3.5 EMERGENCY CORE COOLING SYSTEMS (ECCS)

3.5.1 ECCS — Operating

LCO 3.5.1 Each ECCS subsystem and the Automatic Depressurization System (ADS) function of eight safety/relief valves shall be OPERABLE.

APPLICABILITY: MODE 1,
MODES 2 and 3, except ADS valves and RCIC are not required to be OPERABLE with reactor steam dome pressure $\leq$ 3.5 Kg/cm^{2}g (50 psig) for ADS and $\leq$ 10.5 Kg/cm^{2}g (150 psig) for RCIC.

ACTIONS

CONDITION	REQUIRED ACTION		COMPLETION TIME
A. One motor driven high pressure subsystem and/or one low pressure ECCS subsystem inoperable. OR (One or two) Two low pressure ECCS subsystems inoperable.	A.1	Restore ECCS subsystem(s) to OPERABLE status.	14 30 days
B. Reactor Core Isolation Cooling (RCIC) System inoperable.	B.1	Restore RCIC System to OPERABLE status.	30 days
C. Two high pressure ECCS subsystems inoperable.	C.1	Restore one high pressure ECCS subsystem to OPERABLE status.	14 days

(continued)

ACTIONS (continued)

CONDITION	REQUIRED ACTION		COMPLETION TIME
D. Any three ECCS subsystems inoperable provided at least one high pressure ECCS subsystem is OPERABLE.	D.1	Restore one ECCS subsystem to OPERABLE status.	7 days
E. Three high pressure ECCS subsystems inoperable.	E.1	Restore one high pressure ECCS subsystem to OPERABLE status.	12 hours
F. Required Action and associated Completion Time of Condition A, B, C, D, or E not met.	F.1	Be in MODE 3.	12 hours
	AND		
	F.2	Be in MODE 4.	36 hours
G. Any four ECCS subsystems inoperable.	G.1	Enter LCO 3.0.3.	Immediately
----------NOTE---------- This Condition may exist concurrently with Conditions A through E. ------------------------ H. One, two or three ADS valves inoperable.	H.1	Restore ADS valve(s) to OPERABLE status.	30 days
I. Four or more ADS valves inoperable. OR Required Action and associated Completion Time of Condition H not met.	I.1	Be in MODE 3.	12 hours
	AND		
	I.2	Reduce reactor steam dome pressure to ≤ 3.5 Kg/cm^2g (50 psig)	36 hours

INSERT

E. ----NOTE---- This Condition may exist concurrently with Conditions A through C. ---- One or two ADS valves inoperable.	E.1	Restore ADS valves to OPERABLE status.	14 days
F. ----NOTE---- This Condition may exist concurrently with Conditions A through C. ---- Three ADS valves inoperable.	F.1	Restore one ADS valve to OPERABLE status.	7 days

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.5.1.1	Verify, for each ECCS injection subsystem, the piping is filled with water from the pump discharge valve to the injection valve.	31 days
SR 3.5.1.2	-------------------NOTE------------------- Low pressure core flooder (LPFL) subsystems may be considered OPERABLE during alignment and operation for decay heat removal with reactor steam dome pressure less than 9.5 Kg/cm^2g (135 psig) in MODE 3, if capable of being manually realigned and not otherwise inoperable. -- Verify each ECCS injection subsystem manual, power operated, and automatic valve in the flow path, that is not locked, sealed, or otherwise secured in position, is in the correct position.	31 days
SR 3.5.1.3	Verify ADS nitrogen supply pressure is $\geq$ 11.3 Kg/cm^2g (161 psig).	31 days

(continued)

SURVEILLANCE REQUIREMENTS (continued)

	SURVEILLANCE	FREQUENCY
SR 3.5.1.4	Verify each motor driven ECCS pump develops the specified flow rate against a system head corresponding to the specified reactor pressure. SYSTEM / FLOW RATE / SYSTEM HEAD CORRESPONDING TO A REACTOR PRESSURE OF LPFL: ≥ 954 m^3/h (4200 gpm); ≥ 2.8 Kg/cm^2g (40 psig) HPCF: ≥ 181.7 m^3/h (800 gpm); ≥ 82.8 Kg/cm^2g (1177 psig)	92 days
SR 3.5.1.5	-------------------NOTE------------------- Not required to be performed until 12 hours after reactor steam dome pressure is ≥ 66.4 Kg/cm^2g (945 psig). -- Verify, with RCIC steam supply pressure ≤ 73.5 Kg/cm^2g (1045 psig) and ≥ 66.4 Kg/cm^2g (945 psig), the RCIC pump can develop a flow rate ≥ 181.7 m^3/h (800 gpm) against a system head corresponding to reactor pressure.	
SR 3.5.1.6	-------------------NOTE------------------- Not required to be performed until 12 hours after reactor steam dome pressure is ≥ 10.6 Kg/cm^2g (150 psig). -- Verify, with RCIC steam supply pressure ≤ 11.6 kg/cm^2g (165 psig), the RCIC pump can develop a flow rate ≥ 181.7 m^3/h (800 gpm) against a system head corresponding to reactor pressure.	

(Continued)

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
SR 3.5.1.7	-------------------NOTE------------------- Vessel injection may be excluded. -- Verify each ECCS injection subsystem actuates on an actual or simulated automatic initiation signal.	18 months
SR 3.5.1.8	-------------------NOTE------------------- Valve actuation may be excluded. -- Verify the ADS actuates on an actual or simulated automatic initiation signal.	18 months
SR 3.5.1.9	-------------------NOTE------------------- Not required to be performed until 12 hours after reactor steam dome pressure is ≥ 66.8 Kg/cm^{2}g (950 psig). -- Verify each ADS valve opens when manually actuated.	18 months on a STAGGERED TEST BASIS for each valve solenoid

B 3.5 EMERGENCY CORE COOLING SYSTEMS (ECCS)

B 3.5.1 ECCS — Operating

BASES

BACKGROUND

The ECCS is designed, in conjunction with the primary and secondary containment, to limit the release of radioactive materials to the environment following a loss of coolant accident (LOCA). The ECCS directs water to both inside and outside the core shroud to cool the core during a LOCA. The ECCS network is composed of the High Pressure Core Flooder (HPCF) System, the Reactor Core Isolation Cooling (RCIC) System, and the low pressure core flooder (LPFL) mode of the Residual Heat Removal (RHR) System. The ECCS also consists of the Automatic Depressurization System (ADS). The suppression pool provides the required source of water for the ECCS. Although no credit is taken in the safety analyses for the condensate storage tank (CST), it is capable of providing a source of water for both the RCIC System and the two HPCF subsystems.

On receipt of an initiation signal, ECCS pumps automatically start; simultaneously the system aligns, and the pumps inject water, taken either from the CST or suppression pool, into the Reactor Coolant System (RCS) as RCS pressure is overcome by the discharge pressure of the ECCS pumps. Although the system is initiated, ADS action is delayed, to allow time for confirmation of the initiating signal. The discharge pressure of the HPCF pumps exceeds that of the RCS, and the pumps inject coolant into the flooding sparger above the core. Once the steam driven RCIC turbine has accelerated, the RCIC pump discharge pressure exceeds that of the RCS and injects coolant into the reactor pressure vessel (RPV) via one of the feedwater lines. If the break is small, RCIC or either of the HPCF pumps will maintain coolant inventory, as well as vessel level, while the RCS is still pressurized. If the RCIC and HPCFs fail, they are backed up by ADS in combination with the LPFL. In this event, the ADS timed sequence would be allowed to time out and open the selected safety/relief valves (S/RVs), depressurizing the RCS and allowing the LPFL to overcome RCS pressure and inject coolant into the vessel. If the break is large, RCS pressure drops rapidly, and the HPCF and LPFL subsystems cool the core.

(continued)

BASES

BACKGROUND (continued)

Water from the break returns to the suppression pool where it is used again and again. Water in the suppression pool is circulated through a heat exchanger cooled by the Reactor Building Cooling Water (RCW) System. The ECCS network is effective in cooling the core regardless of the size or location of the piping break.

Apart from its ECCS function the RCIC System is also designed to operate either automatically or manually following reactor pressure vessel (RPV) isolation accompanied by a loss of coolant flow from the feedwater system to provide adequate core cooling and control of RPV water level. Under these conditions, the HPCF and RCIC systems perform similar functions. The RCIC System design requirements ensure that the criteria of Reference 11 are satisfied.

All ECCS subsystems are designed to ensure that no single active component failure will prevent automatic initiation and successful operation of the minimum required ECCS subsystems.

The ECCS injection systems are arranged in three separate divisions each comprised of a high pressure and low pressure subsystem. ECCS Division 1 consists of the RCIC system and LPFL-A. ECCS Division 2 consists of HPCF-B and LPFL-B. ECCS Division 3 consists of HPCF-C and LPFL-C.

LPFL is an independent operating mode of the RHR System. There are three LPFL subsystems. Each LPFL subsystem (Ref. 2) consists of a motor driven pump, a heat exchanger, piping, and valves to transfer water from the suppression pool to the RPV. Each LPFL subsystem has its own suction and discharge piping. Each LPFL subsystem takes suction from the suppression pool. LPFL subsystems B and C have dedicated discharge nozzles to the RPV that connect to flooding spargers in the vessel annulus area outside the core shroud. LPFL subsystem A discharges to one of the main feedwater injection lines and thus also supplies coolant to the vessel annulus area outside the core shroud via the feedwater sparger. The LPFL subsystems are designed to provide core cooling at low RPV pressure. Upon receipt of an initiation signal, each LPFL pump is automatically

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BASES

BACKGROUND (continued)

started approximately 10 seconds after electrical power is available. When the RPV pressure drops sufficiently, LPFL flow to the RPV begins. RHR System valves in the LPFL flow path are automatically positioned to ensure the proper flow path for water from the suppression pool to inject into the RPV. A discharge test line is provided to route water from and to the suppression pool to allow testing of each LPFL pump without injecting water into the RPV.

The HPCF System is comprised of two separate subsystems. Each HPCF subsystem (Ref. 1) consists of a single motor driven pump, a flooder sparger above the core, and piping and valves to transfer water from the suction source to the sparger. Suction piping is provided from the CST and the suppression pool. Pump suction is normally aligned to the CST source to minimize injection of suppression pool water into the RPV. However, if the CST water supply is low or the suppression pool level is high, an automatic transfer to the suppression pool water source ensures a water supply for continuous operation of the HPCF System. The HPCF System is designed to provide core cooling over a wide range of RPV pressures 0 to 82.75 Kg/cm^{2}d (0 psid to 1177 psid), vessel to the air space of the compartment containing the water source for the pump suction. Upon receipt of an initiation signal, the HPCF pumps automatically start (when electrical power is available) and valves in the flow path begin to open. Since the HPCF System is designed to operate over the full range of RPV pressures, HPCF flow begins as soon as the necessary valves are open. A full flow test line is provided to route water from and to the CST to allow testing of the HPCF System during normal operation without injecting water into the RPV.

The RCIC System (Ref. 1) consists of a steam driven turbine pump unit, piping, and valves to provide steam to the turbine, as well as piping and valves to transfer water from the suction source to the core via the feedwater system line. Suction piping is provided from the condensate storage tank (CST) and the suppression pool. Pump suction is normally aligned to the CST to minimize injection of suppression pool water into the RPV. However, if the CST water supply is low, or the suppression pool level is high, an automatic transfer to the suppression pool water source ensures a water supply for continuous operation of the RCIC System. The steam supply to the turbine is piped from main

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BASES

steam line B, upstream of the inboard main steam line isolation valve.

The RCIC System is designed to provide core cooling for a wide range of reactor pressures, 10.55 Kg/cm^{2}d (150 psig) to 81.2 Kg/cm^{2}g (1155 psig). Upon receipt of an initiation signal, the RCIC turbine accelerates to a specified speed. As the RCIC flow increases, the turbine control valve is automatically adjusted to maintain design flow. Exhaust steam from the RCIC turbine is discharged to the suppression pool. A full flow test line is provided to route water from and to the suppression pool to allow testing of the RCIC System during normal operation without injecting water into the RPV.

The ECCS pumps are provided with minimum flow bypass lines, which discharge to the suppression pool. The valves in these lines automatically open to prevent pump damage due to overheating when other discharge line valves are closed or RPV pressure is greater than the LPFL pump discharge pressures following system initiation. To ensure rapid delivery of water to the RPV and to minimize water hammer effects, the ECCS discharge line "keep fill" systems are designed to maintain all pump discharge lines filled with water.

The ADS (Ref. 1) consists of 8 of the 18 S/RVs. It is designed to provide depressurization of the primary system during a small break LOCA if RCIC and HPCF fail or are unable to maintain required water level in the RPV. ADS operation reduces the RPV pressure to within the operating pressure range of the low pressure ECCS subsystems (LPFL), so that these subsystems can provide core cooling. Each ADS valve is supplied with pneumatic power from either its own dedicated accumulator located in the drywell, or from the atmospheric control system (ACS) directly when pneumatic power from the accumulators is not needed. The ACS also supplies the nitrogen (at pressure) necessary to assure the ADS accumulators remain charged for use in emergency actuation.

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BASES

APPLICABLE SAFETY ANALYSES

The ECCS performance is evaluated for the entire spectrum of break sizes for a postulated LOCA. The accidents for which ECCS operation is required are presented in References 2, 3 and 4. The required analyses and assumptions are defined in 10 CFR 50 (Ref. 5), and the results of these analyses are described in Reference 6.

This LCO helps to ensure that the following acceptance criteria for the ECCS, established by 10 CFR 50.46 (Ref. 7), will be met following a LOCA assuming the worst case single active component failure in the ECCS:

a. Maximum fuel element cladding temperature is ≤ 1204°C (2200°F);

b. Maximum cladding oxidation is ≤ 0.17 times the total cladding thickness before oxidation;

c. Maximum hydrogen generation from zirconium water reaction is ≤ 0.01 times the hypothetical amount that would be generated if all of the metal in the cladding surrounding the fuel, excluding the cladding surrounding the plenum volume, were to react;

d. The core is maintained in a coolable geometry; and

e. Adequate long term cooling capability is maintained.

The limiting single failures are discussed in Reference 6. For any LOCA, failure of ECCS subsystems in Division 2 (HPCF-B and LPFL-B) or Division 3 (HPCF-C and LPFL-C) due to failure of its associated diesel generator is the most severe failure. One ADS valve failure is analyzed as a limiting single failure for events requiring ADS operation, however, the above single failure of a diesel generator, and the associated motor driven ECCS injection subsystems in that division, is a more limiting failure. The remaining OPERABLE ECCS subsystems provide the capability to adequately cool the core and prevent excessive fuel damage. Additional functions of the RCIC System are to respond to transient events by providing makeup coolant to the nuclear vessel and to be an independent AC source during station blackout.

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BASES

APPLICABLE SAFETY ANALYSES (continued)

In order to provide increased margin to ECCS acceptance criteria (i.e., 10 CFR 50.46), the ECCS was designed to the more stringent goal of no core uncovery for any postulated DBA or transient event, even given the most limiting single failure. This design philosophy resulted in substantially improved ECCS performance such that, when analyzed consistent with typical licensing basis methodologies (i.e., assuming only the traditional limiting single failure), there was considerable margin relative to existing regulatory requirements. The magnitude of such margin suggested that the ECCS would still be able to perform its intended safety function, even under situations with some equipment initially out of service or unavailable due to multiple postulated failures. Therefore, further ECCS analyses were performed (see Reference 8) in an attempt to identify the minimum amount of ECCS equipment that must operate such that the plant could still meet the 10 CFR 50.46 acceptance criteria listed above.

Analyses were performed for a set of identified limiting scenarios, assuming the unavailability (or failure) of multiple ECCS subsystems, and using the same calculational methods as were used for the traditional design basis analyses. The results of these analyses demonstrated that "success" (i.e., no violation of the above stated 50.46 limits) was achieved under various postulated accident scenarios provided at least one motor driven ECCS injection subsystem was capable of successfully injecting water into the RPV. For any such scenarios also requiring depressurization, "success" was achieved with the actuation of at least five SR/Vs in the ADS mode (in conjunction with successful vessel injection from the one required ECCS subsystem). Thus, it was confirmed that the ABWR ECCS is able to perform its intended safety function (in accordance with the applicable regulatory requirements), even for postulated events involving limiting single failures that might occur with less than the full complement of ECCS subsystems initially available.

The ECCS satisfy Criterion 3 of the NRC Policy Statement.

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BASES

LCO

Each ECCS injection subsystem and eight ADS valves are required to be OPERABLE. The ECCS injection subsystems are defined as the three LPFL subsystems, the two HPCF subsystems, and the RCIC System. The high pressure ECCS injection subsystems are defined as the two HPCF subsystems and the RCIC System.

With less than the required number of ECCS subsystems OPERABLE during a limiting design basis LOCA concurrent with the worst case single failure, the margins to the limits specified in 10 CFR 50.46 (Ref. 7) would be reduced. Furthermore all ECCS subsystems are assumed to be initially available in the comprehensive set of analyses performed to satisfy the single failure criterion required by 10 CFR 50.46 (Ref. 7). Thus all ECCS subsystems must be OPERABLE. The ECCS is supported by other systems that provide automatic ECCS initiation signals (LCO 3.3.5.1, "Emergency Core Cooling System (ECCS) Instrumentation"), cooling and service water to cool rooms containing ECCS equipment (LCO 3.7.1, "Reactor Building Cooling Water (RCW) System, Reactor Service Water (RSW) System and Ultimate Heat Sink (UHS)-Operating", LCO 3.7.2, "RCW/RSW and UHS-Shutdown" and LCO 3.7.3 "RCW/RSW and UHS-Refueling"), electrical power (LCO 3.8.1, "AC Sources-Operating," and LCO 3.8.4, "DC Sources-Operating").

A LPFL subsystem may be considered OPERABLE during alignment and operation for decay heat removal when below the actual RHR cut in permissive pressure in MODE 3, if capable of being manually realigned (remote or local) to the LPFL mode and not otherwise inoperable. At these low pressures and decay heat levels, a reduced complement of ECCS subsystems can provide the required core cooling, thereby allowing operation of an RHR shutdown cooling loop when necessary.

APPLICABILITY

All ECCS subsystems are required to be OPERABLE during MODES 1, 2, and 3 when there is considerable energy in the reactor core and core cooling would be required to prevent fuel damage in the event of a break in the primary system piping. In MODES 2 and 3, the RCIC System is not required to be OPERABLE when pressure is ≤ 10.5 Kg/cm^{2}g (150 psig) since other ECCS subsystems can provide sufficient flow to the vessel. In MODES 2 and 3, the ADS function is not

(continued)

BASES

APPLICABILITY (continued)

required when pressure is ≤ 3.5 Kg/cm^{2}g (50 psig) because the low pressure ECCS subsystems (LPFL) are capable of providing flow into the RPV below this pressure. ECCS requirements for MODES 4 and 5 are specified in LCO 3.5.2, "ECCS — Shutdown."

ACTIONS

A.1

With one or two ~~motor driven~~ ~~high pressure~~ ECCS subsystems ~~(HPCF)~~ ~~and/or one low pressure ECCS subsystem (LPFL)~~ inoperable~~, or any two low pressure ECCS subsystems inoperable,~~ the inoperable subsystem(s) must be restored to OPERABLE status within ~~30~~ 14 days. In this Condition, the remaining OPERABLE subsystems provide more than adequate core cooling during a LOCA. However, overall ECCS reliability is reduced; and a single failure impacting one or more of the remaining OPERABLE subsystems concurrent with a LOCA would result in degraded ECCS performance and reduced margins to 10 CFR 50.46 acceptance criteria. Nonetheless, even given the worse case single failure concurrent with a LOCA initiated from this Condition, there will always be at least one ECCS subsystem available to inject water into the RPV. (For the special case of an LPFL-A line break and failure of a diesel generator, the combustion turbine generator (CTG) would be available to provide emergency electrical power to the ECCS pumps.) Additional analyses of limiting design basis scenarios demonstrate that in such cases 10 CFR 50.46 acceptance criteria will still be met (Ref. 8). Furthermore, results of PRA sensitivity studies performed (see Ref. 9) show that this situation is acceptable from an overall plant risk perspective. The ~~30~~ 14 day Completion Time is thus based on the low probability of a LOCA occurring during this period and the overall redundancy provided by the ECCS and its continued ability to perform its intended safety function, while assuring a return to full ECCS capability in a reasonable time so as to not significantly impact overall ECCS reliability. ~~Additionally, the 30 day Completion Time is consistent with the allowable outage time for a single diesel generator which would affect the operability of a single ECCS division (i.e., one HPCF and one LPFL).~~

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BASES

B.1

If the RCIC System is inoperable during MODE 1, or MODES 2 or 3 with reactor steam dome pressure > 10.5 Kg/cm^2g (150 psig), it must be restored to OPERABLE status within 30 days. In this Condition, loss of the RCIC System will not affect the overall plant capability to provide makeup inventory at high RPV pressure since the two HPCF subsystems would still be available to provide makeup to the reactor during a loss of coolant accident (LOCA) in which the RPV remained at high pressure. However, for transients and certain abnormal events with no LOCA, RCIC (as opposed to HPCF) is the preferred source of makeup coolant because its relatively small capacity and automatic flow control capability allows for easier control of RPV water level. Furthermore, with its steam driven turbine, the RCIC System provides the only source of reactor coolant make-up during a complete loss of AC power event. Therefore, only a limited time is allowed to restore the inoperable RCIC to OPERABLE status.

The 30 day Completion Time is based on the low probability of a LOCA occurring during this period and the overall redundancy provided by the ECCS and its continued ability to perform its intended safety function, while assuring a return to full ECCS capability in a reasonable time so as to not significantly impact overall ECCS reliability. Additionally, a 30 day Completion Time for RCIC has been found to be acceptable through operating experience.

C.1

With two high pressure ECCS subsystems inoperable, at least one inoperable high pressure ECCS subsystem must be restored to OPERABLE status within 14 days. In this Condition, the remaining OPERABLE subsystems provide adequate core cooling during a LOCA. However, overall ECCS reliability is reduced and a single failure impacting one or more of the remaining OPERABLE subsystems concurrent with a LOCA would result in degraded ECCS performance and reduced margins to 10 CFR 50.46 acceptance criteria. Nonetheless, even given the worse case single failure concurrent with a LOCA initiated from these Conditions, there will always be at least one ECCS subsystem available to inject water into the RPV. Additional analyses of limiting design basis scenarios demonstrate that in such cases 10 CFR 50.46 acceptance

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criteria will still be met (Ref. 8). Furthermore, results of PRA sensitivity studies performed (see Reference 9) show that this situation is acceptable from an overall plant risk perspective.

However, for transients and certain abnormal events with no LOCA, RCIC (as opposed to HPCF) is the preferred source of makeup coolant because its relatively small capacity and automatic flow control capability allows for easier control of RPV water level. Furthermore, with its steam driven turbine, the RCIC System provides the only source of reactor coolant make-up during a complete loss of AC power event. Therefore, only a limited time is allowed to restore the inoperable RCIC to OPERABLE status.

The 14 day Completion Time for Required Action C.1 is thus based on the low probability of a LOCA occurring during this period and the overall redundancy provided by the ECCS and its continued ability to perform its intended safety function, while assuring a return to full ECCS capability in a reasonable time so as to not significantly impact overall ECCS reliability.

The 14 day Completion Time is more restrictive than that for Required Action A.1 because a single failure of the remaining high pressure ECCS subsystem may, during a LOCA, require an unwanted actuation of the ADS to reach the operating condtions of the low pressure ECCS subsystems.

B D.1 and C E.1

With any three ECCS subsystems (except for the three high pressure ECCS subsystems) inoperable, at least one ECCS subsystem must be restored to OPERABLE status within 7 days. With any three high pressure ECCS subsystems inoperable, at least one high pressure ECCS subsystem must be restored to OPERABLE status within 12 hours. In these Conditions, the remaining OPERABLE subsystems provide adequate core cooling during a LOCA. In this Condition, core cooling capability is still maintained but the single failure criterion capability for all combinations of system out of service is not satisfied. Therefore, the Completion Time is limited to 7 days. Additional analyses of limiting design basis scenarios demonstrate that in such cases 10 CFR 50.46 acceptance criteria will still be met (Ref. 8). Furthermore, results of PRA sensitivity studies performed

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BASES

(see Reference 9) show that this situation is acceptable from an overall plant risk perspective.

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BASES

ACTIONS

D.1 and E.1 (continued)

Since the ECCS availability is reduced relative to Conditions A or C, a more restrictive Completion Time is imposed. The 7 day Completion Time for Required Action D.1 is based on the low probability of a LOCA occurring during this period and the overall redundancy provided by the ECCS and its continued ability to perform the intended safety function while assuring a return towards full ECCS capability in a reasonable time so as to not significantly impact overall ECCS reliability.

The 12 hour Completion Time for Required Action E.1 is more restrictive because a LOCA may necessitate an unwanted actuation of the ADS to reach the operating conditions of the low pressure ECCS subsystems. However, any one low pressure ECCS subsystem is capable of maintaining core coolant during a LOCA for the spectrum of break sizes.

F.1 and F.2

If any Required Action and associated Completion Time of Condition A, B, C, D or E are not met, 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 MODE 3 within 12 hours and to MODE 4 within 36 hours. The allowed Completion Times are reasonable, based on operating experience, to reach the required plant conditions from full power conditions in an orderly manner and without challenging plant systems.

G.1

When any four ECCS subsystems are inoperable, as stated in Condition G, the plant is in a condition outside of the accident analyses. Therefore, LCO 3.0.3 must be entered immediately.

H.1

With one, two or three ADS valves inoperable, the ADS valves must be restored to OPERABLE status within 30 days. The LCO requires eight ADS valves to be OPERABLE to provide the ADS function. Reference 6 contains the results of the traditional design basis analysis that evaluated the effect

With three ADS valves inoperable, one ADS valve must be restored to OPERABLE status within 7 days.

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ACTIONS

E.1 and F.1 (continued)

of one ADS valve being out of service. However, the results of this analysis are bounded by additional analyses of more limiting single failure scenarios which assume the unavailability of multiple ADS valves (see Reference 8). Per these analyses, operation of only five ADS valves will provide the required depressurization. However, overall reliability of the ADS is reduced and there is a reduction in depressurization capability. Therefore, operation is only allowed for a limited time. The 7 and 14 day Completion Times are based on the low probability of a LOCA occurring during this period and the overall redundancy and capacity of the ADS System and its continued ability to perform its intended safety function, while assuring a return towards full ADS capability in a reasonable time so as to not significantly impact overall ADS or ECCS reliability. Furthermore, each of these conditions has been modified by a NOTE that allows concurrent existence with Conditions A, B or C. Concurrent existence is justified by the additional ECCS analyses that were performed (Ref. 8) and greatly simplifies the necessary Required Actions.

G.1 and G.2

If the Required Action and associated Completion Time of Condition E or F is not met or if four or more ADS valves are inoperable, 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 MODE 3 within 12 hours and reactor steam dome pressure reduced to ≤ 3.5 Kg/cm^2g (50 psig) within 36 hours. The allowed Completion Times are reasonable, based on operating experience, to reach the required plant conditions from full power conditions in an orderly manner and without challenging plant systems.

SURVEILLANCE REQUIREMENTS

SR 3.5.1.1

The flow path piping has the potential to develop voids and pockets of entrained air. Maintaining the pump discharge lines of the HPCF subsystem, RCIC System, and LPFL subsystems full of water ensures that the systems will perform properly, injecting their full capacity into the RCS

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SURVEILLANCE REQUIREMENTS

SR 3.5.1.1 (continued)

upon demand. This will also prevent a water hammer following an ECCS initiation signal. One acceptable method of ensuring the lines are full is to vent at the high points. The 31 day Frequency is based on operating experience, on the procedural controls governing system operation, and on the gradual nature of void buildup in the ECCS piping.

SR 3.5.1.2

Verifying the correct alignment for manual, power operated, and automatic valves in the ECCS flow paths provides assurance that the proper flow paths will exist for ECCS operation. This SR does not apply to valves that are locked, sealed, or otherwise secured in position since these valves were verified to be in the correct position prior to locking, sealing, or securing. A valve that receives an initiation signal is allowed to be in a nonaccident position provided the valve will automatically reposition in the proper stroke time. This SR does not require any testing or valve manipulation; rather, it involves verification that those valves potentially capable of being mispositioned are in the correct position. This SR does not apply to valves that cannot be inadvertently misaligned, such as check valves.

The 31 day Frequency of this SR was derived from the Inservice Testing Program requirements for performing valve testing at least once every 92 days. The Frequency of 31 days is further justified because the valves are operated under procedural control and because improper valve alignment would only affect a single subsystem. This Frequency has been shown to be acceptable through operating experience.

This SR is modified by a Note that allows a LPFL subsystem to be considered OPERABLE during alignment and operation for decay heat removal with reactor steam dome pressure less than the RHR cut in permissive pressure in MODE 3, if capable of being manually realigned (remote or local) to the LPFL mode and not otherwise inoperable. This allows operation in the RHR shutdown cooling mode during MODE 3 if necessary.

(continued)

BASES

SURVEILLANCE REQUIREMENTS

SR 3.5.1.3

Verification every 31 days that ADS nitrogen accumulator pressure is ≥ 11.3 Kg/cm^2g (161 psig) assures adequate nitrogen pressure for reliable ADS operation. The accumulator on each ADS valve provides pneumatic pressure for valve actuation. The designed pneumatic supply pressure requirements for the accumulator are such that, following a failure of the pneumatic supply to the accumulator, at least one valve actuation can occur with the drywell at design pressure, or five valve actuations can occur with the drywell at atmospheric pressure (Ref. 10). The ECCS safety analysis assumes only one actuation to achieve the depressurization required for operation of the low pressure ECCS. This minimum required pressure of 11.3 Kg/cm^2g (161 psig) is provided by the High Pressure Nitrogen Gas Supply System (HPIN). The 31 day Frequency takes into consideration administrative control over operation of the HPIN and alarms for low pneumatic pressure (Ref. 12).

SR 3.5.1.4, SR 3.5.1.5 and SR 3.5.1.6

The performance requirements of the ECCS pumps are determined through application of the 10 CFR 50, Appendix K, criteria (Ref. 5). These periodic Surveillances are performed (in accordance with the ASME Code, Section XI, requirements for the ECCS pumps) to verify that the ECCS pumps will develop the flow rates required by the respective analyses. The ECCS pump flow rates ensure that adequate core cooling is provided to satisfy the acceptance criteria of 10 CFR 50.46 (Ref. 7). The RCIC pump flow rates also ensure that the system can maintain reactor coolant inventory during pressurized conditions with the RPV isolated.

The pump flow rates are verified against a system head that is equivalent to the RPV pressure expected during a LOCA. The total system pump outlet pressure is adequate to overcome the elevation head pressure between the pump suction and the vessel discharge, the piping friction losses, and RPV pressure present during LOCAs. These values may be established during pre-operational testing.

(continued)

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SURVEILLANCE REQUIREMENTS

SR 3.5.1.4, SR 3.5.1.5 and SR 3.5.1.6 (continued)

The flow tests for the RCIC System are performed at two different pressure ranges such that system capability to provide rated flow is tested both at the higher and lower operating ranges of the system. Since the required reactor steam dome pressure must be available to perform SR 3.5.1.5 and SR 3.5.1.6, sufficient time is allowed after adequate pressure is achieved to perform these SRs. Reactor startup is allowed prior to performing the low pressure Surveillance because the reactor pressure is low and the time to satisfactorily perform the Surveillance is short. The reactor pressure is allowed to be increased to normal operating pressure since it is assumed that the low pressure test has been satisfactorily completed and there is no indication or reason to believe that RCIC is inoperable. Therefore, these SRs are modified by Notes that state the Surveillances are not required to be performed until 12 hours after the specified reactor steam dome pressure is reached.

A 92 day Frequency for SRs 3.5.1.4 and 3.5.1.5 is consistent with the Inservice Testing Program requirements. The 18 month Frequency for SR 3.6.1.6 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 that these components usually pass the SR when performed at the 18 month Frequency, which is based on the refueling cycle. Therefore, the Frequency was concluded to be acceptable from a reliability standpoint.

SR 3.5.1.7

The ECCS subsystems are required to actuate automatically to perform their design functions. This Surveillance test verifies that, with a required system initiation signal (actual or simulated), the automatic initiation logic of HPCF, RCIC, and LPFL will cause the systems or subsystems to operate as designed, including actuation of the system throughout its emergency operating sequence, automatic pump startup, and actuation of all automatic valves to their required positions. This Surveillance also ensures that the HPCF and RCIC Systems will automatically restart on an RPV

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BASES

SURVEILLANCE REQUIREMENTS

SR 3.5.1.7 (continued)

low water level (Levels 1.5 and 2, respectively) signal received subsequent to an RPV high water level (Level 8) trip and that the suction is automatically transferred from the CST to the suppression pool. The LOGIC SYSTEM FUNCTIONAL TEST performed in LCO 3.3.5.1 overlaps this Surveillance to provide complete testing of the assumed safety function.

The 18 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 that these components usually pass the SR when performed at the 18 month Frequency, which is based on the refueling cycle. Therefore, the Frequency was concluded to be acceptable from a reliability standpoint.

This SR is modified by a Note that excludes vessel injection during the Surveillance. Since all active components are testable and full flow can be demonstrated by recirculation through the test line, coolant injection into the RPV is not required during the Surveillance.

SR 3.5.1.8

The ADS designated S/RVs are required to actuate automatically upon receipt of specific initiation signals. A system functional test is performed to demonstrate that the mechanical portions of the ADS function (i.e., solenoids) operate as designed when initiated either by an actual or simulated initiation signal, causing proper actuation of all the required components. SR 3.5.1.9 and the LOGIC SYSTEM FUNCTIONAL TEST performed in LCO 3.3.5.1 overlap this Surveillance to provide complete testing of the assumed safety function.

The 18 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 that these components usually pass the SR when performed at the 18 month Frequency, which

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SURVEILLANCE REQUIREMENTS

SR 3.5.1.8 (continued)

is based on the refueling cycle. Therefore, the Frequency was concluded to be acceptable from a reliability standpoint.

This SR is modified by a Note that excludes valve actuation. This prevents an RPV pressure blowdown.

SR 3.5.1.9

A manual actuation of each ADS valve is performed to verify that the valve and solenoids are functioning properly and that no blockage exists in the S/RV discharge lines. This is demonstrated by the response of the turbine control or bypass valve, by a change in the measured steam flow, or by any other method suitable to verify steam flow. Adequate reactor steam dome pressure must be available to perform this test to avoid damaging the valve. Sufficient time is therefore allowed, after the required pressure is achieved, to perform this test. Adequate pressure at which this test is to be performed is [66.8 Kg/cm^2g (950 psig)] (the pressure recommended by the valve manufacturer). Reactor startup is allowed prior to performing this test because valve OPERABILITY and the setpoints for overpressure protection are verified, per ASME requirements, prior to valve installation. Therefore, this SR is modified by a Note that states the Surveillance is not required to be performed until 12 hours after reactor steam dome pressure is ≥ [66.8 Kg/cm^2g (950 psig)]. SR 3.5.1.8 and the LOGIC SYSTEM FUNCTIONAL TEST performed in LCO 3.3.5.1 overlap this Surveillance to provide complete testing of the assumed safety function.

The Frequency of 18 months on a STAGGERED TEST BASIS ensures that both solenoids for each ADS valve are alternately tested. The 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 that these components usually pass the SR when performed at the 18 month Frequency, which is based on the refueling cycle. Therefore, the Frequency was concluded to be acceptable from a reliability standpoint.

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BASES

REFERENCES

1. ABWR SSAR, Section 6.3.2.
2. ABWR SSAR, Section 15.6.4.
3. ABWR SSAR, Section 15.6.5.
4. ABWR SSAR, Section 15.6.6.
5. 10 CFR 50, Appendix K.
6. ABWR SSAR, Section 6.3.3.
7. 10 CFR 50.46.
8. ABWR SSAR, Section 6.3.3.9.
9. ABWR SSAR, Section 19D.9.
10. ABWR SSAR, Section 7.3.1.1.1.2.
11. 10 CFR 50, Appendix A, GDC 33.
12. ABWR SSAR, Section 6.7.