U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

BRANCH TECHNICAL POSITION 6-3

DETERMINATION OF BYPASS LEAKAGE PATHS IN DUAL CONTAINMENT PLANTS

REVIEW RESPONSIBILITIES

Primary - Organization responsible for the review of component integrity issues related to engineered safety features

Secondary - None

A. BACKGROUND

This branch position provides guidance in the determination of that portion of the primary containment leakage not collected and processed by the secondary containment. Bypass leakage is defined as leakage from the primary containment which can circumvent the secondary containment boundary and escape directly to the environment (i.e., bypass 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 (LOCA).

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 forming an annular volume around the primary containment, the auxiliary building where it completely encloses the primary

USNRC STANDARD REVIEW PLAN

This Standard Review Plan, NUREG-0800, has been prepared to establish criteria that the U.S. Nuclear Regulatory Commission staff responsible for the review of applications to construct and operate nuclear power plants intends to use in evaluating whether an applicant/licensee meets the NRC's regulations. The Standard Review Plan is not a substitute for the NRC's regulations, and compliance with it is not required. However, an applicant is required to identify differences between the design features, analytical techniques, and procedural measures proposed for its facility and the SRP acceptance criteria and evaluate how the proposed alternatives to the SRP acceptance criteria provide an acceptable method of complying with the NRC regulations.

The standard review plan sections are numbered in accordance with corresponding sections in Regulatory Guide 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants (LWR Edition)." Not all sections of Regulatory Guide 1.70 have a corresponding review plan section. The SRP sections applicable to a combined license application for a new light-water reactor (LWR) are based on Regulatory Guide 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)."

These documents are made available to the public as part of the NRC's policy to inform the nuclear industry and the general public of regulatory procedures and policies. Individual sections of NUREG-0800 will be revised periodically, as appropriate, to accommodate comments and to reflect new information and experience. Comments may be submitted electronically by email to NRR_SRP@nrc.gov.

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containment, and other regions of the plant with leakage collection and filtration systems. Depressurization systems as parts of the secondary containment decrease or maintain the secondary containment volume at a negative pressure.

All primary containment leakage may not be collected because (a) direct primary containment leakage can occur while the secondary containment is being depressurized and (b) 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 there is an outward positive differential pressure across the secondary containment boundary. The secondary containment can experience a positive pressure transient following a postulated LOCA 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. A "positive" pressure is defined as any pressure greater than -0.063 kPa (-0.25 inches water gauge), to account for wind loads and the uncertainty in the pressure measurements. Whenever the pressure in the secondary containment volume exceeds -0.063 kPa (-0.25 inches water gauge), the leakage-prevention function of the secondary containment is assumed to be negated. The conservative assumption is that all primary containment leakage is released directly to the environment during such time periods because leakage from the secondary containment during positive pressure periods cannot be determined. Therefore, it becomes necessary to determine the time periods during which these threshold conditions exist.

Determination of the duration of periods of positive pressure within the secondary containment should be based on analyses of the secondary containment pressure response to postulated LOCAs within the primary containment and the effectiveness of the depressurization systems.

The evaluation of bypass leakage identifies bypass leakage paths and determines leakage rates. Potential bypass leakage paths are formed by penetrations which pass through both the primary and secondary containment boundaries and which may include a number of barriers to leakage (e.g., isolation valves, seals, gaskets, and welded joints). While these barriers reduce 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 that of the containment leakage tests required by 10 CFR Part 50, Appendix J.

B. BRANCH TECHNICAL POSITION

1. A secondary containment structure should enclose the primary containment structure completely with the exception of such parts imbedded in the soil 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 LOCA unless the magnitude of unprocessed leakage can be adequately demonstrated. Quantitative credit for leakage collection in a partial-dual containment will be reviewed case by case.

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 LOCA whenever the secondary containment volume is at a "positive" pressure (i.e., greater than -0.063 kPa (-0.25 inches water gauge)). Positive pressure periods should be determined by a pressure response analysis of the secondary containment volume including 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 (RG) 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, there should be an exfiltration analysis.

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, should be determined realistically, considering equipment design limitations and test sensitivities. This value should be used in calculating the offsite radiological consequences of postulated LOCAs and in setting technical specification limits with margin for bypass leakage.

7. There should be provisions for preoperational and periodic leakage rate testing similar to the Type B or C tests of 10 CFR Part 50, Appendix J, for each bypass leakage path listed in item 5. An acceptable alternative for local leakage rate testing for welded joints would be 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 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, according to the guidelines for leakage control systems in RG 1.96.

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

   A. Either (a) not directly communicate with the containment atmosphere or (b) not directly communicate with the environment following a LOCA.

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

   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. REFERENCES

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

2. RG 1.26, "Quality Group Classification and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants."

3. RG 1.52, "Design, Testing, and Maintenance Criteria for Atmosphere Cleanup System Air Filtration and Adsorption Units of Light-Water-Cooled Nuclear Power Plants."

4. RG 1.96, "Design of Main Steam Isolation Valve Leakage Control Systems for Boiling Water Reactor Nuclear Power Plants."

PAPERWORK REDUCTION ACT STATEMENT

The information collections contained in the Standard Review Plan are covered by the requirements of 10 CFR Part 50 and 10 CFR Part 52, and were approved by the Office of Management and Budget, approval number 3150-0011 and 3150-0151.

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