NUREG-75/087

U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

SECTION 6.2.1 CONTAINMENT FUNCTIONAL DESIGN

REVIEW RESPONSIBILITIES

Primary - Containment Systems Branch (CSB)

Secondary - See secondary review responsibilities of the seven SRP sections listed below for the various containment types and aspects.

INTRODUCTION

The CSB reviews information regarding the functional capability of the reactor containment presented in Section 6.2.1 of the applicant's safety analysis report (SAR). The containment encloses the reactor system and is the final barrier against the release of significant amounts of radioactive fission products in the event of an accident. The containment structure must be capable of withstanding, without loss of function, the pressure and temperature conditions resulting from postulated loss-of-coolant, steam line or feedwater line break accidents. The containment structure must also maintain functional integrity in the long term following a postulated accident; i.e., it must remain a low leakage barrier against the release of fission products for as long as postulated accident conditions require.

The design and sizing of containment systems are largely based on the pressure and temperature conditions which result from release of the reactor coolant in the event of a loss-of-coolant accident (LOCA). The containment design basis includes the effects of stored energy in the reactor coolant system, decay energy, and energy from other sources such as the secondary system, and metal-water reactions including the recombination of hydrogen and oxygen. The containment system is not required to be a complete and independent safeguard against a LOCA by itself, but functions to contain any fission products released while the emergency core cooling system cools the reactor core.

The evaluation of a containment functional design includes calculation of the various effects associated with the postulated rupture in the primary or secondary coolant system piping. The subsequent thermodynamic effects in the containment resulting from the release of the coolant mass and energy are determined from a solution of the incremental space and time-dependent energy, mass, and momentum equations. The basic functional design requirements for containment are given in General Design Criteria 16 and 50 in Appendix A to 10 CFR Part 50. General Design Criterion 50, among other things, requires that consideration be given to the potential consequences of degraded engineered safety features, such as the containment heat removal system and the emergency core cooling system, the limitations in defining accident phenomena, and the conservatism of calculational models and input parameters, in assessing containment design margins.

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There are a number of different containment types and designs, and several aspects of containment functional design that are within the scope of SAR Section 6.2.1. The various containment types and aspects to be reviewed under this SRP section have been separated and assigned to a set of other SRP sections as follows:

a. Pressurized water reactor (PWR) dry containments, including subatmospheric containments (SRP section 6.2.1.1.A).
b. Ice condenser containments (SRP section 6.2.1.1.B).
c. Mark I, II, and III boiling water reactor (BWR) pressure-suppression type containments (SRP section 6.2.1.1.C).
d. Subcompartment analysis (SRP section 6.2.1.2).
e. Mass and energy release analysis for postulated loss-of-coolant accidents (SRP section 6.2.1.3).
f. Mass and energy release analysis for postulated secondary system pipe ruptures (SRP section 6.2.1.4).
g. Minimum containment pressure analysis for emergency core cooling system (ECCS) performance capability studies (SRP section 6.2.1.5).

A separate SRP section has been prepared for each of these areas.

Areas related to the evaluation of the containment functional capability are treated in other SRP sections; e.g., containment heat removal (SRP section 6.2.2), combustible gas control (SRP section 6.2.5), and containment leakage testing (SRP section 6.2.6).

I. AREAS OF REVIEW

The items reviewed are described in the "Areas of Review" subsections of the seven SRP sections listed above.

II. ACCEPTANCE CRITERIA

The acceptance criteria are given in the "Acceptance Criteria" subsections of the seven SRP sections listed above.

III. REVIEW PROCEDURES

Review procedures are given in "Review Procedures" subsections of the seven SRP sections listed above.

IV. EVALUATION FINDINGS

The results of the reviews under the seven SRP sections listed above are consolidated into a single set of findings. The reviewer verifies that sufficient information has been provided and that his evaluation is adequate to support conclusions of the following type, to be included in the staff's safety evaluation report:

Containment Functional Design

The scope of review of the functional design of the containment for the _____ nuclear power plant has included a review of plant arrangement drawings, system drawings, and descriptive information for the containment building, subcompartments, and associated systems, components, and structures that are essential to the functional capability and integrity of the containment. The review has included the applicant's proposed design bases for the containment building and internal structures, and associated structures and systems upon which the containment function depends, and the applicant's analysis of postulated accidents and operational occurrences which support the adequacy of the design bases.

"The basis for the staff's acceptance has been conformance of designs and design bases for the containment building, internal structures, and associated systems, components, and structures to the Commission's regulations as set forth in the general design criteria, and to applicable regulatory guides, branch technical positions, and industry codes and standards. (Special problems or exceptions that the staff takes to the design or functional capability of containment structures, systems, and components should be discussed.)

"The staff concludes that the containment functional design conforms to applicable regulations, guides, staff positions, and industry standards, and is acceptable."

V. REFERENCES

1. 10 CFR Part 50, Appendix A, General Design Criterion 16, "Containment Design;" Criterion 39, "Inspection of Containment Heat Removal System;" Criterion 40, "Testing of Containment Heat Removal System;" Criterion 50, "Containment Design Basis;" Criterion 54, "Systems Penetrating Containment;" and Criterion 56, "Primary Containment Isolation."

2. 10 CFR §50.46, "Acceptance Criteria for Emergency Core Cooling Systems for Light Water Nuclear Power Reactors," and 10 CFR Part 50, Appendix K, "ECCS Evaluation Models."

3. ASME Boiler and Pressure Vessel Code, Section II, Division 1, Subsection NE, "Class MC Components," American Society of Mechanical Engineers.

4. Regulatory Guide 1.4, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss-of-Coolant Accident for Pressurized Water Reactors."

5. Regulatory Guide 1.26, "Quality Group Classifications and Standards."

6. Regulatory Guide 1.29, "Seismic Design Classifications and Standards."

7. C. F. Carmichael and S. A. Marks, "CONTEMPT-PS, A Digital Computer Code for Predicting the Pressure-Temperature History Within a Pressure-Suppression Containment Vessel in Response to a Loss-of-Coolant Accident," IDO-17252, Phillips Petroleum Company, April 1969.

8. L. C. Richardson, L. J. Finnegan, R. J. Wagner, and J. M. Waage, "CONTEMPT, A Computer Program for Predicting the Containment Pressure-Temperature Response to a Loss-of-Coolant Accident," IDO-17220, Phillips Petroleum Company, June 1967.

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9. R. J. Wagner and L. L. West, "CONTEMPT-LT Users Manual," Interim Report I-214-74-12.1, Aerojet Nuclear Company, August 1973.

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11. D. C. Slaughterbeck, "Comparison of Analytical Techniques Used to Determine Distribution of Mass and Energy in the Liquid and Vapor Regions of a PWR Containment Following a Loss-of-Coolant Accident," Special Interim Report, Idaho Nuclear Corporation, January 1970.

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13. D. C. Slaughterbeck, "Review of Heat Transfer Coefficients for Condensing Steam in a Containment Building Following a Loss-of-Coolant Accident," IN-1388, Idaho Nuclear Corporation, September 1970.

14. T. Tagami, "Interim Report on Safety Assessments and Facilities Establishment Project in Japan for Period Ending June 1965 (No. 1)," prepared for the National Reactor Testing Station, February 28, 1966 (unpublished work).

15. H. Uchida, A. Oyama, and Y. Toga, "Evaluation of Post-Incident Cooling Systems of Light-Water Power Reactors," Proc. Third International Conference on the Peaceful Uses of Atomic Energy, Volume 13. Session 3.9, United Nations, Geneva (1964).

16. "FLOOD/MOD002 - A Code to Determine the Core Reflood Rate for a PWR Plant with Two Core Vessel Outlet Legs and Four Core Vessel Inlet Legs," Interim Report, Aerojet Nuclear Company, November 2, 1972.

17. "FLOOD/MOD001 - A Code to Determine the Core Reflood Rate for a PWR Plant with Two Core Vessel Outlet Legs and Two Core Vessel Inlet Legs," Interim Report, Aerojet Nuclear Company, October 11, 1972.

18. "COMPARE: A Computer Program for the Transient Calculation of a System of Volumes Connected by Flowing Vents," LA-NUREG-6488-MS, September 1976.

19. P. A. Lowe, J. R. Brodrick, and W. E. Burchill, "Steam-Water Mixing Test Program Task D: Formal Report for Task A: 1/5 Scale Intact Loop," CENPD-65 (Rev.1), Combustion Engineering, Inc., March 1973.

20. J. R. Brodrick, W. E. Burchill, and P. A. Lowe, "1/5 Scale Intact Loop Post-LOCA Steam Relief Tests," CENPD-63 (Rev.1), Combustion Engineering, Inc., March 1973.

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29. "Mark III Analytical Investigation of Small-Scale Tests Progress Report," NEDM-10976, General Electric Company, August 1973.

30. "The General Electric Pressure Suppression Containment Analytical Model," NEDO-10320, General Electric Company, April 1971; Supplement 1, May 1971; Supplement 2, January 1973.

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