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(Formerly NUREG-75/087)

U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

6.2.1.1.A PWR DRY CONTAINMENTS, INCLUDING SUBATMOSPHERIC CONTAINMENTS

REVIEW RESPONSIBILITIES

Primary - Containment Systems Branch (CSB)

Secondary - None

I. AREAS OF REVIEW

For pressurized water reactor (PWR) plants with dry containments, the CSB review covers the following areas:

1. The temperature and pressure conditions in the containment due to a spectrum (including break size and location) of postulated loss-of-coolant accidents (i.e., reactor coolant system pipe breaks) and secondary system steam and feedwater line breaks.

2. The maximum expected external pressure to which the containment may be subjected.

3. The minimum containment pressure that is used in analyses of emergency core cooling system capability.

4. The effectiveness of static and active heat removal mechanisms.

5. The pressure conditions within subcompartments that act on system components and supports due to high energy line breaks.

6. The range and accuracy of instrumentation that is provided to monitor and record containment conditions during and following an accident.

CSB will coordinate the primary review responsibilities of other branches that interface with the CSB evaluation of the containment functional design. These interfaces include the following: The Instrumentation and Control Systems Branch (ICSB), under SRP Section 7.5, evaluates (1) the electrical design of the instrumentation provided to monitor and record containment conditions during and following an accident; and (2) the effectiveness of the administrative controls and the instrumentation and control provisions to prevent inadvertent operation of the containment heat removal systems or system trains. The Structural Engineering Branch (SEB), under SRP Section 3.8.3, evaluates the design adequacy of the containment and its internal structures. The Mechanical Engineering Branch (MEB), under SRP Section 3.9.3, evaluates the design adequacy of mechanical components and their supports. The Licensing Guidance Branch (LGB), under SRP Section 16.0, reviews proposed technical specifications at the operating license stage of review that pertains to the surveillance requirements for spring or weight loaded check valves used in subatmospheric containments and vacuum relief devices.

For those areas of review identified above as being reviewed as part of the primary review responsibility of other branches, the acceptance criteria necessary for the review and their methods of application are contained in the referenced SRP section of the corresponding primary branch.

II. ACCEPTANCE CRITERIA

CSB acceptance criteria are based on meeting the following regulations:

1. General Design Criterion (GDC) 16, as it relates to the reactor containment and associated systems being designed to assure that containment design conditions important to safety are not exceeded for as long as postulated accident conditions require. Since the primary reactor containment is the final barrier of the defense-in-depth concept to protect against the uncontrolled release of radioactivity to the environs, preserving containment integrity under the dynamic conditions imposed by postulated loss of coolant accidents is essential.

2. General Design Criterion 50, as it relates to the reactor containment structure and associated heat removal system(s) being designed so that the containment structure and its internal compartments can accommodate the calculated pressure and temperature conditions resulting from any loss-of-coolant accident without exceeding the design leakage rate and with sufficient margin.

3. General Design Criterion 38, as it relates to the containment heat removal system(s) function to rapidly reduce the containment pressure and temperature following any loss-of-coolant accident and maintain them at acceptably low levels.

4. General Design Criterion 13, as it relates to instrumentation and control, requires instrumentation be provided to monitor variables and systems over their anticipated ranges for normal operation and for accident conditions as appropriate to assure adequate safety.

5. General Design Criterion 64, as it relates to monitoring radioactivity releases, requires means be provided for monitoring the reactor containment atmosphere for radioactivity that may be released from normal operations and from postulated accidents.

Specific criterion or criteria that pertain to design and functional capability of PWR dry containment, including subatmospheric containments that are used to meet the relevant requirements of the regulations are as follows:

a. To satisfy the requirements of GDC 16 and 50 regarding sufficient design margin, for plants at the construction permit (CP) stage of review, the containment design pressure should provide at least a 10% margin above the accepted peak calculated containment pressure following a loss-of-coolant accident, or a steam or feedwater line break. For plants at the operating license (OL) stage of review, the peak calculated containment pressure following a loss-of-coolant accident, or a steam or feedwater line break, should be less than the containment design pressure. In general, the peak calculated containment pressure should be approximately the same as at the construction permit stage of review. However, revised or upgraded analytical models or minor changes in the as-built design of the plant may result in a decrease in the margin.

b. To satisfy the requirements of GDC 38 to rapidly reduce the containment pressure, the containment pressure should be reduced to less than 50% of the peak calculated pressure for the design basis loss-of-coolant accident within 24 hours after the postulated accident. If analysis shows that the calculated containment pressure may not be reduced to 50% of the peak calculated pressure within 24 hours, the Accident Evaluation Branch (AEB) should be notified.

c. To satisfy the requirement of GDC 38 to rapidly reduce the containment pressure, the containment pressure for subatmospheric containments should be reduced to below atmospheric pressure within one hour after the postulated accident, and the subatmospheric condition maintained for at least 30 days.

d. To satisfy the requirements of GDC 38 and 50 with respect to the containment heat removal capability and design margin, the loss-of-coolant accident analysis should be based on the assumption of loss of offsite power and the most severe single failure in the emergency power system (e.g., a diesel generator failure), the containment heat removal systems (e.g., a fan, pump, or valve failure), or the core cooling systems (e.g., a pump or valve failure). The selection made should result in the highest calculated containment pressure.

e. To satisfy the requirements of GDC 38 and 50 with respect to the containment heat removal capability and design margin, the containment response analysis for postulated secondary system pipe ruptures should be based on the most severe single active failure in the containment heat removal systems (e.g., a fan, pump, or valve failure) or the secondary system isolation provisions (e.g., a fan, pump, or valve failure) or the secondary system isolation provisions (e.g., main steam isolation valve failure or feedwater line isolation valve failure). The analysis should also be based on a spectrum of pipe break sizes and reactor power levels. The accident conditions selected should result in the highest calculated containment pressure or temperature depending on the purpose of the analysis. Acceptable methods for the calculation of the containment environmental response to main steam line break accidents are found in NUREG-0588 (Ref. 35).

f. To satisfy the requirements of GDC 38 and 50 with respect to the functional capability of the containment heat removal systems and containment structure under loss-of-coolant accident conditions, provisions should be made to protect the containment structure against possible damage from external pressure conditions that may result, for example, from inadvertent operation of containment heat removal systems. The provisions made should include conservative structural design to assure that the containment structure is capable of withstanding the maximum expected external pressure; or interlocks in the plant protection system and administrative controls to preclude inadvertent operation of the systems. If the containment is designed to withstand the maximum expected external pressure, the external design pressure of the containment should provide an adequate margin above the maximum expected external pressure to account for uncertainties in the analysis of the postulated event.

g. In accordance with the requirements of GDC 13 and 64, instrumentation capable of operating in the post-accident environment should be provided to monitor the containment atmosphere pressure and temperature and the sump water level and temperature following an accident. The instrumentation should have adequate range, accuracy, and response to assure that the above parameters can be tracked and recorded throughout the course of an accident. Item II.F.1 of NUREG-0737 and NUREG-0718, and Regulatory Guide 1.97, "Instrumentation For Light Water Cooled Nuclear Power Plants to Assess Plant Conditions During and Following An Accident," should be followed.

h. The minimum calculated containment pressure should not be less than that used in the analysis of the emergency core cooling system capability (See SRP Section 6.2.1.5, "Minimum Containment Pressure Analysis for Emergency Core Cooling System Performance Capability Studies").

i. Containment internal structures and system components (e.g., reactor vessel, pressurizer, steam generators) and supports should be designed to withstand the differential pressure loadings that may be imposed as a result of pipe breaks within the containment subcompartments (See SRP Section 6.2.1.2, "Subcompartment Analysis").

III. REVIEW PROCEDURES

The following procedures are for the review of PWR dry containments. The reviewer selects and emphasizes material from these procedures as may be appropriate for a particular case. Portions of the review may be carried out on a generic basis for aspects of functional design common to a class of dry containments or by adopting the results of previous reviews of plants with essentially the same containment functional design.

Upon request from the primary reviewer, the coordinated review branches will provide input for the areas of review stated in subsection I of this SRP section. The primary reviewer obtains and uses such input as required to assure that this review procedure is complete.

The CSB reviews the containment response analyses to determine the acceptability of the calculated containment design pressure and temperature, and in addition, the containment depressurization time. The AEB must be notified if the containment depressurization time does not meet the acceptance criterion. The CSB reviews the assumptions made in the analyses to maximize the calculated containment pressure and temperature. The CSB determines the conservatism of the respective containment response analyses by comparing the analytical models, and the assumptions made, with the acceptance criteria in subsection II of this SRP section and by performing appropriate confirmatory analyses. It is not necessary to perform accident pressure calculations for every plant. The CSB will ascertain, however, that the adequacy of the applicant's calculational model has been demonstrated. The CSB determines that the applicant has identified the pipe break(s) resulting in the highest containment pressure and temperature. Hot leg, cold leg (pump suction), and cold leg (pump discharge) pipe breaks of the reactor coolant system, and secondary system steam and feedwater line breaks, should be analyzed by the applicant. The CSB reviews the assumptions used to determine that the analyses are acceptably conservative.

The CSB performs confirmatory containment response analyses when necessary using the CONTEMPT-LT computer code (References 6 and 7). The purpose of these analyses is to confirm the applicant's predictions of the response of the containment to loss-of-coolant accidents and main steam and feedwater line breaks. In general, only the limiting pipe breaks, i.e., the pipe breaks which establish the containment design pressure and containment depressurization time, are analyzed. However, if in the judgment of the CSB the worst break has not been identified, other pipe breaks will be analyzed.

The CSB reviews analyses of the external pressure of the containment structure caused by pressure and temperature changes inside the containment due to inadvertent operation of containment heat removal systems. The CSB determines whether the most severe condition has been identified and whether the analysis was done in a conservative manner. If the primary containment is not designed to withstand the maximum external pressure, the CSB will evaluate the acceptability of the provisions made in the plant design to mitigate or withstand the consequences of the above postulated events, and will evaluate in conjunction with the ICSB, the administrative controls and instrumentation and control provisions to preclude these events.

The CSB reviews the accuracy and range of the instrumentation provided to monitor the post-accident environment. The ICSB, under SRP Section 7.5, and the EQB, under SRP Section 3.11, have review responsibility for the acceptability of, and the qualification test program for the sensing and actuation instrumentation of the plant protection system and the post-accident monitoring instrumentation and recording equipment.

IV. EVALUATION FINDINGS

The conclusions reached on completion of the review of this SRP section are presented in SRP Section 6.2.1.

V. IMPLEMENTATION

The following is intended to provide guidance to applicants and licensees regarding the NRC staff's plan for using this SRP section.

Except in those cases in which the applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the method described herein will be used by the staff in its evaluation of conformance with Commission regulations.

Implementation schedules for conformance to parts of the method discussed herein are contained in the referenced regulatory guides and NUREGs.

VI. REFERENCES

The references for this SRP section are listed in SRP Section 6.2.1.