U.S. NUCLEAR REGULATORY COMMISSION
STANDARD REVIEW PLAN
OFFICE OF NUCLEAR REACTOR REGULATION

SECTION 6.2.1.1.C PRESSURE-SUPPRESSION TYPE BWR CONTAINMENTS

REVIEW RESPONSIBILITIES

Primary - Containment Systems Branch (CSB)

Secondary - Core Performance Branch (CPB)
Mechanical Engineering Branch (MEB)
Electrical, Instrumentation and Control Systems Branch (EICSB)
Structural Engineering Branch (SEB)

I. AREAS OF REVIEW

For Mark I, II, and III pressure-suppression type boiling water reactor (BWR) plant containments, the CSB review covers the following areas:

1. The temperature and pressure conditions in the drywell and wetwell due to a spectrum (including break size and location) of postulated loss-of-coolant accidents.

2. The differential pressure across the operating deck of Mark II plants for a spectrum of loss-of-coolant accidents (including break size and location).

3. Suppression pool dynamic effects during a loss-of-coolant accident or following the actuation of one or more reactor coolant system pressure relief valves, including vent clearing, vent interactions, pool swell, pool stratification, and dynamic and asymmetrical loads on suppression pool and other containment structures.

4. The consequences of a loss-of-coolant accident occurring within the containment (wetwell); i.e., outside the drywell (Mark III containments only).

5. The capability of the containment to withstand the effects of steam bypassing the suppression pool.

6. The external pressure capability of the drywell and wetwell, and systems that may be provided to limit external pressures.

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

8. The instrumentation provided to monitor and record containment atmosphere pressure and temperature and pool water temperature under post-accident conditions.

9. The pressure conditions within subcompartments and acting on system components and supports due to high energy line breaks, e.g., the sacrificial shield structure.

10. The proposed technical specifications, at the operating license stage, pertaining to the surveillance requirements for steam bypass area and vacuum relief devices.

The CSB will also review analyses of anticipated transients without scram (ATWS) which discharge fluid to the containment to assure that containment pressure and temperature design conditions are not exceeded.

II. ACCEPTANCE CRITERIA

The following acceptance criteria apply to the design and functional capability of BWR pressure-suppression type containments:

1. For Mark I and II plants at the operating license stage of review, the peak calculated values of pressure and temperature for the drywell and wetwell should not exceed the respective design values. Also, the peak deck differential pressure for Mark II plants should not exceed the design value.

   For Mark III plants, the calculated results for drywell temperature, containment pressure, and differential pressure between the drywell and containment should be based on the General Electric Mark III analytical model (Ref. 30) that was used in the Grand Gulf analysis and evaluated by CSB. The use of this model at the construction permit stage is acceptable if, in the absence of complete large-scale Mark III test results, an appropriate margin (see below) between the calculated and design differential pressures is used. The Mark III analytical model will be verified by the large-scale Mark III test results prior to the operating license stage of review for a Mark III plant. If an analytical model other than the General Electric Mark III analytical model identified above is used, the model should be demonstrated to be physically appropriate and conservative to the extent that the General Electric model has been found acceptable. In addition, it will be necessary to demonstrate its performance with suitable test data in a manner similar to that described above.

   Additional analytical efforts are needed to further confirm the Mark III design. These matters were discussed in the ACRS letters issued on December 12, 1974, following its review of Perry and Allens Creek facilities. The areas of concern relate to vent clearing, vent interaction, pool swell, pool stratification, and dynamic and asymmetric loadings. These would also include an evaluation of oscillatory behavior.

   For Mark III plants at the construction permit stage, the containment design pressure should provide at least a 15% margin above the peak calculated containment pressure, and the drywell design differential pressure should provide at least a 30% margin above the peak calculated drywell differential pressure.

   For Mark III plants at the operating license stage, the peak calculated containment pressure and drywell differential pressure should be less than the design values. In general, it is expected that the peak calculated pressures will be about the same as at the construction permit stage. However, it is possible that the margins may be affected by revised or improved analytical models, test results, or minor changes in the as-built design of the plant.

2. Calculation of dynamic loads on suppression pool retaining structures and structures which may be located directly above the pool, as a result of pool motion during a loss-of-coolant accident or following actuation of one or more primary system pressure relief valves, should be based on appropriate analytical models and supported by applicable test data.

3. High energy lines passing through the containment should be provided with guard pipes or enclosed in other types of protective structures to assure that the suppression pool is not bypassed. If guard pipes are used, they should be designed in accordance with acceptance criteria established by the MEB as set forth in Standard Review Plan 3.6.2.

4. The allowable leakage areas for steam bypass of the suppression pool should be determined for a spectrum of postulated reactor coolant system pipe breaks. The maximum allowable bypass area of the plant should be based on conservative analyses which consider available energy removal mechanisms and the containment design pressure.

5. For Mark I and II containments, the maximum allowable leakage area for steam bypass of the suppression pool should be greater than the technical specification limit for leakage measured in periodic drywell-wetwell leakage tests. "Mark III containments should be designed to accommodate, for a spectrum of postulated reactor coolant system pipe breaks, without exceeding containment design pressure, a minimum bypass leakage area of the order of one square foot in terms of the parameter $A/\sqrt{k}$, where k is the resistance factor of the actual flow area, A." A leakage test of the drywell at about the design pressure should be performed prior to plant operation but as near to startup as feasible. The high pressure test will impose loads on the drywell which are a substantial fraction of the accident loads and will provide the necessary assurance that the drywell, as constructed, conforms to the design bases. Low pressure leakage tests of the drywell should be done periodically thereafter. The acceptance criterion for these tests should be that the measured leakage is less than the leakage corresponding to an equivalent 0.1 ft^2 leakage area (in terms of $A/\sqrt{k}$) at the test pressure. If the test conditions at a given pressure are representative of a substantial fraction of the loss-of-coolant accident loads, the acceptance criterion becomes 10% of the bypass capability at the given pressure. The determination of acceptable test conditions is made by the SEB. Testing methods and procedures should be described at the operating license stage of review.

6. For Mark III containments, justification should be provided for any reduction in the containment leak rate claimed for times less than 30 days after a postulated pipe break accident.

7. Provisions should be made in one of the following ways to protect the drywell and wetwell (or containment) of Mark I, II, and III plants, and the operating deck of Mark II plants, against loss of integrity from negative pressure transients or post-accident atmosphere cooldown:
   a. Structures should be designed to withstand the maximum calculated external pressure.

b. Vacuum relief devices should be provided in accordance with the requirements of the ASME Boiler and Pressure Vessel Code, Section III, Subsection NE, to assure that the design external pressures of the structures are not exceeded.

In either case, the design external pressures of the structures, including the design upward deck differential pressure for Mark II plants, should provide an adequate margin above the maximum calculated external pressures to account for uncertainties in the analyses.

8. Instrumentation capable of operating in the post-accident environment should be provided to monitor the drywell and wetwell (or containment) atmosphere pressure and temperature, and pool temperature following an accident. The instrumentation should have adequate range, accuracy, and response to assure that the above parameters can be tracked throughout the course of an accident. Recording equipment capable of following the transient should be provided.

III. REVIEW PROCEDURES

The procedures described below are followed for the review of BWR pressure-suppression 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 BWR pressure-suppression type containments or by adopting the results of previous reviews of plants with essentially the same containment functional design.

1. The CSB reviews the analyses of the drywell and wetwell temperature and pressure response for Mark I and II containments. The CSB performs confirmatory analyses, when necessary, using the CONTEMPT-LT computer code. Input data for the code, including mass and energy release data, is generally taken from the safety analysis report; however, the CSB is currently working in conjunction with the CPB to develop a staff model to calculate mass and energy releases.

The CSB normally analyzes only the design basis loss-of-coolant accident, which has been found from previous reviews to be the recirculation line break for Mark I and II plants. For Mark III plants, the steam line break has been determined to be the design basis loss-of-coolant accident. However, mass and energy releases from the recirculation line break will be evaluated using various flow correlations.

The CSB evaluates analyses of both the short-term and long-term pressure and temperature responses of Mark III containment plants. For Mark III plants, the peak containment pressure following a loss-of-coolant accident is independent of the postulated pipe break size. The CSB reviews the containment response analysis presented in the safety analysis report to determine that the acceptance criteria in Section II have been satisfied. The CSB evaluates the conservatism of the assumptions, analytical methods, and long-term energy sources used in the analysis. The CSB also reviews the short-term drywell pressure response of Mark III containments. The CSB verifies from

th safety analysis report that the mass and energy releases to the drywell during the period of interest (one second) are based on the acceptance criteria in Section II.

The CSB and its consultants have reviewed the General Electric Mark III analytical model and have determined that the code appears to calculate the drywell pressure response in an acceptable manner. The final acceptance of the code is predicated on its verification by the General Electric Mark III test program. Code modifications and improvements will be made as necessary as test data and other information becomes available.

The CSB verifies from the safety analysis report that the General Electric code has been utilized and that the input assumptions to the code are conservative. If analytical methods other than the General Electric model are used, the CSB, in conjunction with its consultants, will initiate a detailed review of the methods. In this case, the CSB reviews the proposed modeling, analytical methods and assumptions, correlation of results with applicable test data, and comparison with other similar analyses, to determine the acceptability of the proposed model.

The CSB reviews analyses of the drywell response to either a recirculation line rupture or a steam line rupture, as presented in the safety analysis report. The CSB determines from the results of these analyses that the "worst" break has been identified in establishing the drywell design differential pressure as well as the design pressure for subcompartments and equipment supports.

Modifications to the CONTEMP-LT computer code are being made which should provide the capability to perform confirmatory analyses of the Mark III drywell pressure response.

2. The CSB reviews analyses of the dynamic loads associated with suppression pool motion during loss-of-coolant accident or following actuation of one or more primary system pressure relief valves. The CSB evaluates the analytical methods, input assumptions, and results and determines the acceptability of the analyses by comparing the analytical results to applicable test data (e.g., from the General Electric large-scale Mark III tests).

3. For Mark III plants, the CSB verifies from the safety analysis report that high energy lines which pass through the containment outside the drywell are provided with guard pipes or enclosed in other types of protective structures. If guard pipes are used, the design must meet the acceptance criteria established in Standard Review Plan 3.6.2. For unguarded lines, the CSB reviews analyses of the consequences of postulated ruptures in these lines. The CSB bases its acceptance of the analyses on the conservatism of the methods and assumptions and on the margin provided to assure against exceeding the design pressure of the containment. If leakage detection and isolation equipment are provided, the CSB evaluates the effectiveness of the detection instrumentation and isolation devices to mitigate the consequences of a pipe rupture. The EICSB reviews the electrical design criteria for these systems.

4. The CSB evaluates analyses of bypass leakage capability. The CSB determines the adequacy of proposed bypass leakage tests and surveillance programs based on the results of previous reviews, operating experience at similar plants, and engineering judgment. At the operating license stage, CSB evaluates the proposed technical specifications pertaining to bypass leakage surveillance.

5. The CSB evaluates the conservatism of potential depressurization transients. If vacuum relief systems are provided, the CSB verifies from the safety analysis report that the design and operating characteristics of the system meet the requirements of Subsection NE of Section III of the ASME Boiler and Pressure Vessel Code. In evaluating surveillance and test programs for vacuum relief systems, the CSB uses the results of previous reviews and operating experience with similar systems to determine their adequacy. At the operating license stage, the CSB reviews the proposed technical specifications to assure that adequate surveillance and administrative control will be maintained over the vacuum relief devices.

6. The EICSB in Section 7.3 has review responsibility for the acceptability of and the qualification test program for the sensing and actuation instrumentation of the plant post-accident monitoring system.

IV. EVALUATION FINDINGS

The conclusions reached on completion of the review of this section are presented in Standard Review Plan 6.2.1.

V. REFERENCES

The references for this plan are those listed in Standard Review Plan 6.2.1, together with the following:

1a. Standard Review Plan 3.6.2, "Determination of Break Locations and Dynamic Effects Associated with the Postulated Rupture of Piping," and attached Branch Technical Position MEB 3-1, "Postulated Break and Leakage Locations in Fluid System Piping Outside Containment."

SRP 6.2.1.2