

3.4 EMERGENCY COOLING

Applicability: Applies to the operating status of the emergency cooling systems.

Objective: To assure operability of the emergency cooling systems.

Specifications:

A. Core Spray System

1. The Core Spray System shall be OPERABLE at all times with irradiated fuel in the reactor vessel with an absorption chamber water volume of at least 82,000 ft³ except as specified in Table 3.4.1, or as noted below.
2. If Specification 3.4.A.1 is not met the reactor shall be PLACED IN the COLD SHUTDOWN CONDITION and no work shall be performed on the reactor or its connected systems which could result in lowering the reactor water level to less than 4'8" above TOP OF ACTIVE FUEL.

Table 3.4.1

Run or Startup Mode (except for low power physics testing)		
Condition	Requirement	Provided:
Any active loop component becomes inoperable. -OR- Two or more active loop components in the same loop (System 1 or System 2) are inoperable provided no two components are redundant.	The Reactor may remain in operation for a period not to exceed 15 Days.	Both Emergency Diesel Generators are OPERABLE. The Redundant active loop components within the same loop as the inoperable components are verified OPERABLE on a daily basis. Specification 3.4.A.3 is met unless only a core spray booster pump is inoperable.
One Emergency Diesel Generator is inoperable.	The Reactor may remain in operation for a period not to exceed 7 Days. (Refer to Section 3.7.C.2)	All core spray equipment connected to the OPERABLE emergency diesel generator is OPERABLE.

Run or Startup Mode (except for low power physics testing)		
Condition	Requirement	Provided:
<p>One core spray loop (System 1 or System 2) or its core spray header delta-P instrumentation becomes inoperable.</p> <p>-OR-</p> <p>Both of the redundant components in a loop (System 1 or System 2) are inoperable.</p>	<p>The Reactor may remain in operation for a period not to exceed 7 Days.</p>	<p>Both Emergency Diesel Generators are OPERABLE.</p> <p>The remaining loop (System 1 or System 2) has no inoperable components and is verified daily to be OPERABLE.</p> <p>Specification 3.4.A.3 is met.</p>
<p>Two of the four redundant active loop components in the core spray system not in the same loop (System 1 or System 2) are inoperable.</p> <p>-OR-</p> <p>Two or more non-redundant active loop components are inoperable in both loops (System 1 and System 2).</p>	<p>The Reactor may remain in operation for a period not to exceed 7 Days.</p>	<p>Both Emergency Diesel Generators are OPERABLE.</p> <p>The Redundant active loop components within the same loop as the inoperable components are verified OPERABLE on a daily basis.</p> <p>Specification 3.4.A.3 is met.</p>
Shutdown or Refuel Mode		
Condition	Requirement	Provided:
<p>Maintenance or modifications of core spray systems, their power supplies, or water supplies.</p>	<p>Maintain reduced core spray system availability as follows:</p> <ol style="list-style-type: none"> 1. At least one core spray pump, and system components necessary to deliver rated core spray to the reactor vessel, must remain OPERABLE to the extent the pump and any necessary valves can be started or operated from the control room or from local control stations. 2. The Fire protection system is OPERABLE to the extent that one diesel driven fire pump is capable of providing water to the core spray system. 3. Verify the systems in 1 & 2 above are OPERABLE on a weekly basis. 	<p>The Reactor is maintained in the COLD SHUTDOWN CONDITION or in the REFUEL MODE with the reactor coolant system maintained at less than 212°F and vented.</p> <p>-AND-</p> <p>No work is performed on the reactor vessel and connected systems that could result in lowering the reactor water level to less than 4'8" above the TOP OF ACTIVE FUEL.</p>

Shutdown or Refuel Mode		
Condition	Requirement	Provided:
<p>Maintenance or modifications of core spray systems, their power supplies, or water supplies while work is in progress having the potential to lower reactor water level below 4'8" TAF.</p> <p>-OR-</p> <p>The Reactor is in the startup mode for low power physics testing.</p>	<p>Maintain reduced core spray system availability as follows:</p> <p>1. At least one core spray pump in each loop, and system components necessary to deliver rated core spray to the reactor vessel, must remain OPERABLE to the extent that the pump and any necessary valves in each loop can be started or operated from the control room or from local control stations.</p> <p>2. Fire protection system is OPERABLE to the extent that one diesel driven fire pump is capable of providing water to the core spray system.</p> <p>3. Verify the systems in 1 & 2 above are OPERABLE every 72 hours.</p>	<p>The Reactor is:</p> <p>In the REFUEL MODE with the reactor coolant system maintained at less than 212°F.</p> <p>-OR-</p> <p>In the STARTUP MODE for the purpose of low power physics testing.</p>
<p>The requirements for maintenance or modification can not be met.</p>	<p>Initiate work to meet the requirements.</p>	<p>Specification 3.4.A.2 is met.</p>

3. In the event of inoperable active loop components the APLHGR of all the rods in any fuel assembly, as a function of average planar exposure, at any axial location shall not exceed 90% of the limits given in Specification 3.10.A. The action to bring the core to 90% of the APLHGR Limits must be completed within two hours after the component has been determined to be inoperable.
4. The core spray system is not required to be operable when the following conditions are met:
 - a. The reactor mode switch is locked in the "Refuel" or "Shutdown" position.
 - b. (1) There is an operable flow path capable of taking suction from the condensate storage tank and transferring water to the reactor vessel, and
 - (2) The fire protection system is OPERABLE to the extent that one diesel driven fire pump is capable of providing water to the core spray system, and
 - (3) These systems are verified to be OPERABLE on a weekly basis.

- c. The reactor coolant system is maintained at less than 212 °F and vented (except during reactor vessel pressure testing).
- d. At least one core spray pump, and system components necessary to deliver rated core spray flow to the reactor vessel, must remain operable to the extent that the pump and any necessary valves can be started or operated from the control room or from local control stations, and the torus is mechanically intact. Verify the pump and components are OPERABLE, as described, on a weekly basis.
- e. (1) No work shall be performed on the reactor or its connected systems which could result in lowering the reactor water level to less than 4'8" above the TOP OF the ACTIVE FUEL and there is a minimum of 360,000 gallons of water available between the torus and condensate storage tank water inventories. At least two redundant core spray systems including core spray pumps and system components must remain operable as defined in d. above. At least one recirculation loop discharge valve and its associated suction valve shall be in the full open position. Verify the pumps and components are OPERABLE, as described, on a weekly basis.

OR

- (2) The reactor vessel head, fuel pool gate, and separator-dryer pool gates are removed and the water level is above elevation 117 feet. When filling or draining the reactor cavity, a sufficient water inventory (between the condensate storage tank and the reactor cavity) to complete the flooding operation shall be maintained. The 360,000 gallons of water minimum requirement in (1) above does not apply during the filling and draining operation provided there is a sufficient amount of water to complete the flooding operation.

B. Automatic Depressurization System

1. Five electromatic relief valves, which provide the automatic depressurization and pressure relief functions, shall be operable when the reactor water temperature is greater than 212°F and pressurized above 110 psig, except as specified in 3.4.B.2 and during Reactor Vessel Pressure Testing consistent with Specifications 1.39 and 3.3.A.(i).
2. If at any time there are only four operable electromatic relief valves, the reactor may remain in operation for a period not to exceed 3 days provided the motor operated isolation and condensate make-up valves in both isolation condensers are verified daily to be operable.
3. If Specifications 3.4.B.1 and 3.4.B.2 are not met; reactor pressure shall be reduced to 110 psig or less, within 24 hours.
4. The time delay set point for initiation after coincidence of low-low-low reactor water level and high drywell pressure shall be set not to exceed two minutes.

C. Containment Spray System and Emergency Service Water System

NOTE: LCO 3.0.C.2 is not applicable to the Containment Spray System and Emergency Service Water System

1. The containment spray system and the emergency service water system shall be operable at all times with irradiated fuel in the reactor vessel, except as specified in Specifications 3.4.C.3, 3.4.C.4, 3.4.C.6 and 3.4.C.8.
2. The absorption chamber water volume shall not be less than 82,000 ft³ in order for the containment spray and emergency service water system to be considered operable.
3. If one emergency service water system loop becomes inoperable, its associated containment spray system loop shall be considered inoperable. If one containment spray system loop and/or its associated emergency service water system loop becomes inoperable during the run mode, the reactor may remain in operation for a period not to exceed 7 days provided the remaining containment spray system loop and its associated emergency service water system loop each have no inoperable components and are verified daily to be operable.
4. If a pump in the containment spray system or emergency service water system becomes inoperable, the reactor may remain in operation for a period not to exceed 15 days provided the other similar pump is verified daily to be operable. A maximum of two pumps may be inoperable provided the two pumps are not in the same loop. If more than two pumps become inoperable, the limits of Specification 3.4.C.3 shall apply.
5. During the period when one diesel is inoperable, the containment spray loop and emergency service water system loop connected to the operable diesel shall have no inoperable components.

6. If primary containment integrity is not required (see Specification 3.5.A), the containment spray system may be made inoperable.
7. If Specifications 3.4.C.3, 3.4.C.4, 3.4.C.5 or 3.4.C.6 are not met, the reactor shall be placed in cold shutdown condition. If the containment spray system or the emergency service water system becomes inoperable, the reactor shall be placed in the cold shutdown condition and no work shall be performed on the reactor or its connected systems which could result in lowering the reactor water level to less than 4'8" above the top of the active fuel.
8. The containment spray system may be made inoperable during the integrated primary containment leakage rate test required by Specification 4.5, provided that the reactor is maintained in the cold shutdown condition and that no work is performed on the reactor or its connected systems which could result in lowering the reactor level to less than 4'8" above the top of the active fuel.

D. Control Rod Drive Hydraulic System

1. The control rod drive (CRD) hydraulic system shall be operable when the reactor water temperature is above 212°F except as specified in 3.4.D.2 and 3.4.D.3 below.
2. If one CRD hydraulic pump becomes inoperable when the reactor water temperature is above 212°F, the reactor may remain in operation for a period not to exceed 7 days provided the second CRD hydraulic pump is operating and is checked at least once every 8 hours. If this condition cannot be met, the reactor water temperature shall be reduced to less than 212°F.
3. During reactor vessel pressure testing, at least one CRD pump shall be operable.

E. Core Spray and Containment Spray Pump Compartments Doors

The core spray and containment spray pump compartments doors shall be closed at all times except during passage in order to consider the core spray system and the containment spray system operable.

F. Fire Protection System

1. The fire protection system shall be operable at all times with fuel in the reactor vessel except as specified in Specification 3.4.F.2.
2. If the fire protection system becomes inoperable during the run mode, the reactor may remain in operation provided both core spray system loops are operable with no inoperable components.

Bases:

This specification assures operability of the emergency core cooling system to provide adequate core cooling. The Oyster Creek ECCS has two core spray loops (system 1 and system 2); each containing a core spray sparger and redundant active loop components consisting of two main pumps, two booster pumps, two parallel isolation valves (outside the drywell) and two check valves in parallel (inside the drywell). Specification 3.4.A.1 insures the availability of core cooling to meet the ECCS acceptance criteria in 10 CFR 50.46 utilizing the MAPLHGR limits provided in Section 3.10. These limits are from calculations⁽¹⁾ that include models and procedures which are specified in 10 CFR 50 Appendix K. A core spray flow of at least 3400 gpm (1 main and 1 booster pump) from 1 loop plus 2200 gpm (1 main pump) from the other loop at a vessel pressure of 110 psig is used in the calculation. Core spray loop 2 would be required to deliver 3640 gpm if loop 2 is relied upon as the two pump contributor and 2360 gpm if loop 2 is the single pump contributor, since loop 2 has flow losses through cracks in the core spray sparger.

Table 3.4.1 allows continued operation with one core spray loop inoperable for a limited period of time. An evaluation of data presented in Reference 5 shows that flow from a single core spray sparger, main and booster pumps delivering 3400 gpm (3640 gpm for loop 2) at a vessel pressure of 110 psig, will meet 10 CFR 50.46 criteria with a 10% reduction in MAPLHGR Limits specified in Section 3.10. At 90% of the APLHGR, each core spray system is capable of supplying the required minimum bundle flow rate to ensure core cooling (References 6 and 7). Two hours is allowed for a reduction in the APLHGR limit which is consistent with two hours provided by Specification 3.10.A.3 to return an exceeded APLHGR to within the prescribed limit.

Under the APLHGR operational constraints of specification 3.4.A.3 the operable core spray loop meets all Appendix K requirements except for the case of a core spray line break inside the drywell in the operable loop. As a result, reactor operation is permitted for a period not to exceed seven days. The allowed time out of service for the redundant core spray loop is justified based on the low probability of the event, the direct operator indication of a Core Spray System pipe break, and emergency procedures which provide for additional cooling water through the fire system.

The probability of a pipe break between the reactor vessel and the core spray check valve in the operable core spray loop (approx. 28 feet of 6 inch pipe) compared to the total pipe in the reactor coolant pressure boundary is very small. The probability of a core spray line break in conjunction with the other core spray loop out of service, which in itself is a low probability, is so small that it does not constitute an unacceptable risk. In the extremely unlikely event that this LOCA scenario were to occur, the operators are provided with a specific visual and audible alarm alerting them of a "Core Spray System I (II) Pipe Break" (one for each core spray loop). These alarms are initiated by differential pressure detectors on each core spray loop. In such a case the core spray line break would occur above the top of the active fuel allowing the core to be re-flooded from the fire protection system through the intact core spray loop.

In addition, a small break LOCA in the operable core spray loop prior to a larger break will be detected by the drywell unidentified leakage system (drywell sump) even before it is detected by the core spray alarm system. This will provide the operators with additional time to respond.

Therefore, the out-of-service time for one of the two core spray loops, as evaluated as per the guidelines in Reference 8, has been conservatively selected to be 7 days.

Table 3.4.1 allows continued operation with one redundant active loop component inoperable for a limited period of time. Each core spray loop contains redundant active components based upon Reference 1 or 5, as appropriate. Therefore, with the loss of one of these components, the system as a whole (both loops) can tolerate an additional single failure of one of its active components and still perform the intended function and meet 10 CFR 50.46 criteria. If a redundant active loop component fails, a fifteen day period is allowed for repairs, based on 1 out of 4 components being required. The 1 out of 4 requirement is maintained by assuring no two inoperable components are redundant.

Table 3.4.1 ensures that if one diesel is out of service for repair, the core spray components fed by the other diesel must be OPERABLE. Since each diesel will provide power to components for both core spray loops, the required flow specified in the bases for Specification 3.4.A.1 will be met.

When the reactor is in the shutdown or refueling mode and the reactor coolant system is less than 212°F and vented and no work is being performed that could result in lowering the water level to less than 4'8" above the core, the likelihood of a leak or rupture leading to uncovering of the core is very low. The only source of energy that must be removed is decay heat and one day after shutdown this heat generation rate is conservatively calculated to be not more than 0.6% of rated power. Sufficient core spray flow to cool the core can be supplied by one core spray pump or one of the two fire protection system pumps under these conditions. When it is necessary to perform repairs on the core spray system components, power supplies or water sources, Table 3.4.1 permits reduced cooling system capability to that which could provide sufficient core spray flow from two independent sources. Manual initiation of these systems is adequate since it can be easily accomplished within 15 minutes during which time the temperature rise in the reactor fuel cladding will not reach 2200°F.

In order to allow for certain primary system maintenance, which will include control rod drive repair, LPRM removal/installation, reactor leak test, etc., (all performed according to approved procedure), Table 3.4.1 requires the availability of an additional core spray pump in an independent loop, while this maintenance is being performed. The likelihood of the core being uncovered is still considered to be very low, however, the requirement of a second core spray pump capable of full rated flow and the 72 hour OPERABILITY verification of both core spray pumps is specified.

Specification 3.4.A.4 allows the core spray system to be inoperable in the cold shutdown or refuel modes if the reactor cavity is flooded and the spent fuel pool gates are removed and a source of water supply to the reactor vessel is available as specified in 3.4.A.4.b.1 which may include the core spray pump, a condensate pump through the feedwater system, or other defined path from the condensate storage tank capable of providing the required makeup capability. Water would then be available to keep the core flooded.

The requirement in Specification 3.4.A.4.e(1) to maintain at least one recirculation loop discharge valve and its associated suction valve in the full open position assures that an adequate flow path exists from the annular space, between the pressure vessel wall and the core shroud, to the core region.

The relief valves of the automatic depressurization system enable the core spray system to provide protection against the small break in the event the feedwater system is not active.

The containment spray system is provided to remove heat energy from the containment in the event of a loss-of-coolant accident. Actuation of the containment spray system in accordance with plant emergency operating procedures ensures that containment and torus pressure and temperature conditions are within the design basis for containment integrity, EQ, and core spray NPSH requirements. The flow from one pump in either loop is more than ample to provide the required heat removal capability (2). The emergency service water system provides cooling to the containment spray heat exchangers and, therefore, is required to provide the ultimate heat sink for the energy release in the event of a loss-of-coolant accident. The emergency service water pumping requirements are those which correspond to containment cooling heat exchanger performance implicit in the containment cooling description. Since the loss-of-coolant accident while in the cold shutdown condition would not require containment spray, the system may be deactivated to permit integrated leak rate testing of the primary containment while the reactor is in the cold shutdown condition.

The core spray main pump compartments and containment spray pump compartments were provided with water-tight doors(4). Specification 3.4.E ensures that the doors are in place to perform their intended function.

Similarly, since a loss-of-coolant accident when primary containment integrity is not required would not result in pressure build-up in the drywell or torus, the containment spray system may be made inoperable under these conditions.

References

1. NEDC-31462P, "Oyster Creek Nuclear Generating Station SAFER/CORECOOL/GESTR-LOCA Loss-of-Coolant Accident Analysis," August 1987.
2. Licensing Application, Amendment 32, Question 3
3. (Deleted)
4. Licensing Application, Amendment 18, Question 4
5. GPUN Topical Report 053, "Thermal Limits with One Core Spray Sparger" December 1988.
6. NEDE-30010A, "Performance Evaluation of the Oyster Creek Core Spray Sparger", January 1984.
7. Letter and enclosed Safety Evaluation, Walter A. Paulson (NRC) to P. B. Fiedler (GPUN), July 20, 1984.
8. APED-5736, "Guidelines for Determining Safe Test Intervals and Repair Times for Engineered Safeguards", April 1969.

2. Maintenance and repair, including draining of the suppression pool, may be performed provided that the following conditions are satisfied:
- a. The reactor mode switch is locked in the refuel or shutdown position.
 - b.
 - (1) There is an OPERABLE flow path capable of taking suction from the condensate storage tank and transferring water to the reactor vessel, and
 - (2) The fire protection system is OPERABLE to the extent that one diesel driven fire pump is capable of providing water to the core spray system, and
 - (3) These systems are verified to be OPERABLE on a weekly basis.
 - c. The reactor coolant system is maintained at less than 212°F and vented.
 - d. At least one core spray pump, and system components necessary to deliver rated core spray flow to the reactor vessel, must remain OPERABLE to the extent that the pump and any necessary valves can be started or operated from the control room or from local control stations, and the torus is mechanically intact. Verify the pump and components are operable, as described, on a weekly basis.
 - e.
 - (1) No work shall be performed on the reactor or its connected systems which could result in lowering the reactor water level to less than 4'8" above the TOP OF the ACTIVE FUEL and there is a minimum of 360,000 gallons of water available between the torus and condensate storage tank water inventories. At least two redundant core spray systems including core spray pumps and system components must remain operable as defined in d. above. At least one recirculation loop discharge valve and its associated suction valve shall be in the full open position. Verify the pumps and components are operable, as described, on a weekly basis.

or

- (2) The reactor vessel head, fuel pool gate, and separator-dryer pool gates are removed and the water level is above elevation 117 feet. When filling or draining the reactor cavity, a sufficient water inventory (between the condensate storage tank and the reactor cavity) to complete the flooding operation shall be maintained. The 360,000 gallons of water minimum requirement in (1) above does not apply during the filling and draining operation provided there is a sufficient amount of water to complete the flooding operation.