ENCLOSURE 2

PROPOSED

BRANCH TECHNICAL POSITION RSB 5-1

DESIGN REQUIREMENTS OF THE RESIDUAL HEAT REMOVAL SYSTEM

BACKGROUND

GDC 19 states that "A control room shall be provided from which actions can be taken to operate the nuclear power unit under normal conditions...."

Normal operating conditions include the shutting down of a reactor; therefore, since the residual heat removal (RHR) system is one of several systems involved in the normal shutdown of all reactors, this system must be operable from the control room.

GDC 34 states that "Suitable redundancy...shall be provided to assure that for onsite electrical power system operation (assuming offsite power is not available) and for offsite electrical power system operation (assuming onsite power is not available), the system safety function can be accomplished, assuming a single failure."

In all current plant designs the RHR system has a lower design pressure than the reactor coolant system (RCS). In most current designs it is located outside of containment and is part of the emergency core cooling system (ECCS). However, it is possible for the RHR system to have different design characteristics. For example, the RHR system might have the same design pressure as the RCS, or be located inside of containment. This position sets forth the staff requirements for the design of RHR systems, considering both current designs and certain other possible designs. The functional, isolation, pressure relief, pump protection, and test requirements for the RHR system are included in this position.

DEFINITIONS

To establish the RHR system design requirements, three RHR system designs are defined as listed below:

A. Type 1 RHR System

To qualify as a Type 1 system, the RHR system must satisfy all of the following requirements.

1. The RHR system design pressure is equal to or greater than the RCS design pressure and the design satisfies all other mechanical and structural requirements applicable to the RCS,

2. The RHR system is located entirely inside of the primary containment, and

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3. Any postulated loss of coolant accident (LOCA) resulting from failure of the RHR system shall not reduce ECCS capability to a point where the ECCS cannot mitigate the consequences of the postulated RHR system LOCA, despite any postulated single failure.

B. Type 2 RHR System

To qualify as a Type 2 system, the RHR system must satisfy all of the following requirements.

1. The RHR system is located entirely inside of the primary containment,

2. Overpressurization of the RHR system shall not cause consequential failure of any connecting systems that are located outside of containment. That is, connecting systems located outside of containment must be designed such that in event that the RHR system fails because of overpressurization:

   a. The consequential failure of the connecting system will occur only in the portion of the system located within the containment, or

   b. The consequential failure of the connecting system will be isolatable so that reactor coolant will not be discharged outside of the containment, despite any postulated single failure of an active fluid system component or an active or passive electrical component.

3. Structural failure of the RHR system, or of any connecting systems located within containment, due to overpressurization of the RHR system shall not reduce ECCS capability to a point where the ECCS cannot mitigate the consequences of the postulated RHR system or connecting systems failure, despite any postulated single failure, and

4. Structural failure of the RHR system due to overpressurization shall not generate missiles that consequentially cause or induce any system or component failure that would increase the severity of the LOCA event or reduce the performance capability of any other engineered safety feature (e.g., containment spray system, ECCS, containment integrity).

C. Type 3 RHR System

Any RHR system that does not satisfy the requirements of a Type 1 or Type 2 system is defined as a Type 3 system.

BRANCH POSITION

A. Functional Requirements

The system or systems employed to remove residual heat over the entire range from normal reactor operating conditions to cold shutdown* conditions shall satisfy the functional requirements listed below. These requirements apply to all RHR systems, whether Type 1, 2, or 3:

1. The system(s) shall be capable of performing the function of transferring heat from the reactor to the environment using only safety grade systems. These systems shall satisfy the requirements of General Design Criteria 1 through 5.

2. The system(s) shall have suitable redundancy in components and features, and suitable interconnections, leak detection, and isolation capabilities to assure that for onsite electrical power system operation (assuming offsite power is not available) and for offsite electrical power system operation (assuming onsite power is not available) the system safety function can be accomplished, assuming a single failure.

3. The system(s) shall be capable of being operated from the control room with either only onsite or only offsite power available with an assumed single failure. In demonstrating that the system can perform its function assuming a single failure, limited operator action outside of the control room would be considered acceptable if suitably justified.

4. The system(s) shall be capable of bringing the reactor to a cold shutdown condition*, with only offsite or onsite power available, within a reasonable period of time following shutdown, assuming the most limiting single failure.

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*Cold shutdown is defined by the Standard Technical Specifications; that is, reactor subcritical and reactor coolant temperature no greater than 200°F.

B. RHR Isolation Requirements

The RHR system isolation requirements are listed below for the three types of RHR system designs that were previously defined:

1. Type 1 RHR System

a. There shall be two barriers between the RCS and and the low pressure service water system that provides cooling water to the RHR system heat exchangers. One of these barriers is provided by the boundary of the high pressure RHR system. The other barrier is to be provided by valves. An acceptable design would be a single, normally closed, power operated valve in the line that connects the RCS to the suction of the RHR pump and a single check valve in the line that connects the discharge of the RHR system to the RCS. The position of the power operated valve shall be indicated in the control room. An alarm shall be provided in the control room to alert the operator in the event the valve is left open when the reactor is at power.

b. Any other low pressure system that connects to a Type 1 RHR system shall be evaluated on a case by case basis.

2. Type 2 RHR System

a. Isolation of the suction side of the RHR system shall be provided by at least two power operated valves in series. The valve positions shall be indicated in the control room. Alarms in the control room shall be provided to alert the operator if either valve is open when the RCS pressure exceeds the RHR system design pressure. The valves shall have independent diverse interlocks to prevent the valves from being opened unless the RCS pressure is below the RHR system design pressure. Failure of a power supply shall not cause any valve to change position.

b. One of the following shall be provided on the discharge side of the RHR system to isolate it from the RCS.

(1) The valves, position indicators, and alarms described in item 2.a,

(2) One or more check valves in series with a normally closed power operated valve. The power operated valve position shall be indicated in the control room. If the RHR system discharge line is used for an ECCS function, the power operated valve is to be opened upon receipt of a safety injection signal once the reactor coolant pressure has decreased below the ECCS design pressure,

(3) Three check valves in series, or

(4) Two check valves in series, provided that there are design provisions to permit periodic testing of the check valves for leak tightness and the testing is performed at least annually.

3. Type 3 RHR System

a. The following shall be provided in the suction side of the RHR system to isolate it from the RCS.

(1) Isolation shall be provided by a least two power operated valves in series. The valve positions shall be indicated in the control room.

(2) The valves shall have independent diverse interlocks to prevent the valves from being opened unless the RCS pressure is below the RHR system design pressure. Failure of a power supply shall not cause any valve to change position.

(3) The valves shall have independent diverse interlocks to provide power actuation to automatically close each valve if the pressure in the RCS increases above the design pressure of the RHR system.

b. One of the following shall be provided on the discharge side of the RHR system to isolate it from the RCS.

(1) The valves, position indicators, and interlocks described in item 3.a.,

(2)-(4) Identical to items 2.b.(2)-(4).

C. Pressure Relief Requirements

The RHR system isolation requirements are listed below for the three types of RHR system designs that were previously defined.

1. Type 1 RHR System

The RHR system shall have pressure relief capacity in accordance with the ASME Boiler and Pressure Vessel code.

2. Type 2 and 3 RHR Systems

To protect the RHR system against accidental over-pressurization when it is in operation (not isolated from the RCS), pressure relief in the RHR system shall be provided with relieving capacity in accordance with the ASME Boiler and Pressure Vessel Code. The most limiting pressure transient resulting from a single equipment malfunction or operator error during the plant operating condition when the RHR system is not isolated from the RCS shall be considered when selecting the pressure relieving capacity of the RHR system. For example, during shutdown cooling in a PWR with no steam bubble in the pressurizer, inadvertent operation of an additional charging pump or inadvertent opening of an ECCS accumulator valve should be considered as design bases.

Fluid discharged through the RHR system pressure relief valves must be collected and contained such that a stuck open relief valve will not:

a. Result in flooding of any safety related equipment.

b. Reduce the capability of the ECCS below that needed to mitigate the consequences of a postulated LOCA.

c. Result in a non-isolatable situation in which the water provided to the RCS to maintain the core in a safe condition is discharged outside of the containment. (Type 3 system only.)

If interlocks are provided to automatically close the isolation valves when the RCS pressure exceeds the RHR design pressure, adequate relief capacity shall be provided during the time period while the valves are closing.

D. Pump Protection Requirements

The design of any RHR system which includes automatic closure of the isolation valves shall have design provisions to prevent damage to the RHR system pumps due to the loss of pump suction fluid.

E. Test Requirements

For Type 1, 2, and 3 systems, the isolation valve operability and interlock (Type 2 and 3 systems) circuits must be designed so as to permit on line testing when operating in the RHR mode. Testability shall meet the requirements of IEEE Standard 338 and Regulatory Guide 1.22. The preoperational and initial startup test programs shall meet the intent of Regulatory Guide 1.68.

DRAFT PROPOSED REVISION SRP 5.4.7

Marginal lines indicate revisions categorized as follows:

Notes to Revisions to SRP 5.4.7

1. Editorial change

2. SRP 5.4.7 covers only the detailed review performed by RSB. Therefore, the review responsibilities must be defined for the other branches so that the entire proposed position on residual heat removal is adequately covered.

3. The proposed technical position encompasses more than the RHR system. SRP 5.4.7 was revised to reflect this.

4. Some detailed review items were deleted from SRP 5.4.7 because they are treated in proposed Branch Technical Position RSB 5-1. Other items are added to reflect RSB 5-1, which is referenced.

5. The "Evaluation and Findings" section was subdivided into two separate writeups for PWR's and BWR's. This was done to reflect the differences in the RSB scope of review for these plants.