6.2.6 Containment Leakage Testing

The reactor containment, containment penetrations, and isolation barriers are designed to permit periodic leakage rate testing in accordance with GDC 52, GDC 53, and GDC 54. The containment leakage rate testing (CLRT) program complies with 10 CFR 50, Appendix J, Option B and follows the guidance of RG 1.163. The program is implemented in accordance with ANSI N45.4 (Reference 9) and ANSI/ANS 56.8 (Reference 10). The program is fully described, as defined in SRM-SECY-04-0032 (Reference 11), in this section.

A COL applicant that references the U.S. EPR design certification will identify the implementation milestones for the CLRT program described under 10 CFR 50, Appendix J.

6.2.6.1 Containment Integrated Leakage Rate Test (Type A)

Prerequisites

Following completion of the Reactor Building construction, preoperational and periodic leakage rate tests are conducted for all portions of mechanical, fluid, electrical, and instrumentation systems penetrating the containment.

The preoperational containment integrated leakage rate test (CILRT) is described in Section 14.2 (Test #029) and is performed after the preoperational structural integrity test (SIT). CILRT is performed periodically at intervals that are specified by 10 CFR 50, Appendix J.

The following prerequisites and system alignment are required prior to test performance:

- Type B and Type C local leakage rate tests are performed.
- Containment isolation system functionality is verified.
- A general inspection of the accessible interior and exterior surfaces of the primary containment structure and components is performed to identify evidence of structural deterioration that might affect either the primary containment structural integrity or tightness.
- The visual examination of containment concrete surfaces is performed in accordance with the requirements specified by the ASME Boiler and Pressure Vessel Code (ASME Code) Section XI (Reference 12), Subsection IWL, except where relief has been authorized by the NRC.
- The visual examination of the steel liner plate inside containment is performed in accordance with the requirements specified by the ASME Code Section XI, Subsection IWE, except where relief has been authorized by the NRC. Corrective

action is taken prior to performing the Type A test if there is evidence of structural deterioration.

- Containment visual inspections will be performed during two refueling outages when Type A test intervals have been extended to 10 years.

- The structural deterioration and corrective action are reported in accordance with 10 CFR 50, Appendix J.

- During the period between the initiation of the containment inspection and the performance of the Type A test, no repairs or adjustments are made so that the containment can be tested in as close to the “as-is” condition as practical.

- All test instrument calibrations are verified as being current prior to initiation of the CILRT.

- The containment isolation valves are closed without performing preliminary exercising or adjustments. Table 6.2.4-1 provides the postaccident position for the valves and identifies any exceptions to valve position during testing.

- During the CILRT, flow paths that would be open to the containment atmosphere following a loss of coolant accident (LOCA) are drained and vented to the containment atmosphere. Flowpaths that are considered open are those that may have the system fluid drained or driven off by the LOCA or as a result of the line rupturing inside the containment.

- Fluid systems that are open directly to the containment atmosphere under post-accident conditions are opened or vented to the containment atmosphere prior to and during the test.

- Systems that would be normally operating under post-LOCA conditions are not vented during the test and are identified as essential systems in Table 6.2.4-1.

- Tanks inside the containment are vented to the containment atmosphere as necessary to protect them from the effects of external test pressure or to preclude leakage that could affect test results. Similarly, instrumentation and other components that could be adversely affected by the test pressure are vented or removed from containment.

- Certain instrumentation lines that penetrate containment are identified in the test plan and isolated during the CILRT. For those lines isolated, valves are aligned as appropriate and local leak rate testing (LLRT) performed. Results of these LLRTs are added to the CILRT result. Upon completion of the CILRT, valves are realigned to return these instrumentation lines to their normal configurations.

In accordance with 10 CFR 50, Appendix J, the containment atmospheric conditions are allowed to stabilize for a period of time prior to beginning the leakage rate test. The CILRT test procedure addresses the specific time period.

Methodology

The Type A test is conducted in accordance with ANSI N45.4, the Total Time and Point-to-Point methods, or ANSI/ANS-56.8, the Mass Point Method. The duration of testing after the stabilization period is established consistent with these standards. Changes in containment air mass during this time are calculated using periodic measurements of containment pressure, dry bulb temperature, and dew point temperatures (i.e., water vapor pressure).

Accuracy of the Type A test results is then verified by a supplemental verification test. The supplemental verification test is performed using the methodology for this purpose described by ANSI N45.4.

Type A tests use temporary air compressors, which are installed and connected to the permanent system piping. The number and capacity of the compressors is sufficient to pressurize the primary containment to test pressure. The compressors include air coolers, moisture separators, and air dryers to reduce the moisture content of the air entering the primary containment. Temperature and humidity sensors are installed inside containment for Type A testing. Data acquisition hardware and instrumentation is available outside containment. Instrumentation that is not required during normal plant operation may be installed temporarily for the Type A test.

The maximum allowable containment leakage rate denoted L_a, is not to exceed 0.25% of containment air weight per day at P_a. The conservative value for P_a, 56.1 psig, is greater than the calculated peak internal pressure associated with the design basis accident (DBA).

As soon as practical after completion of a Type A test that identified leakage, and prior to initiation of containment inspection for the subsequent Type A test, repairs or adjustments are made to components that exceeded individual leakage limits.

Preservice Test

Preoperational Type A tests are conducted at peak pressure in accordance with 10 CFR 50, Appendix J, as follows:

- Peak pressure tests—A test is performed at pressure P_a to measure the leakage rate L_{am}.
- Peak pressure acceptance criteria—The leakage rate L_{am} is less than 0.75 L_a at pressure P_a.
- If the Type A test fails to meet this criterion, a retest is conducted in accordance with the requirements of 10 CFR 50, Appendix J.

Inservice Test

- Peak pressure tests—A test is performed at pressure P_a to measure the leakage rate L_{am}.
- Peak pressure acceptance criteria—The leakage rate L_{am} is less than 0.75 L_a. If local leakage measurements are taken to effect repairs in order to meet the acceptance criteria, these measurements are taken at a test pressure P_a.
- The as-found value for L_a shall be ≤ 1.0.
- The as-left value for L_a shall be ≤ 0.75 L_a. This applies to both the preoperational (prior to unit initial startup) and the subsequent periodic Type A tests.
- If a Type A test fails to meet this criterion, the test schedule for subsequent tests is adjusted in accordance with the requirements of 10 CFR 50, Appendix J, as directed by the CLRT program.

6.2.6.2 Containment Penetration Leakage Rate Tests (Type B)

Preoperational and periodic testing of containment penetrations (i.e., Type B leakage rate tests) are performed in accordance with 10 CFR 50, Appendix J. A list of containment mechanical penetrations subject to Type B tests is provided in Table 6.2.4-1.

The following containment penetrations receive preoperational and periodic Type B leakage rate tests:

- Penetrations designed with resilient seals, gaskets or sealant compounds.
- Air locks and associated door seals.
- Equipment and access hatches and associated seals.
- Electrical penetrations.

Portable test panels are used to perform the testing of containment penetration and isolation valve leak testing using either air or nitrogen. The panels include pressure regulators, filters, pressure gauges, and flow instrumentation as required to perform specific tests.

Containment penetrations and testing requirements are identified in Table 6.2.4-1. Type B testing is performed at a pressure of P_a.

Airlock testing acceptance criteria are:

- Overall air lock leakage ≤ 0.05 L_a tested at ≥ P_a.

- Leakage for each door ≤ 0.01 La when pressurized to ≥ 10 psig.

The combined leakage rate for all penetrations and valves subject to Type B and C tests shall be less than 0.60 L_a.

6.2.6.3 Containment Isolation Valve Leakage Rate Test (Type C)

Preoperational and periodic testing of CIVs (i.e., Type C leakage rate tests) are performed in accordance with 10 CFR 50, Appendix J. A list of CIVs subject to Type C tests is provided in Table 6.2.4-1. The applicable system piping and instrumentation diagrams (P&ID) illustrate CIV arrangements and test connections for Type C testing.

Type C leakage tests are performed by local pressurization. Each tested valve is closed by normal means without preliminary exercising or adjustments, and pressure is applied in the same direction as would be present during the DBA. If pressure is to be applied in the opposite direction, justification for the deviation is provided.

Portable test panels are used to perform the testing of containment penetration and isolation valve leak testing using either air or nitrogen. The panels include pressure regulators, filters, pressure gauges and flow instrumentation as required to perform specific tests.

Fixed test connections used for Type C testing are shown on the respective system P&IDs.

The valves are tested by pressurizing with either air or nitrogen at a pressure of $P_{a.}$

The combined leakage rate for all penetrations and valves subject to Type B and C tests shall be less than 0.60 L_a.

6.2.6.4 Scheduling and Reporting of Periodic Tests

The NRC regulations in 10 CFR 50, Appendix J allow for a performance-based Option B for containment leakage testing. Test intervals are based on criteria established in Nuclear Energy Institute (NEI) 94-01 (Reference 13) in accordance with the regulatory positions stated in RG 1.163.

A summary report documents the preoperational and periodic tests and includes a schematic arrangement of the leakage rate measurement system, the instrumentation used, the supplemental test method, and the test program selected as applicable to the preoperational test and subsequent periodic tests. The report contains analysis and interpretation of the leakage rate test data for the Type A test and provides an evaluation of the results against the acceptance criteria.

The summary report includes periodic leakage test results from the Type A, B, and C tests and contains an analysis and interpretation of the Type A test results and a summary analysis of the periodic Type B and Type C tests that were performed since the last Type A test. Leakage test results from Type A, B, and C tests that failed to meet the acceptance criteria are included in a separate accompanying summary report that includes an analysis and interpretation of the test data, the least squares fit analysis of the test data, the instrumentation error analysis, and the structural conditions of the containment or components, if any, that contributed to the failure in meeting the acceptance criteria. Results and analyses of the supplemental verification test employed to demonstrate the validity of the leakage rate test measurements are also included.

The CLRT program requirements and acceptance criteria are listed in the Technical Specifications program (Chapter 16), Section 5.5.15 for the Type A, B, and C leakage tests.

6.2.6.5 Leak-off System

The leak-off system (LOS) is located in the reactor containment building, reactor shield building, fuel building, and safeguard building 3. The LOS consists of valves, sensors and piping and is composed of two main subsystems: containment inflating/deflating subsystem (CIDS), and containment leak-tightness test subsystem (CLTS). See Figure 6.2.6-1—Leak-Off System Functional Arrangement.

The CIDS is used for the pressurization, depressurization, and evacuation in order to test the structural integrity and leak-tightness of the Reactor Containment Building. The CLTS uses temporary sensors to measure the leak-tightness of the Reactor Containment Building. LOS containment penetrations that are paths for potential bypass leakage terminate in areas of the surrounding buildings that are filtered during a postulated accident. Section 6.2.6.6 addresses the treatment of potential bypass leakage for containment leakage rate testing.

6.2.6.6 Special Testing Requirements and Bypass Leakage

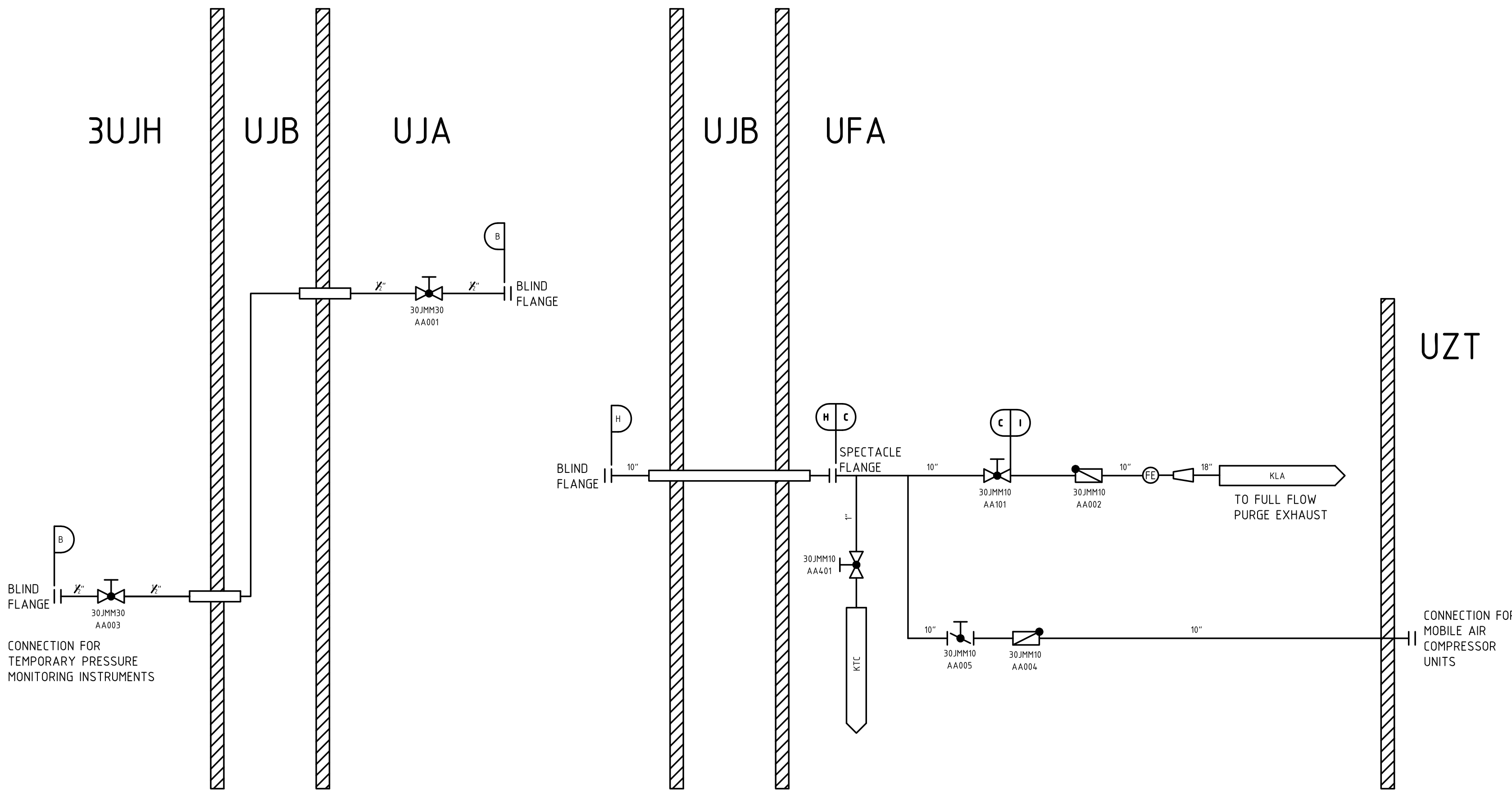
The U.S. EPR Reactor Containment Building is completely enclosed by the Reactor Shield Building, forming an annulus between the two structures. The combined containment and shield buildings are penetrated by a variety of pipes, air locks, and hatches. These penetrations provide an escape mechanism by which atmosphere from the containment may leak when pressurized during accident conditions. A DBA will pressurize the containment to a pressure above atmospheric, providing the motive force for leakage from the containment to the annulus and other buildings.

All penetrations that are welded or have mechanical connections are tested using methods that conform to regulatory requirements and guidance for measuring the leakage rate of potential bypass leakage paths in dual containment plant designs.

Containment penetrations identified as potential bypass leakage paths are listed in Table 6.2.4-1. The table provides a brief description of each penetration and provides a determination of potential bypass leakage path.

U.S. EPR design has no primary containment penetrations or seals that terminate outside the secondary containment to the general environment. All U.S. EPR penetrations are defined by one of three categories described in Section 6.2.3.2.3. Leakage through penetrations and seals do not become bypass leakage during normal or accident operation modes. Therefore, the maximum combined leakage rate for all bypass penetrations is assumed to be zero (0.00 L_a) at a primary containment pressure of P_a.

Figure 6.2.6-1—Leak-Off System Functional Arrangement



I	E	NSC
H	B	I
C	E	NSC
B	B	I
DESIGN AREA	SSC QUALITY GROUP	SSC SEISMIC CLASS

EPR2845T2

6.2.7 Fracture Prevention of Containment Pressure Vessel

Section 3.8.2 identifies the ferritic steel parts of the reactor containment pressure boundary and specifies how they meet the requirements of GDC 1 and GDC 16. The selected materials provide sufficient margin to assure that under operating, maintenance, testing, and postulated accident conditions:

- Ferritic materials behave in a nonbrittle manner.
- Probability of rapidly propagating fracture of the pressure boundary is minimized (GDC 51).

The materials of the carbon steel liner plate and carbon steel and low alloy steel attachments and appurtenances subject to ASME Section III (Reference 14), Division 2 requirements meet the fracture toughness requirements of ASME Section III, Division 2, Article CC-2520. Materials used in ASME Section III, Division 1 attachments and appurtenances meet the fracture toughness requirements of ASME Section III, Division 1, Article NE-2300. This provision meets the requirement that the reactor containment pressure boundary remain intact during the harshest expected conditions, thereby precluding release of radioactivity to the environment.

6.2.8 References

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*NRC Staff approval is required prior to implementing a change in this information marked in this section; see FSAR Introduction.

Next File