### 3.9.6 Inservice Testing of Pumps and Valves

This subsection describes inservice testing of certain safety-related valves typically designated as Code Class 1, 2 and 3 components. Inservice testing of ASME Code, Section III, Class 1, 2, and 3 pumps and valves is performed in accordance with the ASME Operations and Maintenance (OM) Code edition and applicable addenda, as required by 10 CFR 50.55a(f), except where specific relief has been granted by the NRC in accordance with 10 CFR 50.55a(f). Other safety-related pumps and valves not categorized as Code Class 1, 2, or 3 may be included in the inservice testing program.

The inservice testing of pumps and valves is in conformance with the relevant requirements of 10 CFR Part 50, Appendix A, General Design Criteria 1, 37, 40, 43, 46, 54, and 10 CFR 50.55a(f). The relevant requirements are as follows:

(1) GDC 1, as it relates to testing safety-related components to quality standards commensurate with the importance of the safety functions to be performed.

(2) GDC 37, as it relates to periodic functional testing of the emergency core cooling system to ensure the leak tight integrity and performance of its active components.

(3) GDC 40, as it relates to periodic functional testing of the containment heat removal system to ensure the leak tight integrity and performance of its active components.

(4) GDC 43, as it relates to periodic functional testing of the containment atmospheric cleanup systems to ensure the leak tight integrity and the performance of the active components, such as pumps and valves.

(5) GDC 46, as it relates to periodic functional testing of the cooling water system to ensure the leak tight integrity and performance of the active components.

(6) GDC 54, as it relates to piping systems penetrating containment being designed with the capability to test periodically the operability of the isolation and determine valve leakage acceptability.

(7) Subsection 50.55a(f) of 10 CFR, as it relates to including pumps and valves whose function is required for safety in the inservice testing program to verify operational readiness by periodic testing.

The inservice test plan includes periodic tests and inspections that demonstrate the operational readiness of safety-related components and their capability to perform their safety-related functions. The inservice testing program is based on the requirements of ASME OM Code, Subsections ISTA, ISTB, ISTC and (mandatory) Appendix I. The specific ASME OM Code requirements for functional testing of pumps are found in the ASME OM Code, Subsection ISTB, requirements for inservice testing of valves are found in the ASME OM Code, Subsection ISTC, and requirements for inservice testing of pressure relief devices are found in ASME OM Code, (mandatory) Appendix I. General requirements for inservice testing are found in ASME OM Code, Subsection ISTA.

The requirements for system pressure testing are defined in ASME Code Section XI, Subsection IWA-5000; this testing, which verifies pressure boundary integrity, is included within the scope of the inservice inspection program which is described in DCD Subsection 5.2.4 and DCD Section 6.6.

### *3.9.6.1 ASME OM Code Inservice Testing of Pumps*

The inservice test plan does not include testing of pumps in nonsafety-related systems unless they perform safety-related functions. The ESBWR design does not use pumps to mitigate the consequences of an accident or to maintain the reactor in a safe shutdown condition, therefore, there are no pumps listed in DCD Table 3.9-8. There are no safety-related pumps or nonsafety-related pumps that perform any safety-related functions in the ESBWR design. As a result, the inservice test plan does not include any pumps.

### *3.9.6.2 ASME OM Code Inservice Testing of Valves*

Safety-related valves are subject to operational readiness testing. Inservice testing of valves assesses operational readiness including actuating and position indicating systems. The valves that are subject to inservice testing include those valves that perform a specific function in shutting down the reactor to a safe shutdown condition, in maintaining a safe shutdown condition, or in mitigating the consequences of an accident. In addition, pressure relief devices used for protecting systems or portions of systems that perform a function in shutting down the reactor to a safe shutdown condition, in maintaining a safe shutdown condition, or in mitigating the consequences of an accident, are subject to inservice testing.

The inservice test plan does not include testing of non-safety-related valves except where they perform safety-related functions. Valves that are identified as having important non-safety-related functions have provisions to allow testing but are not included in the inservice test plan unless inservice testing is identified as part of the regulatory oversight required for investment protection.

The valve test program is controlled administratively and is based on the plan outlined in this subsection. Valves (including relief valves) subject to inservice testing in accordance with the ASME OM Code are indicated in DCD Table 3.9-8. The valve test program conforms to the requirements of the ASME OM Code, Subsection ISTC. The guidance in NRC NUREGs, Generic Letters, AEOD reports, and industry and utility guidelines (e.g., NUREG-1482 and Generic Letter 89-04) is also considered in developing the test program. Inservice testing incorporates the use of nonintrusive techniques as required to periodically assess the degradation and performance of selected valves.

Safety-related check valves with an active function are exercised in response to flow except as allowed by the Code (e.g., where valve disassembly and inspection is required). Safety-related power-operated valves with an active function are subject to an exercise test.

DCD Table 3.9-8 lists the inservice testing parameters, frequencies, and exemptions for the safety-related valves. Relief from the Code requirements for testing, if required, and any alternative tests are identified in DCD Table 3.9-8. Demonstration of the impracticality of the testing required by the Code, and justification for the alternative testing proposed is provided in the inservice testing program documentation.

#### *3.9.6.2.1 Valve Functions Tested*

The inservice testing program identifies the safety-related functions for safety-related valves. The following are typical safety-related functions that are identified in the inservice test program.

- Maintain closed
- Maintain open
- Transfer closed (active function)

- Transfer open (active function)

Based on the safety-related functions identified for each valve, the inservice tests to confirm the capability of the valve to perform these functions are identified. Active valves include valves that transfer open, and those that transfer closed. Active valves, as defined in the ASME Code, include valves that change obturator (the part of the valve that blocks the flow stream) position to accomplish the safety-related function(s). Valve functions to maintain closed and maintain open are designated as passive and do not include valve exercise inservice testing.

If upon removal of the actuator power (electrical, air or fluid power for actuation) an active valve fails (transfers) to the position associated with performing its safety-related function, it is identified as "active-to-fail."

Valve functions are used in determining the type of inservice testing for the valve. These valve functions include:

- Active fulfillment of the safety-related function(s)
- Reactor coolant system pressure boundary isolation function
- Containment isolation function
- Seat leakage (in the closed position), is limited to a specific maximum amount when important for fulfillment of the safety-related function(s)
- Actuators that fail ("active-to-fail") to a specific position (open/closed) upon loss of actuating power for fulfillment of the safety-related function(s)
- Passive fulfillment of the safety-related function(s)

The ASME inservice testing categories are assigned based on the safety-related valve functions and the valve characteristics. The following criteria are used in assigning the ASME inservice testing categories to the valves (ISTC-1300).

Category A - safety-related valves with safety-related leakage requirements

Category B - safety-related valves requiring inservice testing, but without safety-related seat leakage requirements

Category C - safety-related, self-actuated valves (such as check valves and pressure relief valves)

Category D - safety-related, explosively actuated valves and nonreclosing pressure relief devices capable of only one operation

### *3.9.6.2.2 Valve Testing*

Four basic groups of valve inservice tests as required by the ASME OM Code are described below.

**Remote Valve Position Indication Inservice Tests**

Active and passive valves that are included in the IST program and that are equipped with remote position indication require periodic verification of the remote position indication function. Valves that require remote position indication testing are observed locally during valve exercising to verify proper operation of the position indication. The frequency for this position indication test is once every two years. Where local observation is not practicable, other

methods will be used for verification of valve position indicator operation. The alternate method and justification are provided in the IST program documentation.

**Valve Leakage Inservice Tests**

Valves with safety-related seat leakage limits will be tested to verify their seat leakage is within limits. These valves include (containment isolation) valves that provide isolation of piping/lines that penetrate containment. Valves with seat leakage test requirements are identified in DCD Table 3.9-8.

Containment isolation valves are tested in accordance with 10 CFR 50, Appendix J. Depending on the function and configuration, some valves are tested during the Integrated Leak Rate Testing (ILRT) Type A tests, or individually as a part of the Type C testing program, or both. The leak rate test frequency for containment isolation valves is defined in subsection 6.2.5.

The ASME Code specifies a test frequency of a test at least once every 2 years. The ASME Code does not require additional leak testing for valves that demonstrate operability during the course of plant operation. In such cases, the acceptability of the valve performance is recorded during plant operation to satisfy inservice testing requirements. Therefore, a specific inservice test need not be performed on valves that meet this criteria.

Pressure isolation valves (PIVs) are defined as two normally closed valves in series that isolate the reactor coolant system (RCS) from an attached low pressure system. The periodic surveillance and leak rate testing requirements for pressure isolation valves are not applicable, because, as shown in DCD Appendix 3K, the ESBWR design does not contain a pressure isolation valve between the reactor coolant pressure boundary and a low pressure piping system.

The ESBWR has no temperature isolation valves whose leakage may cause unacceptable thermal loading to piping or supports.

**Manual/Power-Operated Valve Tests**

Safety-related active valves, both manual and power-operated (motor-operated, pneumatic-operated, hydraulic-operated, solenoid-operated) will be exercised periodically. The ASME OM Code specifies a quarterly valve exercise frequency. In some cases power-operated valves are tested on a less frequent basis because it is not practical to exercise the valve during plant operation. If an exception is taken to performing quarterly exercise testing, then exercise testing is performed during cold shutdown, on a frequency not more often than quarterly. If this is not practicable, exercise testing is performed during each refueling outage. The valve test frequencies are identified in DCD Table 3.9-8.

Valves that operate during the course of normal plant operation at a frequency that satisfies the exercising requirement need not be additionally exercised, provided that the observations required to satisfy inservice testing are made and recorded at intervals no greater than that specified in the IST program.

Safety-related valves that fail to the safety-related actuation position to perform the safety-related function, are subject to a valve exercise inservice test. The test verifies that the valve repositions to the safety-related position on loss of actuator power. The valve exercise test satisfies this test as long as the test removes the actuator power for the valve. The fail-safe test is not identified as a separate test in DCD Table 3.9-8.

**Check Valve Tests**

**Check Valve Flow Tests** - Safety-related check valves identified with specific safety-related functions to transfer open or transfer closed are tested periodically. Exercising a check valve confirms the valve capability to move to the position(s) to fulfill the safety-related function(s). The exercise test shows that the check valve opens in response to flow and closes when the flow is stopped. Sufficient flow is provided to fully open the check valve unless the maximum accident flows are not sufficient to fully open the check valve. Either permanent or temporarily installed nonintrusive check valve position indication may be used for this test.

Valves that normally operate at a frequency that satisfies the exercising requirement need not be additionally exercised, provided that the observations required for inservice testing are made and recorded at intervals no greater than that specified in this section.

The ASME Code specifies a quarterly valve exercise frequency. In some cases, check valves are tested on a less frequent basis because it is not practical to exercise the valve during plant operation. If an exception is taken to performing quarterly exercise testing, then exercise testing is performed during cold shutdown on a frequency not more often than quarterly. If this is not practical, exercise testing is performed during each refueling outage. If exercise testing during a refueling outage is not practical, then an alternative means is provided. Alternative means include nonintrusive diagnostic techniques. Nonintrusive methods may include monitoring an upstream pressure indicator, monitoring tank level, performing a leak test, a system hydrostatic or pressure test, or radiography. The test frequencies for check valves in the IST program are identified in DCD Table 3.9-8.

**Check Valve Disassembly Examination** - As an alternative to check valve exercise testing check valves, the ASME OM Code allows a disassembly examination program wherein valves are grouped with valves of similar design, application and service condition. One valve from each group is then disassembled and examined each refueling outage, with each valve in the group having been examined at least once every eight (8) years. Check valves that are included in the disassembly examination program are identified in the inservice test program documentation.

**Other Valve Inservice Tests**

**Explosively Actuated Valves** - Explosively actuated valves are subject to periodic test firing of the explosive actuator charges. The inservice tests for these valves is specified in the ASME OM Code. At least 20 percent of the charges installed in the plant in explosively actuated valves are fired and replaced at least once every 2 years. If a charge fails to fire, all charges within the same batch number are removed, discarded, and replaced with charges from a different batch. The firing of the explosive charge may be performed inside the valve or outside of the valve in a test fixture.

The maintenance and review of the service life for charges for explosively actuated valves follows the requirements in the ASME OM Code.

**Pressure/Vacuum Relief Devices**

Pressure relief devices that provide safety-related functions or that protect equipment in systems that perform safety-related functions require periodic inservice testing. The inservice tests for these valves are identified in ASME OM Code (mandatory) Appendix I.

The periodic inservice testing includes visual inspection, seat tightness determination, set pressure determination, and operational determination of balancing devices, alarms, and position indication as appropriate. The frequency for this inservice test is every 5 years for

ASME Class 1, and every 10 years for ASME Classes 2 and 3 devices. Nonreclosing pressure relief devices are inspected when installed and replaced every 5 years unless historical data indicate a requirement of more frequent replacement.

Vacuum breaker valves are tested in accordance with the requirements for check valves or pressure relief devices, as applicable.

#### *3.9.6.2.3 Valve Preservice Testing*

Preservice testing for valves is performed in accordance with ASME OM, ISTC-3100.

#### *3.9.6.2.4 Valve Replacement, Repair and Maintenance*

Testing in accordance with ASME OM, ISTC-3310 and ISTC-5000 is performed after a valve is replaced, repaired, or has undergone maintenance that could affect the valve's performance.

#### *3.9.6.2.5 Relief Requests and Alternative Testing*

Considerable experience has been used in designing a locating systems and valves to permit preservice and inservice testing required by the ASME OM Code. A relief request is not required for deferral of testing to cold shutdown or refueling outages in conformance with the rules of the ASME OM Code, when testing during power operations is not practical. Relief from the testing requirements of ASME OM Code will be requested when compliance with requirements of the ASME OM Code is not practical. In such cases, specific information will be provided which identifies the impractical code requirement, justification for the relief request, and the testing method to be used as an alternative.

### *3.9.6.3 Power-Operated Valve Design Basis Operability Testing Program*

Operability testing as required by 10 CFR 50.55a(b)(3)(ii) is performed on motor-operated valves that are included in the ASME OM Code inservice testing program to demonstrate that the MOVs are capable of performing their design basis safety function(s). Other safety-related valves as discussed in GL 89-10 (e.g., position-changeable), and valves that are identified as having important non-safety-related functions where inservice testing is identified as part of the regulatory oversight required for investment protection may be included in the program. The operability test may be either a static or a dynamic (flow and differential pressure) test. The frequency for operability testing is a maximum of once every 10 years. The test frequency for periodic testing of each MOV included in the program is established based on the valve classification, risk ranking and functional margin in accordance with the recommendations of the Joint Owners Group (JOG) MOV Periodic Verification (PV) study, as accepted in an NRC safety evaluation in September 2006.

For any MOVs that are outside the scope of applicability of the JOG overall program or the JOG dynamic test program, such as in terms of valve manufacturer, size, type, materials, or service conditions, a separate program for MOV periodic verification for those valves, materials, and service conditions not encompassed by the JOG program is established using the guidance of the JOG PV program as a basis for establishing periodic testing requirements and frequency. Justification for the periodic verification of design basis functional testing of these valves (Class D valves per the JOG PV program) is provided in the IST program documentation.

### *3.9.6.4 Check Valve Low Differential Pressure Tests*

Safety-related check valves that perform a safety-related function to transfer open under low differential pressure conditions have periodic inservice testing to verify the capability of the valve to initiate flow. The intent of this inservice test is to verify that the valve will open to allow flow to

initiate at low differential pressure. This low pressure differential inservice test is performed in addition to exercise inservice tests. The frequency for this test is once each refueling cycle.

### *3.9.6.5 Inservice Testing Program Implementation*

The milestones for the ASME OM Code preservice and inservice testing programs implementation, and the Motor-Operated Valve Testing Program, are defined in Section 13.4.

ASME OM Code inservice test intervals are as required by ISTA-3120; the initial 120-month test interval beginning following the start of commercial service. The duration of each 120-month test interval may be modified by as much as one year as allowed by the Code.

### *3.9.6.6 ASME OM Code Edition/Addenda Applicable to Inservice Testing*

The IST Program for the initial test interval complies with the requirements in the edition and addenda of the ASME OM Code incorporated by reference in 10 CFR 50.55a(b) on the date 12 months before the date for initial fuel load. Inservice tests conducted during successive 120-month intervals will comply with the requirements of the latest edition and addenda of the Code incorporated by reference in 10 CFR 50.55a(b) 12 months before the start of the 120-month interval.

## Table 3.9-8

## In-Service Testing

| No. | Qty | Description (g) | Code Class (a) | Code Cat. (c) | Valve Func. (d) | Test Para. (e) | Test Freq. (f) |
|---|---|---|---|---|---|---|---|
| F020 | 1 | N2 supply line inboard isolation check valve to ADS, SRV and ICIV accumulator (h) | | A, C | I, A | L, P, S | R0 |
| **T10 Containment** | | | | | | | |
| F001 | 3 | Drywell wetwell vacuum breaker isolation valve | 2 | B | A | P<br>S | R0<br>3 mo |
| F002 | 3 | Drywell wetwell vacuum breaker valve | 2 | C | A | P<br>R | R0<br>E3 |
| **T31 Containment Inerting System Valves** | | | | | | | |
| F012 | 1 | Suppression pool exhaust line outboard isolation valve | 2 | A | I, A | L, P<br>S | R0 |
| F007 | 1 | Air/N2 supply line to suppression pool outboard isolation valve | 2 | A | I, A | L, P, S | R0 |
| F008 | 1 | Air/N2 supply line to outboard isolation valve | 2 | A | I, A | L, P, S | R0 |
| F009 | 1 | Air/N2 supply line to upper drywell outboard isolation valve | 2 | A | I, A | L, P, S | R0 |
| F023 | 1 | N2 makeup line outboard isolation valve | 2 | A | I, A | L, P<br>S | R0<br>3 mo |
| F024 | 1 | N2 makeup line to suppression pool outboard isolation valve | 2 | A | I, A | L, P, S | R0 |
| F025 | 1 | N2 makeup line to upper drywell outboard isolation valve | 2 | A | I, A | L, P<br>S | R0<br>3 mo |

## Table 3.9-8

## In-Service Testing

| No. | Qty | Description [g] | Code Class (a) | Code Cat. (c) | Valve Func. (d) | Test Para. (e) | Test Freq. (f) |
|---|---|---|---|---|---|---|---|
| F010 | 1 | Lower drywell exhaust line outboard isolation valve | 2 | A | I, A | L, P S | R0 3 mo |
| F011 | 1 | Containment atmospheric exhaust line outboard isolation valve | 2 | A | I, A | L, P, S | R0 3 mo |
| F014 | 1 | Containment atmospheric bleed line outboard isolation valve | 2 | A | I, A | L, P, S | R0 |
| F015 | 1 | Containment atmospheric bleed line outboard isolation valve | 2 | A | I, A | L, P S | R0 3 mo |
| **U40 Reactor Building HVAC System Valves (COL Phase)** | | | | | | | |
| **U77 Control Building HVAC System Valves (COL Phase)** | | | | | | | |
| **U98 Fuel Building HVAC System Valves (COL Phase)** | | | | | | | |

Notes:

a) 1, 2 or 3 – ASME Section III Code classes per, Section 3.2.

c) A, B, C or D – Valve category per ASME OM Code –Subsection ISTC.

d) Valve Function:

I – Primary containment isolation per Subsection 6.2.4.

A or P – Active or passive per ASME OM Code – Paragraph ISTC-1300.

e) Valve test parameters per ASME OM Code – Subsection ISTC and Appendix I:

L - Seat leakage rate (Paragraph ISTC-3600 and DCD Tier 2 Subsection 6.2.6.3 for valves with function I in (d) above)

P - Valve position verification (Paragraph ISTC-3700)

R - Safety and relief test including visual examination, set pressure and seat tightness testing in accordance Paragraph ISTC-3000, -5230, -5240, Table ISTC-3500-1, Note (2), and Appendix I). Category A and B requirements for safety and relief valves of ISTC-3500 and ISTC-3700 are excluded per ISTC-1200.

S - Exercising tests for Category A and B valves (Paragraph ISTC-3521) and Category C valves (Paragraph ISTC-3522).

X - Explosively actuated valve tests (Paragraph ISTC-5260)

f) Valve test frequency for the specified test parameter including summary of exclusions and alternatives per ASME OM Code – Subsection ISTC and Appendix I:

CS — Cold shutdown

R0 — Refueling outages. For position verification: refueling outages, but in no case greater than two years.

E1 – Valves used only for operating convenience, i.e., passive vent, drain, instrument, test, maintenance and system control valves. These valves are not required for primary containment isolation. Tests are not required per Paragraph ISTC-1200 (i.e., the valves are exempt per the criteria given in ISTC-1200).

E2 – Fired and replaced per Paragraph ISTC-5260.

E3 – Test scheduled per Appendix I, Paragraph I-3000.

g) Summary justification for code defined testing exceptions or alternatives against Paragraphs ISTC-3510 for exercising tests and ISTC-3630 for seat leakage rate tests.

g1) Inaccessible inerted containment and/or steam tunnel radiation during power operations.

g2) Avoid valve damage during power operations.

g3) Avoid impacts on power operations.

g4) May not be Category C tested, but is subject to the periodic Category A test per DCD Tier 2 Subsection 6.2.6.3 for instrument lines that penetrate containment.

g5) These lines are subject to periodic Category A test for verifying their leaktight integrity and may not be Category C tested.

g6) These lines terminate below the drywell sumps water level and are sealed from the containment atmosphere. No Category C leakage rate test is required.

h) General Note on Check Valves: To satisfy the requirement for position verification of ISTC-3700 for check valves, where local observation is not possible, other indications shall be used for verification of valve operation.