required to allow continued operation. LCO 3.3.F, "Rod Worth Minimizer", provides additional requirements when the RWM is bypassed to ensure compliance with the CRDA analysis. With one withdrawn control rod stuck, the local scram reactivity rate assumptions may not be met if the stuck control rod separation criteria is not met. Therefore, a verification that the separation criteria is met must be performed immediately. The separation criteria is not met if the stuck control rod is not separated from all other inoperable control rods by at least two OPERABLE control rods in all directions, including the diagonal. In addition, the associated control rod drive must be disarmed within 2 hours. The allowed completion time of 2 hours is acceptable, considering the reactor can still be shut down. Assuming no additional control rods fail to insert, this provides a reasonable time to perform the required action in an orderly manner. Isolating the control rod from a scram prevents damage to the control rod drive mechanism (CRDM). The control rod can be isolated from the scram and normal insert and withdraw pressures, yet still maintain cooling water to the CRD.

Monitoring of the insertion capability of each withdrawn control rod must also be performed within 24 hours from the discovery of ACTION A concurrent with thermal power greater than the low power setpoint (LPSP) of the RWM. SR 4.3.B.1.1 and SR 4.3.B.1.2 perform periodic tests of the control rod insertion capability of withdrawn control rods. Testing each withdrawn control rod ensures that a generic problem does not exist. This completion time also allows for an exception to the normal "time zero" for beginning the allowed outage time "clock." The required ACTION A.3 completion time only begins upon discovery of ACTION A concurrent with thermal power greater than the actual LPSP of the RWM, since the notch insertions may not be compatible with the requirements of rod pattern control (LCO 3.3.H) and the RWM (LCO 3.3.F). The allowed completion time of 24 hours from discovery of ACTION A concurrent with thermal power greater than the LPSP of the RWM provides a reasonable time to test the control rods, considering the potential for a need to reduce power to perform the tests.

ACTIONS (continued)

A.1, A.2, A.3, and A.4 (continued)

To allow continued operation with a withdrawn control rod stuck, an evaluation of adequate reactivity margin is also required within 72 hours. Should a DBA or transient require a shutdown, the original reactivity margin demonstration may not be valid. To preserve the

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single failure criterion and account for the stuck control rod, an additional control rod would have to be assumed to fail to insert when required. Therefore, the reactivity margin must be evaluated (by measurement or analysis) with the stuck control rod at its stuck position and the highest worth OPERABLE control rod assumed to be fully withdrawn.

The allowed completion time of 72 hours to verify reactivity margin is adequate, considering that with a single control rod stuck in a withdrawn position, the remaining OPERABLE control rods are capable of providing the required scram and shutdown reactivity. Failure to reach COLD SHUTDOWN is only likely if an additional control rod adjacent to the stuck control rod also fails to insert during a required scram. LCO 3.3.B.1, ACTION A.1 assures adjacent control rods are immediately confirmed to be OPERABLE.

A.5

The generic banked position withdrawal sequence (BPWS) analysis (Reference 4) only evaluates the effect on the maximum incremental rod worth for fully inserted, inoperable control rods not in compliance with the sequence. BPWS does not allow operation with a stuck control rod with reactor thermal power ≤ 20 % RTP, unless analysis exist to support such operation. Stuck control rods must be repaired before plant startup is initiated, unless analysis exist to support such operation. If a control rod becomes stuck during power ascent or descent the reactor will be brought to a shutdown condition, unless analysis exist to support such operation.

In addition to the requirement to verify shutdown margin is met (required ACTION A.4) with a stuck control rod, it is also necessary to ensure that the maximum incremental rod worth has not been adversely affected when operating with reactor thermal power ≤ 20 % RTP. This may be accomplished by either ensuring that the position of the stuck control rod is in compliance with the BPWS sequence or by performing an analysis to verify that the maximum incremental rod worth remains below the amount required to insert the CRDA design limit of 280 cal/gm peak fuel enthalpy. Determination that the maximum incremental rod worth is < 0.01 ΔK verifies that the peak fuel enthalpy of 280 cal/gm will not be exceeded.

ACTIONS (continued)

A.5 (continued)

Ensuring the position of the stuck control rod is in compliance with the BPWS may necessitate the repositioning of other control rods.

The allowed completion time of 8 hours is reasonable, considering the restrictions on the number of allowed out of sequence control

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BASES

rods and the low probability of a CRDA occurring during the time the control rods are out of sequence.

B.1

With two or more withdrawn control rods stuck, the plant must be brought to the HOT SHUTDOWN MODE within 12 hours. The occurrence of more than one control rod stuck at a withdrawn position increases the probability that the reactor cannot be shut down if required. Insertion of all insertable control rods eliminates the possibility of an additional failure of a control rod to insert. The allowed completion time of 12 hours is reasonable, based on operating experience, to reach HOT SHUTDOWN from full power conditions in an orderly manner and without challenging plant systems.

C.1 and C.2

With one or more control rods inoperable for reasons other than being stuck in the withdrawn position, operation may continue, provided the control rods are fully inserted within 3 hours and disarmed (electrically or hydraulically) within 4 hours. During the 3 hour time limit, attempts to re-couple the rod, by fully inserting the rod and withdrawing it to the "full-out" position to verify that the rod does not go to the "overtravel" position, may be made. However, numerous attempts to re-couple the rod should be avoided to prevent further damage to the rod or drive. If the rod can not be re-coupled, inserting the control rod ensures the shutdown and scram capabilities are not adversely affected. The control rod is disarmed to prevent inadvertent withdrawal during subsequent operations. The control rods can be hydraulically disarmed by closing the drive water and exhaust water isolation valves. The control rods can be electrically disarmed by disconnecting power from all four directional control valve solenoids. This is equivalent to valving out of the drive and is preferred because, in this condition, drive water cools and minimizes crud accumulation in the drive. Electrical disarming does not eliminate position indication.

ACTIONS (continued)

C.1 and C.2 (continued)

ACTION C is modified by a note indicating that a separate condition entry is allowed for each control rod. The note allows ACTION C to be entered separately for each inoperable control rod, and the completion time tracked on a per control rod basis. When a control rod is declared inoperable, ACTION C is entered and its completion time starts. If subsequent control rods are declared inoperable, ACTION C is entered for each control rod and separate completion times are tracked for each control rod. This is acceptable, because ACTION D ensures the separation criteria is met and ACTION E

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BASES

limits the number of inoperable control rods allowed. Complying with the required ACTIONS may allow for continued operation, and subsequent inoperable control rods are governed by subsequent condition entries and application of associated required ACTIONS.

Required ACTION C.1 is modified by a note, which allows the RWM to be bypassed, if required, to allow insertion of the inoperable control rods and continued operation. LCO 3.3.F, "Rod Worth Minimizer", provides additional requirements when the RWM is bypassed, to ensure compliance with the CRDA analysis.

The allowed completion times are reasonable, considering the small number of allowed inoperable control rods, and provide time to insert and disarm the control rods in an orderly manner and without challenging plant systems.

D.1, D.2, and D.3

Out of sequence control rods may increase the potential reactivity worth of a dropped control rod during a CRDA. At ≤ 20% RTP, the generic banked position withdrawal sequence (BPWS) analysis (Reference 4) requires inserted control rods not in compliance with the BPWS to be separated by at least two OPERABLE control rods in all directions, including the diagonal. Therefore, if two or more inoperable control rods are not in compliance with the BPWS and not separated by at least two OPERABLE control rods, action must be taken to restore compliance with the BPWS, perform an analysis to verify that the maximum incremental rod worth remains below the amount required to insert the control rod drop accident design limit of 280 cal/gm peak fuel enthalpy, or restore the control rods to OPERABLE status. Determination that the maximum incremental rod worth is < 0.01 ΔK verifies that the peak fuel enthalpy of 280 cal/gm will not be exceeded. ACTION D is modified by a note indicating that

ACTIONS (continued)

D.1, D.2, and D.3 (continued)

the ACTION is not applicable when > 20% RTP, since the BPWS is not required to be followed under these conditions, as described in the Bases for LCO 3.3.H, "Rod Pattern Control". The allowed completion time of 8 hours is reasonable, considering the restrictions on the number of allowed out of sequence control rods and the low probability of a CRDA occurring during the time the control rods are out of sequence.

E.1

In addition to the separation requirements for inoperable control rods, an assumption in the CRDA analysis is that no more than three inoperable control rods are allowed in any one BPWS group. Therefore, with one or more BPWS groups having four or more inoperable control rods, the control rods must be restored to OPERABLE status. Required ACTION E.1 is modified by a note indicating that the Condition is not applicable when thermal power is > 20% RTP since the BPWS is not required to be followed under these conditions, as described in the Bases for LCO 3.3.H. The allowed completion time of 8 hours is acceptable, considering the low probability of a CRDA occurring.

F.1

If any required ACTION and associated completion time of ACTIONS A, C, D, or E are not met, or there are nine or more inoperable control rods, the plant must be brought to a MODE in which the LCO does not apply. To achieve this status, the plant must be brought to the HOT SHUTDOWN MODE within 12 hours. This ensures all insertable control rods are inserted and places the reactor in a condition that does not require the active function (i.e., scram) of the control rods. The number of control rods permitted to be inoperable when operating above 20% RTP (e.g., no CRDA considerations) could be more than the value specified, but the occurrence of a large number of inoperable control rods could be indicative of a generic problem, and investigation and resolution of the potential problem should be undertaken.

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BASES

SURVEILLANCE REQUIREMENTS

SR 4.3.B.1.1 and SR 4.3.B.1.2

Control rod insertion capability is demonstrated by inserting each partially or fully withdrawn control rod at least one notch and observing that the control rod moves. The control rod may then be returned to its original position. This ensures the control rod is not stuck and is free to insert on a scram signal. These surveillances are not required when thermal power is less than or equal to the actual LPSP of the RWM, since the notch insertions may not be compatible with the requirements of the BPWS (LCO 3.3.H) and the RWM (LCO 3.3.F). The 7 day frequency of SR 4.3.B.1.1 is based on operating experience related to the changes in CRD performance and the ease of performing notch testing for fully withdrawn control rods. Partially withdrawn control rods are tested at a 31 day frequency, SR 4.3.B.1.2. The 31 day frequency is based on the potential power reduction required to allow the control rod movement and consideration of the large testing sample of SR 4.3.B.1.1.

SR 4.3.B.1.3

Coupling verification is performed to ensure the control rod is connected to the CRDM and will perform its intended function when necessary. The surveillance requires verifying a control rod does not go to the withdrawn overtravel position. The overtravel position feature provides a positive check on the coupling integrity since only an uncoupled CRD can reach the overtravel position. The verification is required to be performed any time a control rod is withdrawn to the "full out" position (notch position 48) or prior to declaring the control rod OPERABLE after work on the control rod or CRD system that could affect coupling. This includes control rods inserted one notch and then returned to the "full out" position during the performance of SR 4.3.B.1.1. This frequency is acceptable, considering the low probability that a control rod will become uncoupled when it is not being moved and operating experience related to uncoupling events.

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BASES

SURVEILLANCE REQUIREMENTS (continued)

SR 4.3.B.1.4

Verifying that the maximum scram time for each OPERABLE control rod from de-energization of the scram pilot valve solenoids to dropout of notch 04 is ≤ 7 seconds provides reasonable assurance that the control rod will insert when required during a DBA or transient, thereby completing its shutdown function. This SR is performed in conjunction with the control rod scram time testing of SR 4.3.C.1, or SR 4.3.C.2. The associated frequencies are acceptable, considering the more frequent testing performed to demonstrate other aspects of control rod OPERABILITY and operating experience, which shows scram times do not significantly change over an operating cycle.

SR 4.3.B.1.5

The position of each control rod must be determined to ensure adequate information on control rod position is available to the operator for determining CRD OPERABILITY and controlling rod patterns. Control rod position may be determined by the use of OPERABLE position indicators, by moving control rods to a position with an OPERABLE indicator, or by the use of other appropriate methods. The 24 hour frequency of this SR is based on operating experience related to expected changes in control rod position and the availability of control rod position indications in the control room.

REFERENCES

1. FSAR, Section 14.5.1
2. FSAR, Section R.2.3.4
3. FSAR, Section 14.5.2
4. NEDO-21231, "Banked Position Withdrawal Sequence", Section 7.2, January 1977.

B 3/4.3 REACTIVITY CONTROL

B 3/4.3.B.2 Control Rod Drive Housing Support

BASES

BACKGROUND	The control rod drive (CRD) housing support restricts the outward movement of a control rod to less than 3 inches in the extremely remote event of a housing failure. The amount of reactivity which could be added by this small amount of rod withdrawal, which is less than a normal single withdrawal increment, will not contribute to any damage to the primary coolant system. The design basis is given in Reference 1 and the safety evaluation is given in Reference 2.
APPLICABLE SAFETY ANALYSIS	Downward travel of CRD housing and its control rod following the postulated housing failure is the sum of the compression of the disk springs under dynamic loading and the initial gap between the grid and the bottom contact surface of the CRD flange. If the reactor were cold and pressurized, the downward motion of the control rod would be limited to the approximate 2 in spring compression plus approximately a 1 in gap. If the reactor were hot and pressurized, the gap would be approximately 1/4 in and the spring compression slightly less than in the cold ACTION. In either case, the control rod movement following a housing failure is limited substantially below any drive "notch" movement (6 in). The nuclear transient from sudden withdrawal of any control rod through a distance of one drive notch at any position in the core, does not result in a transient sufficient to cause damage to any radioactive material barrier.
LCO	Control rod downward motion shall be limited, following a postulated CRD housing failure, so that any resulting nuclear transient could not be sufficient to cause fuel damage.
APPLICABILITY	This support is not required if the reactor coolant system is at atmospheric pressure, since there would then be no driving force to rapidly eject a drive housing.

B 3/4.3 REACTIVITY CONTROL

BASES

ACTIONS

A.1

If the CRD housing support is determined to be not in place, the plant must be brought to COLD SHUTDOWN within 24 hours, to limit additional damage to the nuclear system process barrier, or damage to the fuel barrier in the event a drive housing breaks or separates from the bottom of the reactor vessel.

SURVEILLANCE REQUIREMENTS

SR 4.3.B.2

When the reactor is in the SHUTDOWN MODE, the CRD housing supports may be removed to permit inspection and maintenance of the CRDs. When the support structure is reinstalled, it is inspected for proper assembly, particular attention being given to assure that the correct gap between the CRD flange lower contact surface and the grid is maintained.

REFERENCES

1. FSAR, Section 3.5.2
2. FSAR, Section 3.5.4

B 3/4.3 REACTIVITY CONTROL

B 3/4.3.B.3 Source Range Monitors

BASES

BACKGROUND

The source range monitors (SRMs) provide the operator with information relative to the neutron flux level at very low flux levels in the core. As such, the SRM indication is used by the operator to monitor the approach to criticality and to determine when criticality is achieved. The SRMs are maintained fully inserted until the count rate is greater than a minimum allowed count rate (a control rod block is set at this condition).

The SRM is a subsystem of the neutron monitoring system (NMS) and consists of four channels. Each of the SRM channels can be bypassed by the operation of a bypass switch, but only one at any given time. Each channel includes one detector that can be physically positioned in the core. Each detector assembly consists of a miniature fission chamber with associated cabling, signal conditioning equipment, and electronics associated with the various SRM functions. The signal conditioning equipment converts the current pulses from the fission chamber to analog DC currents that correspond to the count rate. Each channel also includes indication, alarm, and control rod blocks. However, this LCO specifies OPERABILITY requirements only for the monitoring and indication functions of the SRMs (See LCO 3/4.2.C for operability requirements of the SRMs).

During refueling, shutdown, and low power operations, the primary indication of neutron flux levels is provided by the SRMs or special movable detectors connected to the normal SRM circuits. The SRMs provide monitoring of reactivity changes during fuel or control rod movement and give the control room operator early indication of unexpected subcritical multiplication that could be indicative of an approach to criticality.

APPLICABLE SAFETY ANALYSIS

The SRMs have no safety function and are not assumed to function during any FSAR design basis accident or transient analysis. However, the SRMs provide the only on-scale monitoring of neutron flux levels during startup and refueling. Therefore, they are being retained in Technical Specifications.

LCO

During startup, three of the four SRM channels are required to be OPERABLE to monitor the reactor flux level prior to and during

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BASES

control rod withdrawal, subcritical multiplication and reactor criticality, and neutron flux level and reactor period until the flux level is sufficient to maintain the IRM on Range 3 or above. All but one of the channels are required in order to provide a representation of the overall core response during those periods when reactivity changes are occurring throughout the core.

The requirement of at least 3 counts per second assures that any transient, should it occur, begins at or above the initial value of 10^{-8} of rated thermal power (RTP) used in the analyses of transients from cold conditions (moderator temperature 68°F). The analysis requires initial power prior to a transient to be $>10^{-8}$ % RTP because too low a starting power will allow inadvertent prompt criticality to progress too long before SRMs and IRMs register the count rate. Starting above $>10^{-8}$ % RTP assures quick discovery of the transient so the IRMs will terminate the transient with little or no damage. One operable SRM channel would be adequate to monitor the approach to critical using homogeneous patterns of scattered control rod withdrawal. A minimum of two operable SRMs are provided as an added conservatism.

APPLICABILITY

The SRMs are required to be OPERABLE with at least 3 counts per second prior to control rod withdrawal for startup. This assures that any transient, should it occur, begins at or above the initial value of 10^{-8} % RTP used in the analyses of transients from cold conditions.

ACTIONS

A.1

If the required number of counts cannot be restored, the plant must be brought to a condition where the LCO does not apply. Placing the mode switch in shutdown accomplishes this. This will prevent a transient, should it occur, from beginning below the initial value of 10^{-8} % RTP used in the analyses of transients from cold conditions

SURVEILLANCE REQUIREMENTS

SR 4.3.B.3

Verifying that at least two source range channels have an observed count rate of at least three counts per second prior to control rod withdrawal for startup will ensure a transient, should it occur, begins above the initial value of 10^{-8} RTP used in the analyses of transients from cold conditions.

BACKGROUND

The scram function of the control rod drive (CRD) system controls reactivity changes during abnormal operational transients to ensure that specified acceptable fuel design limits are not exceeded . The control rods are scrammed by positive means using hydraulic

B 3/4.3 REACTIVITY CONTROL (continued)

B 3/4.3.C Scram Insertion Times

BASES

pressure exerted on the CRD piston.

When a scram signal is initiated, control air is vented from the scram valves, allowing them to open by spring action. Opening the exhaust valve reduces the pressure above the main drive piston to atmospheric pressure, and opening the inlet valve applies the accumulator or reactor pressure to the bottom of the piston. Since the notches in the index tube are tapered on the lower edge, the collet fingers are forced open by cam action, allowing the index tube to move upward without restriction because of the high differential pressure across the piston. As the drive moves upward and the accumulator pressure reduces below the reactor pressure, a ball check valve opens, letting the reactor pressure complete the scram action. If the reactor pressure is low, such as during startup, the accumulator will fully insert the control rod in the required time without assistance from reactor pressure.

APPLICABLE SAFETY ANALYSIS

The analytical methods and assumptions used in evaluating the control rod scram function are presented in References 1, 2, and 3. The design basis accident (DBA) and transient analyses assume that all of the control rods scram at a specified insertion rate. The resulting negative scram reactivity forms the basis for the determination of plant thermal limits (e.g., the MCPR). Other distributions of scram times (e.g., several control rods scramming slower than the average time with several control rods scramming faster than the average time) can also provide sufficient scram reactivity. Surveillance of each individual control rod's scram time ensures the scram reactivity assumed in the DBA and transient analyses can be met.

The CRD system is designed to bring the reactor subcritical at a rate fast enough to prevent fuel damage; i.e., to prevent the MCPR from becoming less than the Safety Limit MCPR. Analysis of the limiting power transient shows that the negative reactivity rates resulting from the scram with the average response of all the drives as given in LCO 3.3.C, provide the required protection, and the MCPR remains greater than the Safety Limit MCPR.

LCO

The specified scram times are required to ensure that the scram reactivity assumed in the DBA and transient analysis is met (Reference 4).

The scram times are specified relative to measurements based on reed switch positions, which provide the control rod position

B 3/4.3 REACTIVITY CONTROL

BASES

indication. The reed switch closes ("pickup") when the index tube passes a specific location and then opens ("dropout") as the index tube travels upward. Verification of the specified scram times is accomplished through measurement of the "dropout" times. To ensure that local scram reactivity rates are maintained within acceptable limits are placed on the average scram time for the three fastest OPERABLE control rods in each group of four control rods in all two by two arrays. This LCO applies only to OPERABLE control rods since inoperable control rods will be inserted and disarmed (LCO 3.3.B.1).

APPLICABILITY

In the RUN and STARTUP MODES, a scram is assumed to function during transients and accidents analyzed for these plant conditions. These events are assumed to occur during startup and power operation; therefore, the scram function of the control rods is required during these MODES. In the HOT SHUTDOWN and COLD SHUTDOWN MODES, the control rods are not able to be withdrawn since the reactor mode switch is in shutdown and a control rod block is applied. This provides adequate requirements for control rod scram capability during these conditions. CTS 3/4.10, "CORE ALTERATIONS", provides requirements to ensure that core reactivity is within the capability of the control rods and to prevent criticality during refueling conditions.

ACTIONS

A.1

When the requirements of this LCO are not met, the rate of negative reactivity insertion during a scram may not be within the assumptions of the safety analyses. Therefore, the plant must be brought to a MODE in which the LCO does not apply. To achieve this status, the plant must be brought to the HOT SHUTDOWN MODE within 12 hours. The allowed completion time of 12 hours is reasonable, based on operating experience, to reach HOT SHUTDOWN from full power conditions in an orderly manner and without challenging plant systems.

SURVEILLANCE REQUIREMENTS

SR 4.3.C.1 and SR 4.3.C.2

To ensure that scram time testing is performed within a reasonable time following fuel movement within the reactor pressure vessel or after a shutdown ≥120 days or longer, control rods are required to be tested before exceeding 40% RTP following the shutdown. This frequency is acceptable considering the additional surveillances performed for control rod OPERABILITY, the frequent verification of adequate accumulator pressure, and the required testing of control

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rods affected by work on control rods or the CRD System.

Additional testing of a sample of control rods is required to verify the continued performance of the scram function during the cycle. A representative sample contains at least 10% of the control rods. For planned testing during an operating cycle, the control rods selected for the sample should be different for each test. The 120 -day Frequency is based on operating experience that has shown control rod scram times do not significantly change over an operating cycle.

REFERENCES

1. FSAR, Section 14.2
2. FSAR, Section 14.5.1
3. FSAR, Appendix R.3.2
4. NEDE-24011-P-A-13, "General Electric Standard Application for Reactor Fuel", Section 3.2.4.1.

B 3/4.3 REACTIVITY CONTROL (continued)

B 3/4.3.D Control Rod Accumulators

BASES

BACKGROUND

The control rod scram accumulators are part of the control rod drive (CRD) system and are provided to ensure that the control rods scram under varying reactor conditions. The control rod scram accumulators store sufficient energy to fully insert a control rod at any reactor vessel pressure. The accumulator is a hydraulic cylinder with a free floating piston. The piston separates the water used to scram the control rods from the nitrogen, which provides the required energy. Below 800 psig reactor pressure, the scram accumulators are necessary to scram the control rods within the required insertion times of LCO 3.3.C, "Scram Insertion Times."

APPLICABLE SAFETY ANALYSES

The analytical methods and assumptions used in evaluating the control rod scram function are presented in References 1, 2, and 3. The design basis accident (DBA) and transient analyses assume all of the control rods scram at a specified insertion rate. OPERABILITY of each individual control rod scram accumulator, along with LCO 3.3.B.1, "Control Rod Operability", and LCO 3.3.C "Scram Insertion Times", ensures that the scram reactivity assumed in the DBA and transient analyses can be met. The existence of an inoperable accumulator may invalidate prior scram time measurements for the associated control rod.

The scram function of the CRD system, and therefore the OPERABILITY of the accumulators, protects the "MCPR Safety Limit" (SL 2.1.1), and LCO 3.11.C, "MINIMUM CRITICAL POWER RATIO (MCPR)" and the 1% cladding plastic strain fuel design limit (see Bases for LCO 3.11.A, "AVERAGE PLANAR LINEAR HEAT GENERATION RATE (APLHGR)", and LCO 3.11.B, "LINEAR HEAT GENERATION RATE (LHGR)", which ensure that no fuel damage will occur if these limits are not exceeded. In addition, the scram function at low REACTOR VESSEL PRESSURE (i.e., startup conditions) provides protection against violating fuel design limits during reactivity insertion accidents (see Bases for LCO 3.3.H, "Rod Pattern Control").

LCO

The OPERABILITY of the control rod scram accumulators is required to ensure that adequate scram insertion capability exists when needed over the entire range of reactor pressures. The OPERABILITY of the scram accumulators is based on maintaining adequate accumulator pressure.

APPLICABILITY

In the RUN and STARTUP MODES the scram function is required for

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BASES

mitigation of DBAs and transients, and therefore the scram accumulators must be OPERABLE to support the scram function. In the HOT SHUTDOWN and COLD SHUTDOWN MODES, control rods are not allowed to be withdrawn since the reactor mode switch is in shutdown and a control rod block is applied. This provides adequate requirements for control rod scram accumulator OPERABILITY during these conditions. CTS 3/4.10, "CORE ALTERATIONS", provides requirements to ensure that core reactivity is within the capability of the control rods and to prevent criticality during refueling conditions.

ACTIONS

The ACTIONS are modified by a note indicating that a separate condition entry is allowed for each control rod scram accumulator. This is acceptable since the required ACTIONS for each condition provide appropriate compensatory actions for each affected accumulator. Complying with the required ACTIONS may allow for continued operation and subsequent affected accumulators governed by subsequent condition entry and application of associated required ACTIONS.

A.1.1 and A.1.2

With reactor steam dome pressure ≥ 950 psig, even those control rods with inoperable accumulators will be able to meet required scram insertion times due to the action of reactor pressure. Requiring a control rod with an inoperable accumulator to be separated from control rods that are stuck or have inoperable accumulators by one OPERABLE control rod will ensure that the effects on reactivity insertion rates will be minimized. The results of a series of XY PDQ-4 quarter core calculations of a cold, clean core show that the worst case in a nine-rod withdrawal sequence resulted in a $k_{eff} < 1.0$, other repeating rod sequences with more rods withdrawn resulted in $k_{eff} > 1.0$.

The allowed completion time of 1 hour is reasonable, based on the large number of control rods available to provide the scram function.

ACTIONS (continued)

A.2

If required ACTIONS A.1.1 and A.1.2 cannot be met, the control rod

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must be declared inoperable within 1 hour. Once declared inoperable, the requirements of LCO 3.3.B.1 apply.

The allowed completion time of 1 hour is reasonable, based on the large number of control rods available to provide the scram function.

B.1 and B.2

With reactor steam dome pressure < 950 psig control rods with inoperable accumulators may not be able to meet required scram insertion times. In addition, when reactor thermal power is ≤ 20 % RTP the BPWS requires inoperable scram accumulators be restored to OPERABLE status within 8 hours or the control rod must be declared inoperable. Once declared inoperable, the requirements of LCO 3.3.B.1 apply.

The allowed completion time of 8 hours is reasonable, based on the large number of control rods available to provide the scram function.

C.1 and C.2

With two or more control rod accumulators inoperable, concurrent with loss of charging water pressure, when reactor steam dome pressure ≥ 950 psig, adequate pressure must be supplied to the charging water header. With inadequate charging water pressure, all of the accumulators could become inoperable, resulting in a potentially severe degradation of the scram performance. Therefore, required ACTION C.1 requires adequate charging water header pressure must be restored within 20 minutes from discovery of loss of charging water header pressure. The allowed completion time of 20 minutes is reasonable to place a CRD pump into service to restore the charging header pressure, if required.

If restoration of charging water pressure does not restore the accumulators to OPERABLE status, required ACTION C.2 provides additional time to restore the accumulators to OPERABLE status. This 8 hour allowance provides a reasonable time to attempt investigation and restoration of the inoperable accumulators considering that reactor pressure is adequate to assure the scram function of the control rods with inoperable accumulators and the low probability of a DBA or transient occurring while the affected accumulators are inoperable.

ACTIONS (continued)

D.1 and D.2

With two or more control rod accumulators inoperable, concurrent with loss of charging water pressure, when reactor steam dome pressure is < 950 psig, the pressure supplied to the charging water

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BASES

header must be adequate to ensure that accumulators remain charged. With the reactor steam dome pressure < 950 psig, the function of the accumulators in providing the scram force becomes much more important since the scram function could become severely degraded during a depressurization event or at low reactor pressures. Therefore, immediately upon discovery of loss of charging water header pressure, concurrent with reactor steam dome pressure <950 psig, all control rods associated with inoperable accumulators must be verified to be fully inserted. Withdrawn control rods with inoperable accumulators may fail to scram under these low pressure conditions. The associated control rods must also be declared inoperable within 1 hour. The allowed completion time of 1 hour is reasonable for required ACTION D.2, considering the low probability of a DBA or transient occurring during the time that the accumulators are inoperable.

E.1

The reactor mode switch must be immediately placed in the shutdown position if either required ACTION and associated completion time associated with loss of the CRD charging pump (required ACTIONS C.1 and D.1) cannot be met. This ensures that all insertable control rods are inserted and that the reactor is in a condition that does not require the active function (i.e., scram) of the control rods. This required ACTION is modified by a note stating that the ACTION is not applicable if all control rods associated with the inoperable scram accumulators are fully inserted, since the function of the control rods has been performed.

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BASES

SURVEILLANCE REQUIREMENTS

SR 4.3.D

SR 4.3.D requires that the accumulator pressure and level alarms be checked every shift to ensure adequate accumulator pressure exists to provide sufficient scram force. The primary indication of accumulator OPERABILITY is the accumulator pressure. A minimum accumulator pressure is specified, below which the capability of the accumulator to perform its intended function becomes degraded and the accumulator is considered inoperable. The minimum accumulator pressure is well below the expected pressure of 1380 psig (Reference 1). Declaring the accumulator inoperable when the minimum pressure is not maintained ensures that significant degradation in scram times does not occur.

REFERENCES

1. FSAR, Section 14.2.
2. FSAR, Section 14.5.
3. FSAR, Appendix R.2.
4. FSAR, Appendix G.

B 3/4.3 REACTIVITY CONTROL

B 3/4.3.E Reactivity Anomalies

BASES

BACKGROUND

Reactivity anomaly is used as a measure of the predicted versus measured core reactivity during power operation. The continual confirmation of core reactivity is necessary to ensure that the design basis accident (DBA) and transient safety analyses remain valid. A large reactivity anomaly could be the result of unanticipated changes in fuel reactivity or control rod worth or operation at conditions not consistent with those assumed in the predictions of core reactivity, and could potentially result in a loss of reactivity margin or violation of acceptable fuel design limits. Comparing predicted versus measured core reactivity validates the nuclear methods used in the safety analysis and supports the reactivity margin demonstrations (LCO 3.3.A.1, " Reactivity Margin - Core Loading") in assuring the reactor can be brought safely to cold, subcritical conditions.

When the reactor core is critical or in normal power operation, a reactivity balance exists and the net reactivity is zero. A comparison of the predicted and measured reactivity is convenient under such a balance, since the parameters are being maintained relatively stable under steady state power conditions. The positive reactivity inherent in the core design is balanced by the negative reactivity of the control components, thermal feedback, neutron leakage, and materials in the core that absorb neutrons, such as burnable absorbers, producing zero net reactivity.

In order to achieve the required fuel cycle energy output, the uranium enrichment in the new fuel loading and the fuel loaded in the previous cycles provide excess positive reactivity beyond that required to sustain steady state operation at the beginning of the cycle (BOC). When the reactor is critical at rated thermal power (RTP) and operating moderator temperature, the excess positive reactivity is compensated by burnable absorbers (if any), control rods, and whatever neutron poisons (mainly xenon and samarium) are present in the fuel. The core reactivity is determined from control rod densities for actual plant conditions and is then compared to the predicted value for the cycle exposure.

The predicted core reactivity, as represented by control rod density, may be determined from the calculated rod position inventory curves (reactivity anomaly curves) or calculated by a 3D core simulator code as a function of cycle exposure for projected operating states and conditions throughout the cycle.

APPLICABLE SAFETY ANALYSES

Accurate prediction of the core reactivity is an assumption in the accident analysis (References 1 and 2). In particular, reactivity

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BASES

margin and reactivity transients, such as control rod withdrawal accidents or rod drop accidents, are very sensitive to accurate prediction of core reactivity. These accident analysis evaluations rely on computer codes that have been qualified against available test data, operating plant data, and analytical benchmarks. Monitoring reactivity anomaly provides additional assurance that the nuclear methods provide an accurate representation of the core reactivity.

The comparison between the measured and predicted initial core reactivity provides a normalization for the calculational models used to predict core reactivity. If the measured and predicted rod density for identical core conditions at BOC do not reasonably agree, then the assumptions used in the reload cycle design analysis or the calculation models used to predict rod density may not be accurate. If reasonable agreement between measured and predicted core reactivity exists at BOC, then the prediction may be normalized to the measured value. Thereafter, any significant deviations in the measured rod density from the predicted rod density that develop during fuel depletion may be an indication that the assumptions of the DBA and transient analyses are no longer valid, or that an unexpected change in core conditions has occurred.

LCO

The reactivity anomaly limit is established to ensure plant operation is maintained within the assumptions of the safety analyses. Large differences between monitored and predicted core reactivity may indicate that the assumptions of the DBA and transient analyses are no longer valid, or that the uncertainties in the "Nuclear Design Methodology" are larger than expected. A limit on the difference between the monitored and the predicted rod density of ± 1% Δk/k has been established based on engineering judgment. A > 1% deviation in reactivity from that predicted is larger than expected for normal operation and should therefore be evaluated.

APPLICABILITY

In the RUN MODE, most of the control rods are withdrawn and steady state operation is typically achieved. Under these conditions, the comparison between predicted and monitored core reactivity provides an effective measure of the reactivity anomaly. In the STARTUP MODE, control rods are typically being withdrawn during a startup. In

B 3/4.3 REACTIVITY CONTROL

BASES

the HOT SHUTDOWN and COLD SHUTDOWN MODES, all control rods are fully inserted and therefore the reactor is in the least reactive state, where monitoring core reactivity is not necessary. During refueling, fuel loading results in a continually changing core reactivity. Reactivity margin requirements (LCO 3.3.A.1) ensure that fuel movements are performed within the bounds of the safety analysis, and reactivity margin demonstration is required during the first startup following operations that could have altered core reactivity (e.g., fuel movement, control rod replacement, shuffling). The reactivity margin test, required by LCO 3.3.A.1, provides a direct comparison of the predicted and monitored core reactivity at cold conditions; therefore, reactivity anomaly is not required during these conditions.

ACTIONS

A.1

If the core reactivity cannot be restored to within the 1% Δk/k limit, the plant must be brought to a MODE in which the LCO does not apply. To achieve this status, the plant must be brought to at least HOT SHUTDOWN within 12 hours. The allowed completion time of 12 hours is reasonable, based on operating experience, to reach HOT SHUTDOWN from full power conditions in an orderly manner and without challenging plant systems.

SURVEILLANCE REQUIREMENTS

SR 4.3.E

Verifying the reactivity difference between the actual and predicted rod density is within the limits of the LCO provides added assurance that plant operation is maintained within the assumptions of the DBA and transient analyses. A comparison of the actual rod density to the predicted rod density at the same cycle exposure is used to calculate the reactivity difference. The comparison is required when the core reactivity has potentially changed by a significant amount. This may occur following a refueling in which new fuel assemblies are loaded, fuel assemblies are shuffled within the core, or control rods are replaced or shuffled. Also, core reactivity changes during the cycle. The core reactivity anomaly surveillance criteria of ± 1% ΔK assumes ≥ 75% RTP and steady state operations (no control rod movement or core flow changes in progress). Requiring a reactivity comparison at the specified frequency ensures a comparison will be made before

SURVEILLANCE REQUIREMENTS (continued)

SR 4.3.E (continued)

the core reactivity change exceeds 1% ΔK. Deviations in core reactivity greater than 1% ΔK are not expected and require thorough evaluation. One percent reactivity limit is considered safe since an insertion of the reactivity into the core would not lead to transients exceeding design conditions of the reactor core.

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BASES

REFERENCES

1. FSAR, Chapter 14.5
2. FSAR, Appendix R.2

B 3/4.3 REACTIVITY CONTROL (continued)

B 3/4.3.F Rod Worth Minimizer

BASES

BACKGROUND

During low power operations, control rod blocks from the rod worth minimizer (RWM) enforce specific control rod sequences designed to mitigate the consequences of the control rod drop accident (CRDA) (Reference 1).

The purpose of the RWM is to control rod patterns during startup, such that only specified control rod sequences and relative positions are allowed over the operating range from all control rods inserted to 20% RTP. The sequences effectively limit the potential amount and rate of reactivity increase during a CRDA. Prescribed control rod sequences are stored in the RWM, which will initiate control rod withdrawal and insert blocks when the actual sequence deviates beyond allowances from the stored sequence. The RWM determines the actual sequence based on position indication for each control rod. The RWM also uses feedwater flow and steam flow signals to determine when the reactor power is above the preset power level at which the RWM is automatically bypassed (Reference 2). The RWM is a single channel system that provides input into both reactor manual control system (RMCS) rod block circuits.

APPLICABLE SAFETY ANALYSIS

The RWM enforces the banked position withdrawal sequence (BPWS) below 20% RTP to ensure the fuel enthalpy addition due to a potential CRDA to < 280 cal/gm which is the threshold for fuel damage. The analytical methods and assumptions used in evaluating the CRDA are summarized in References 1, 3, and 4. The BPWS requires that control rods be moved in groups, with all control rods assigned to a specific group required to be within specified banked positions. The RWM enforces the BPWS sequence by rod blocks which require correction of rod position errors prior to resuming rod withdrawal or insertion. Requirements that the control rod sequence is in compliance with the BPWS are specified in SR 4.3.F.3

B 3/4.3 REACTIVITY CONTROL (continued)

B 3/4.3.F Rod Worth Minimizer

BASES

LCO

The RWM is a hardwired system designed to act as a backup to operator control of the rod sequences. Only one channel of the RWM is available and is required to be OPERABLE. Special circumstances provided for in the required ACTION of LCO 3.3.B.1 ACTIONS A and C may necessitate bypassing the RWM to allow continued operation with inoperable control rods, or to allow correction of a control rod pattern not in compliance with the BPWS. The RWM may be bypassed as required by these ACTIONS, but then it must be considered inoperable and the required ACTIONS of this LCO followed.

APPLICABILITY

Compliance with the BPWS, and therefore OPERABILITY of the RWM, is required in the STARTUP and RUN MODES when thermal power is ≤ 20% RTP. When thermal power is > 20% RTP, there is no possible control rod configuration that results in a control rod worth that could exceed the 280 cal/gm fuel damage limit during a CRDA (References 1, 3, and 4). In the HOT SHUTDOWN and COLD SHUTDOWN MODES, all control rods are required to be inserted into the core; therefore, a CRDA cannot occur. Since only a single control rod can be withdrawn from a core cell containing fuel assemblies in the REFUEL MODE, adequate shutdown margin ensures that the consequences of a CRDA are acceptable, i.e., the reactor will remain subcritical.

ACTIONS

A.1, 2.1, and 2.2

With the RWM inoperable during a reactor startup, the operator is still capable of enforcing the prescribed control rod sequence. However, the overall reliability is reduced because a single operator error can result in violating the control rod sequence. Therefore, control rod movement must be immediately suspended except by scram. Alternatively, startup may continue if a reactor startup with an inoperable RWM was not performed in the last 12 months. ACTION A.2.1 requires verification, by review of plant logs, that a reactor startup with an inoperable RWM was not performed in the last 12 months. Once ACTION A.2.1 is satisfactorily completed, control rod withdrawal may proceed provided a double check of compliance with the prescribed rod sequence is performed by a second licensed operator (Reactor Operator or Senior Reactor Operator) or other qualified member of the technical staff (ACTION A.2.2).

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BASES

ACTIONS (continued)

A.1, 2.1, and 2.2 (continued)

The RWM may be bypassed under these conditions to allow continued operation. In addition, ACTIONS A.1 and C.1 of LCO 3.3.B.1 may require bypassing the RWM, during which time the RWM must be considered inoperable with ACTION A entered and its required actions taken.

B.1

With the RWM inoperable during a reactor shutdown, the operator is still capable of enforcing the prescribed control rod sequence. ACTION B.1 allows for the RWM function to be performed manually and requires a double check of compliance with the prescribed rod sequence by a second licensed operator (Reactor Operator or Senior Reactor Operator) or other qualified member of the technical staff. The RWM may be bypassed under these conditions to allow the reactor shutdown to continue.

SURVEILLANCE REQUIREMENTS

SR 4.3.F.1

An INSTRUMENT FUNCTIONAL TEST is performed for the RWM to ensure that the entire system will perform the intended function. The INSTRUMENT FUNCTIONAL TEST for the RWM is performed by:

a. performing the RWM computer diagnostic test,
b. verifying the annunciation of the selection errors of at least one out-of-sequence control rod in each distinct RWM group, and
c. verifying the rod block function of an out-of-sequence control rod which is withdrawn no more than three notches.

Performance of the INSTRUMENT FUNCTIONAL TEST prior to the time the RWM is required to be OPERABLE assures the actions of the Reactor Operator are always monitored and blocked when an error could lead to a condition which might cause fuel damage during a CRDA.

B 3/4.3 REACTIVITY CONTROL

BASES

SURVEILLANCE REQUIREMENTS (continued)

SR 4.3.F.2

The RWM is automatically bypassed when power is above a specified value. The power level is determined from feedwater flow and steam flow signals. The automatic bypass setpoint must be verified periodically to be ≥ 20% RTP. If the RWM low power setpoint is nonconservative, then the RWM is considered inoperable. Alternately, the low power setpoint channel can be placed in the conservative condition (nonbypass). If placed in the nonbypassed condition, the SR is met and the RWM is not considered inoperable. The frequency takes into consideration the plant conditions required to perform the test and is intended to be consistent with a fuel cycle length of 24 months.

SR 4.3.F.3

The RWM will only enforce the proper control rod sequence if the rod sequence is properly input into the RWM computer. This SR ensures that the proper sequence is loaded into the RWM so that it can perform its intended function. The surveillance is performed once prior to declaring RWM OPERABLE following loading of sequence into RWM, since this is when rod sequence input errors are possible.

REFERENCES

1. FSAR, Section 14.5.1
2. FSAR, Section 7.16
3. NEDO-21231, "Banked Position Withdrawal Sequence", January 1977.
4. NRC SER, "Acceptance of Referencing of Licensing Topical Report NEDE-24011-P-A", "General Electric Standard Application for Reactor Fuel, Revision 8, Amendment 17", December 27, 1987.

B 3/4.3 REACTIVITY CONTROL (continued)

B 3/4.3.G Scram Discharge Volume Vent and Drain Valves

BASES

BACKGROUND

The scram discharge volume (SDV) vent and drain valves are normally open and discharge any accumulated water in the SDV to ensure that sufficient volume is available at all times to allow a complete scram. During a scram, the SDV vent and drain valves close to contain reactor water. The SDV is a volume of header piping that connects to each hydraulic control unit (HCU) and drains into an instrument volume. There are two SDV (headers) and two instrument volumes, each receiving approximately one half of the control rod drive (CRD) discharges. The two instrument volumes are connected to a common drain line with two valves in series. Each header is connected to a common vent line with two valves in series for a total of four vent valves. The header piping is sized to receive and contain all the water discharged by the CRDs during a scram. The design and functions of the SDV are described in Reference 1.

APPLICABLE SAFETY ANALYSIS

The acceptance criteria for the SDV vent and drain valves are that they operate automatically to:

a. Close during a scram to limit the amount of reactor coolant discharged so that adequate core cooling is maintained and offsite doses remain within the limits of 10 CFR 100 (Reference 2), and

b. Open on scram reset to maintain the SDV vent and drain path open so that there is sufficient volume to accept the reactor coolant discharged during a scram.

Isolation of the SDV can also be accomplished by manual closure of the SDV valves. Additionally, the discharge of reactor coolant to the SDV can be terminated by scram reset or closure of the hydraulic control unit (HCU) manual isolation valves. For a bounding leakage case, the offsite doses are well within the limits of 10 CFR 100 (Reference 2), and adequate core cooling is maintained (Reference 3). The SDV vent and drain valves allow continuous drainage of the SDV during normal plant operation to ensure that the SDV has sufficient capacity to contain the reactor coolant discharge during a full core scram. To automatically ensure this capacity, a reactor scram is initiated if the SDV water level in the instrument volume exceeds a specified setpoint. The setpoint is chosen so that all control rods are inserted before the SDV has insufficient volume to accept a full scram.

LCO

The OPERABILITY of all SDV vent and drain valves ensures that the SDV vent and drain valves will close during a scram to contain reactor water discharged to the SDV piping. Since the vent and drain

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lines are provided with two valves in series, the single failure of one valve in the open position will not impair the isolation function of the system. Additionally, the valves are required to open on a scram reset to ensure that a path is available for the SDV piping to drain freely at other times.

APPLICABILITY

In the RUN and STARTUP MODES, scram may be required; therefore, the SDV vent and drain valves must be OPERABLE. In the HOT SHUTDOWN and COLD SHUTDOWN MODES, control rods are not able to be withdrawn since the reactor mode switch is in shutdown and a control rod block is applied. This provides adequate requirements for control rod OPERABILITY during these conditions. CTS 3/4.10, "CORE ALTERATIONS", provides requirements to ensure that core reactivity is within the capability of the control rods and to prevent criticality during refueling conditions.

ACTIONS

A.1

If any scram discharge vent or drain valve becomes inoperable the, the plant must be brought to a condition in which the LCO does not apply. To achieve this status, the plant must be brought to at least HOT SHUTDOWN within 12 hours. The allowed Completion Time of 12 hours is reasonable, based on operating experience, to reach HOT SHUTDOWN from full power conditions in an orderly manner and without challenging plant systems.

SURVEILLANCE REQUIREMENTS

SR 4.3.G.1 and SR 4.3.G.2

During normal operation, the SDV vent and drain valves should be in the open position (except when performing SR 4.3.G.2) to allow for drainage of the SDV piping. Verifying that each valve is in the open position (SR 4.3.G.1) ensures that the SDV vent and drain valves will perform their intended functions during normal operation. This SR does not require any testing or valve manipulation; rather, it involves verification that the valves are in the correct position.

The 31 day frequency is based on engineering judgment and is consistent with the procedural controls governing valve operation, which ensure correct valve positions.

SURVEILLANCE REQUIREMENTS

SR 4.3.G.1 and SR 4.3.G.2 (continued)

During a scram, the SDV vent and drain valves should close to contain the reactor water discharged to the SDV piping. Cycling each valve (SR 4.3.G.2) through its complete range of motion (closed and

B 3/4.3 REACTIVITY CONTROL

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open) ensures that the valve will function properly during a scram. The frequency is in accordance with the Inservice Testing Program for pumps and valves.

SR 4.3.G.3

SR 4.3.G.3 is an integrated test of the SDV vent and drain valves to verify total system performance. After receipt of a simulated or actual scram signal, the closure of the SDV vent and drain valves is verified. Similarly, after receipt of a simulated or actual scram reset signal, the opening of the SDV vent and drain valves is verified. The 24 month frequency is based on the need to perform this surveillance under the conditions that apply during a plant outage and the potential for an unplanned transient if the surveillance were performed with the reactor at power. Operating experience has shown these components usually pass the surveillance when performed at the 24 month frequency; therefore, the frequency was concluded to be acceptable from a reliability standpoint.

REFERENCES

1. FSAR, Section 3.4.
2. 10 CFR 100.
3. NUREG-0803, "Generic Safety Evaluation Report Regarding Integrity of BWR Scram System Piping", August 1981.

B 3/4.3 REACTIVITY CONTROL (continued)

B 3/4.3.H Rod Pattern Control

BASES

BACKGROUND

Control rod patterns during startup conditions are controlled by the operator and the rod worth minimizer (RWM) (LCO 3.3.F), so that only specified control rod sequences and relative positions are allowed over the operating range of all control rods inserted to 20% RTP. The sequences limit the potential amount of reactivity addition that could occur in the event of a control rod drop accident (CRDA) (Reference 1).

This LCO assures that the control rod patterns are consistent with the assumptions of the CRDA analyses of Reference 2.

APPLICABLE SAFETY ANALYSIS

The analytical methods and assumptions used in evaluating the CRDA are summarized in References 1 and 2. CRDA analyses assume that the reactor operator follows prescribed withdrawal sequences. These sequences define the potential initial conditions for the CRDA analysis. The RWM (Specification 3.3.F) provides backup to operator control of the withdrawal sequences to ensure that the initial conditions of the CRDA analysis are not violated.

Prevention or mitigation of positive reactivity insertion events is necessary to limit the energy deposition in the fuel, thereby preventing significant fuel damage which could result in the undue release of radioactivity. Generic evaluations (References 2 and 4) of a design basis CRDA (i.e., a CRDA resulting in a peak fuel energy deposition of 280 cal/gm) have shown that if the peak fuel enthalpy remains below 280 cal/gm, then the maximum reactor pressure will be less than the required ASME Code limits (Reference 5) and the calculated offsite doses will be well within the required limits (Reference 6).

Control rod patterns analyzed in Reference 2 follow the banked position withdrawal sequence (BPWS). The BPWS is applicable from the condition of all control rods fully inserted to 20% rated thermal power (RTP) (Reference 3). For the BPWS, the control rods are required to be moved in groups, with all control rods assigned to a specific BPWS group required to be within specified banked positions (e.g., between notches 08 and 12). The banked positions are established to minimize the maximum incremental control rod worth without being overly restrictive during normal plant operation. Generic analysis of the BPWS (Reference 1) has demonstrated that the 280 cal/gm fuel damage limit will not be violated during a CRDA while following the BPWS

APPLICABLE

mode of operation. The generic BPWS analysis (Reference 3) also

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SAFETY ANALYSIS (continued)

evaluates the effect of fully inserted, inoperable control rods not in compliance with the sequence, to allow a limited number (i.e., eight) and distribution of fully inserted, inoperable control rods.

LCO

Compliance with the prescribed control rod sequences minimizes the potential consequences of a CRDA by limiting the initial conditions to those consistent with the BPWS. This LCO only applies to OPERABLE control rods. For inoperable control rods required to be inserted, separate requirements are specified in LCO 3.3.B.1, "Control Rod Operability", consistent with the allowances for inoperable control rods in the BPWS.

APPLICABILITY

In the STARTUP and RUN MODES, when thermal power is ≤ 20% RTP, the CRDA is a design basis accident and, therefore, compliance with the assumptions of the safety analysis is required. When thermal power is > 20% RTP, there is no credible control rod configuration that results in a control rod worth that could exceed the 280 cal/gm fuel damage limit during a CRDA (Reference 2). In the HOT SHUTDOWN and COLD SHUTDOWN MODES, control rods are not able to be withdrawn since the reactor mode switch is in shutdown and a control rod block is applied. This provides adequate requirements for control rod OPERABILITY during these conditions. In the REFUEL MODE there are no DBAs or transients identified in the station nuclear safety operations analysis (Reference 4) that require the scram function because only a single control rod can be withdrawn (except for control rods removed per LCO 3.10.D).

ACTIONS

A.1, A.2, and A.3

With one or more OPERABLE control rods not in compliance with the prescribed control rod sequence, actions may be taken to either correct the control rod pattern, verify maximum incremental rod worth is less than the amount required to insert 280 cal/gm peak fuel enthalpy, or declare the associated control rods inoperable within 8 hours. Determination that the maximum incremental rod worth is < 0.01 ΔK verifies that the peak fuel enthalpy of 280 cal/gm will not be exceeded. Noncompliance with the prescribed sequence may be the result of "double notching", drifting from a control rod drive cooling water transient, leaking scram valves, or a power reduction to ≤ 20% RTP before establishing the correct control rod pattern. The

ACTIONS (continued)

A.1, A.2, and A.3 (continued)

number of OPERABLE control rods not in compliance with the prescribed sequence is limited to eight, to prevent the operator from attempting to correct a control rod pattern that significantly deviates

B 3/4.3 REACTIVITY CONTROL

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from the prescribed sequence. When the control rod pattern is not in compliance with the prescribed sequence, all control rod movement should be stopped except for moves needed to correct the rod pattern, or scram if warranted.

ACTION A.1 is modified by a note which allows the RWM to be bypassed to allow the affected control rods to be returned to their correct position. LCO 3.3.F requires verification of control rod movement by a second licensed operator (Reactor Operator or Senior Reactor Operator) or other qualified member of the technical staff. This ensures that the control rods will be moved to the correct position. A control rod not in compliance with the prescribed sequence is not considered inoperable except as required by ACTION A.2. OPERABILITY of control rods is determined by compliance with LCO 3.3.B.1, "Control Rod Operability", LCO 3.3.C, "Scram Insertion Times", and LCO 3.3.D, "Control Rod Accumulators." The allowed completion time of 8 hours is reasonable, considering the restrictions on the number of allowed out of sequence control rods and the low probability of a CRDA occurring during the time the control rods are out of sequence.

B.1 and B.2

If nine or more OPERABLE control rods are out of sequence, the control rod pattern significantly deviates from the prescribed sequence. Control rod withdrawal should be suspended immediately to prevent the potential for further deviation from the prescribed sequence. Control rod insertion to correct the control rod pattern to be within BPWS is allowed since rod insertion reduces power which is in the conservative direction. ACTION B.1 is modified by a note which allows the RWM to be bypassed to allow the affected control rods to be returned to their correct position. LCO 3.3.F, ACTIONS A.2.2 and B.1 require verification of control rod movement by a second licensed operator (Reactor Operator or Senior Reactor Operator) or other qualified member of the technical staff.

ACTIONS

B.1 and B.2 (continued)

When nine or more OPERABLE control rods are not in compliance with BPWS, the reactor mode switch must be placed in the shutdown position within 1 hour. The allowed completion time of 1 hour is reasonable to allow insertion of control rods to restore compliance, and is appropriate relative to the low probability of a CRDA occurring

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with the control rods out of sequence. With the mode switch in shutdown, the reactor is shutdown, and as such, does not meet the applicability requirements of this LCO.

SURVEILLANCE REQUIREMENTS

SR 4.3.H

The control rod pattern is verified to be in compliance with the BPWS on a 24 hour frequency to ensure the assumptions of the CRDA analyses are met. The 24 hour frequency was developed considering that the primary check on compliance with the BPWS is performed by the RWM (LCO 3.3.F), which provides control rod blocks to enforce the required sequence and is required to be OPERABLE when operating at ≤ 20% RTP.

REFERENCES

1. FSAR, Section 14.5.2
2. NEDE-24011-P-A-13-US, “General Electric Application for Reload Fuel”, Supplement for United States, Section S2.2.3.1.
3. NEDO-21231, "Banked Position Withdrawal Sequence", January 1977.
4. NEDO-21778-A, "Transient Pressure Rises Affected Fracture Toughness Requirements for Boiling Water Reactors", December 1978.
5. ASME, Boiler and Pressure Vessel Code.
6. 10 CFR 100.11.