15.3.1 REACTOR COOLANT SYSTEM

Applicability

Applies to the operating status of the Reactor Coolant System.

Objective

To specify those limiting conditions for operation of the Reactor Coolant System which must be met to ensure safe reactor operation.

Specification

A. OPERATIONAL COMPONENTS

Specification:

1. Coolant Pumps
   a. At least one reactor coolant pump or the residual heat removal system shall be in operation when a reduction is made in the boron concentration of the reactor coolant.
   b. When the reactor is critical and above 1% of rated power except for natural circulation tests, at least one reactor coolant pump shall be in operation.
   c. (1) Reactor power shall not be maintained above 10% of rated power unless both reactor coolant pumps are in operation.
      (2) If either reactor coolant pump ceases operating, immediate power reduction shall be initiated under administrative control as necessary to reduce power to less than 10% of rated power.
2. Components Required For Redundant Decay Heat Removal Capability
   a. Reactor Coolant Temperature less than 350°F and greater than 140°F
      (1) At least two of the decay heat removal methods listed shall be operable.
         (a) Steam Generator A
         (b) Steam Generator B
         (c) Residual Heat Removal Loop (A)*
         (d) Residual Heat Removal Loop (B)*

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* Because of piping and valving provisions which permit the necessary flexibility, an operable residual heat removal loop could consist of the RHR pump from one loop coupled with the RHR heat exchanger from the other loop. Also, when less than 200°F, the normal or emergency power source may be inoperable or tied together.

(2) If the conditions of specification (1) above cannot be met, immediately initiate corrective action to return a second decay heat removal method to operable status as soon as possible.

(3) At least one of the above decay heat removal methods shall be in operation except when required to be secure for testing.

(4) If no decay heat removal method is in operation, corrective actions should be immediately initiated to return a decay heat removal method to operation.

b. Reactor Coolant Temperature Less Than 140°F.

(1) Both residual heat removal loops shall be operable except as permitted in Item (4) below.

(2) The provisions of Specification 15.3.8.A.4 must be met, that is, at least one residual heat removal loop* shall be in operation.

(3) With no residual heat removal loop in operation, suspend all operations involving an increase in the reactor decay heat load or a reduction in reactor coolant system boron concentration. Immediately initiate corrective actions to return a decay heat removal method to operation.

(4) One residual heat removal loop may be out of service when the reactor vessel head is removed and the refueling cavity flooded and no core alterations are being performed.

3. Pressurizer Safety Valves

a. At least one pressurizer safety valve shall be operable whenever the reactor head is on the vessel.

b. Both pressurizer safety valves shall be operable whenever the reactor is critical.

4. Pressurizer Power Operated Relief Valves (PORV) and PORV Block Valves

a. Two PROVs and their associated block valves shall be operable.

1. If a PORV is inoperable, the PORV shall be restored to an operable condition within one hour or the associated block valve shall be closed.

2. If a PORV block valve is inoperable, the block valve shall be restored to an operable condition within one hour or

the block valve shall be closed with power removed from the block valve, otherwise the unit shall be shut down and in hot standby within the next six hours.

5. The pressurizer shall be operable with at least 100 KW of pressurizer heaters available and a water level greater than 10% and less than 95% during steady-state power operation. At least one bank of pressurizer heaters shall be supplied by an emergency bus power supply.

Basis:

When the boron concentration of the reactor coolant system is to be reduced, the process must be uniform to prevent sudden reactivity changes in the reactor. Mixing of the reactor coolant will be sufficient to maintain a uniform boron concentration if at least one reactor coolant pump or one residual heat removal pump is running while the change is taking place. The residual heat removal pump will circulate the primary system volume in approximately one half hour. The pressurizer is of little concern because of the lower pressurizer volume and because pressurizer boron concentration normally will be higher than that of the rest of the reactor coolant.

Specification 15.3.1.A.1 requires that a sufficient number of reactor coolant pumps be operating to provide core cooling. The flow provided in each case will keep DNBR well above 1.30 as discussed in FFDSAR Section 14.1.9. Therefore, cladding damage and release of fission products to the reactor coolant will not occur. Heat transfer analyses[1] show that reactor heat equivalent to 10% of rated power can be removed with natural circulation only; hence, the specified upper limit of 1% rated power without operating pumps provides a substantial safety factor.

Item 15.3.1.A.1.c.(2) permits an orderly reduction in power if a reactor coolant pump is lost during operation between 10% and 50% of rated power. Above 50% power, an automatic reactor trip will occur if either pump is lost. The power-to-flow ratio will be maintained equal to or less than 1.0, which ensures that the minimum DNB ratio increases at lower flow since the maximum enthalpy rise does not increase above its normal full-flow maximum value.[2]

Specification 15.3.1.A.2 provides limiting conditions for operation to ensure that redundancy in decay heat removal capability is provided. A single reactor coolant loop with its associated steam generator or a single residual heat removal loop provides sufficient heat removal capacity for removing the reactor core decay heat; however, single failure considerations require that at least two decay heat removal methods be available. Operability of a steam generator for decay heat removal includes two sources of secondary water, water level indication in the steam generator, a vent path to atmosphere, and the primary side filled and vented so thermal convection cooling of the core is possible. If the steam generators are not available for decay heat removal, this specification requires both residual heat removal loops to be operable unless the reactor system is in the refueling shutdown condition with the refueling cavity flooded and no core alterations in progress. In this condition, the reactor vessel is essentially a fuel storage pool and removing an RHR loop from service for maintenance provides conservative conditions should operability problems develop in the other RHR loop.

Each of the pressurizer safety valves is designed to relieve 288,000 lbs. per hour of saturated steam at set point. If no residual heat is removed by any of the means available, the amount of steam which could be generated at safety valve relief pressure would be less than half the valves' capacity. One valve, therefore, provides adequate defense against overpressurization. Below 350°F and 400 psig in the reactor coolant system, the residual heat removal system can remove decay heat and thereby control system temperature and pressure.

Reference

(1) FSAR Section 14.1.6

(2) FSAR Section 7.2.3

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 1000 psig, the source of AC power shall be removed from the accumulator isolation valves MOV-841 A & B at the motor control center and the valves shall be open.

i. Power may be restored to MOV-841 A & B for the purpose of valve testing or maintenance providing the testing and maintenance is completed and power is removed within 4 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. 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 for a period of up to one hour to permit a check valve leakage test.

   b. One safety injection pump may be out of service, provided the pump is restored to operable status within 24 hours. The other safety injection pump shall be tested to demonstrate operability prior to initiating repair of the inoperable pump.

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

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. 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.

a. One residual heat removal pump may be out of service, provided the pump is restored to operable status within 24 hours. The other residual heat removal pump shall be tested to demonstrate operability prior to initiating repair of the inoperable pump.

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

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

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.	4.5
30 min.	2.0
1 hour	1.62
8 hours	0.96
48 hours	0.62

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. However, when the failures involve the residual heat removal system, in order to insure redundant means of decay heat removal, the reactor system should 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.

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

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 in operable when the reactor is made critical and during power operation.

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. One 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 postaccident phase the component cooling water supply is lost, core and containment cooling could be maintained until repairs were affected.[5]

A total of six service water pumps are installed, only three 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 condition in the other unit.

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

15.3.8 REFUELING AND SPENT FUEL ASSEMBLY STORAGE

Applicability

Applies to operating limitations during refueling operations and to operating limitations concerning the movement of heavy loads over or into the spent fuel storage pools.

Objective

To ensure that no incident could occur during refueling operations or during auxiliary building crane operations that would affect public health and safety.

Specifications

A. During refueling operations.

1. The equipment hatch shall be closed and the personnel locks shall be capable of being closed. A temporary third door on the outside of the personnel lock shall be in place whenever both doors in a personnel lock are open (except for initial core loading).
2. Radiation levels in fuel handling areas, the containment, and spent fuel storage pool shall be monitored continuously.
3. Core subcritical neutron flux shall be continuously monitored by at least two neutron monitors, each with continuous visual indication in the control room and one with audible indication in the containment available whenever core geometry is being changed. When core geometry is not being changed at least one neutron flux monitor shall be in service.
4. At least one residual heat removal loop shall be in operation. However, if refueling operations are affected by the residual heat removal loop flow, the operating residual heat removal loop may be removed from operation for up to one hour per eight hour period.
5. During reactor vessel head removal and while loading and unloading fuel from the reactor, a minimum boron concentration of 1800 ppm shall be maintained in the primary coolant system.