NUREG-75/087

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

SECTION 6.2.3 SECONDARY CONTAINMENT FUNCTIONAL DESIGN

REVIEW RESPONSIBILITIES

Primary - Containment Systems Branch (CSB)

Secondary - Accident Analysis Branch (AAB)

I. AREAS OF REVIEW

The CSB reviews the information in the applicant's safety analysis report (SAR) concerning the functional capability of the secondary containment system. The secondary containment system includes the outer containment structure of dual containment plants and the associated systems provided to mitigate the radiological consequences of postulated accidents. The secondary containment structure and supporting systems are provided to collect and process radioactive material that may leak from the primary containment following an accident. The supporting systems maintain a negative pressure within the secondary containment and process this leakage. Other plant areas contiguous to the secondary containment may also be served by these or similar systems.

The CSB review of the functional capability of the secondary containment system of dual containment designs includes the following points:

1. Analyses of the pressure and temperature response of the secondary containment to a loss-of-coolant accident within the primary containment.

2. Analyses of the effect of openings in the secondary containment on the capability of the depressurization and filtration system to accomplish its design objective of establishing a negative pressure in a prescribed time.

3. Analyses of the pressure and temperature response of the secondary containment to a high energy line rupture within the secondary containment.

4. The functional design criteria applied to guard pipes surrounding high energy lines within the secondary containment.

5. Analyses of any primary containment leakage paths that bypass the secondary containment.

6. The design provisions for periodic leakage testing of secondary containment bypass leakage paths.

7. The proposed technical specifications pertaining to the functional capability of the secondary containment system and the leakage testing of bypass leakage paths.

The AAB reviews the design requirements and the periodic inspection and operability test program for the depressurization and filtration systems, from the standpoint of assuring that the systems and system components are functionally capable of depressurizing the secondary containment. The fission product removal capability of the secondary containment supporting systems is reviewed by the AAB under Standard Review Plan 6.5.3.

II. ACCEPTANCE CRITERIA

1. Analyses of the pressure and temperature response of the secondary containment to a loss-of-coolant accident occurring in the primary containment should be based on the following guidelines:

   a. Both radiative and convective heat transfer from the primary containment structure to the secondary containment atmosphere should be considered.

   b. Adiabatic conditions should be assumed for the secondary containment structure, i.e., no heat transfer from the secondary containment structure to the environs should be assumed.

   c. The compressive effect of primary containment expansion on the secondary containment atmosphere should be considered.

   d. Secondary containment inleakage should be considered.

   e. No credit should be taken for secondary containment outleakage.

   f. Any delay in actuating the secondary containment depressurization and filtration system should be considered.

2. High energy lines passing through the secondary containment should be provided with guard pipes. Design criteria for guard pipes are given in Standard Review Plan 3.6.2. If guard pipes are not provided, analyses should be provided which demonstrate that the secondary containment structure is capable of withstanding the effects of a high energy pipe rupture occurring inside the secondary containment without loss of integrity.

3. The fraction of primary containment leakage bypassing the secondary containment and escaping directly to the environment should be specified. Branch Technical Position (BTP) CSB 6-3 (Ref. 7) provides guidance for identifying the leakage paths to the environment which may bypass the secondary containment. The periodic leakage rate testing program for measuring the fraction of primary containment leakage that may directly

bypass the secondary containment and other contiguous areas served by ventilation and filtration systems should be described.

4. The negative pressure to be maintained in the secondary containment and other contiguous plant areas should be low enough to preclude exfiltration under wind loading conditions characteristic of the plant site. If the leakage rate is in excess of 100% of the volume per day, a special exfiltration analysis should be performed.

5. The containment depressurization and filtration systems should be capable of maintaining a uniform negative pressure throughout the secondary containment, as well as other areas served by the systems.

6. Provisions should be made in the design of the secondary containment system to permit inspection and monitoring of functional capability. The determination of the depressurization time, the uniformity of negative pressure throughout the secondary containment and other contiguous areas, and the potential for exfiltration should be included in the preoperational and periodic test programs.

7. All openings, such as personnel doors and equipment hatches, should be under administrative control. These openings should be provided with position indicators and alarms having readout and alarm capability in the main control room. The effect of open doors or hatches on the functional capability of the depressurization and filtration systems should be evaluated and confirmatory preoperational tests conducted.

Some plants may have only portions of the primary containment enclosed, rather than having a secondary containment structure or shield building that completely encloses the primary containment. These enclosed areas are areas into which the primary containment would most likely leak, and they may be equipped with air filtration systems. Quantitative credit cannot be given for the holdup effect of these enclosed areas or for the air filtration systems, to mitigate the radiological consequences of a postulated accident, unless the magnitude of unprocessed leakage can be adequately demonstrated. Quantitative credit for leakage collection in a partial-dual containment will be reviewed on a case-by-case basis.

III. <u>REVIEW PROCEDURES</u>

The procedures described below provide guidance on the review of the secondary containment system. The reviewer selects and emphasizes material from the review procedures as may be appropriate for a particular case. Portions of the review may be done on a generic basis for aspects of secondary containment functional design common to a class of plants, or by adopting the results of previous reviews of similar plants.

CSB reviews the analytical models used and the assumptions made in the analyses of the pressure and temperature response of the secondary containment to loss-of-coolant accidents in the primary containment. In general, CSB determines that the analyses conservatively predict the secondary containment pressure response. In so doing, CSB compares the analyses to the guidelines in Section II.

If considered necessary, CSB performs confirmatory analyses of the pressure and temperaturae response of the secondary containment for loss-of-coolant accidents within the primary containment for for high energy line (e.g., steam line and feedwater line) ruptures occurring within the secondary containment. The analyses are done using the CONTEMPT-LT computer code (Ref. 6). It should be noted that for the analysis of the pressure and temperature response in the secondary containment for loss-of-coolant accidents within the primary containmeht, the present version of the CONTEMPT-LT only has the capability of calculating the pressure in the secondary containment up to the time of peak pressure. The code is being improved to permit the calculation of the pressure response for the entire course of an accident.

The analysis will be based on the guidelines given in Section II, and code input data obtained from the SAR. CSB determines that the secondary containment design pressure is not exceeded and that the depressurization time is consistent with that assumed in the AAB analysis of the radiological consequences of the accident. In addition, CSB determines that the primary containment external design pressure is not exceeded.

CSB determines that all direct leakage paths have been properly identified, and from a review of the proposed leakage testing program that provisions have been made in the design of the plant to measure the fraction of total primary containment leakage that bypasses the secondary containment. The acceptability of the leakage testing program is considered in Standard Review Plan 6.2.6. CSB advises AAB of any inadequacies in the applicant's direct leakage assumptions used in the radiological analysis. At the operating license stage of review, CSB reviews technical specifications which specify the surveillance requirements for leakage testing of the secondary containment bypass leakage paths.

CSB reviews analyses of the capability of the secondary containment system to resist exfiltration under post-accident conditions. If the secondary containment leakage rate is in excess of 100% of the volume per day, CSB advises AAB in order that they may perform a special exfiltration analysis. CSB reviews the preoperational and periodic inservice testing programs to assure that testing will be done to verify the extent of exfltration.

CSB reviews the proposed secondary containment system testing program and the surveillance requirements in the technical specifications (operating license stage) to assure that tests will be periodically conducted to verify that the prescribed negative pressure can be uniformly maintained throughout the secondary containment.

CSB reviews the proposed technical specifications to assure that adequate administrative control will be exercised over the secondary containment openings, such as personnel access doors and equipment hatches. CSB determines from the descriptive information in the SAR that all doors and hatches are provided with position indicators having readout and alarm capability inthe main control room. The CSB will ascertain that normally open doors were considered in the analyses of the functional capability of the secondary containment system.

IV. EVALUATION FINDINGS

The reviewer verifies that sufficient information has been provided and that his evaluation supports conclusions of the following type, to be included in the staff's safety evaluation report:

"6.2.3 Seconda.y Containment Functional Design

The scope of review of the functional design of the secondary containment system for the has included plan and elevation drawings, system drawings, and descriptive information. This system is provided to control the atmosphere within the secondary containment and contiguous areas. The review has included the applicant's proposed design bases and analyses of the functional capability of the secondary containment system.

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

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

V. REFERENCES

1. 10 CFR Part 50, Appendix A, General Design Criterion 41, "Containment Atmosphere Cleanup."

2. 10 CFR Part 50, Appendix A, General Design Criterion 42, "Inspection of Containment Atmosphere Cleanip Systems."

3. 10 CFR Part 50, Appendix A, General Design Criterion 43, "Testing of Containment Atmosphere Cleanup Systems."

4. Regulatory Guide 1.26, "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants," Revision 1.

5. Regulatory Guide 1.29, "Seismic Design Classification," Revision 1.

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

7. Branch Technical Position CSB 6-3, "Determination of Bypass Leakage Paths in Dual Containment Plants," attached to this plan.

BRANCH TECHNICAL POSITION CSB 6-3

DETERMINATION OF BYPASS LEAKAGE
PATHS IN DUAL CONTAINMENT PLANTS

A. BACKGROUND

The purpose of this branch position is to provide guidance in the determination of that portion of the primary containment leakage that will not be collected and processed by the secondary containment. Bypass leakage is defined as that leakage from the primary containment which can circumvent the secondary containment boundary and escape directly to the environment, i.e., bypasses the leakage collection and filtration systems of the secondary containment. This leakage component must be considered in the radiological analysis of a loss-of-coolant accident.

The secondary containment consists of a structure which completely encloses the primary containment and can be maintained at a pressure lower than atmospheric so that primary containment leakage can be collected or processed before release to the environment. The secondary containment may include an enclosure building which forms an annular volume around the primary containment, the auxiliary building where it completely encloses the primary containment, and other regions of the plant that are provided with leakage collection and filtration systems. Depressurization systems are provided as part of the secondary containment to decrease or maintain the secondary containment volume at a negative pressure.

All primary containment leakage may not be collected because (1) direct primary containment leakage can occur while the secondary containment is being depressurized and (2) primary containment leakage can bypass the secondary containment through containment penetrations and seals which do not terminate in the secondary containment.

Direct leakage from the secondary containment to the environment can occur whenever an outward positive differential pressure exists across the secondary containment boundary. The secondary containment can experience a positive pressure transient following a postulated loss-of-coolant accident in the primary containment as a result of thermal loading and infiltration from the environment and the primary containment that will occur until the depressurization systems become effective. An outward positive differential on the secondary containment wall can also be created by wind loads. In this regard, a "positive" pressure is defined as any pressure greater than -0.25 in. w.g. (water gauge), to account for wind loads and the uncertainty in the pressure measurements. Whenever the pressure in the secondary containment volume exceeds -0.25 in. w.g., the leakage-prevention function of the secondary containment is assumed to be negated. Since leakage from the secondary containment during positive pressure periods cannot be determined, the conservative assumption is made that, all primary containment leakage is released directly to the environment during these time periods. Therefore, it becomes necessary to determine the time periods during which these threshold conditions exist.

The existence and duration of periods of positive pressure within the secondary containment should be based on analyses of the secondary containment pressure response to postulated loss-of-coolant accidents within the primary containment and the effectiveness of the depressurization systems.

The evaluation of bypass leakage involves both the identification of bypass leakage paths and the determination of leakage rates. Potential bypass leakage paths are formed by penetrations which pass through both the primary and secondary containment boundaries. Penetrations that pass through both the primary and secondary containment may include a number of barriers to leakage (e.g., isolation valves, seals, gaskets, and welded joints). While each of these barriers aid in the reduction of leakage, they do not necessarily eliminate leakage. Therefore, in identifying potential leakage paths, each of these penetrations should be considered, together with the capability to test them for leakage in a manner similar to the containment leakage tests required by Appendix J to 10 CFR Part 50.

B. BRANCH TECHNICAL POSITION

1. A secondary containment structure should completely enclose the primary containment structure, with the exception of those parts of the primary containment that are imbedded in the soil, such as the base mat of the containment structure. For partial dual containment concepts, leak rates less than the design leak rate of the primary containment should not be used in the calculation of the radiological consequences of a loss-of-coolant accident, unless the magnitude of unprocessed leakage can be adequately demonstrated. Quantitative credit for leakage collection in a partial-dual containment will be reviewed on a case-by-case basis.

2. Direct leakage from the primary containment to the environment, equivalent to the design leak rate of the primary containment, should be assumed to occur following a postulated loss-of-coolant accident whenever the secondary containment volume is at a "positive" pressure; i.e., a pressure greater than -0.25 in. w.g. Positive pressure periods should be determined by a pressure response analysis of the secondary containment volume that includes thermal loads from the primary containment and infiltration leakage.

3. The secondary containment depressurization and filtration systems should be designed in accordance with Regulatory Guide 1.52, "Design, Testing, and Maintenance Criteria for Atmosphere Cleanup System Air Filtration and Adsorption Units of Light-Water Cooled Nuclear Power Plants." Preoperational and periodic inservice inspection and test programs should be proposed for these systems and should include means for determining the secondary containment infiltration rate, and the capability of the systems to draw down the secondary containment to the prescribed negative pressure in a prescribed time.

4. For secondary containments with design leakage rates greater than 100 volume percent per day, an exfiltration analysis should be provided.

5. The following leakage barriers in paths which do not terminate within the secondary containment should be considered potential bypass leakage paths around the leakage collection and filtration systems of the secondary containment:

a. Isolation valves in piping which penetrates both the primary and secondary containment barriers.

b. Seals and gaskets on penetrations which pass through both the primary and secondary containment barriers.

c. Welded joints on penetrations (e.g., guard pipes) which pass through both the primary and secondary containment barriers.

6. The total leakage rate for all potential bypass leakage paths, as identified in item 5 above, should be determined in a realistic manner, considering equipment design limitations and test sensitivities. This value should be used in calculating the offsite radiological consequences of postulated loss-of-coolant accidents and in setting technical specification limits with margin for bypass leakage.

7. Provisions should be made to permit preoperational and periodic leakage rate testing in a manner similar to the Type B or C tests of Appendix J to 10 CFR Part 50 for each bypass leakage path listed in item 5 above. An acceptable alternate for local leakage rate testing for welded joints would be to conduct a soap bubble test of the welds concurrently with the integrated (Type A) leakage test of the primary containment required by Appendix J. Any detectable leakage determined in this manner would require repair of the joint.

8. If air or water sealing systems or leakage control systems are proposed to process or eliminate leakage through valves, these systems should be designed, to the extent practical, using the guidelines for leakage control systems given in Branch Technical Position APCSB 6-1 (Ref. 3).

9. If a closed system is proposed as a leakage boundary to preclude bypass leakage, then the system should:

a. Either (1) not directly communicate with the containment atmosphere, or (2) not directly communicate with the environment, following a loss-of-coolant accident.

b. Be designed in accordance with Quality Group B standards, as defined by Regulatory Guide 1.26. (Systems designed to Quality Group C or D standards that qualify as closed systems to preclude bypass leakage will be considered on a case-by-case basis.)

c. Meet seismic Category I design requirements.

d. Be designed to at least the primary containment pressure and temperature design conditions.

e. Be designed for protection against pipe whip, missiles, and jet forces in a manner similar to that for engineered safety features.

f. Be tested for leakage, unless it can be shown that during normal plant operations the system integrity is maintained.

C. <u>REFERENCES</u>

1. 10 CFR Part 50, Appendix J, "Primary Reactor Containment Leakage Testing for Water-Cooled Power Reactors."

2. Regulatory Guide 1.26, "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants," Revision 1.

3. Branch Technical Position APCSB 6-1, "Main Steam Isolation Valve Leakage Control Systems," attached to Standard Review Plan 6.7.

11/24/75

SRP 6.2.4

FOLDER #2