15.3.3 EMERGENCY CORE COOLING SYSTEM, AUXILIARY COOLING SYSTEMS, AIR RECIRCULATION FAN COOLERS, AND CONTAINMENT SPRAY

Applicability:

Applies to the operating status of the Emergency Core Cooling System, Auxiliary Cooling Systems, Air Recirculation Fan Coolers, and Containment Spray.

Objective:

To define those limiting conditions for operation that are necessary: (1) to remove decay heat from the core in emergency or normal shutdown situations, (2) to remove heat from containment in normal operating and emergency situations, and (3) to remove airborne iodine from the containment atmosphere following a postulated Design Basis Accident.

Specification:

A. Safety Injection and Residual Heat Removal Systems

1. A reactor shall not be made critical, except for low temperature physics tests, unless the following conditions associated with that reactor are met:

    a. The refueling water tank contains not less than 275,000 gal. of water with a boron concentration of at least 2000 ppm.

    b. Each accumulator is pressurized to at least 700 psig and contains at least 1100 ft^3 but no more than 1136 ft^3 of water with a boron concentration of at least 2000 ppm. Neither accumulator may be isolated.

    c. Two safety injection pumps are operable.

    d. Two residual heat removal pumps are operable.

    e. Two residual heat exchangers are operable.

f. The isolation valves in the discharge header of the high head safety injection system are in the open position.

g. All valves, interlocks, and piping associated with the above components and required to function during accident conditions are operable.

h. During conditions of operation with reactor coolant system pressure in excess of 1,000 psig, the source of AC power shall be removed from the accumulator isolation valves MOV-841A and B at the motor control center and the valves shall be open.

i. Power may be restored to MOV-841A and B for the purpose of valve testing or maintenance providing the testing and maintenance is completed and power is removed within four hours.

2. During power operation, the requirements of 15.3.3.A.1, Items b and c, may be modified to allow one of each of the following components to be inoperable at any one time. If the system is not restored to meet the requirements of 15.3.3.A.1 within the time period specified, the reactor shall be placed in the hot shutdown condition within six hours and in cold shutdown within 36 hours. ~~If the requirements of 15.3.3.A.1 are not satisfied within an additional 48 hours, the reactor shall be placed in the cold shutdown condition.~~

a. One accumulator may be isolated to perform a check valve leakage test or be otherwise inoperable for a period of up to one hour. Before isolating an accumulator, the other accumulator isolation valve shall be checked open.

b. One safety injection pump may be out of service, provided the pump is restored to operable status within ~~24~~ 72 hours. The other safety injection pump shall be operable.

c. Any valve in these systems required to function during accident conditions may be inoperable provided repairs are completed within ~~24~~ 72 hours. Prior to initiating repairs, all valves in the system that provide the duplicate function shall be operable.

3. During power operation, the requirements of 15.3.3.A.1, Items d and e, may be modified to allow one of each of the following components to be inoperable at any one time. If the component is not restored to meet

the requirements of 15.3.3.A.1 within the time specified, the reactor shall be placed in the hot shutdown condition within six hours. ~~If the requirements of 15.3.3.A.1 are not satisfied within an additional 48 hours, the~~ reactor shall be maintained in a condition with reactor coolant temperatures between 500 and 350°F, unless one residual heat removal loop is being relied upon to provide redundancy for decay heat removal. In this case the reactor shall be maintained between 350°F and 140°F.

a. One residual heat removal pump may be out of service, provided the pump is restored to operable status within ~~24~~ 72 hours. The other residual heat removal pump shall be operable.

b. One residual heat exchanger may be out of service for a period of no more than ~~48~~ 72 hours.

c. Any valve in the system, required to function during accident conditions, may be inoperable provided repairs are completed within ~~24~~ 72 hours. Prior to initiating repairs, all valves in the system that provide the duplicate function shall be operable.

B. Containment Cooling and Iodine Removal Systems

1. A reactor shall not be made critical, except for low temperature physics tests, unless the following conditions associated with that reactor are met:

   a. The spray additive tank contains not less than 2675 gal. of solution with a sodium hydroxide concentration of not less than 30% by weight.

   b. Two containment spray pumps are operable.

   c. Four accident fan-cooler units are operable.

   d. All valves and piping, associated with the above components and required to function during accident conditions, are operable.

2. During power operation, the requirements of 15.3.3.B-1 may be modified to allow any one of the following components to be inoperable at any one time. If the system is not restored to meet the requirements of 15.3.3.B-1 within the time period specified, the reactor shall be placed in the hot shutdown condition within six hours and in cold shutdown within 36 hours. ~~If the requirements of 15.3.3.B-1 are not satisfied within an additional 48 hours, the reactor shall be placed in the cold shutdown condition.~~

   a. One accident fan cooler may be out of service provided that cooler is returned to operable status within 48 hours. The other accident fan coolers shall be operable before initiating maintenance on the inoperable accident fan cooler.

b. One containment spray pump may be out of service provided the pump is restored to operable status within ~~48~~ 72 hours. The remaining containment spray pump shall be operable before initiating maintenance on the inoperable pump.

c. Any valve required for the functioning of the system during accident conditions may be inoperable provided repairs are completed within ~~24~~ 72 hours. Prior to initiating repairs, all valves in the system that provide the duplicate function shall be operable. ~~(Exception: If a spray pump is removed from service per b above, valves associated with that train may be removed from service for the period specified for the pump.)~~

C. <u>Component Cooling System</u>

<u>Single Unit Operation</u>

1. One reactor shall not be made critical unless the following conditions are met:

   a. The two component cooling pumps assigned to that unit are operable.

   b. Either the component cooling heat exchanger associated with the unit together with one of the shared spare heat exchangers are operable or the two shared spare heat exchangers are operable.

   c. All valves, interlocks and piping associated with the above components, and required for the functioning of the system during accident condition, are operable.

2. During power operation, the requirements of 15.3.3.C-1 may be modified to allow one of each of the following conditions at any one time. If the system is not restored to meet the conditions of 15.3.3.C-1 within the time period specified, the reactor shall be placed in the hot shutdown condition. If the requirements of 15.3.3.C-1 are not

satisfied within an additional 48 hours, the reactor shall be placed in the cold shutdown condition.

a. One of the assigned component cooling pumps may be out of service provided a pump is restored to operable status within 24 hours.

b. Two heat exchangers which may be aligned to the operating unit may be out of service provided repairs can be completed within 48 hours.

Two Unit Operation

1. Both reactors shall not be made critical unless the following conditions are met:

   a. Three component cooling pumps are operable.

   b. Three component cooling heat exchangers are operable.

   c. All valves, interlocks and piping required for the functioning of the system during accident conditions and associated with the above components are operable.

2. During power operation, the requirements of 15.3.3.C-1 may be modified to allow one of the following conditions at any one time. If the system is not restored to meet the conditions of 15.3.3.C-1 within the time period specified, one reactor shall be placed in the hot shutdown condition. If the requirements of 15.3.3.C-1 are not satisfied within an additional 48 hours, the reactor shall be placed in the cold shutdown condition.

   a. One of the three assigned component cooling pumps may be out of service provided a pump is restored to operable status within 24 hours.

   b. Two heat exchangers may be out of service provided repairs can be completed within 48 hours.

D. Service Water System

1. Neither reactor shall be made or maintained critical unless the following conditions are met:

a. Four service water pumps are operable, two from each train.

b. All necessary valves, interlocks and piping required for the functioning of the Service Water System during accident conditions are also operable.

2. During power operation, the requirements of 15.3.3.D-1 may be modified to allow one of the following components to be inoperable at any one time. If the system is not restored to meet the conditions of 15.3.3.D-1 within the time period specified, both reactors will be placed in the hot shutdown condition within six hours and in cold shutdown within 36 hours. ~~If the requirements of 15.3.3.D-1 are not satisfied within an additional 48 hours, both reactors shall be placed in the cold shutdown condition.~~

   a. One of the four required service water pumps may be out of service provided a pump is restored to operable status within 24 hours.

   b. One of the two loop headers may be out of service for a period of 24 hours.

   c. A valve or other passive component may be out of service provided repairs can be completed within 48 hours.

Basis

The normal procedure for starting the reactor is, first, to heat the reactor coolant to near operating temperature, by running the reactor coolant pumps. The reactor is then made critical by withdrawing control rods and/or diluting boron in the coolant.[1] With this mode of start-up, the energy stored in the reactor coolant during the approach to criticality is substantially equal to that during power operation and therefore to be conservative most engineered safety system components and auxiliary cooling systems, shall be fully operable. During low temperature physics tests there is a negligible amount of stored energy in the reactor coolant, therefore an accident comparable in severity to the Design Basis Accident is not possible, and the engineered safety systems are not required.

The operable status of the various systems and components is to be demonstrated by periodic tests, defined by Specification 15.4.5. A large fraction of these tests will be performed while the reactor is operating in the power range. If a component is found to be inoperable it will be possible in most cases to effect repairs and restore the system to full operability within a relatively short time. For a single component to be inoperable does not negate the ability of the system to perform its function, but it reduces the redundancy provided in the reactor design and thereby limits the ability to tolerate additional equipment failures. If it develops that (a) the inoperable component is not repaired within the specified allowable time period or (b) a second component in the same or related system is found to be inoperable, the reactor will initially be put in the hot shutdown condition to provide for reduction of the decay heat from the fuel, and consequent reduction of cooling requirements after a postulated loss-of-coolant accident. This will also permit improved access for repairs in some cases. After a limited time in hot shutdown, if the malfunction(s) are not corrected, the reactor will be placed in the cold shutdown condition, utilizing normal shutdown and cooldown procedures. For example, specification 15.3.3.A.2.a allows one accumulator to be isolated or otherwise inoperable for periods of up to one hour. An inoperable accumulator may be defined as one with its outlet MOV shut, no pressure instrumentation operable, or water and/or nitrogen spaces cross-connected with the accumulator on the other loop. If the inoperable accumulator is not restored within one hour then the conditions of specification 15.3.0.A and 15.3.0.B apply which requires the affected unit, if critical, to be in hot shutdown within three hours and in cold shutdown within 48 hours if the condition is not corrected. In the cold shutdown condition there is no possibility of an accident that would release fission products or damage the fuel elements.

The specified repair times do not apply to regularly scheduled maintenance of the engineered safety systems, which is normally to be performed during refueling shutdowns. The limiting times to repair are based on:

1) Assuring with high reliability that the safety system will function properly if required to do so.

2) Allowances of sufficient time to effect repairs using safe and proper procedures.

Assuming the reactor has been operating at full rated power for at least 100 days, the magnitude of the decay heat decreases as follows after initiating hot shutdown.*

Time After Shutdown	Decay Heat % of Rated Power
1 min.	3.6
30 min.	1.55
1 hour	1.25
8 hours	0.7
48 hours	0.4

*Based on ANS 5.1-1979, "Decay Heat Power in Light-Water Reactors"

Thus, the requirement for core cooling in case of a postulated loss-of-coolant accident while in the hot shutdown condition is significantly reduced below the requirements for a postulated loss-of-coolant accident during power operation. Putting the reactor in the hot shutdown condition significantly reduces the potential consequences of a loss-of-coolant accident, and also allows more free access to some of the engineered safety system components in order to effect repairs.

~~Failure to complete safety injection system repairs within 48 hours of going to the hot shutdown condition is considered indicative of a requirement for major maintenance and, therefore, in such a case, the reactor is to be put into the cold shutdown condition.~~ When the failures involve the residual heat removal system, in order to insure redundant means of decay heat removal, the reactor system may remain in a condition with reactor coolant temperatures between 500 and 350°F so that the reactor coolant loops and associated steam generators may be utilized for redundant decay heat removal. However, when the remaining RHR loop must be relied upon for redundant decay heat removal capability, reactor coolant temperatures shall be maintained between 350°F and 140°F.

With respect to the core cooling function, there is some functional redundancy for certain ranges of break sizes.[2]

The operability of the Refueling Water Storage Tank (RWST) as part of the ECCS ensures that a sufficient supply of borated water is available for injection by the ECCS in the event of either a LOCA or a steamline break. The limits on RWST

minimum volume and boron concentration ensure that: (1) sufficient water is available within containment to permit recirculation cooling flow to the core; (2) the reactor will remain subcritical in the cold condition (68 to 212 degrees F) following a small break LOCA assuming complete mixing of the RWST, RCS, spray additive tank, containment spray system piping and ECCS water volumes with all control rods inserted except the most reactive control rod assembly (ARI-1); (3) the reactor will remain subcritical in the cold condition following a large break LOCA (break flow area greater than 3 ft^2) assuming complete mixing of the RWST, RCS, ECCS water and other sources of water that may eventually reside in the sump post-LOCA with all control rods assumed to be out (ARO); and (4) long term subcriticality is maintained following a steamline break assuming ARI-1 and fuel failure is precluded.

The containment cooling function is provided by two independent systems: (a) fan coolers and (b) containment spray which, with sodium hydroxide addition, provides the iodine removal function. During normal power operation, only three of the four fan coolers are required to remove heat lost from equipment and piping within the containment.[3] In the event of a Design Basis Accident, any one of the following combinations will provide sufficient cooling to reduce containment pressure: (1) four fan coolers, (2) two containment spray pumps, (3) two fan coolers plus one containment spray pump.[4] Sodium hydroxide addition via one spray pump reduces airborne iodine activity sufficiently to limit off-site doses to acceptable values. One of the four fan coolers is permitted to be inoperable for up to 48 hours during power operation.

Specification 15.3.3.B.2.c requires valves that provide the duplicate function be operable prior to initiating repairs on an inoperable valve. For the specific case of the containment spray pump discharge (SI-860) valves, SI-860A and SI-860D provide duplicate functions. Valves SI-860B and SI-860C are not required for system operability. Hence, prior to removing valve SI-860A from service, valve SI-860D must be operable and vice versa.

The component cooling system is different from the other systems discussed above in that the components are so located in the Auxiliary Building as to be accessible for repair after a loss-of-coolant accident. The component cooling water pump together with one component cooling heat exchanger can accommodate the heat removal load on one unit either following a loss-of-coolant accident, or during normal plant shutdown. If during the post-accident phase the component cooling water supply is lost, core and containment cooling could be maintained until repairs were effected.[5]

A total of six service water pumps are installed, only ~~three~~ two of which are required to operate during the injection and recirculation phases of a postulated loss-of-coolant accident,[6] in one unit together with a hot shutdown or normal operation condition in the other unit. For either reactor to be critical, four service water pumps must be operable. Two of the pumps must be powered from the 'A' train, and the other two must be powered from the 'B' train.

References

(1) FSAR Section 3.2.1

(2) FSAR Section 6.2

(3) FSAR Section 6.3.2

(4) FSAR Section 6.3

(5) FSAR Section 9.3.2

(6) FSAR Section 9.6.2