## ArevaEPRDCPEm Resource

**From:** BRYAN Martin (EXT) [Martin.Bryan.ext@areva.com]
**Sent:** Monday, June 14, 2010 5:08 PM
**To:** Tesfaye, Getachew
**Cc:** WELLS Russell D (AREVA NP INC); ROMINE Judy (AREVA NP INC); VAN NOY Mark (EXT); CORNELL Veronica (EXT); WILLIFORD Dennis C (AREVA NP INC)
**Subject:** DRAFT Response to U.S. EPR Design Certification Application RAI No. 381, FSAR Ch. 3 OPEN ITEM, Supplement 1
**Attachments:** RAI 381 Supplement 1 Response US EPR DC - DRAFT.pdf; 33 FSAR Tier 2 Section 3.9.6.pdf

Getachew,

AREVA NP Inc. provided a schedule for a technically correct and complete response to the 4 Open Item questions of RAI No. 381 on May 20, 2010. The attached file, "RAI 381 Supplement 1 Response US EPR DC-Draft.pdf" provides a DRAFT response to 3 of the 4 remaining Open Item questions.

Appended to this file is the affected page of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which supports the response to RAI 381 Questions 03.09.06-15, 03.09.06-16, and 03.09.06-17

The schedule for a technically correct and complete FINAL response to the RAI 381 questions is unchanged (July 14, 2010).
Also, to assist NRC in their review of this DRAFT RAI response, attached is a complete version of U.S. EPR FSAR Tier 2, Section 3.9.6 (minus the tables) including the changes contained in this RAI response. Available times to support a telecon to go over these draft responses has been provided separately.

Sincerely,

Martin (Marty) C. Bryan
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.
Tel: (434) 832-3016
702 561-3528 cell
Martin.Bryan.ext@areva.com

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**From:** BRYAN Martin (EXT)

**Created By:** Martin.Bryan.ext@areva.com

**Recipients:**
"WELLS Russell D (AREVA NP INC)" <Russell.Wells@areva.com>
Tracking Status: None
"ROMINE Judy (AREVA NP INC)" <Judy.Romine@areva.com>
Tracking Status: None
"VAN NOY Mark (EXT)" <Mark.Vannoy.ext@areva.com>
Tracking Status: None
"CORNELL Veronica (EXT)" <Veronica.Cornell.ext@areva.com>
Tracking Status: None
"WILLIFORD Dennis C (AREVA NP INC)" <Dennis.Williford@areva.com>
Tracking Status: None
"Tesfaye, Getachew" <Getachew.Tesfaye@nrc.gov>
Tracking Status: None

**Post Office:** AUSLYNCMX02.adom.ad.corp

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**Response to**

**Request for Additional Information No. 381(4421, 4529)**
**Supplement 1, Revision 1,**
**4/21/2010**

**U. S. EPR Standard Design Certification**
**AREVA NP Inc.**
**Docket No. 52-020**
**SRP Section: 03.07.04 - Seismic Instrumentation**
**SRP Section: 03.09.06 - Functional Design Qualification and Inservice Testing Programs for Pumps, Valves, and Dynamic Restraints**

**Application Section: FSAR Chapter 3**

**QUESTIONS for Geosciences and Geotechnical Engineering Branch 2 (RGS2)**
**QUESTIONS for Component Integrity, Performance, and Testing Branch 1 (AP1000/EPR Projects) (CIB1)**

**Question 03.09.06-15:**

**OPEN ITEM**

FSAR Tier 2, Sections 3.9.3.3 and 3.9.3.4 state that FSAR Tier 2, Section 3.9.6 provides a description of the functional design and qualification provisions for pumps, valves, and snubbers. While FSAR Tier 2, Section 3.9.6.1 states that the “functional design and qualification of each safety-related pump and valve is performed such that each pump and valve is capable of performing its intended function for a full range of system differential pressure and flow, ambient temperatures, and available voltage (as applicable) under conditions ranging from normal operating to design-basis accident conditions,” this FSAR section focuses on IST rather than functional design and qualification. As discussed below, the staff has determined that the current provisions in FSAR Tier 2, Section 3.9.3.3, 3.9.3.4, and Section 3.9.6 are not sufficient to adequately describe a program that will provide reasonable assurance of the design-basis capability of pump, valves, and dynamic restraints for the U.S. EPR.

As documented in numerous NRC generic communication issuances, weaknesses in the design programs for plant components used at operating nuclear power plants have resulted in situations in which valves might not have been able to perform their safety-related functions under design-basis conditions. As a result of the lessons learned from nuclear power plant operating experience and NRC and industry research programs, the staff has provided guidance related to the functional design of safety-related pumps, valves, and dynamic restraints in SRP Section 3.9.6; RG 1.206, and RG 1.100. One lesson learned from nuclear power plant operating experience and research programs is that the IST provisions of the ASME OM Code alone do not adequately provide assurance of the design-basis capability of safety-related valves.

In RAI 49, Question 03.09.06-1, the staff requested that the Design Certification applicant describe its plans to provide assurance of the design-basis capability of pumps, valves, and dynamic restraints for the U.S. EPR design.

In a June 11, 2009, Supplement 2 response to RAI 49, Question 03.09.06-1, the applicant indicated that it intended to use ASME QME-1-2007, “Qualification of Active Mechanical Equipment Used in Nuclear Power Plants,” as guidance for qualifying active mechanical equipment. However, the applicant did not provide an FSAR markup indicating that it would follow all of the provisions of ASME QME-1-2007, nor are the current provisions in the U.S. EPR FSAR Tier 2 for design testing in Sections 3.9.3 and 3.9.6 sufficient to allow the staff to evaluate the process for the functional design and qualification to ensure the systematic review and documentation of the design basis for safety-related pumps, valves, and snubbers. For example, the design process should include consideration of the maximum differential pressure and flow rate expected during operation of the component for both normal operations and abnormal events, to the extent that these operations and events are part of the design basis. One acceptable method for providing assurance that active mechanical equipment (such as pumps, valves, and dynamic restraints) will meet their design-basis functional capability is specified in ASME QME-1-2007, as accepted by the staff in Revision 3 to RG 1.100. Therefore, in follow-up RAI 49, Question 03.09.06-15, the staff requests that the applicant revise the U.S. EPR FSAR to adequately describe the functional design and qualification process for pumps, valves, and dynamic restraints (or specify implementation of QME-1-2007 as accepted in Revision 3 to RG 1.100), with examples of the implementation of the FSAR provisions in the design specifications made available for NRC audit.

**Response to Question 03.09.06-15:**

U.S. EPR FSAR Tier 2, Section 3.9.6.1, Section 3.10.1.1, and Section 3.10.2 will be revised to indicate that the functional design and qualification testing of safety-related pumps, valves, and snubbers is performed in accordance with ASME QME-1-2007, with clarifications regarding the non-mandatory appendices of ASME QME-1-2007 as described in U.S. EPR FSAR Tier 2, Section 3.10.2. U.S. EPR FSAR Tier 2, Table 1.9-2 will be revised to change the reference from RG 1.100, Revision 2 to Revision 3. U.S. EPR FSAR Tier 2, Section 3.10.1.1, Section 3.11.2.3.4, and Table 3.11-4 will be revised to indicate that RG 1.100, Revision 3 endorses IEEE Std 344-2004.

The availability of design specifications for NRC audit will be addressed in the Response to RAI 404, Question 03.09.03-24, which is a follow-up question to the Response to RAI 107, Question 03.09.03-4 and the Response to RAI 178, Question 03.09.03-18.

**FSAR Impact:**

U.S. EPR FSAR Tier 2, Table 1.9-2, Section 3.9.6.1, Section 3.10.1.1, Section 3.10.2, Section 3.11.2.3.4, and Table 3.11-4 will be revised as described in the response and indicated on the enclosed markup.

**Question 03.09.06-16:**

**OPEN ITEM**

FSAR Tier 2, Section 3.9.6.1 indicates that the IST program provides for pump and valve testing over the full range of system differential pressures, flow-rates, temperatures, and available voltages (as applicable) from normal operating to design-basis conditions and considers degraded flow that may occur during post-accident conditions. The staff was unable to confirm that safety-related systems were provided with full-flow test capabilities on design drawings. This was the subject of RAI 49, Question 03.09.06-3. In a June 11, 2009, Supplement 2 response to RAI 49, Question 03.09.06-3, the applicant explained how each safety-related pump was capable of being tested at the accident assumed flow rates. In regard to safety-related valves, the applicant referred to the test procedures, acceptance criteria, and corrective actions specified in the ASME OM Code. As discussed above, the ASME OM Code inservice test alone cannot be used to demonstrate the design-basis capability of safety-related valves. Therefore, in follow-up RAI 49, Question 03.09.06-16, the staff requests that the applicant revise the U.S. EPR FSAR to describe the testing and/or analysis performed to demonstrate the design-basis capability of safety-related valves.

**Response to Question 03.09.06-16:**

Additional information on the testing and/or analysis performed to demonstrate the design-basis capability of safety-related valves will be added to new U. S. EPR FSAR Tier 2, Section 3.9.6.1.1. As stated in the Response to Question 03.09.06-15, the primary method for functional design and qualification is based on ASME QME-1-2007. Based on the Response to Question 03.09.06-15 and its associated U.S EPR FSAR Tier 2, Section 3.9.6.1 markup, U.S. EPR FSAR Tier 2, Section 3.9.6.1 has been revised to delete extraneous information or relocate some of the information to U.S. EPR FSAR Tier 2, Section 3.9.6.

**FSAR Impact:**

U.S. EPR FSAR Tier 2, Sections 3.9.6 and 3.9.6.1 will be revised as described in the response and indicated on the enclosed markup.

**Question 03.09.06-17:**

**OPEN ITEM**

In RAI 49, Question 03.09.06-6 the staff requested that the applicant clarify the use of static tests for the operability determinations of POVs. In a June 11, 2009, response to RAI 49, Question 03.09.06-6, the applicant proposed revisions to FSAR Tier 2, Sections 3.9.6.3.1, "Inservice Testing Program for Motor-Operated Valves," and 3.9.6.3.2, "Inservice Testing Program for Power-Operated Valves Other Than MOVs."

1. Proposed FSAR Tier 2, Section 3.9.6.3.1.3 states that the interval between testing to demonstrate continued design-basis capability does not exceed 5 years or three refueling outages, whichever is longer. However, the JOG MOV programs test frequencies vary from one refueling outage (e.g., for high-risk low-margin MOVs) up to 5 years or three refueling outages, whichever is longer. Test frequency should be established to provide assurance that the MOVs will remain capable of performing their design-basis function until at least the next scheduled test. Test frequencies should be evaluated each refueling outage based on data trends from MOV test results and operating experience. Therefore, the staff requests that the applicant revise the frequency of MOV testing to be consistent with the JOG MOV program.

2. Based on its review, the staff does not consider the applicant to have fully described the IST program for POVs, other than MOVs, for the U.S. EPR. In particular, the applicant has not described how the POV testing program for the U.S. EPR compares to the JOG AOV Program, how POV functional margin and test frequencies will be determined, and how static or dynamic tests (or both) will be performed to confirm operability and develop the basis for future testing for POVs. Therefore, in follow-up RAI XXX, Question 03.09.06-17, the staff requests that the applicant revise the U.S. EPR FSAR to (1) reference the NRC comments on the JOG AOV program contained in the NRC letter to the Nuclear Energy Institute (NEI), October 8, 1999, and (2) incorporate into the FSAR additional attributes of a successful POV design capability and long-term periodic verification program as listed in Regulatory Issue Summary (RIS) 2000-3. The following program attributes should be included in the description of the IST program for POVs:

    a. Valves will be categorized according to their safety significance and risk ranking.

    b. Post-maintenance procedures will include appropriate instructions and criteria to ensure baseline testing is re-performed as necessary when maintenance on a valve, valve repair, or replacement has the potential to affect valve functional performance.

    c. Procedures and training specific to the AOV program will address lessons learned from other valve programs and documentation from AOV testing, and maintenance records and records from the corrective action program will be retained and periodically evaluated as part of the AOV program.

3. Finally, the U.S. EPR FSAR should indicate that the attributes of the AOV testing program described above, to the extent that they apply to and can be implemented with respect to other safety-related POVs will be applied to those other POVs.

**Response to Question 03.09.06-17:**

1. The test frequency in U.S. EPR FSAR Tier 2, Section 3.9.6.3.1.3 is based on the initial test interval for motor operated valves (MOVs) in the ASME OM code. As noted in U.S. EPR FSAR Tier 2, Section 3.9.6.3.1.3, longer design-basis verification intervals may be justified through implementation of ASME Code Case OMN-1, as accepted in RG 1.192. U.S. EPR FSAR Tier 2, Section 3.9.6.3.1.3 will be revised to state that test frequency is specified and evaluated in each refueling outage based on data trends as a result of testing in accordance with the Joint Owners Group (JOG) MOV Program (See U.S. EPR FSAR Tier 2, Section 3.9.6.6, Reference 9).
2. The last bullet in U.S. EPR FSAR Tier 2, Section 3.9.6.3.2.2 will be revised to state that the frequency for periodic testing is in accordance with the JOG AOV Program (See U.S. EPR FSAR Tier 2, Section 3.9.6.6, Reference 11) and the NRC comments on the JOG AOV program (See U.S. EPR FSAR Tier 2, Section 3.9.6.6, Reference 13) with a minimum of five years (or three refueling cycles) of data collected and evaluated before extending test intervals.
   A. Because of the small number of safety-related air-operated valves (AOVs) in the U.S. EPR (i.e., 10) as shown in U.S. EPR FSAR Tier 2, Table 3.9.6-2, the safety-related AOVs will be assigned the highest category according to the JOG AOV Program (i.e., Category 1, which are AOVS that are safety-related, active, and have high safety significance). This statement will be added to U.S. EPR FSAR Tier 2, Section 3.9.6.3.2.2. According to the JOG AOV program, high safety significance is defined as "designation referring to the importance to plant safety by a blended process of risk ranking and expert panel evaluations." This ranking will be assigned in accordance with the reliability assurance program described in U.S. EPR FSAR Tier 2, Section 17.4.
   B. The requested information regarding post-maintenance procedures will be added to U.S. EPR FSAR Tier 2, Section 3.9.6.3.2.2.
   C. The requested information regarding procedures and training specific to the AOV program will be added to U.S. EPR FSAR Tier 2, Section 3.9.6.3.2.2.
3. The requested information regarding the attributes of the AOV testing program will be added to U.S. EPR FSAR Tier 2, Section 3.9.6.3.2.2.

**FSAR Impact:**

U.S. EPR FSAR Tier 2, Section 3.9.6.3.1.3 and Section 3.9.6.3.2.2 will be revised as described in the response and indicated on the enclosed markup.

# U.S. EPR Final Safety Analysis Report Markups

**Table 1.9-2—U.S. EPR Conformance with Regulatory Guides**
**Sheet 8 of 19**

| RG / Rev | Description | U.S. EPR Assessment | FSAR Section(s) |
|---|---|---|---|
| 1.96, R1 | Design of Main Steam Isolation Valve Leakage Control Systems for Boiling Water Reactor Nuclear Power Plants | N/A-BWR | N/A |
| 1.97, R4 | Criteria For Accident Monitoring Instrumentation For Nuclear Power Plants | Y | 3.10<br>3.11.2<br>7.1<br>7.5<br>11.5<br>12.3<br>16.B3.3<br>18.7 |
| 1.98, 03/1976 | Assumptions Used for Evaluating the Potential Radiological Consequences of a Radioactive Offgas System Failure in a Boiling Water Reactor | N/A-BWR | N/A |
| 1.99, R2 | Radiation Embrittlement of Reactor Vessel Materials | Y | 5.3.1<br>5.3.2 |
| 1.100, R~~2~~3 | Seismic Qualification of Electrical and Active Mechanical Equipment and Functional Qualification of Active Mechanical Equipment for Nuclear Power Plants | Y | 3.10<br>3.11<br>~~App 3D, Att. E~~<br>3.9.6,<br>Appendix 3D Attach E |
| 1.101, R5 | Emergency Planning and Preparedness for Nuclear Power Reactors | N/A-COL | N/A |
| 1.102, R1 | Flood Protection for Nuclear Power Plants | Y | 3.4 |

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This information was previously in 3.9.6.1.1

Reference 2 defines the IST scope by establishing the PST, IST, and examination of components to assess their operational readiness. The ASME OM Code identifies components subject to test examination, as well as testing responsibilities, methods, intervals, parameters to be measured and evaluated, criteria for evaluating results, corrective action, personnel qualification, and record keeping. These requirements apply to:

- Pumps and valves that are required to perform a specific function in bringing the reactor to a safe shutdown condition, maintaining the reactor in safe shutdown condition, or mitigating the consequences of an accident.
- Pressure relief devices that protect systems, or portions of systems, that perform one or more of the three functions described above.
- Dynamic restraints used in systems that perform one or more of these three functions, or that protect the integrity of the RCPB.

The initial testing program (ITP) is described in Section 14.2 and envelopes the PST program. Detailed test procedures are developed and conducted as a part of the initial plant startup program. These tests include parameters and acceptance criteria that can be used to establish and measure reference values for components in the IST program. These tests also include requirements for instrumentation range and accuracy. The IST program will evaluate results of preoperational testing to establish IST baseline values.

The IST program for pumps is addressed in Section 3.9.6.2, for valves in Section 3.9.6.3, and for snubbers in Section 3.9.6.4. The IST program also includes provisions for relief requests and requests for alternate testing methods, which are addressed in Section 3.9.6.5.



A COL applicant that references the U.S. EPR design certification will submit the PST program and IST program for pumps, valves, and snubbers as required by 10 CFR 50.55a.

A COL applicant that references the U.S. EPR design certification will identify the implementation milestones and applicable ASME OM Code for the preservice and inservice examination and testing programs. These programs will be consistent with the requirements in the latest edition and addenda of the OM Code incorporated by reference in 10 CFR 50.55a on the date 12 months before the date for initial fuel load.

### 3.9.6.1 Functional Design and Qualification of Pumps, Valves, and Dynamic Restraints

IST of safety-related pumps, valves, and snubbers is performed in accordance with Reference 2 and applicable addenda, as required by 10 CFR 50.55a(f), and the guidance provided in RG 1.192 and NUREG-1482, Revision 1 (Reference 3). The ASME OM

Code is incorporated by reference in 10 CFR 50.55a(b)(3). ASME OM Code Subsection ISTB defines the functional testing requirements for pumps. Subsection ISTC defines the functional testing requirements for valves, and Subsection ISTD defines the functional testing requirements for snubbers.

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The functional design and qualification of safety-related pumps, valves, and snubbers is performed in accordance with ASME QME-1-2007 (Reference 12) with clarifications as described in Section 3.10.2. The IST program for pumps is addressed in Section 3.9.6.2, for valves in Section 3.9.6.3, and for snubbers in Section 3.9.6.4. The IST program also includes provisions for relief requests and requests for alternate testing methods, which are addressed in Section 3.9.6.5.. As described in Section 3.9.6.3, the IST program also incorporates operating experience.

In accordance with RG 1.206 and the acceptance criteria of SRP 3.9.6, functional design and qualification of pumps, valves, and snubbers includes the following:

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this bullet is identical to the criteria in RG 1.206 and the SRP

- Safety-related pump, valve, and piping designs include provisions to allow testing of pumps and valves at the maximum flow specified in the plant accident analyses.
- Functional design and qualification of each safety-related pump and valve is performed such that each pump and valve is capable of performing its intended function for a full range of system differential pressure and flow, ambient temperatures, and available voltage (as applicable) under conditions ranging from normal operating to design-basis accident conditions.
- The provisions for the design and qualification of snubbers are provided in Section 3.9.3, Section 3.9.6.4, and the U.S. EPR Piping Analysis and Pipe Support Design Topical Report, Section 6.6 (Reference 6). Snubbers in safety-related systems include provisions to allow access for IST program activities (Section 3.9.6.4).
- The design and installation of safety and relief valves is described in Section 3.9.3.
- The seismic and dynamic qualification of mechanical and electrical is described in Section 3.10.
- Section 3.11 addresses the environmental qualification of safety-related pumps and valves.
- As required by GDC 14, safety-related valves that are part of the RCPB are designed and tested such that these valves will not experience any abnormal leakage, or increase in leakage, from their loading, as addressed in Section 3.10.
- As required by GDC 15 and in accordance with SRP 3.9.6, pumps, valves, and snubbers are designed with sufficient margin to demonstrate that the design conditions are not exceeded in accordance with Reference 2. Pump motors are designed to tolerate anticipated frequency and voltage variations due to degraded electrical power supply line conditions.

#### 3.9.6.1.1 Additional Information on Design and Qualification of Valves

Consistent with Bellefonte COLA

The ability of a valve to meet its design basis functional requirements (i.e., required capability) is verified during valve qualification testing as required by procurement specifications. Requirements for qualification testing of motor-operated active valves are included in procurement specifications. Valve qualification testing measures valve actuator output capability. Actuator output capability is compared to the valve's required capability defined in procurement specifications, establishing functional margin; that is, that increment by which the MOV's actual output capability exceeds the capability required to operate the MOV under design basis conditions.

##### 3.9.6.1.1.1 Motor-Operated Valves (MOV) Design and Qualification

Consistent with AP1000 Section 5.4.8.1.2

Design basis and required operating conditions are established for active safety-related MOVs. Based on the design conditions, the MOVs have a structural analysis performed to demonstrate their components are within the structural limits at the design conditions. The MOVs are designed for a range of conditions up to the design conditions, which includes fluid flow, differential pressure (including line break, if necessary), system pressure and temperature, ambient temperature, operating voltage range, and stroke time. The sizing of the motor operators on the valves consider diagnostic equipment accuracies, changes in output capability for increasing differential pressures and flow, and ambient temperature and reduction in motor voltage, control switch repeatability, friction variations, and other changes in parameters that could result in an increase in operating loads or a decrease in operator output.

The MOVs have a functional qualification performed to demonstrate by test, by analysis, or by a combination thereof, the ability to operate over a range up to the design conditions. This functional qualification demonstrates the MOV capability during and after loads representative of the maximum seismic or vibratory event (as required to perform their intended function), demonstrate the valve sealing capability, demonstrate capability under cold and hot operating conditions, demonstrate capability under maximum pipe end loads, and demonstrate flow interruption and functional capability. The testing includes test data provided by the manufacturer, field test data, empirical data supported by testing or analysis of prototype tests of similar MOVs that support the qualification where similarity must be justified by technical data. The qualification is used for validating the required thrust and torque as applicable to operate the valve and the output capability of the motor operator.

Further information on MOVs is described in Section 3.9.6.3.1.

##### 3.9.6.1.1.2 Other Power-Operated Valves (POV) Design and Qualification

Consistent with AP1000 Section 5.4.8.1.2

Design basis and required operating conditions are established for POVs with an active safety-related function. POV assemblies include pneumatic-hydraulic-, air piston-, and solenoid-operated assemblies. POVs have a structural analysis performed to demonstrate their components are within the structural limits at the design conditions. POVs are designed to accept the maximum compression, tension, and torsional loads which the assembly is capable of producing in combination with other loads such as pressure, thermal, or externally applied loads. The maximum loading resulting from the design conditions and transients is evaluated in accordance with the ASME Code Section III, Class 1 design requirements. Packing adjustment limits are identified to reduce the potential for stem binding.

03.09.06-16

POVs have a functional qualification performed to demonstrate by test, by analysis, or by a combination thereof, the ability to operate at the design conditions. Qualification testing of each size, type, and model is performed under a range of differential pressures and maximum achievable flow conditions up to the design conditions. This functional qualification will demonstrate the POVs capability during and after loads representative of the maximum seismic or vibratory event (as required to perform their intended function), demonstrate the valve sealing capability, demonstrate capability under cold and hot operating conditions, demonstrate capability under maximum pipe end loads and demonstrate flow interruption and functional capability. The testing includes test data from the manufacturer, field test data, empirical data supported by test, or analysis of prototype tests of similar power-operated valves that support qualification of the power-operated valve. Similarity must be justified by technical data. Solenoid-operated valves are verified to satisfy the applicable requirements for Class 1E components. Solenoid-operated valves are verified to perform their safety-related design requirements over a range of electrical power supply conditions including minimum and maximum voltage.

Further information on POVs is described in Section 3.9.6.3.2.

~~Pumps and valves are tested within the IST program requirements to confirm that the required components are capable of performing their intended safety function. The safety analysis includes information concerning the design limitations and functional requirements for the performance of pumps and valves, including operation at the maximum flowrate. The IST pump functional design and pump qualification include an assessment for degraded flow conditions. The IST program requires pump and valve testing over the full range of system differential pressures, flowrates, temperatures, and available voltages (as applicable), from normal operating to design basis conditions and considers degraded flow that may occur during post-accident conditions. IST testing is also performed on RCPB valves to demonstrate that they will not experience leakage, or increased leakage, from their loading.~~

~~The U.S. EPR design provides ready access to SSC to facilitate comprehensive testing using currently available equipment and techniques. Accessibility incorporated into the design complies with the requirements of Reference 2 and 10 CFR 50.55a(f). System design incorporates provisions, including alternate flow paths and required~~

MOVs are tested in accordance with the Reference 2 and the guidance of Reference 3, including the following:

- Remote position-indication tests: Valves with position indicators that are included in the IST program are observed locally during valve exercising to verify that the indicators are operating correctly. Where local observation is not practical, other methods are used to verify correct valve position indicator operation.

- Leakage tests: Safety-related valves with seat leakage limits are tested to verify that leakage does not exceed allowable limits. This testing includes valves that isolate piping and lines that penetrate containment; these valves are tested in accordance with 10 CFR 50, Appendix J. Most valves are tested individually as a part of the Type C testing, depending on the valve function and configuration.

- Exercise tests: Safety-related MOVs are exercised periodically, and generally undergo full-stoke exercise testing quarterly. Measuring stroke time is not a separate inservice test, but is done as part of periodic testing. If it is impractical to exercise a valve during plant operation, the valve may be full-stroke tested during cold shutdowns. Valves that operate during normal plant operation and at a frequency that satisfies exercising requirements need not be additionally exercised, provided that IST-required observations are made at intervals no greater than that specified in the IST plan.

A list of MOVs included in the IST program is provided in Table 3.9.6-2.

**Non-Code Testing of MOVs**

The MOV testing program incorporates the Joint Owners' Group (JOG) Motor-Operated Valve (MOV) Periodic Verification (PV) Program (Reference 9) to address Generic Letter 96-05, (Reference 4).

Operability testing relies on non-intrusive diagnostic techniques. These tests are conducted in either static or dynamic conditions in accordance with Reference 9.

Testing is performed to confirm that an adequate margin exists in MOV capabilities. These tests include verification that the MOV achieves maximum required torque or thrust, as applicable. The tests include consideration of diagnostic equipment inaccuracies, degraded voltages, control switch repeatability, load-sensitive MOV behavior, and the margin for degradation. These tests also indicate hard seat-contact and verify that the tests performed do not exceed the allowable structural and under-voltage motor capability limits for the individual parts of the MOV.

### 3.9.6.3.1.3 Testing Frequency

The interval between testing to demonstrate continued design basis capability does not exceed five years or three refueling outages, whichever is longer. Longer design-basis verification intervals may be justified through implementation of ASME Code Case OMN-1, as accepted in RG 1.192. Test frequency is also specified and evaluated each

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refueling outage based on data trends as a result of testing. Frequency for periodic testing is in accordance with Reference 9.

### 3.9.6.3.1.4 Acceptance Criteria

Acceptance criteria for successful completion of the PST and IST of MOVs includes the following:

- Consistent with the safety function, the valve fully opens and/or the valve fully closes or both. Diagnostic equipment indicates hard seat contact.
- The testing demonstrates adequate margin with respect to the design basis, including consideration of diagnostic equipment inaccuracies, degraded voltage, control switch repeatability, load sensitive MOV behavior, and margin for degradation.
- The maximum torque and/or thrust (as applicable) achieved by the MOV, allowing sufficient margin for diagnostic equipment inaccuracies and control switch repeatability, does not exceed the allowable structural and undervoltage motor capability limits for the individual parts of the MOV.

~~IST of ASME Section III Class 1, 2, and 3, and safety-related motor-operated valves (MOV) is performed in accordance with the Reference 2 and applicable addenda, as required by 10 CFR 50.55 a(f). Testing is required except where specific relief has been granted by the NRC. The IST program incorporates the guidance of RG 1.192 and Reference 3. NRC accepted Code Case OMN-1 (RG 1.192) is also used for PST and IST to assess the operational readiness of MOVs.~~

~~Periodic verification of safety-related MOVs is performed in accordance with Generic Letter 96-05 (Reference 4) which supersedes Generic Letter 89-10 (Reference 5) and its supplements with regard to MOV periodic performance verification. The MOV testing program also incorporates the recommendations from the Joint Owners Group (JOG) MOV Periodic Verification (Reference 9).~~

~~The MOV testing program requires either in-plant valve operation or prototype valve testing at system flow and pressure or system differential pressure to verify correct MOV actuator sizing and control settings. The PST program for MOVs is conducted in accordance with 10 CFR 50.55a(b)(3)(ii) and Reference 2, ISTC 3100 under conditions as near as practical to those expected during subsequent IST. The interval between testing to demonstrate continued design basis capability does not exceed five years or three refueling outages, whichever is longer.~~

~~IST of an MOV relies on diagnostic techniques that assess valve performance under actual loading. Periodic testing per Reference 2, Subsection ISTC and Reference 4 is conducted under adequate differential pressure and flow conditions to demonstrate that the MOV continues to perform its safety function to open and close, as applicable,~~

the plant for the valve, which would provide adequate periodic demonstration of air-operated valve capability. If required based on valve qualification or operating experience, periodic dynamic testing is performed to re-verify the capability of the valve to perform its required functions.

- Sufficient diagnostics are used to collect relevant data (e.g., valve stem thrust and torque, fluid pressure and temperature, stroke time, operating and/or control air pressure, etc.) to verify the valve meets the functional requirements of the qualification specification.

- Test frequency is specified, and is evaluated each refueling outage based on data trends as a result of testing. Frequency for periodic testing is in accordance with References 11 and 13, with a minimum of five years (or three refueling cycles) of data collected and evaluated before extending test intervals.

- Safety-related air operated valves are assigned the highest category according to Reference 11.

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- Post-maintenance procedures (which are the responsibility of the COL applicant as described in Section 17.6) include appropriate instructions and criteria to demonstrate baseline testing is re-performed as necessary when maintenance on a valve, valve repair, or replacement has the potential to affect valve functional performance.

Consistent with North Anna COLA

- Guidance is included to address lessons learned from other valve programs in procedures and training specific to the AOV program.

- Documentation from AOV testing, including maintenance records and records from the corrective action program, are retained and periodically evaluated as a part of the AOV program.

- The attributes of the AOV testing program described above, to the extent that they apply to and can be implemented on other safety-related power-operated valves, such as electro-hydraulic valves, are applied to those other power-operated valves.



~~Power-operated valves (POV), other than MOVs, include valves actuated by solenoid, hydraulic, or pneumatic operators. The ability of POVs to perform their design-basis functions is verified either before installation or as part of preoperational testing performed during the initial plant startup test program, as described in Section 14.2. This includes verification that solenoid-operated valves (SOV) continue to be capable of performing their design-basis safety functions.~~

~~The POV IST program incorporates industry and regulatory experience (including Generic Letters 89-10 and 96-05 (Reference 4 and Reference 5) and INPO operating experience) and information gained through analysis, design, maintenance, and testing of the valves within specific safety-related systems. The IST program for POVs includes programmatic features of the Joint Owners Group (JOG) Program in response to Reference 4. When the margin between component capability and design-basis~~

4. Generic Letter 96-05, "Periodic Verification of Design Basis Capability of Safety-Related Motor-Operated Valves," U.S. Nuclear Regulatory Commission, September 18, 1996.

5. Generic Letter 89-10, "Safety-Related Motor-Operated Valve testing and Surveillance," U.S. Nuclear Regulatory Commission, June 28, 1989.

6. ANP-10264NP-A, Revision 0, "U.S. EPR Piping Analysis and Pipe Support Design Topical Report," AREVA NP Inc., November 2008.

7. ASME Boiler and Pressure Vessel Code, Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," The American Society of Mechanical Engineers, 2004 edition.

8. Generic Letter 90-09, "Alternative Requirements for Snubber Visual Inspection Intervals and Corrective Actions," U.S. Nuclear Regulatory Commission, May 14, 1990.

9. MPR-2524-A, "Joint Owners Group (JOG) Motor Operated Valve Periodic Verification Program Summary," MPR Associates, November 2006.

10. Regulatory Issue Summary 2000-03, "Resolution of Generic Safety Issue 158: Performance of Safety-Related Power-Operated Valves Under Design Basis Conditions," March 15, 2000.

11. Joint Owners Group Air Operated Valve Program Document, Revision 1, December 13, 2000.

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12. ASME QME-1-2007 Edition, "Qualification of Active Mechanical Equipment Used in Nuclear Power Plants," 2007 edition.

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13. Eugene V. Imbro (NRC) to Mr. David J. Modeen, Nuclear Energy Institute, Comments On Joint Owners' Group Air Operated Valve Program Document, October 8, 1999.

### 3.10.1 Seismic Qualification Criteria

#### 3.10.1.1 Qualification Standards

The methods employed for seismic and dynamic qualification of mechanical and electrical equipment are described or referenced in Section 3.10.2. These methods comply with the requirements of GDC 1, GDC 2, GDC 4, GDC 14, GDC 30, and 10 CFR 50, Appendix S. The methods used to implement the requirements of 10 CFR 50, Appendix B are described in Chapter 17.

An acceptable method for complying with the NRC regulations on the seismic qualification of electrical and mechanical equipment is described in RG 1.100, Revision ~~2~~3. This Regulatory Guide states that the procedures described in IEEE Std 344-~~1987~~2004 are acceptable to the NRC staff for satisfying the NRC regulations pertaining to seismic qualification of electrical and mechanical equipment. AREVA NP ~~plans to~~ uses IEEE Std 344-2004[1] (Reference 5) to provide the technical requirements for seismic qualification of components that are included in the environmental qualification (EQ) program, along with other components that are not addressed in the EQ program. Seismic qualification based on experience, per Section 10 of IEEE Std 344-2004, is not utilized by AREVA NP.

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The methods and guidance in ASME QME-1-2007 (Reference 7), as endorsed in RG 1.100, Rev. 3 are also used for seismic qualification of active mechanical equipment. See Section 3.10.2 for further discussion on QME-1-2007.

The U.S. EPR design utilizes the following procedures in IEEE Std 344 for seismic qualification of electrical and mechanical equipment:

- Predicting equipment performance by analysis.
- Testing the equipment under simulated seismic conditions.
- Qualifying the equipment by a combination of analysis and testing.
- Use of applicable test data from previous qualification of similar equipment.

Electrical and mechanical equipment for the U.S. EPR is qualified only for the case of the SSE defined in Section 3.7.1. As described in Section 3.7, consideration of design cases for an operating basis earthquake (OBE) is not a design requirement for the U.S. EPR. Therefore, low-level seismic effects (fatigue) required by IEEE Std 344 to qualify electrical and mechanical equipment are considered using the equivalent of five OBE

1. Section 3.11 provides the justification for the use of the latest version of the IEEE standards referenced in this section that have not been endorsed by existing Regulatory Guides. AREVA NP maintains the option to use current NRC-endorsed versions of the IEEE standards.

Testing is the preferred method for seismic equipment qualification. The type of test used to establish qualification depends on many factors, such as the type of equipment, its safety function, its location, and its flexibility.

Qualification by analysis only, can be used under the following conditions:

- Maintaining the structural and pressure boundary integrity is sufficient to perform its safety-related functions.
- The equipment is structurally simple and its behavior can be predicted by a conservative analytical approach.
- The equipment is too large or heavy to obtain a representative test input at existing test facilities. As required, the essential control devices and electrical parts of the equipment are tested separately.
- The interfaces, such as interconnecting cables to a cabinet, cannot be conservatively considered in the testing.

The loads to be considered in the analysis and the methods of combining responses are described in Section 3.9 and Attachment E to Appendix 3D.

Active valves and dampers can be qualified by a combination of analysis and testing to demonstrate operability and structural integrity. Attached appurtenances, such as operators, limit switches, and solenoid valves, can be qualified separately by testing, as recommended in IEEE Std 382 (Reference 6) and IEEE Std 344.

Mechanical and electrical equipment may also be seismically qualified using previous seismic qualification testing, subject to suitable similarity analyses, where such previous testing has been determined to meet the specified performance requirements and acceptance criteria. This qualification is based on the guidelines in IEEE Std 344-2004, supplemented with analysis as required.

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AREVA position developed on QME-1, consistent with similar position taken by GE in a recent RAI response

In endorsing the use of ASME QME-1-2007, the NRC in RG 1.100 Rev. 3 acknowledged that several appendices are designated as either non-mandatory or mandatory (e.g., Non-mandatory Appendix QR-A; Nonmandatory Appendix QR-B; Non-mandatory Appendices QDR-A, QDR-B, and QDR-C; Nonmandatory Appendices QP-A, QP-B, QP-C, QP-D, and QP-E; and Mandatory Appendix QV-I and Non-mandatory Appendix QV-A). RG 1.100 Rev. 3 states that if a licensee commits to the use of non-mandatory appendices in ASME QME-1-2007 for its qualification of active mechanical equipment, then the criteria and procedures delineated in those nonmandatory appendices become part of the requirements for its qualification program, unless specific deviations are requested and justified. Section 3.9.6 defines the functional design, qualification, and inservice testing programs for pumps, valves, and dynamic restraints.

As noted in Section 3.10.1.1, QME-1-2007 is used for the seismic qualification of active mechanical equipment with the following clarifications:

Non-mandatory Appendix QR-A, "Seismic Qualification of Active Mechanical Equipment."
Non-mandatory Appendix QR-A is not utilized because seismic qualification is in accordance with IEEE 344-2004, which is consistent with QME-1-2007, Sections QV-7450(b), QR-A7100, QR-A7200, and QR-A7300. Additionally, Section 10.2, Earthquake Experience Data, QR-A7400 and QR-A7500, is not utilized by AREVA NP.

Non-mandatory Appendix QR-B, "Guide for Qualification of Nonmetallic Parts." Qualification of non-metallic parts is consistent with non-mandatory Appendix QR-B as described in Section 3.11.2.2.5.

Non-mandatory Appendices to Section QDR, "Qualification of Dynamic Restraints."
The provisions for the design and qualification of snubbers, regarding Section Appendix QDR and non-mandatory Appendices QDR-A, QDR-B, and QDR-C, are provided in Section 3.9.3, Section 3.9.6.4, and Reference 3, Section 6.6. As noted in Section 3.9.6.4, snubbers in safety-related systems include provisions to allow access for IST program activities.

Non-mandatory Appendices to Section QP, "Qualification of Active Pump Assemblies."
AREVA NP is not utilizing non-mandatory Appendices QP-A through QP-E. Pump and motor assemblies are designed and qualified in accordance with applicable standards (e.g., ASME B&PV Code, QME-1, ASME B16, IEEE 323, IEEE 334, IEEE 344, RG 1.84, ASME NQA-1).

Appendices to Section QV, "Functional Qualification Requirements for Active Valve Assemblies for Nuclear Power Plants."

- Mandatory Appendix QV-I, "Qualification Specification for Active Valves," was used in the development of valve specifications.

- Non-mandatory Appendix QV-A, "Functional Specification for Active Valves for Nuclear Power Plants," is used as guidance in the development of valve specifications to demonstrate that lessons learned from industry experience are included in the specifications.

- The definition of "valve assembly" in Section QV-4000, "Definitions," refers to power operated valves. NRC considers the power actuators for valve assemblies to include all types of power actuators, such as motor, pneumatic, hydraulic, solenoid, and other drivers. The guidance in ASME QME-1-2007 may also be used, where applicable, in the qualification of manually operated valves.

- Section QV-6000, "Qualification Specification," states that the owner or owner's designee is responsible for identifying the functional requirements for

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a valve assembly, and that these requirements be provided in a qualification specification prepared in accordance with Mandatory Appendix QV-I. NRC considers Mandatory Appendix QV-I to be a necessary part of the implementation of Section QV of ASME QME-1-2007. For example, Mandatory Appendix QV-I provides the definitions of QV Category A and B valve assemblies used in Section QV of ASME QME-1-2007. As previously noted, Mandatory Appendix QV-I is used by AREVA NP in the development of valve specifications. Valves listed as active valves on the valve data sheets shall be functionally qualified in accordance with Section QV of ASME QME-1-2007, including mandatory Appendix QV-1 and Section QV-G, while being subjected to mechanical operating and mechanical loads (e.g., connected pipe loads), design pressure as specified in the valve data sheet, and the specified seismic accelerations. Functional testing includes mounted appurtenances.

### 3.10.2.1 Seismic Qualification of Electrical Equipment and Instrumentation

#### 3.10.2.1.1 Seismic Qualification by Type Test

Seismic qualification by testing is performed in accordance with IEEE Std 344. Multi-frequency and multi-axis testing are the preferred method of qualification, though the standard allows alternative testing methods, such as single-frequency and single-axis testing. Regardless of which testing method is used, the test will conservatively simulate and envelop the required seismic motion at the location of the equipment.

Recommended testing methods for different types and locations of equipment are detailed in Appendix 3D, Attachment E.

#### 3.10.2.1.2 Seismic Qualification by Analysis and Test

Qualification by analysis only when justified, or by analysis and testing when required, is permitted per IEEE Std 344. Operability and structural integrity of some components can be demonstrated by calculating critical component deflections and stresses under various combinations of operational and seismic loads. Resulting values are then compared to allowable levels, per applicable codes and equipment specification.

The methods of qualification by analysis are described in Appendix 3D, Attachment E.

### 3.10.2.2 Seismic Qualification of Active Mechanical Equipment

Active mechanical equipment is equipment that is required to perform a mechanical operation during or after a seismic event, while accomplishing its safety-related functions. The equipment in this category includes, but is not limited to, active valves and pumps. A list of all active valves and pumps is included in Section 3.9.6.

Active mechanical equipment is seismically qualified either by testing, using the methodology stated in IEEE Std 344 and detailed in Appendix 3D, Attachment E, or by compliance with the specified criteria. These records are updated and maintained current as equipment is replaced, modified, further tested, or requalified.

The equipment seismic qualification file contains a list of the systems' equipment and the equipment support structures. The equipment list identifies which equipment is NSSS supplied and which equipment is balance-of-plant supplied. The equipment qualification file includes qualification summary data sheets for each mechanical and electrical component of each system which summarizes the component's qualification. See Appendix 3D, Attachment F for a sample SQDP and Appendix 3D, Attachment A for a sample equipment qualification data package.

## 3.10.5 References


1. NUREG-1030, "Seismic Qualification of Equipment in Operating Nuclear Power Plants," U.S. Nuclear Regulatory Commission, February 1987.
2. European Utility Requirement for LWR Nuclear Power Plants, Volume 3, EPR Subset, December 1999.
3. ANP-10264NPA, Revision 0, "U.S. EPR Piping Analysis and Pipe Support Design," AREVA NP Inc., November 2008.
4. ASME Boiler and Pressure Vessel Code, Section III, "Rules for Construction of Nuclear Power Plant Components," The American Society of Mechanical Engineers, 2004.
5. IEEE Standard 344-2004, "IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations," Institute of Electrical and Electronics Engineers, June 2005.
6. IEEE Standard 382-2006, "IEEE Standard for Qualification of Safety-Related Actuators for Nuclear Power Generating Stations," Institute of Electrical and Electronics Engineers, March 2007.

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7. ASME QME-1-2007 Edition, "Qualification of Active Mechanical Equipment Used in Nuclear Power Plants," 2007 edition.

margin. The 2006 version specifies one transient with 15°F margin. The 1971 and 1994 versions do not address condition monitoring, but the 2006 version does.

The 1971 and 1994 versions define formettes and motorettes, but give no explanation how to include them in qualification. The 2006 version addresses how to include these items into the qualification test program as test specimens. The 1971 and 1994 versions do not include loading versus thermal requirements during qualification test. The 2006 version requires evaluation of the worst-case loading in DBA (continuous run or start/stop).

The latest edition of the standard, IEEE Std 334-2006 is a clarification and more up-to-date qualification standard that incorporates the knowledge and experience gained in the application of earlier standards. Therefore, AREVA NP believes that it is acceptable to use IEEE Std 334-2006 as the document to be used for qualification.

### 3.11.2.3.4 IEEE Std 344-2004, Recommended Practices for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations

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IEEE Std 344-2004 provides the recommended practices for seismic qualification of class 1E equipment. IEEE Std 344-2004 has been endorsed by NRC in RG 1.100, Rev. 3 (see Section 3.10.1.1).The following is a summary of a comparison of the various versions of this standard.

The IEEE Std 344-1971/1975 versions do not mention the Seismic Qualification Utility Group experience databases. The 1987 and 2004 versions discuss experience databases and how to apply operating experience to seismic qualification. Similarity for type testing is mentioned briefly in IEEE Std 1971/1975. Further discussion is given in IEEE Std 1987/2004. The IEEE Std 344-1971/1975 versions address uniaxial and biaxial excitation only. The 1987/2004 versions specify triaxial (preferred), then biaxial, then uniaxial and axial independence must be justified.

The IEEE Std 344-1971/1975 versions specify RMF or single frequency testing; 1987/2004 specifies RMF or RIM. Per application RMF can be supplemented with single frequency for peaks. The IEEE Std 1971/1975 versions specify static and dynamic analysis methods in general terms. The IEEE Std 344-1987/2004 versions specify numerous varieties of static and dynamic analyses with specific guidance. The IEEE Std 344-1971/1975 versions discuss only resonant search and modal testing. The IEEE Std 344-1987/2004 versions specify resonant search and modal testing and requirements to address resonances in testing to justify coupling. Transmissibility plots are required.

The IEEE Std 344-1971/1975 versions discuss the low impedance method and the exploratory tests used for qualification method selection. The IEEE Std 344-1987/2004 versions allow exploratory tests to be used as input for dynamic/static qualification analyses. The IEEE Std 344-1971/1975 versions defined "damping;" the 1987/2004

~~versions provide a method for calculating damping. The IEEE Std 344-1971/1975 versions define "seismic vibration." The IEEE Std 1987/2004 versions define and differentiate between Seismic and Non-Seismic vibration. The IEEE Std 344-1971/1975 versions defined "ZPA;" the IEEE Std 1987/2004 versions provide a method for calculating ZPA.~~

~~The latest edition of the standard, IEEE Std 344-2004, is a clarification and more up-to-date qualification standard that incorporates the knowledge and experience gained in the application of earlier standards. Therefore, AREVA NP believes that it is acceptable to use IEEE Std 344-2004 as the document to be used for qualification.~~

#### 3.11.2.3.5 IEEE Std 382-2006, Standard for Type Test of Class 1 Electric Valve Operators for Nuclear Power Generating Stations

The following discussion provides technical justification for the use of IEEE Std 382-2006 versus IEEE Std 382-1972, as endorsed by RG 1.73, Revision 0. A comparison of these documents is provided below:

- Documentation: The 2006 version requires additional configuration detail and specimen selection justification over the 1972 version and is considered to be more conservative.

- Type Testing: The 1972 version defines type testing and requires it, but provides no guidance or information on how to accomplish it. The 2006 version requires strict adherence to type test procedures and provides a definitive means to determine representative specimens to qualify a complete range of different equipment sizes. Therefore, the 2006 version is considered to be more conservative than the 1972 version.

- Test Sequence/Synergisms: Although synergisms were unknown in the 1972 version, test sequence was specified, in a manner similar to that provided by IEEE Std 323-1974, endorsed by RG 1.89 Revision 1. The 2006 version does account for synergisms, and requires the most severe test sequence to be followed, in accordance with IEEE Std 323-1974. Therefore, there is no significant difference between the two versions.

- Margin: Margin was not addressed in the 1972 version. The 2006 version requires that margin be addressed, in accordance with IEEE Std 323-1974. Therefore, the 2006 version is considered to be more conservative than the 1972 version.

- Functional Tests: These are stated only in very general terms in the 1972 version. The 2006 version contains specific requirements for the performance of functional testing during the qualification program, including the specific times during testing. Therefore, the 2006 version is considered to be more conservative than the 1972 version.

## Table 3.11-4—Summary Comparison of IEEE Endorsed Standards versus Latest IEEE Standards

| Endorsed IEEE Standard | Regulatory Guide | Equipment Type/ Subject | Latest IEEE Standard Edition |
|---|---|---|---|
| 317-1983 | 1.63, Rev. 3 | Penetrations | 317-1983 R2003[2] |
| 323-1974 (Harsh Env.) | 1.89, Rev. 1 | Electrical /I&C | 323-2003 |
| 323-2003 (Mild Env.) | 1.209 (3/2007) | Computer Based/Digital I&C | 323-2003 |
| 334-1971 | 1.40, Rev. 0 | Motors | 334-2006 |
| 344-~~1987~~2004 | 1.100, Rev. ~~2~~3 | Seismic | 344-2004 |
| 382-1974 | 1.73, Rev. 0 | Actuators | 382-2006 |
| 383-1974 | 1.131, P1[1] | Cables | 383-2003 |
| 387-1995 | 1.9, Rev. 4 | EDG | 387-1995 R2007 |
| 497-2002 | 1.97, Rev. 4 | PAM | 497-2002 |
| 535-1986 | 1.158, Rev. 0 | Batteries | 535-1986 R1994 |
| 572-1985 | 1.156, Rev. 0 | Connectors | 572-2006 |
| 7-4.3.2-2003 | 1.152, Rev. 2 | Computers | 7-4.3.2-2003 |
| None | 1.180, Rev. 1 | RFI/EMI | None |
| None | 1.183 (7/2000) | Alt. Radiation Source Term | None |

**Notes:**

1. RG 1.131, P1, 1979 is a Proposed Revision 1 (P1) “for comment” version of the Reg. Guide revision.

2. For an IEEE standard, the “R” just prior to the year means that the previously cited version of the standard was “Reaffirmed” in the later year shown. Reaffirmation is an approval process whereby the document is not changed, just agreed to be re-issued, as is. This reaffirmation is performed and noted because there is an IEEE requirement that standards be re-evaluated every 5 years to determine if a revision is deemed necessary. If a change is needed, then the document will be revised, and the year of revision is cited for the new document. If no changes are needed, then the document is cited with the date of latest publication followed by a notation that it was reaffirmed and the year of reaffirmation.

## 3.9.6 Functional Design, Qualification, and Inservice Testing Programs for Pumps, Valves, and Dynamic Restraints

This section describes the functional design and qualification provisions and inservice testing (IST) programs for safety-related pumps, valves, and dynamic restraints (snubbers). This includes both ASME Code, Section III, Class 1, 2, or 3 (Reference 1), and non-ASME Code safety-related pumps, valves, and snubbers. The provisions and programs described here verify that these components are in a state of operational readiness to perform their safety functions throughout the life of the plant.

The following GDC apply to this section:

- GDC 1 and 10 CFR 50.55a require, in part, that structures, systems, and components (SSC), which include pumps, valves, and dynamic restraints important to safety, be designed, fabricated, erected, constructed, and inspected to quality standards commensurate with the importance of the safety functions they perform. As noted in Section 3.1.1, the U.S. EPR Quality Assurance (QA) Program, which has been approved by the NRC (refer to Section 17.5), describes the recognized codes, standards, and design criteria that govern safety-related SSC. This program also confirms that these SSC are designed to quality standards commensurate with the safety functions they perform. Where applicable, design is in accordance with the codes required in 10 CFR 50.55a.

- GDC 2 requires, in part, that components important to safety be designed to withstand the effects of severe natural phenomena, combined with appropriate effects of normal and accident conditions, without a loss of capability to perform their safety functions. As noted in Section 3.1.1, safety-related SSC are designed either to withstand the effects of natural phenomena without loss of the capability to perform their safety functions, or to fail in a safe condition. Additional information on the seismic classifications of safety-related SSC is provided in Section 3.2.

- GDC 4 requires, in part, that components important to safety be designed to accommodate the effects of, and be compatible with, the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents. As noted in Section 3.1.1, safety-related SSC are designed to accommodate the effects of, and be compatible with, the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, which includes loss-of-coolant accidents. Additionally, the U.S. EPR design applies the leak-before-break methodology, as described in Section 3.6.3, to eliminate the dynamic effects of pipe rupture.

- GDC 14 requires that the reactor coolant pressure boundary (RCPB) be designed with an extremely low probability of abnormal leakage, rapidly propagating failure, and gross rupture. As noted in Section 3.1.2, the RCPB is designed to accommodate the system pressures and temperatures attained under the expected modes of plant operation, including anticipated transients, with stresses within applicable limits.

- GDC 15 requires that the reactor coolant system (RCS) be designed with sufficient margin of safety so that the design conditions of the RCPB are not exceeded during conditions of normal operation, including anticipated operational occurrences (AOO). As noted in Section 3.1.2, steady-state and transient analyses are performed to verify that the design conditions of the RCS and its associated auxiliary systems are not exceeded. These analyses address normal operations, including AOOs. Additionally, RCPB components have a sufficient margin of safety through the use of proven materials and design codes, proven fabrication techniques, nondestructive shop examination, and integrated hydrostatic testing of assembled components. Chapter 5 describes the RCS design.

- GDC 37 requires that the emergency core cooling system be designed to permit appropriate periodic pressure and functional testing to confirm the structural and leak-tight integrity of its components, as well as the operability and performance of the active components of the system. ISTs required by the ASME OM Code (Reference 2), as well as other preservice tests (PST) and ISTs for pumps and valves, demonstrate leak-tight integrity, operability, and performance. This testing specifically applies to safety-related pumps and valves in the emergency core cooling system and meets the requirements of GDC 37.

- GDC 40 requires that the containment heat removal system be designed to permit appropriate periodic pressure and functional testing to confirm the structural and leak-tight integrity of its components, as well as the operability and performance of the active components of the system. ISTs required by Reference 2, as well as other PSTs and ISTs for pumps and valves, demonstrate leak-tight integrity, operability, and performance. This testing specifically applies to safety-related pumps and valves in the containment heat removal system and meets the requirements of GDC 40.

- GDC 43 requires that the containment atmospheric cleanup system be designed to permit appropriate periodic pressure and functional testing to confirm the structural and leak-tight integrity of its components, as well as the operability and performance of the active components of the system, including pumps and valves. ISTs required by Reference 2, as well as other PSTs and ISTs for pumps and valves, demonstrate leak-tight integrity, operability, and performance. This testing specifically applies to safety-related pumps and valves in the containment atmospheric cleanup system and meets the requirements of GDC 43.

- GDC 46 requires that the cooling water system be designed to permit appropriate periodic pressure and functional testing to confirm the structural and leak tight integrity of its components, as well as the operability and performance of the active components of the system. ISTs required by Reference 2, as well as other PSTs and ISTs for pumps and valves, demonstrate leak-tight integrity, operability, and performance. This testing specifically applies to safety-related pumps and valves in the cooling water system and meets the requirements of GDC 46.

- GDC 54 requires that piping systems penetrating the primary reactor containment be provided with leak detection and isolation capabilities. These piping systems are designed with a capability to test the operability of the isolation valves periodically to determine if valve leakage is within acceptable limits. ISTs required by Reference 2, as well as other PSTs and ISTs for pumps and valves, demonstrate leak-tight integrity, operability, and performance. This testing specifically applies to safety-related valves in systems that penetrate the primary containment and meets the requirements of GDC 54.

Other FSAR sections that interface with this section are:

- Section 3.2.2 addresses the classification system and quality group for pumps and valves.
- Section 3.9.2 addresses dynamic testing and analysis of safety-related pumps, valves, and snubbers.
- Section 3.9.3 addresses the structural design of safety-related pumps, valves, and snubbers.
- Section 3.10 addresses the seismic and dynamic qualification of safety-related pumps and valves.
- Section 3.11 addresses the environmental qualification of safety-related pumps and valves.
- Section 3.12 addresses the design and leak testing provisions of pressure retaining systems and components that interface with the reactor coolant system as part of the primary review responsibility for intersystem loss-of-coolant accidents.
- Section 3.13 addresses programs for ensuring bolting and threaded fastener adequacy and integrity.
- Section 5.2.2 addresses the valves specified for overpressure protection of the reactor coolant pressure boundary.
- Section 5.4.7 and Section 6.3 address residual heat remove and emergency core cooling systems piping, respectively that is connected to the reactor coolant system and is subject to thermally stratified flow, thermal striping, and/or thermal cyclic effects.
- Section 6.2.1.2 addresses the analyses of subcompartment differential pressures resulting from postulated pipe breaks.
- Section 6.2.4 and Section 6.2.6 address the containment isolation system and the overall containment leakage testing program, respectively.
- Section 9.2.1 addresses surveillance, testing, inspection, and maintenance programs of service water systems.
- Section 10.3 addresses the number and size of valves specified for the main steam supply system.

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Reference 2 defines the IST scope by establishing the PST, IST, and examination of components to assess their operational readiness. The ASME OM Code identifies components subject to test examination, as well as testing responsibilities, methods, intervals, parameters to be measured and evaluated, criteria for evaluating results, corrective action, personnel qualification, and record keeping. These requirements apply to:

- Pumps and valves that are required to perform a specific function in bringing the reactor to a safe shutdown condition, maintaining the reactor in safe shutdown condition, or mitigating the consequences of an accident.
- Pressure relief devices that protect systems, or portions of systems, that perform one or more of the three functions described above.
- Dynamic restraints used in systems that perform one or more of these three functions, or that protect the integrity of the RCPB.

The initial testing program (ITP) is described in Section 14.2 and envelopes the PST program. Detailed test procedures are developed and conducted as a part of the initial plant startup program. These tests include parameters and acceptance criteria that can be used to establish and measure reference values for components in the IST program. These tests also include requirements for instrumentation range and accuracy. The IST program will evaluate results of preoperational testing to establish IST baseline values.

The IST program for pumps is addressed in Section 3.9.6.2, for valves in Section 3.9.6.3, and for snubbers in Section 3.9.6.4. The IST program also includes provisions for relief requests and requests for alternate testing methods, which are addressed in Section 3.9.6.5.

A COL applicant that references the U.S. EPR design certification will submit the PST program and IST program for pumps, valves, and snubbers as required by 10 CFR 50.55a.

A COL applicant that references the U.S. EPR design certification will identify the implementation milestones and applicable ASME OM Code for the preservice and inservice examination and testing programs. These programs will be consistent with the requirements in the latest edition and addenda of the OM Code incorporated by reference in 10 CFR 50.55a on the date 12 months before the date for initial fuel load.

### 3.9.6.1 Functional Design and Qualification of Pumps, Valves, and Dynamic Restraints

IST of safety-related pumps, valves, and snubbers is performed in accordance with Reference 2 and applicable addenda, as required by 10 CFR 50.55a(f), and the guidance provided in RG 1.192 and NUREG-1482, Revision 1 (Reference 3). The ASME OM

Code is incorporated by reference in 10 CFR 50.55a(b)(3). ASME OM Code Subsection ISTB defines the functional testing requirements for pumps. Subsection ISTC defines the functional testing requirements for valves, and Subsection ISTD defines the functional testing requirements for snubbers.

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The functional design and qualification of safety-related pumps, valves, and snubbers is performed in accordance with ASME QME-1-2007 (Reference 12) with clarifications as described in Section 3.10.2. The IST program for pumps is addressed in Section 3.9.6.2, for valves in Section 3.9.6.3, and for snubbers in Section 3.9.6.4. The IST program also includes provisions for relief requests and requests for alternate testing methods, which are addressed in Section 3.9.6.5.. As described in Section 3.9.6.3, the IST program also incorporates operating experience.

In accordance with RG 1.206 and the acceptance criteria of SRP 3.9.6, functional design and qualification of pumps, valves, and snubbers includes the following:

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- Safety-related pump, valve, and piping designs include provisions to allow testing of pumps and valves at the maximum flow specified in the plant accident analyses.
- Functional design and qualification of each safety-related pump and valve is performed such that each pump and valve is capable of performing its intended function for a full range of system differential pressure and flow, ambient temperatures, and available voltage (as applicable) under conditions ranging from normal operating to design-basis accident conditions.
- The provisions for the design and qualification of snubbers are provided in Section 3.9.3, Section 3.9.6.4, and the U.S. EPR Piping Analysis and Pipe Support Design Topical Report, Section 6.6 (Reference 6). Snubbers in safety-related systems include provisions to allow access for IST program activities (Section 3.9.6.4).
- The design and installation of safety and relief valves is described in Section 3.9.3.
- The seismic and dynamic qualification of mechanical and electrical is described in Section 3.10.
- Section 3.11 addresses the environmental qualification of safety-related pumps and valves.
- As required by GDC 14, safety-related valves that are part of the RCPB are designed and tested such that these valves will not experience any abnormal leakage, or increase in leakage, from their loading, as addressed in Section 3.10.
- As required by GDC 15 and in accordance with SRP 3.9.6, pumps, valves, and snubbers are designed with sufficient margin to demonstrate that the design conditions are not exceeded in accordance with Reference 2. Pump motors are designed to tolerate anticipated frequency and voltage variations due to degraded electrical power supply line conditions.

#### 3.9.6.1.1 Additional Information on Design and Qualification of Valves

The ability of a valve to meet its design basis functional requirements (i.e., required capability) is verified during valve qualification testing as required by procurement specifications. Requirements for qualification testing of motor-operated active valves are included in procurement specifications. Valve qualification testing measures valve actuator output capability. Actuator output capability is compared to the valve's required capability defined in procurement specifications, establishing functional margin; that is, that increment by which the MOV's actual output capability exceeds the capability required to operate the MOV under design basis conditions.

##### 3.9.6.1.1.1 Motor-Operated Valves (MOV) Design and Qualification

Design basis and required operating conditions are established for active safety-related MOVs. Based on the design conditions, the MOVs have a structural analysis performed to demonstrate their components are within the structural limits at the design conditions. The MOVs are designed for a range of conditions up to the design conditions, which includes fluid flow, differential pressure (including line break, if necessary), system pressure and temperature, ambient temperature, operating voltage range, and stroke time. The sizing of the motor operators on the valves consider diagnostic equipment accuracies, changes in output capability for increasing differential pressures and flow, and ambient temperature and reduction in motor voltage, control switch repeatability, friction variations, and other changes in parameters that could result in an increase in operating loads or a decrease in operator output.

The MOVs have a functional qualification performed to demonstrate by test, by analysis, or by a combination thereof, the ability to operate over a range up to the design conditions. This functional qualification demonstrates the MOV capability during and after loads representative of the maximum seismic or vibratory event (as required to perform their intended function), demonstrate the valve sealing capability, demonstrate capability under cold and hot operating conditions, demonstrate capability under maximum pipe end loads, and demonstrate flow interruption and functional capability. The testing includes test data provided by the manufacturer, field test data, empirical data supported by testing or analysis of prototype tests of similar MOVs that support the qualification where similarity must be justified by technical data. The qualification is used for validating the required thrust and torque as applicable to operate the valve and the output capability of the motor operator.

Further information on MOVs is described in Section 3.9.6.3.1.

##### 3.9.6.1.1.2 Other Power-Operated Valves (POV) Design and Qualification

Design basis and required operating conditions are established for POVs with an active safety-related function. POV assemblies include pneumatic-hydraulic-, air piston-, and solenoid-operated assemblies. POVs have a structural analysis performed to demonstrate their components are within the structural limits at the design conditions. POVs are designed to accept the maximum compression, tension, and torsional loads which the assembly is capable of producing in combination with other loads such as pressure, thermal, or externally applied loads. The maximum loading resulting from the design conditions and transients is evaluated in accordance with the ASME Code Section III, Class 1 design requirements. Packing adjustment limits are identified to reduce the potential for stem binding.

POVs have a functional qualification performed to demonstrate by test, by analysis, or by a combination thereof, the ability to operate at the design conditions. Qualification testing of each size, type, and model is performed under a range of differential pressures and maximum achievable flow conditions up to the design conditions. This functional qualification will demonstrate the POVs capability during and after loads representative of the maximum seismic or vibratory event (as required to perform their intended function), demonstrate the valve sealing capability, demonstrate capability under cold and hot operating conditions, demonstrate capability under maximum pipe end loads and demonstrate flow interruption and functional capability. The testing includes test data from the manufacturer, field test data, empirical data supported by test, or analysis of prototype tests of similar power-operated valves that support qualification of the power-operated valve. Similarity must be justified by technical data. Solenoid-operated valves are verified to satisfy the applicable requirements for Class 1E components. Solenoid-operated valves are verified to perform their safety-related design requirements over a range of electrical power supply conditions including minimum and maximum voltage.

Further information on POVs is described in Section 3.9.6.3.2.

~~Pumps and valves are tested within the IST program requirements to confirm that the required components are capable of performing their intended safety function. The safety analysis includes information concerning the design limitations and functional requirements for the performance of pumps and valves, including operation at the maximum flowrate. The IST pump functional design and pump qualification include an assessment for degraded flow conditions. The IST program requires pump and valve testing over the full range of system differential pressures, flowrates, temperatures, and available voltages (as applicable), from normal operating to design basis conditions and considers degraded flow that may occur during post-accident conditions. IST testing is also performed on RCPB valves to demonstrate that they will not experience leakage, or increased leakage, from their loading.~~

~~The U.S. EPR design provides ready access to SSC to facilitate comprehensive testing using currently available equipment and techniques. Accessibility incorporated into the design complies with the requirements of Reference 2 and 10 CFR 50.55a(f). System design incorporates provisions, including alternate flow paths and required~~

~~instrumentation, to allow full flow testing of pumps under the IST program. The design also incorporates provisions to permit the IST program testing of valves at the maximum flow specified in the plant accident analysis. The Chapter 15 safety analyses describe bounding design-basis requirements for safety-related pump and valve performance, including assumed design basis accident (DBA) flowrates and margin for degraded flow conditions. Degraded flow conditions are those caused by post-accident circumstances, such as debris that may collect on the Reactor Building sump strainers and cause reduced flow in accident mitigation systems.~~

~~As required by GDC 15 and in accordance with SRP 3.9.6, pumps, valves, and snubbers are designed with sufficient margin to demonstrate that the design conditions are not exceeded in accordance with Reference 2. Pump motors are designed to tolerate anticipated frequency and voltage variations due to degraded electrical power supply line conditions.~~

~~Reference 2 defines the IST scope by establishing the PST, IST, and examination of components to assess their operational readiness. The ASME OM Code identifies components subject to test examination, as well as testing responsibilities, methods, intervals, parameters to be measured and evaluated, criteria for evaluating results, corrective action, personnel qualification, and record keeping. These requirements apply to:~~

- ~~Pumps and valves that are required to perform a specific function in bringing the reactor to a safe shutdown condition, maintaining the reactor in safe shutdown condition, or mitigating the consequences of an accident.~~
- ~~Pressure relief devices that protect systems, or portions of systems, that perform one or more of the three functions described above.~~
- ~~Dynamic restraints used in systems that perform one or more of these three functions, or that protect the integrity of the RCPB.~~

~~The initial testing program (ITP) is described in Section 14.2 and envelopes the PST program. Detailed test procedures are developed and conducted as a part of the initial plant startup program. These tests include parameters and acceptance criteria that can be used to establish and measure reference values for components in the IST program. These tests also include requirements for instrumentation range and accuracy. The IST program will evaluate results of preoperational testing to establish IST baseline values.~~

~~Other design information that interfaces with this section is provided in the following sections:~~

- ~~Section 3.2.2 addresses the classification system and quality group for pumps and valves.~~

- ~~Section 3.9.2 addresses dynamic testing and analysis of safety-related pumps, valves, and dynamic restraints.~~
- ~~Section 3.9.3 addresses the structural design of safety-related pumps, valves, and dynamic restraints and also pump and valve operability assurance.~~
- ~~Section 3.10 addresses the seismic and dynamic qualification of safety-related pumps and valves.~~
- ~~Section 3.11 addresses the environmental qualification of safety-related pumps and valves.~~

~~The IST program for pumps is addressed in Section 3.9.6.2, for valves in Section 3.9.6.3, and for snubbers in Section 3.9.6.4. The IST program also includes provisions for relief requests and requests for alternate testing methods, which are addressed in Section 3.9.6.5.~~

### 3.9.6.2 Inservice Testing Program for Pumps

This section describes the IST of pumps to assess their operational readiness, in compliance with ASME OM Code Subsections ISTA and ISTB. The program applies to pumps that are required to perform a specific function of bringing the reactor to the safe shutdown condition, in maintaining the safe shutdown condition, or in mitigating the consequences of a DBA. Pumps that are designated as Class 1, 2, and 3, and non-class pumps that perform a safety-related function are included in the IST program.

Associated systems that contain pumps in the IST program include the necessary valving, instrumentation, test loops, fluid inventory, or other provisions to perform the required testing. Each pump is categorized as either a Group A or Group B pump. A pump that meets both Group A and Group B pump definitions is categorized as a Group A pump. Group A pumps are operated continuously or routinely during normal operation, cold shutdown, or refueling operations. Group B pumps are in standby systems that are not operated routinely, except for testing. When a Group A test is required, a comprehensive test may be substituted. When a Group B test is required, a Group A or comprehensive test may be substituted. A PST may be substituted for an inservice test.

IST testing conforms to the following:

- IST frequency is established in accordance with requirements set forth by Reference 2, Subsections ISTA and ISTB.
- IST interval is determined by calendar years following placement of the unit into commercial service.
- IST intervals are established in compliance with the following:

  - Initial test interval is the 10 years following commencement of unit commercial service.
  - Successive test intervals are 10 years following the previous test interval.

- Each IST interval may be extended or decreased by as much as one year. Adjustments will not cause successive intervals to be altered by more than one year from the original pattern of intervals.
- For units that are out of service continuously for six months or more, the IST interval during which the outage occurred may be extended for a period equivalent to the outage, and the original pattern of intervals extended accordingly for successive intervals.

An initial set of reference values are established for each pump during the PST period or before implementing IST. Reference values are to be determined only when the equipment being tested is known to be operating acceptably. Following the PST, the IST commences when the pump is required to be operable to fulfill the required function. When a pump has been replaced, repaired, or has undergone maintenance that could affect the pump's performance, a new reference value will be determined or the previous value reconfirmed by an inservice test performed before the time it is returned to service or immediately if not removed from service.

A list of pumps included in the IST program is provided in Table 3.9.6-1—Inservice Pump Testing Program Requirements. Parameters to be measured during IST program testing include pump speed (if required), discharge and differential pressures, flowrate, and vibration at IST conditions, as required by ISTB-3000 for each specific pump category. Range and accuracy requirements for instruments used to measure pressure, flowrate, speed, vibration, and differential pressure are provided in Reference 2, Table ISTB-3510-1. Instrument accuracy, range, location, fluctuations, and frequency response range requirements are established in accordance with ISTB-3510. The specific testing requirements and acceptance criteria are identified in ISTB-5000. A COL applicant that references the U.S. EPR design certification will identify any additional site-specific pumps in Table 3.9.6-1 to be included within the scope of the IST program.

### 3.9.6.3 Inservice Testing Program for Valves

This section describes the IST of valves to assess their operational readiness, in compliance with Reference 2, Subsections ISTA and ISTC. The program applies to valves classified as ASME Code Class 1, 2, or 3 valves and non-ASME valves that perform a safety-related function. Additional information on MOVs, power-operated valves, and check valves is provided in Section 3.9.6.3.1, Section 3.9.6.3.2, and Section 3.9.6.3.3, respectively.

Valve testing requirements include exercise, leakage, and position verification. Other specific testing requirements for power-operated valves require stroke-time testing and may require diagnostic testing to determine valve operating conditions to verify operability under design-basis conditions. The IST requirement for measuring the stroke time for valves is performed in conjunction with a valve exercise inservice test. The stroke time test is not identified as a separate IST. IST program valves are classified as either active or passive. Active valves change obturator position to accomplish a specific function in shutting down a reactor to the safe-shutdown condition, maintaining the safe shutdown condition, or mitigating the consequences of an accident. Passive valves maintain obturator position and do not change the obturator position to accomplish the required safety functions. Passive valves are not included in the valve exercise testing.

Pre-conditioning of valves or their associated actuators or controls prior to IST testing undermines the purpose of IST testing and is not allowed. Pre-conditioning includes manipulation, pre-testing, maintenance, lubrication, cleaning, exercising, stroking, operating, or disturbing the valve to be tested in any way except as may occur in an unscheduled, unplanned, and unanticipated manner during normal operation.

The IST program complies with the requirements of Reference 2, Subsection ISTC ~~to the extent practical~~. If a valve cannot be tested during normal operation, justification for testing during cold shutdown or a refueling outage is included in the test plan. The IST program incorporates nonintrusive techniques to periodically assess the degradation and performance of ~~selected valves~~check valves (see Section 3.9.6.3.3)..

Valves within the scope of the IST program are categorized as follows:

- Category A valves, for which seat leakage in the closed position is limited to a specific maximum amount to fulfill their required functions.
- Category B valves, for which seat leakage in the closed position is inconsequential to fulfill their required functions.
- Category C valves, which are self-actuating in response to some system characteristic to fulfill their required functions, such as pressure for relief valves or flow direction for check valves. Category C valves are addressed in Section 3.9.6.3.3 (check valves) and Section 3.9.6.3.6 (safety and relief valves).
- Category D valves, which are actuated by an energy source capable of only one operation, such as rupture disks or explosively actuated valves.

Category A and Category B valves are tested as follows:

- Valves are tested by full-stroke exercising during operation at power to the positions required to fulfill their functions. If full-stroke testing is not practical, testing may be limited to part-stroke exercising of the valves during operation at power and full-stroke exercising during cold shutdowns.

- If valve exercising is not practical during operation at power then the testing may be limited to full-stroke exercising of the valves during cold shutdowns. Valve exercising may be limited to part-stroke during cold shutdowns and full-stroke during refueling outages.
- Valve exercising is not required if the time period since the previous full-stroke exercise is less than three months and no activities that could change operating parameters have been performed. During extended shutdowns, valves that are required to be operable must remain capable of performing their intended safety function.
- Exercising valves during cold shutdown commences within 48 hours of achieving cold shutdown and continues until testing is complete or the plant is ready to return to operation at power.
- Valve testing required to be performed during a refueling outage is completed before returning the plant to operation at power.

Valve testing uses reference values determined from the results of PST or IST. These tests are performed under conditions as near as practical to those expected during the IST. Reference values are established only when the valve is known to be operating acceptably. When a valve or its control system has been replaced, repaired, or has undergone maintenance that could affect valve performance, a new reference value is determined or the previous value is reconfirmed by an inservice test. This test is performed before the valve is returned to service or immediately if the valve is not removed from service. Deviations between the previous and new reference values are identified and analyzed. Verification that the new values represent acceptable operation is documented. The plant corrective action program documents valve failures.

A list of valves included in the IST program is provided in Table 3.9.6-2—Inservice Valve Testing Program Requirements. A COL applicant that references the U.S. EPR design certification will identify any additional site-specific valves in Table 3.9.6-2 to be included within the scope of the IST program. Valve test procedures and schedules are included in the test plan which is provided by the COL applicant.

#### 3.9.6.3.1 Inservice Testing Program for Motor-Operated Valves

##### 3.9.6.3.1.1 MOV Program Requirements and Guidance

In addition to the IST program requirements in the ASME OM Code incorporated by reference in 10 CFR 50.55a(f), 10 CFR 50.55(b)(3)(ii) requires establishment of a program to ensure that the safety-related MOVs continue to be capable of performing their design-basis safety functions. Accordingly, IST of ASME Section III Class 1, 2, and 3, and safety-related MOVs is performed in accordance with ISTC of Reference 2 and applicable addenda, as required by 10 CFR 50.55 a(f). Furthermore, ASME Code Case OMN-1, as accepted by the NRC staff with conditions in RG 1.192, is also used which provides an alternative method to MOV stroke-time testing that also satisfies the requirement in 10 CFR 50.55a to supplement the OM Code IST provisions with a program to ensure that safety-related MOVs continue to be capable of performing their safety functions.

The IST program also incorporates the guidance of NUREG-1482, Revision 1 (Reference 3). Periodic verification of safety-related MOVs incorporates the guidance of Generic Letter 96-05 (Reference 4) which supersedes Generic Letter 89-10 (Reference 5) and its supplements with regard to MOV periodic performance verification. The MOV testing program also incorporates the recommendations from the Joint Owners Group (JOG) MOV Periodic Verification (Reference 9).

The PST program for MOVs is conducted in accordance with ISTC 3100 under conditions as near as practical to those expected during subsequent IST.

#### 3.9.6.3.1.2 Description of MOV Testing Program

##### Code Testing of MOVs

IST of an MOV relies on diagnostic techniques that assess valve performance under actual loading. Periodic testing per Reference 2, Subsection ISTC, and Reference 4 is conducted under adequate differential pressure and flow conditions to demonstrate that the MOV continues to perform its safety function to open and close, as applicable, during design-basis conditions. MOVs that fail to meet their respective acceptance criteria are declared inoperable.

Safety-related MOV functions are used to determine the type of required IST and PST. These functions include:

- Active or active-to-fail for fulfillment of a safety-related function.
- RCPB isolation function.
- Containment isolation function.
- Maximum seat leakage (in the closed position) for fulfillment of a safety-related function.
- Safety-related remote-position-indication function.

Retesting MOVs to verify functionality is required after valve or valve-actuator maintenance. The extent of retesting depends upon the type of maintenance performed. MOV testing is incorporated into the initial plant startup test program (refer to Section 14.2). Containment isolation valve (CIV) leak rate test frequency is addressed in Section 6.2.6.

MOVs are tested in accordance with the Reference 2 and the guidance of Reference 3, including the following:

- Remote position-indication tests: Valves with position indicators that are included in the IST program are observed locally during valve exercising to verify that the indicators are operating correctly. Where local observation is not practical, other methods are used to verify correct valve position indicator operation.
- Leakage tests: Safety-related valves with seat leakage limits are tested to verify that leakage does not exceed allowable limits. This testing includes valves that isolate piping and lines that penetrate containment; these valves are tested in accordance with 10 CFR 50, Appendix J. Most valves are tested individually as a part of the Type C testing, depending on the valve function and configuration.
- Exercise tests: Safety-related MOVs are exercised periodically, and generally undergo full-stoke exercise testing quarterly. Measuring stroke time is not a separate inservice test, but is done as part of periodic testing. If it is impractical to exercise a valve during plant operation, the valve may be full-stroke tested during cold shutdowns. Valves that operate during normal plant operation and at a frequency that satisfies exercising requirements need not be additionally exercised, provided that IST-required observations are made at intervals no greater than that specified in the IST plan.

A list of MOVs included in the IST program is provided in Table 3.9.6-2.

**Non-Code Testing of MOVs**

The MOV testing program incorporates the Joint Owners' Group (JOG) Motor-Operated Valve (MOV) Periodic Verification (PV) Program (Reference 9) to address Generic Letter 96-05, (Reference 4).

Operability testing relies on non-intrusive diagnostic techniques. These tests are conducted in either static or dynamic conditions in accordance with Reference 9.

Testing is performed to confirm that an adequate margin exists in MOV capabilities. These tests include verification that the MOV achieves maximum required torque or thrust, as applicable. The tests include consideration of diagnostic equipment inaccuracies, degraded voltages, control switch repeatability, load-sensitive MOV behavior, and the margin for degradation. These tests also indicate hard seat-contact and verify that the tests performed do not exceed the allowable structural and under-voltage motor capability limits for the individual parts of the MOV.

#### 3.9.6.3.1.3 Testing Frequency

The interval between testing to demonstrate continued design basis capability does not exceed five years or three refueling outages, whichever is longer. Longer design-basis verification intervals may be justified through implementation of ASME Code Case OMN-1, as accepted in RG 1.192. Test frequency is also specified and evaluated each

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refueling outage based on data trends as a result of testing. Frequency for periodic testing is in accordance with Reference 9.

### 3.9.6.3.1.4 Acceptance Criteria

Acceptance criteria for successful completion of the PST and IST of MOVs includes the following:

- Consistent with the safety function, the valve fully opens and/or the valve fully closes or both. Diagnostic equipment indicates hard seat contact.
- The testing demonstrates adequate margin with respect to the design basis, including consideration of diagnostic equipment inaccuracies, degraded voltage, control switch repeatability, load sensitive MOV behavior, and margin for degradation.
- The maximum torque and/or thrust (as applicable) achieved by the MOV, allowing sufficient margin for diagnostic equipment inaccuracies and control switch repeatability, does not exceed the allowable structural and undervoltage motor capability limits for the individual parts of the MOV.

~~IST of ASME Section III Class 1, 2, and 3, and safety-related motor-operated valves (MOV) is performed in accordance with the Reference 2 and applicable addenda, as required by 10 CFR 50.55 a(f). Testing is required except where specific relief has been granted by the NRC. The IST program incorporates the guidance of RG 1.192 and Reference 3. NRC-accepted Code Case OMN-1 (RG 1.192) is also used for PST and IST to assess the operational readiness of MOVs.~~

~~Periodic verification of safety-related MOVs is performed in accordance with Generic Letter 96-05 (Reference 4) which supersedes Generic Letter 89-10 (Reference 5) and its supplements with regard to MOV periodic performance verification. The MOV testing program also incorporates the recommendations from the Joint Owners Group (JOG) MOV Periodic Verification (Reference 9).~~

~~The MOV testing program requires either in-plant valve operation or prototype valve testing at system flow and pressure or system differential pressure to verify correct MOV actuator sizing and control settings. The PST program for MOVs is conducted in accordance with 10 CFR 50.55a(b)(3)(ii) and Reference 2, ISTC 3100 under conditions as near as practical to those expected during subsequent IST. The interval between testing to demonstrate continued design basis capability does not exceed five years or three refueling outages, whichever is longer.~~

~~IST of an MOV relies on diagnostic techniques that assess valve performance under actual loading. Periodic testing per Reference 2, Subsection ISTC and Reference 4 is conducted under adequate differential pressure and flow conditions to demonstrate that the MOV continues to perform its safety function to open and close, as applicable,~~

~~during design-basis conditions. MOVs that fail to meet their respective acceptance criteria are declared inoperable.~~

~~Safety-related MOV functions are used to determine the type of required IST and PST. These functions include:~~

- ~~Active or active-to-fail for fulfillment of a safety-related function.~~
- ~~RCPB isolation function.~~
- ~~Containment isolation function.~~
- ~~Maximum seat leakage (in the closed position) for fulfillment of a safety-related function.~~
- ~~Safety-related remote-position-indication function.~~

~~Retesting MOVs to verify functionality is required after valve or valve-actuator maintenance. The extent of retesting depends upon the type of maintenance performed. MOV testing is incorporated into the initial plant startup test program (refer to Section 14.2). Containment isolation valve (CIV) leak rate test frequency is addressed in Section 6.2.6.~~

~~MOVs are tested in accordance with the Reference 2 and the guidance of Reference 4, including the following:~~

- ~~Remote position-indication tests: Valves with position indicators that are included in the IST program are observed locally during valve exercising to verify that the indicators are operating correctly. Where local observation is not practical, other methods are used to verify correct valve position indicator operation.~~
- ~~Leakage tests: Safety-related valves with seat leakage limits are tested to verify that leakage does not exceed allowable limits. This testing includes valves that isolate piping and lines that penetrate containment; these valves are tested in accordance with 10 CFR 50, Appendix J. Most valves are tested individually as a part of the Type C testing, depending on the valve function and configuration.~~
- ~~Exercise tests: Safety-related MOVs are exercised periodically, and generally undergo full-stoke exercise testing quarterly. Measuring stroke time is not a separate inservice test, but is done as part of periodic testing. If it is impractical to exercise a valve during plant operation, the valve may be full-stroke tested during cold shutdowns. Valves that operate during normal plant operation and at a frequency that satisfies exercising requirements need not be additionally exercised, provided that IST-required observations are made at intervals no greater than that specified in the IST plan.~~
- ~~Operability tests: Inservice operability testing of power-operated valves, including MOVs, relies on nonintrusive diagnostic techniques. These tests are conducted in either static or dynamic conditions in accordance with Reference 9.~~

- ~~Additional tests: Testing is performed to confirm that an adequate margin exists in MOV capabilities. These tests include verification that the MOV achieves maximum required torque or thrust, as applicable. The tests include consideration of diagnostic equipment inaccuracies, degraded voltages, control switch repeatability, load-sensitive MOV behavior, and the margin for degradation. These tests also indicate hard seat-contact and verify that the tests performed do not exceed the allowable structural and under-voltage motor capability limits for the individual parts of the MOV.~~

~~A list of MOVs included in the IST program is provided in Table 3.9.6-2.~~

### 3.9.6.3.2 Inservice Testing Program for Power-Operated Valves Other Than MOVs

#### 3.9.6.3.2.1 Power-Operated Valves, Other Than MOV, Program Requirements and Guidance

Power-operated valves, other than MOVs, include valves actuated by solenoid, hydraulic, or pneumatic operators. In accordance with the IST program requirements in the ASME OM Code incorporated by reference in 10 CFR 50.55a(f), IST of ASME Code, Section III, Class 1, 2 and 3 safety-related power-operated valves is performed in accordance with ISTC of Reference 2 and applicable addenda, as required by 10 CFR 50.55 a(f). The power-operated valve IST program incorporates industry and regulatory experience and INPO operating experience and information gained through analysis, design, maintenance, and testing of the valves within specific safety-related systems. Specifically, the power-operated valve test program incorporates the guidance of Regulatory Issue Summary 2000-03 (Reference 10) that incorporates the lessons learned from MOV analysis and tests in response to GL 96-05 (Reference 4), GL 89-10 (Reference 5), and the JOG air-operated valve program (Reference 11).

#### 3.9.6.3.2.2 Description of Power-Operated Valve, Other Than MOV, Testing Program

**Code Testing of Power-Operated Valves, Other Than MOVS**

Safety-related power-operated valves are subject to operational readiness testing in accordance with the requirements stated in the ASME OM Code. IST of valves assesses operational readiness including actuating, stroke timing, fail safe, and verification of position indicating systems. The ability of power-operated valves to perform their design-basis functions is verified either before installation or as part of preoperational testing performed during the initial plant startup test program, as described in Section 14.2.

When the margin between component capability and design-basis requirements have not been previously determined due to different valve design features, materials, or operating parameters, then dynamic testing will be performed to determine these margins. This includes verification that solenoid-operated valves continue to be capable of performing their design-basis safety functions.

Installed solenoid-operated valves are tested using Class 1E electrical power supply voltage and current to verify they remain capable of performing their required safety function during design-basis accident conditions. Solenoid-operated valves are also tested to confirm the valve moves to its energized position and is maintained in that position, and to confirm that the valve moves to the appropriate fail position when de-energized.

A list of power-operated valves included in the IST program is provided in Table 3.9.6-2.

### Non-Code Testing of Power-Operated Valves, Other Than MOVs

Although the design basis capability of active, safety-related power-operated valves is verified as part of the design and qualification process, power-operated valves that perform an active safety function are tested again after installation in the plant, as required, to ensure valve setup is acceptable to perform their required functions, consistent with valve qualification. These tests, which are typically performed under static (no flow or pressure) conditions, also document the baseline performance of the valves to support maintenance and trending programs. During the testing, critical parameters needed to ensure proper valve setup are measured. Depending on the valve and actuator type, these parameters include seat load, running torque or thrust, valve travel, actuator spring rate, bench set and regulator supply pressure. Uncertainties associated with performance of these tests and use of the test results (including those associated with measurement equipment and potential degradation mechanisms) are addressed appropriately. Uncertainties are considered in the specification of acceptable valve setup parameters or in the interpretation of the test results (or a combination of both). Uncertainties affecting both valve function and structural limits are addressed.

Additional testing is performed as part of the air-operated valve program, which includes the elements for an air-operated valve program as identified in Reference 11. The air-operated valve program incorporates the attributes for a successful power-operated valve long-term periodic verification program, as discussed in Reference 10 by incorporating lessons learned from previous nuclear power plant operations and research programs as they apply to the periodic testing of air-operated valves and other power-operated valves included in the IST program. For example, lessons learned addressed in the air-operated valve program include:

- Setpoints for air-operated valves are defined based on current vendor information or valve qualification diagnostic testing, such that the valve is capable of performing its design-basis function(s).
- Periodic static testing is performed to identify potential degradation, unless those valves are periodically cycled during normal plant operation under conditions that meet or exceed the worst case operating conditions within the licensing basis of

the plant for the valve, which would provide adequate periodic demonstration of air-operated valve capability. If required based on valve qualification or operating experience, periodic dynamic testing is performed to re-verify the capability of the valve to perform its required functions.

- Sufficient diagnostics are used to collect relevant data (e.g., valve stem thrust and torque, fluid pressure and temperature, stroke time, operating and/or control air pressure, etc.) to verify the valve meets the functional requirements of the qualification specification.

- Test frequency is specified, and is evaluated each refueling outage based on data trends as a result of testing. Frequency for periodic testing is in accordance with References 11 and 13, with a minimum of five years (or three refueling cycles) of data collected and evaluated before extending test intervals.

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- Safety-related air operated valves are assigned the highest category according to Reference 11.

- Post-maintenance procedures (which are the responsibility of the COL applicant as described in Section 17.6) include appropriate instructions and criteria to demonstrate baseline testing is re-performed as necessary when maintenance on a valve, valve repair, or replacement has the potential to affect valve functional performance.

- Guidance is included to address lessons learned from other valve programs in procedures and training specific to the AOV program.

- Documentation from AOV testing, including maintenance records and records from the corrective action program, are retained and periodically evaluated as a part of the AOV program.

- The attributes of the AOV testing program described above, to the extent that they apply to and can be implemented on other safety-related power-operated valves, such as electro-hydraulic valves, are applied to those other power-operated valves.

~~Power-operated valves (POV), other than MOVs, include valves actuated by solenoid, hydraulic, or pneumatic operators. The ability of POVs to perform their design-basis functions is verified either before installation or as part of preoperational testing performed during the initial plant startup test program, as described in Section 14.2. This includes verification that solenoid-operated valves (SOV) continue to be capable of performing their design-basis safety functions.~~

~~The POV IST program incorporates industry and regulatory experience (including Generic Letters 89-10 and 96-05 (Reference 4 and Reference 5) and INPO operating experience) and information gained through analysis, design, maintenance, and testing of the valves within specific safety-related systems. The IST program for POVs includes programmatic features of the Joint Owners Group (JOG) Program in response to Reference 4. When the margin between component capability and design-basis~~

~~requirements have not been previously determined due to different valve design features, materials, or operating parameters, dynamic testing will be performed to determine these margins. The POV test program also incorporates the guidance of NRC Regulatory Issue Summary 2000-03 (Reference 10) that incorporates the lessons learned from MOV analysis and tests in response to GL 96-05 (Reference 4), GL 89-10 (Reference 5), and the JOG air-operated valve (AOV) program (Reference 11).~~

~~SOVs are qualified for minimum and maximum voltage and amperage during factory acceptance testing, which also includes maintaining the valve in its energized position. Installed SOVs are tested using Class 1E electrical power supply voltage and current to verify they remain capable of performing their required safety function during design basis accident conditions. SOVs are also tested to confirm the valve moves to its energized position and is maintained in that position, and to confirm that the valve moves to the appropriate fail position when de-energized.~~

~~A list of POVs included in the IST program is provided in Table 3.9.6-2.~~

#### 3.9.6.3.3 Inservice Testing Program for Check Valves

Check valve testing requires verification that obturator movement is in the direction required for the valve to perform its safety function. For check valves that perform a safety function in the open and closed directions, the valve is tested by initiating flow and observing whether or not the obturator moves to the full-open position. During flow conditions, the obturator moves to and maintains contact with the backseat without fluctuating, while allowing the flowrate and maximum differential pressure across the valve to remain within acceptable design limits for the system. When flow ceases or reverses, the obturator moves to the valve seat to fulfill the test requirements.

For valves that have a safety function in only the open direction, the valve is exercised by initiating flow and observing whether or not the obturator moves to the full-open position. Check valves that have a safety function in only the closed direction are exercised by initiating flow and observing whether or not the obturator moves to at least the partially open position. When flow ceases or reverses, the obturator moves to the valve seat.

The U.S. EPR design incorporates provisions to permit safety-related check valves to be tested for performance in both the forward and reverse flow directions. Check valve testing includes observations of a direct indicator or other positive means, such as changes in system pressure, flowrate, level, temperature, seat leakage, testing, or nonintrusive testing results. Acceptance criteria for this testing consider the specific system design and valve application. For example, a valve's safety function may require obturator movement in both open and closed directions. A mechanical exerciser may be used to operate a check valve for testing. Where a mechanical exerciser is used, acceptance criteria are provided for the force or torque required to move the check valve's obturator. Exercise tests also detect missing, sticking, or binding obturators.

As noted in Subsection ISTC-5221 of Reference 2, i~~I~~f these test methods are impractical ~~for certain check valves~~, or if sufficient flow cannot be achieved or verified, a sample disassembly examination program verifies valve obturator movement. In accordance with Subsection ISTC-5221 of Reference 2 and the guidance of Reference 3, t~~T~~he sample disassembly examination program groups check valves by category of similar design (manufacturer, size, model number and materials), application, and service condition, including valve orientation, and requires a periodic examination of one valve from each group.

During the disassembly process, the full-stroke motion of the obturator is verified and verification is performed that the internals of the valve are structurally sound (i.e., no loose or corroded parts). Also, if the disassembly is to verify the full-stroke capability of the valve, the disk is manually exercised. While the valve is in a partially disassembled condition the valve internals are inspected and the condition of the moving parts evaluated. Nondestructive examination is performed on the hinge pin to assess wear, and seat contact surfaces are examined to verify adequate contact. Full-stroke motion of the obturator is re-verified immediately prior to completing reassembly. At least one valve from each group is disassembled and examined at each refueling outage, and the valves in each group are disassembled and examined at least once every eight years. A condition monitoring program may be established to modify testing or disassembly inspection periods when sufficient operating data have been collected for a valve type. The condition monitoring program is prescribed by post-maintenance program or ASME OM Code Appendix II requirements for each equipment type. Before returning to service, valves disassembled for examination or valves that received maintenance that could affect their performance are exercised with a full or part stroke. Details and bases of the sampling program are documented and recorded in the test plan.

When operating conditions, valve design, valve location, or other considerations prevent direct observation or measurements by use of conventional methods to determine adequate check valve function, diagnostic equipment and nonintrusive techniques are used to monitor internal conditions. Nonintrusive techniques include acoustic, ultrasonic, magnetic, and x-ray technologies, that are used to measure valve-operating parameters (e.g., fluid flow, disk position, disk movement, and disk impact forces). Nonintrusive techniques also detect valve degradation. Diagnostic equipment and techniques used for valve operability determinations are verified as effective and accurate under the PST program. Testing is performed, to the extent practical, under normal operation, cold shutdown, or refueling conditions applicable to each check valve. Testing includes effects created by sudden starting and stopping of pumps, if applicable, or other conditions, such as flow reversal. When maintenance that could affect valve performance is performed on a valve in the IST program, post-maintenance testing is conducted prior to returning the valve to service.

Preoperational testing is performed during the ITP (refer to Section 14.2) to verify that valves are installed in a configuration that allows correct operation, testing, and maintenance. Preoperational testing verifies that piping design features accommodate check valve testing requirements. Tests also verify disk movement to and from the seat and determine, without disassembly, that the valve disk positions correctly, fully opens or fully closes as expected, and remains stable in the open position under the full spectrum of system design-basis fluid flow conditions. Additional information on leak rate testing is provided in Section 6.2.6.

A list of check valves included in the IST program is provided in Table 3.9.6-2.

#### 3.9.6.3.4 Pressure Isolation Valve Leak Testing

Pressure isolation valves (PIV) are the two normally closed valves, in series, within the RCPB that isolate the RCS from an attached low-pressure system. PIVs are classified as A or A/C in accordance with the provisions of Subsection ISTC-1300 of Reference 2. PIV seat leakage rate tests are conducted in accordance with Subsection ISTC-3630, which specifies a PIV leakage limit of 0.5 gpm per inch of nominal valve diameter up to 5 gpm maximum for each PIV. PIV leakage tests are described further in the Technical Specifications.

A list of PIVs included in the IST program is provided in Table 3.9.6-2.

#### 3.9.6.3.5 Containment Isolation Valve Leak Testing

CIVs are leak tested in accordance with 10 CFR 50, Appendix J. Additional information on CIVs is provided in Sections 6.2.4 and 6.2.6.

A list of CIVs included in the IST program is provided in Table 3.9.6-2. Section 6.2.4 also contains a list of CIVs.

#### 3.9.6.3.6 Inservice Testing Program for Safety and Relief Valves

Safety and relief valves protect systems that are required to provide a safety function. Stroke tests are performed for dual-function safety and relief valves. Safety and relief valve tests are conducted in accordance with Appendix I to Reference 2. Power-operated relief valves subject to the IST program are tested in accordance with Subsection ISTC-5100 for Category B valves and Subsection ISTC-5240 for Category C valves. Using test equipment, including gages, transducers, load cells, and calibration standards, to determine valve set-pressure is acceptable if the overall combined accuracy does not exceed ±one percent of the indicated (measured) set pressure.

A list of safety and relief valves included in the IST program is provided in Table 3.9.6-2.

#### 3.9.6.3.7 Inservice Testing Program for Manually Operated Valves

Manual valves are exercised at least every two years. Exercise of a manual valve includes a complete cycle from fully open to fully closed.

A list of manual valves included in the IST program is provided in Table 3.9.6-2.

#### 3.9.6.3.8 Inservice Testing Program for Explosively Actuated Valves

The U.S. EPR does not use explosively actuated valves.

### 3.9.6.4 Inservice Testing Program for Dynamic Restraints

Safety-related systems inside and outside of containment may experience dynamic effects under various accident conditions, including seismic events and DBAs. Snubbers are attached to these systems to reduce these dynamic effects in areas where rigid supports are unacceptable. As noted in Section 6.6 of Reference 6, snubber supports for piping systems allow free thermal movements, while restraining movements due to dynamic loadings.

Snubbers are designed to meet the requirements of Reference 2. The criteria for the size and location of the snubbers are further described in Section 6.6 of Reference 6, which also identifies the type of information to be provided in the design specification, as well as the design and analysis considerations that enable the snubbers to activate correctly for their design loadings. For example, snubber lockup velocity is designed so that the snubber does not lock up under routine static and thermal loading. Section 3.9.2 addresses dynamic testing and analysis of safety-related pumps, valves, and dynamic restraints. The IST program for snubbers complies with all these provisions, including the guidance provided by RG 1.192.

A COL applicant that references the U.S. EPR design certification will provide a table identifying the safety-related systems and components that use snubbers in their support systems, including the number of snubbers, type (hydraulic or mechanical), applicable standard, and function (shock, vibration, or dual-purpose snubber). For snubbers identified as either a dual-purpose or vibration arrester type, the COL applicant shall indicate whether the snubber or component was evaluated for fatigue strength. Per the ASME Code, Section III, Subsection NF, fatigue evaluation is not required for shock snubbers.

Snubbers are procured components and specific snubber suppliers are selected in accordance with the COL applicant's approved quality assurance program, established in accordance with 10 CFR 50, Appendix B. Records of supplier information are maintained in the COL applicant's record management system.

#### 3.9.6.4.1 Snubber Installation

The snubber supplier provides manufacturer recommendations for snubber installation. These recommendations include operating requirements (e.g., operation in compression or retraction modes), accommodation of vertical movement, and the designated first natural frequency (a specific Hertz value). Snubbers are installed using the manufacturer recommendations and installation instructions, which provide guidance on the storage, handling, installation, and adjustments of each of the required snubbers. The installation instructions contain the snubber settings for hot and cold conditions, as well as additional location-specific information that may be needed for the installation. Installation drawings provide the location of the snubber and the orientation on the pipe, or the relationship to an associated component. The pipe support design specification requires that hydraulic snubbers be equipped with a level indicator for observation of fluid level in the snubber.

The final installation of the snubber is an iterative process. The snubber's spring constant specified by the snubber supplier for a given load capacity is compared against the spring constant from the piping system model. Other pipe support components (e.g., pipe clamp, pipe extensions) and the auxiliary structural steel stiffness values are considered in the model and structural analysis. If the snubber location and support direction are confirmed and the spring constants are the same, then installation can proceed. If the spring constants do not agree, additional analysis is required to confirm the snubber load requirements. This iteration continues until the snubber load capacities and spring constants are reconciled.

The U.S. EPR design incorporates provisions that allow ready access for maintenance, inspection, and testing of components. The correct installation and operation of snubbers is confirmed as part of the ITP described in Section 14.2. This program includes visual inspections, hot and cold position measurements, and documenting thermally induced component movement that occurs during plant startup.

#### 3.9.6.4.2 Snubber Examination and Testing Program

Snubber PST and IST are performed in accordance with the ASME OM Code Subsection ISTD (Reference 2). The overall PST and IST intervals are as defined in the administrative requirements (in Subsection ISTA) of the code. The specific examination and testing intervals are in accordance with Subsection ISTD, as described below.

### Visual Examination

Snubbers are visually examined to identify impaired function caused by physical damage, leakage, corrosion, or degradation from environmental exposure or operating conditions. External features that may affect operability are also examined. Visual inspections are conducted in accordance with the requirements of the ASME Code, Section XI (Reference 7) for VT-3 examinations. A maintenance inspection checklist is used to describe the examination requirements. The intervals for visual examination are in accordance with NRC-accepted Code Case OMN-13 (RG 1.192).

Snubber examination requirements include the following:

- The snubber load, rating, location, orientation, position setting, and configuration (e.g., attachments and extensions) are in accordance with design drawings and specifications.
- Installation records (based on physical examinations) provide verification that the snubbers are installed according to the design drawings and their specifications meet the requirements.
- Adequate swing clearance is provided to allow snubber movement.
- Testing systems used for functional testing of snubbers determine compression loads and spring/hydraulic conditions.

### Functional Testing

Preservice functional testing is performed on snubbers prior to initial plant operation. This testing may be performed at the manufacturer's facility. Inservice functional testing is performed over the test plan intervals specified in Reference 2. Snubbers are tested in their installed location or removed and bench tested. Snubbers are tested in their as-found condition and the test parameters are selected so that the snubbers are tested to the fullest extent practicable.

Functional tests for snubbers are performed to verify the following:

- Activation is within the specified range of velocity or acceleration in tension and in compression.
- Release rate, when applicable, is within the specified range in tension and in compression. Snubbers specifically required not to displace under continuous load withstand load without displacement.
- For mechanical snubbers, the drag force is within specified limits in tension and in compression.
- For hydraulic snubbers, the drag force is within specified limits in tension and in compression (if required to verify correct assembly).

#### Unacceptable Snubbers

Generic Letter 90-09 (Reference 8) states that a snubber is considered unacceptable if it fails the acceptance criteria of the visual inspection. For an unacceptable snubber, an engineering evaluation determines if the snubber has adversely affected components in the system to which it is attached. Unacceptable snubbers will be adjusted, repaired, modified, or replaced and then retested.

#### Repair or Replacement of Snubbers

Snubbers that are maintained or repaired by removing or adjusting a snubber part that can affect the results of tests are examined and tested in accordance with the applicable code requirements before being returned to service.

#### Service Life Monitoring

The service of snubbers is evaluated at least once each fuel cycle, and increased or decreased if warranted. This evaluation is based on technical data from representative snubbers that have been in service in the plant or on other information related to service life. If the evaluation indicates that service life will be exceeded before the next scheduled system or plant outage, then one of the following actions occurs:

- The snubber is replaced.
- The snubber is reconditioned.
- A technical justification is documented for extending the service life.

### 3.9.6.5 Relief Requests and Alternative Authorizations to the OM Code

If it is determined that compliance with the requirements of the ASME OM Code (Reference 2) is impractical, relief is requested from the code in accordance with 10 CFR 50.55a. These relief requests identify the applicable code requirements, justify the relief request, and provide alternate testing methods.

### 3.9.6.6 References

1. ASME Boiler and Pressure Vessel Code, Section III, “Rules for Construction of Nuclear Power Plant Components,” The American Society of Mechanical Engineers, 2004 edition.

2. ASME OM Code, “Code for Operation and Maintenance of Nuclear Power Plants,” The American Society of Mechanical Engineers, 2004 edition.

3. NUREG-1482, Revision 1, “Guidelines for Inservice Testing at Nuclear Power Plants,” U.S. Nuclear Regulatory Commission, January 2005.

4. Generic Letter 96-05, "Periodic Verification of Design Basis Capability of Safety-Related Motor-Operated Valves," U.S. Nuclear Regulatory Commission, September 18, 1996.

5. Generic Letter 89-10, "Safety-Related Motor-Operated Valve testing and Surveillance," U.S. Nuclear Regulatory Commission, June 28, 1989.

6. ANP-10264NP-A, Revision 0, "U.S. EPR Piping Analysis and Pipe Support Design Topical Report," AREVA NP Inc., November 2008.

7. ASME Boiler and Pressure Vessel Code, Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," The American Society of Mechanical Engineers, 2004 edition.

8. Generic Letter 90-09, "Alternative Requirements for Snubber Visual Inspection Intervals and Corrective Actions," U.S. Nuclear Regulatory Commission, May 14, 1990.

9. MPR-2524-A, "Joint Owners Group (JOG) Motor Operated Valve Periodic Verification Program Summary," MPR Associates, November 2006.

10. Regulatory Issue Summary 2000-03, "Resolution of Generic Safety Issue 158: Performance of Safety-Related Power-Operated Valves Under Design Basis Conditions," March 15, 2000.

11. Joint Owners Group Air Operated Valve Program Document, Revision 1, December 13, 2000.

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12. ASME QME-1-2007 Edition, "Qualification of Active Mechanical Equipment Used in Nuclear Power Plants," 2007 edition.

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13. Eugene V. Imbro (NRC) to Mr. David J. Modeen, Nuclear Energy Institute, Comments On Joint Owners' Group Air Operated Valve Program Document, October 8, 1999.