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Subject: Draft IST Program Description for May 22 Meeting
Attachments: DRAFT ESBWR IST Program Description 051608.pdf

Importance: High

Hi Tom,

Attached is a draft ESBWR DCWG IST program description for the NRC staff to consider in preparation for our meeting on May 22. This description includes information on valve qualification in Section 3.9.3.5 and snubbers in Section 3.9.3.7, along with valve IST in Section 3.9.6. It is an integrated document, and is written so that the reviewer can see which document (e.g., DCD Rev. 4, COLA Rev. 0) contains each statement.

We plan to provide this document as a handout at Thursday's meeting.

Please let me know if you have any questions.

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Red Text – currently shown in DCD Draft Revision 5, which incorporates GEH RAI responses (3.9-159 S01, 3.9-168 S01, 3.9-178, 3.9-180 through 3.9-196, 3.9-199, 3.9-178 S01, 3.9-188 S01, and 3.9-189 S01) and other changes. (Underline from DCD draft R5 markups is removed.)

Blue Text – suggested additional text to be added to or to replace DCD R4 or draft R5 text (from the RAI responses), or deletion (with strikethrough) of DCD or RAI response text.

Green Text – recommended text to be added to or deleted from the COLA IST Program description, or text that is currently included in COLA R0.

Black text – DCD Revision 4 text.

3.9.3.5 Valve Operability Assurance

~~Active mechanical (with or without electrical operation) equipment designed to perform a mechanical motion for its safety-related function is Seismic Category I. Equipment with faulted condition functional requirements includes active pumps and valves in fluid systems such as the Residual Heat Removal (RHR) System, Emergency Core Cooling System (ECCS), and MS system.~~

This subsection discusses operability assurance of active Code valves, including ~~the~~ actuators ~~that is a part of the valve~~ (Subsection 3.9.2.2).

[*Valves that perform an active safety-related function are functionally qualified to perform their required functions. For valve designs developed for the ESBWR that were not previously qualified, the qualification programs meet the requirements of QME-1-2007. For valve designs previously qualified to standards other than ASME QME-1-2007, the following approach is used:*

- *The ESBWR general valve requirements specification includes requirements related to design and functional qualification of safety-related valves that incorporate lessons learned from nuclear power plant operations and research programs.*
- *Qualification specifications (e.g., design specifications) consistent with Appendices QV-I and QV-A of QME-1-2007 will be prepared to ensure the operating conditions and safety functions for which the valves are to be qualified are communicated to the manufacturer or qualification facility.*
- *Suppliers are required to submit, for GEH review and approval, application reports, as described in QME-1-2007, that describe the basis for the application of specific predictive methods and/or qualification test data to a valve application.*
- *GEH reviews the application reports provided by the suppliers for adherence to specification requirements to ensure the methods used are applicable and justified and to verify any extrapolation techniques used are justified. A gap analysis is performed to identify any deviations from QME-1-2007 in the valve qualification. Each deviation is evaluated for impact on the overall valve qualification. If the conclusion of the gap analysis is that the valve qualification is inadequate, then the valve may be qualified using a test-based methodology, as allowed by QME-1-2007.*
- *GEH performs independent sizing calculations, using bounding design parameters (such as sliding friction coefficients), to verify supplier actuator sizing.*

Functional qualification addresses key lessons learned from industry efforts, particularly on air- and motor-operated valves, many of which are discussed in Section QV-G of QME-1-2007.]* For example:

- Evaluation of valve performance is based on a combination of testing and analysis, using design similarity to apply test results to specific valve designs.
- Testing to verify proper valve setup and acceptable operating margin is performed using diagnostic equipment to measure stem thrust and/or torque.
- Sliding friction coefficients used to evaluate valve performance (e.g. disk-to-seat friction coefficients for gate valves and bearing coefficients for butterfly valves) account for the effects of temperature, cycle history, load and internal parts geometry.
- Actuator sizing allows margin for aging/degradation, test equipment accuracy and other uncertainties, as appropriate.
- Material combinations that may be susceptible to galling or other damage mechanisms under certain conditions are not used.

Subsection 3.9.2.2 and Section 3.10 provide details on the seismic qualification of valves. Section 3.11 provides details on the environmental qualification of valves.~~Safety-related valves are qualified by testing and analysis and by satisfying the stress and deformation criteria at the critical locations within the valves. Operability is assured by meeting the requirements of the programs defined in Subsection 3.9.2.2, Section 3.10, Section 3.11 and the following subsections.~~

Section 4.4 of GE's Environmental Qualification Program (Reference 3.9-3) applies to this subsection, and the seismic qualification methodology presented therein is applicable to mechanical as well as electrical equipment.

3.9.3.5.1 Major Active Valves

Some of the major safety-related active valves (Tables 6.2-21, 6.2-42 and 3.2-1) discussed in this subsection for illustration are the main steamline isolation valves and safety relief valves, and standby liquid control valves and depressurization valves. These valves are designed to meet the Code requirements and perform their mechanical motion in conjunction with a dynamic (SSE and other RBV) load event. These valves are supported entirely by the piping (i.e., the valve operators are not used as attachment points for piping supports) (Subsection 3.9.3.7). The dynamic qualification for operability is unique for each valve type; therefore, each method of qualification is detailed individually below.

Main Steamline Isolation Valves (MSIVs)

The typical Y-pattern MSIVs described in Subsection 5.4.5.2 are evaluated by analysis and test for capability to operate under the design loads that envelop the predicted loads during a design basis accident and safe shutdown earthquake.

The valve body is designed, analyzed and tested in accordance with the Code, Class 1 requirements. The MSIVs are modeled mathematically in the main steamline system analysis. The loads, amplified accelerations and resonance frequencies of the valves are determined from the overall steamline analysis. The piping supports (snubbers, rigid restraints, etc.) are located and designed to limit amplified accelerations of and piping loads in the valves to the design limits.

As described in Subsection 5.4.5.3, the MSIV and associated electrical equipment (wiring, solenoid valves, and position switches) are dynamically qualified to operate during an accident condition.

Main Steam Safety Relief Valves

The typical SRV design described in Subsection 5.2.2.2 is qualified by type test to IEEE 344 for operability during a dynamic event. Structural integrity of the configuration during a dynamic event is demonstrated by both the Code Class 1 analysis and test.

- The valve is designed for maximum moments on inlet and outlet, which may be imposed when installed in service. These moments are resultants due to dead weight plus dynamic loading of both valve and connecting pipe, thermal expansion of the connecting pipe, and reaction forces from valve discharge.
- A production SRV is demonstrated for operability during a dynamic qualification (shake table) type test with moment and "g" loads applied greater than the required equipment's design limit loads and conditions.

A mathematical model of this valve is included in the main steamline system analysis, as with the MSIVs. This analysis ensures the equipment design limits are not exceeded.

Standby Liquid Control Valve (Injection Valve)

The typical SLC injection valve design is qualified by type test to IEEE 344. The valve body is designed, analyzed and tested per the Code, Class 1. The qualification test demonstrates the ability to remain operable after the application of the horizontal and vertical dynamic loading exceeding the predicted dynamic loading.

Depressurization Valves (DPV)

The DPV design described in Subsection 6.3.2.8 is qualified by test to IEEE 344 for operability during a dynamic event. Structural integrity of the configuration during dynamic events is demonstrated by both the Code Class 1 analysis and test.

- The valve is designed for maximum moments on the inlet that may be imposed when installed in service. These moments are resultants due to dead weight plus dynamic loading of both valve and connecting pipe, thermal expansion of the connecting pipe, and reaction forces from valve discharge.
- A production DPV is demonstrated for operability after the performance of a dynamic qualification (shake table) type test with moment and "g" loads applied greater than the required equipment's design limit loads and conditions.

A mathematical model of this valve is included in the main steamline system analysis and in the analysis of stub lines attached directly to the reactor vessel. These analyses assure that the equipment design limits are not exceeded.

3.9.3.5.2 Other Active Valves

Other safety-related active valves are ASME Class 1, 2 or 3 and are designed to perform their mechanical motion during dynamic loading conditions. The operability assurance program ensures that these valves operate during a dynamic seismic and other RBV event.

Procedures

Qualification tests accompanied by analyses are conducted for all active valves. Procedures for qualifying electrical and instrumentation components, which are depended upon to cause the valve to accomplish its intended function, are described in Section 3.10.

Tests

Prior to installation of the safety-related valves, the following tests are performed: (1) shell hydrostatic test to the Code requirements; (2) back seat and main seat leakage tests; (3) disk hydrostatic test; (4) functional tests to verify that the valve opens and closes within the specified time limits when subject to the design differential pressure; and (5) operability qualification of valve actuators for the environmental conditions over the installed life. Environmental qualification procedures for operation follow those specified in Section 3.11. The results of all required tests are properly documented and included as a part of the operability acceptance documentation package.

Dynamic Load Qualification

The functionality of an active valve during and after a seismic and other RBV event may be demonstrated by an analysis or by a combination of analysis and test. The qualification of electrical and instrumentation components controlling valve actuation is discussed in Section 3.10. The valves are designed using either stress analyses or the pressure temperature rating requirements based upon design conditions. An analysis of the extended structure is performed for static equivalent dynamic loads applied at the center of gravity of the extended structure. Refer to Subsection 3.9.2.2 for further details.

The maximum stress limits allowed in these analyses confirm structural integrity and are the limits developed and accepted by the ASME for the particular ASME Class of valve analyzed. When qualification of mechanisms that must change position to complete their safety-related function is based on dynamic testing or equivalent static load testing, operability testing is performed for the loads defined by the applicable events and conditions per Subsection 3.9.1.1 and Table 3.9-1.

The dynamic qualification testing procedure for valve operability is outlined below. A subject valve assembly is mounted in a test stand or fixture in a manner that conservatively represent typical valve installation(s). Each test valve assembly includes the actuator and accessories that are attached to an in-service valve. Additional discussion of test criteria and method is provided in Subsection 3.9.2.2, and also in the portions of Subsections 3.10.1 and 3.10.2 applicable to active valve assemblies.

Dynamic load qualification is accomplished in the following way:

(1) The active valves are designed to have a fundamental frequency that is greater than the high frequency asymptote of the dynamic event. This is shown by suitable test or analysis.

(2) The actuator and yoke of the valve system is statically loaded to an amount greater than that due to a dynamic event. The load is applied at the center of gravity to the actuator alone in the direction of the weakest axis of the yoke. The simulated operational differential pressure is simultaneously applied to the valve during the static deflection tests.

(3) The valve is then operated while in the deflected position (i.e., from the normal operating position to the safe position). The valve is verified to perform its safety-related function within the specified operating time limits.

(4) Powered valve actuators and other accessory components directly attached onto the valve or actuator that are necessary for operation are qualified as operable during a dynamic event by appropriate qualification tests prior to installation on the valve. The powered actuator assemblies then have individual Seismic Category I supports attached to decouple the dynamic loads between the actuators and valves themselves.

The piping, stress analysis, and pipe support designs maintain the actuator assembly accelerations below the qualification levels with adequate margin of safety.

If the fundamental frequency of the valve, by test or analysis, is less than that for the ZPA, a dynamic analysis of the valve is performed to determine the equivalent acceleration to be applied during the static test. The analysis provides the amplification of the input acceleration considering the natural frequency of the valve and the frequency content of the applicable plant floor response spectra. The adjusted accelerations have been determined using the same conservatism contained in the horizontal and vertical accelerations used for rigid valves. The adjusted acceleration is then used in the static analysis and the valve operability is assured by the methods outlined in Steps (2) through (4), using the modified acceleration input. Alternatively, the valve, including the actuator and other accessories, is qualified by shake table test.

Valves that are safety-related but can be classified as not having an overhanging structure, such as check valves and pressure-relief valves, are considered as follows:

Check Valves

Due to the particular simple characteristics of the check valves, the active check valves are qualified by a combination of the following tests and analysis:

- Stress analysis including the dynamic loads where applicable;
- In-shop hydrostatic tests;
- In-shop seat leakage test; and
- Periodic in-situ valve exercising and inspection to assure the functional capability of the valve.

Pressure-Relief Valves

The active pressure relief valves (RVs) are qualified by the following procedures. These valves are subjected to test and analysis similar to check valves, stress analyses including the dynamic loads, in-shop hydrostatic seat leakage, and performance tests. In addition to these tests, periodic in-situ valve inspection, as applicable, and periodic valve removal, refurbishment, performance testing, and reinstallation are performed to assure the functional capability of the valve. Tests of the RV under dynamic loading conditions demonstrate that valve actuation can occur during application of the loads. The tests include pressurizing the valve inlet with nitrogen and subjecting the valve to accelerations equal to or greater than the dynamic event (SSE plus other RBV) loads.

Qualification of Electrical and Instrumentation Components Controlling Valve Actuation

A practical problem arises in attempting to describe tests for devices (relays, motors, sensors, etc.) as well as for complex assemblies such as control panels. It is reasonable to assume that a device, as an integral part of an assembly, can be subjected to dynamic loads tests while in an operating condition and its performance monitored during the test. However, in the case of complex panels, such a test is not always practical. In such a situation, the following alternate approach may be followed.

The individual devices are tested separately in an operating condition and the test levels recorded as the qualification levels of the devices. The panel, with similar devices installed but inoperative, is vibration tested to determine if the panel response accelerations, as measured by accelerometers installed at the device attachment locations, are less than the levels at which the devices were qualified. Installing the non-operating devices assures that the test panel has representative structural characteristics. If the acceleration levels at the device locations are found to be less than the levels to which the device is qualified, then the total assembly is considered qualified. Otherwise, either the panel is redesigned to reduce the acceleration level to the device locations and retested, or the devices are requalified to the higher levels.

Documentation

All of the preceding requirements are satisfied to demonstrate that functionality is assured for active valves. The documentation is prepared in a format that clearly shows that each consideration has been properly evaluated, and a designated quality assurance representative has validated the tests. The analysis is included as a part of the certified stress report for the assembly.

3.9.3.7.1 Piping Supports

Supports and their attachments for safety-related Code Class 1, 2, and 3 piping are designed in accordance with Subsection NF up to the interface of the building structure, with jurisdictional boundaries as defined by Subsection NF. The design of the nuclear power plant structures, systems, and components will provide access for the performance of inservice testing (IST) and inservice inspection (ISI) as required by the applicable ASME Code. The building structure component supports (connecting the NF support boundary component to the existing building structure) are designed in accordance with ANSI/AISC N690, Nuclear Facilities-Steel Safety-Related Structures for Design, Fabrication and Erection, or the AISC Specification for the Design, Fabrication, and Erection of Structural Steel. The applicable loading combinations and allowables used for design of supports are shown on Tables 3.9-10, -11, and -12. The stress limits are per ASME-III, Subsection NF and Appendix F.

Maximum calculated static and dynamic deflections of the piping at support locations do not exceed the allowable limits specified in the piping design specification.

Seismic Category II pipe supports are designed so that the SSE would not cause unacceptable structural interaction or failure. Support design follows the intent and general requirement specified in ASME-III, Nonmandatory Appendix F. This is used to evaluate the total design load condition with respect to the requirements of the safe shutdown earthquake (SSE) condition to ensure the structural integrity of the pipe supports are maintained.

The design of supports for the non-nuclear piping satisfies the requirements of ASME B31.1 Power Piping Code, Paragraphs 120 and 121.

For the major active valves identified in Subsection 3.9.3.5, the valve operators are not used as attachment points for piping supports.

The friction loads caused by unrestricted motion of the piping due to thermal displacements are considered to act on the support with a friction coefficient of 0.3, in the case of steel-to-steel friction. For stainless steel, Teflon, and other materials, the friction coefficient could be less. The friction loads are not considered during seismic or dynamic loading evaluation of pipe support structures.

For the design of piping supports, a deflection limit of 1.6 mm (1/16 in.) for erection and operation loadings is used, based on WRC-353 paragraph 2.3.2. For the consideration of loads due to SSE and in the cases involving springs, the deflection limit is increased to 3.2 mm (1/8 in.).

For frame type supports, the total gap is limited to 3.2 mm (1/8 inch). In general, this gap is adequate to avoid thermal binding due to radial thermal expansion of the pipe. For large pipes with higher temperatures, this gap is evaluated to assure that no thermal binding occurs. The minimum total gap is specified to ensure that it is adequate for the thermal radial expansion of the pipe to avoid any thermal binding.

The small bore lines (e.g. small branch and instrumentation lines) are supported taking into account the flexibility, and thermal and dynamic motion requirements of the pipe to which they connect. Subsection 3.7.3.16 provides details for the support design and criteria for instrumentation lines 50 mm (1.97 in.) and less where it is acceptable practice by the regulatory agency to use piping handbook methodology.

The design criteria and dynamic testing requirements for the ASME-III piping supports are as follows:

(1) Piping Supports—All piping supports are designed, fabricated, and assembled so that they cannot become disengaged by the movement of the supported pipe or equipment after they have been installed. All piping supports are designed in accordance with the rules of Subsection NF of the Code up to the building structure interface as defined by the jurisdictional boundaries in Subsection NF.

(2) Spring Hangers—The operating load on spring hangers is the load caused by dead weight. The hangers are calibrated to ensure that they support the operating load at both their hot and cold load settings. Spring hangers provide a specified down travel and up travel in excess of the specified thermal movement.

(3) Snubbers—The operating loads on snubbers are the loads caused by dynamic events (e.g., seismic, RBV due to LOCA, SRV and DPV discharge, discharge through a relief valve line or valve closure) during various operating conditions. Snubbers restrain piping against response to the dynamic excitation and to the associated differential movement of the piping system support anchor points. The criteria for locating snubbers and ensuring adequate load capacity, the structural and mechanical performance parameters used for snubbers and the installation and inspection considerations for the snubbers are as follows:

a. Required Load Capacity and Snubber Location

The loads calculated in the piping dynamic analysis, described in Subsection 3.7.3.8, cannot exceed the snubber load capacity for design, normal, upset, emergency and faulted conditions.

Snubbers are generally used in situations where dynamic support is required because thermal growth of the piping prohibits the use of rigid supports. The snubber locations and support directions are first decided by estimation so that the stresses in the piping system have acceptable values. The snubber locations and support directions are refined by performing the dynamic analysis of the piping and support system as described above in order that the piping stresses and support loads meet the Code requirements.

The pipe support design specification requires that snubbers be provided with position indicators to identify the rod position. This indicator facilitates the checking of hot and cold settings of the snubber, as specified in the installation manual, during plant preoperational and startup testing.

b. Inspection, Testing, Repair and/or Replacement of Snubbers

The pipe support design specification requires that the snubber supplier prepare an installation instruction manual. This manual is required to contain complete instructions for the testing, maintenance, and repair of the snubber. It also contains inspection points and the period of inspection. The program for inservice examination and testing of snubbers in the completed ESBWR construction is prepared in accordance with the requirements of ASME Section XI Code and ASME OM Code, ISTD, and the applicable industry and regulatory guidance including RG 1.192. The intervals for visual examination are the subject of Code Case OMN-13, which is accepted under the RG 1.192. The preparation and submittal of a program for the inservice testing and examination of snubbers is addressed in Subsection 3.9.9.

The pipe support design specification requires that hydraulic snubbers be equipped with a fluid level indicator so that the level of fluid in the snubber can be ascertained easily.

The spring constant achieved by the snubber supplier for a given load capacity snubber is compared against the spring constant used in the piping system model. If the spring constants are the same, then the snubber location and support direction become confirmed. If the spring constants are not in agreement, they are brought in agreement, and the system analysis is redone to confirm the snubber loads. This iteration is continued until all snubber load capacities and spring constants are reconciled.

A thermal motion monitoring program is established for verification of snubber movement, adequate clearance and gaps, including motion measurements and acceptance criteria to assure compliance with ASME Section III Subsection NF.

c. Snubber Design and Testing

To assure that the required structural and mechanical performance characteristics and product quality are achieved, the following requirements for design and testing are imposed by the design specification:

(i) The snubbers are required by the pipe support design specification to be designed in accordance with the rules and regulations of the ASME Section III Code, Subsection NF and consider the following:

- Design requirements include analysis for normal, upset, emergency and faulted loads. Calculated loads are then compared against allowable loads as established by snubber vendor.

- Swing angles, as supplied by the snubber vendor, are incorporated into the design. Pipe movements in the horizontal and vertical direction are taken into account to prevent end bracket/paddle plate binding.

- Snubber stiffness, as supplied by the snubber vendor, is included in the piping analysis. Other support components such as the pipe clamp/extension piece/transition tube and structural auxiliary steel stiffness values are incorporated into the final determination of the stiffness value used in the analysis.

In multiple snubber applications where mismatch of end fitting clearance and lost motion could possibly exist, the synchronism of activation level or release rate is evaluated, if deemed necessary, in the piping analysis model when this application could be considered critical to the functionality of the system, such as a multiple snubber application located near rotating equipment. Equal load sharing of multiple snubber supports is not assumed if a mismatch in end fitting clearances exists and is evaluated as a part of this assessment.

(ii) A list of snubbers on systems which experience sufficient thermal movement to measure cold to hot position is provided as part of the testing program after the piping analysis has been completed.

(iii) The snubbers are tested to ensure that they can perform as required during the seismic and other RBV events, and under anticipated operational transient loads or other mechanical loads associated with the design requirements for the plant. Production and qualification test programs for both hydraulic and mechanical snubbers are carried out by the snubber vendors in accordance with the snubber installation instruction manual required to be furnished by the snubber supplier. Acceptance criteria to assure compliance with ASME Section III Subsection NF ~~are cited in this manual~~, and other applicable codes~~, and~~ standards and requirements are as follows:~~referenced. The following test requirements are included:~~

– ~~Snubbers are subjected to force or displacement versus time loading at frequencies within the range of significant modes of the piping system.~~Snubber production and qualification test programs are carried out by strict adherence to the manufacturer's snubber installation and instruction manual, which is prepared by the snubber manufacturer and subjected to review by the applicant for compliance with the applicable provisions of the ASME Pressure Vessel and Piping Code of record. The test program is periodically audited during implementation by the applicant for compliance.

– ~~Dynamic cyclic load tests are conducted for hydraulic snubbers to determine the operational characteristics of the snubber control valve.~~All snubbers will be inspected and tested for compliance with the design drawings and functional requirements of the procurement specifications.

– ~~Displacements are measured to determine the performance characteristics specified.~~All snubbers are inspected and tested. No sampling methods may be used in the qualification tests.

– ~~Tests are conducted at various temperatures to ensure operability over the specified range.~~All snubbers are load rated by testing in accordance with the snubber manufacturer's testing program and in compliance with the applicable sections of ASME QME-1-2007, Subsection QDR and ASME OM Code, Subsection ISTD.

- ~~Peak test loads in both tension and compression are required to be equal to or higher than the rated load requirements.~~Design compliance of the snubbers per ASME Section III Subsections NF-3128, NF-3411.3 and NF-3412.4.

- The snubbers are tested for various abnormal environmental conditions. Upon completion of the abnormal environmental transient test, the snubber is tested dynamically at a frequency within a specified frequency range. The snubber must operate normally during the dynamic test. The functional parameters cited in Subsection NF-3412.4 are included in the snubber qualification and testing program. Other parameters in accordance with applicable ASME QME-1-2007 and the ASME OM Code will be incorporated.

- The codes and standards used for snubber qualification and production testing are as follows:

  - ASME B&PV Code Section III (Code of Record date) and Subsection NF.

  - ASME QME-1-2007, Subsection QDR and ASME OM Code, Subsection ISTD.

- All large bore hydraulic snubbers include full Service Level D load testing, including verifying bleed rates, control valve closure within the specified velocity ranges and drag forces/breakaway forces are acceptable in accordance with ASME, QME-1-2007 and ASME OM Codes.

(iv) All safety-related components which utilize snubbers in their support systems will be identified and inserted into the Final Safety Analysis Report ~~(FSAR)~~ in table format and will include the following:

- identification of systems and components

- number of snubbers utilized in each system and on that component

- snubber type (s) – (hydraulic or mechanical) – and name of supplier

- constructed to ASME Code Section III, Subsection NF or other

- snubber use such as shock, vibration, or dual purpose

- those snubbers identified as dual purpose or vibration arrestor type, will include an indication if both snubber and component were evaluated for fatigue strength

d. Snubber Installation Requirements

An installation instruction manual is required by the pipe support design specification. This manual is required to contain instructions for storage, handling, erection, and adjustments (if necessary) of snubbers. Each snubber has an installation location drawing that contains the installation location of the snubber on the pipe and structure, the hot and cold settings, and additional information needed to install the particular snubber.

e. Snubber Preservice and Inservice Examination and Testing

Preservice Examination and Testing

The preservice examination plan for ~~of all~~ snubbers is prepared in accordance with the requirements of the ASME Code for Operation and Maintenance of Nuclear Power Plants (OM Code), Subsection ISTD, and the additional requirements of this section. The~~is~~ preservice examinations are~~is~~ made after snubber installation but not more than 6 months prior to initial system pre-operational testing. The preservice examination verifies the following:

(i) There are no visible signs of damage or impaired operability as a result of storage, handling, or installation.

(ii) The snubber load rating, location, orientation, position setting, and configuration (attachments, extensions, etc.) are according to design drawings and specifications.

(iii) Snubbers are not seized, frozen or jammed.

(iv) Adequate swing clearance is provided to allow snubber movements.

(v) If applicable, fluid is to the recommended level and is not to be leaking from the snubber system.

(vi) Structural connections such as pins, fasteners and other connecting hardware such as lock nuts, tabs, wire, cotter pins are installed correctly.

If the period between the initial preservice examination and initial system preoperational tests exceeds 6 months, reexamination of Items i, iv, and v is performed. Snubbers, which are installed incorrectly or otherwise fail to meet the above requirements, are repaired or replaced and re-examined in accordance with the above criteria.

A preservice thermal movement examination, as required by ISTD-4130, is also performed - during initial system heatup and cooldown, for systems whose design operating temperature exceeds 250ºF (121ºC), snubber thermal movement is verified in accordance with ISTD-4131 through ISTD-4133.

Additionally, preservice operational readiness testing is performed on all snubbers in accordance with ISTD-5100. The operational readiness test is performed to verify the parameters of ISTD-5120 as required by ISTD-3210. Snubbers that fail the Preservice Operational Readiness Test shall be evaluated and retested in accordance with ISTD-5130.

Snubbers that are installed incorrectly or otherwise fail preservice testing requirements are re-installed correctly, adjusted, modified, repaired or replaced, as required. Preservice examination and testing is re-performed on installation-corrected, adjusted, modified, repaired or replaced snubbers as required by ISTD-4140 and ISTD-5134.

Inservice Examination and Testing

Inservice examination of all safety-related snubbers is conducted in accordance with the requirements of ISTD-4200 and inservice testing requirements of ISTD-5200. Inservice examination is initially performed not less than two months after attaining 5% reactor power operation and will be completed within 12 calendar months after attaining 5% reactor power (ISTD-4251). Subsequent examinations are performed at intervals defined by ISTD-4252 and Table ISTD-4252-1. Examination intervals are adjusted as allowed by Table ISTD-4252-1, based on the number of unacceptable snubbers identified in the current interval.

An inservice visual examination is performed on all snubbers in accordance with ISTD-4200 to identify physical damage, leakage, corrosion, degradation, indication of binding, misalignment or deformation and potential defects generic to a particular design (ISTD-4231 through ISTD-4233). Snubbers that do not meet examination requirements of ISTD-4230 are evaluated to determine the root cause of the unacceptability, and corrective actions (snubber adjusted, repaired, modified, or replaced) are taken in accordance with ISTD-4280. Snubbers evaluated as unacceptable during visual examination may be accepted for continued service by successful completion of an operational readiness test of ISTD-5210 (ISTD-4233).

Snubbers are tested inservice to determine operational readiness, in accordance with ISTD-5200 during each fuel cycle, beginning no sooner than 60 days before the start of the refueling outage. Snubbers tests are conducted with the snubber in the as-found condition, to the extent practical, either in place or on a test bench, to verify the test parameters of ISTD-5210 (ISTD-5220). When an in-place test or bench test can not be performed, snubber subcomponents that control the parameters to be verified are examined and tested in accordance with ISTD-5225. Preservice examinations of ISTD-5224 are performed on snubbers after reinstallation, when bench testing is used, or on snubbers where individual subcomponents are reinstalled after examination.

Defined test plan groups (DTPG) are established and the snubbers of each DTPG tested according to an established sampling plan each fuel cycle (ISTD-5250, and ISTD-5260). Sample plan size and composition is determined as required by ISTD-5310/ISTD-5410, and additional sampling as may be required by ISTD-5320 or ISTD-5420. Snubbers that do not meet test requirements are evaluated to determine root cause of the failure, and are assigned to failure mode groups based on the evaluation unless the failure is considered unexplained or isolated. For unacceptable snubbers, additional testing is conducted for the DTPG or FMG until the requirements of ISTD-5330 or ISTD-5430 are satisfied.

Unacceptable snubbers are adjusted, repaired, modified, or replaced. Replacement snubbers meet the requirements of ISTD-1600. Post-maintenance testing and testing of repaired snubbers is in accordance with ISTD-1500.

Service life for snubbers is established, monitored and adjusted as required by ISTD-6000 and the guidance of ASME OM Code Nonmandatory Appendix F .

The inservice examination and testing plan for of all snubbers covered by the plant-specific Technical Specifications is prepared in accordance with the requirements of the ASME OM Code, Subsection ISTD and is in conformance with the relevant requirements of 10 CFR 50 Part B, Appendix A, GDC 1. Snubber maintenance, repairs, replacements and modifications are performed in accordance with the requirements of the ASME OM Code, Subsection ISTD. The COL Applicant will provide a full description of the snubber preservice and inservice inspection and test programs, and a milestone for program implementation.Details of the in-service examination and testing program, including test schedules and frequencies and an, are reported in the inservice inspection and testing plan., which will be provided by the COL applicant.. See Subsection 3.9.9.

[The above COL Applicant item text (last sentence) would be replaced with the following in the COLA]
The inservice testing program for snubbers will be completed in accordance with milestones described in Section 13.4.

f. Snubber support data

The COL Holder will prepare a plant-specific table to be included as part of the inspection and test program for snubbers (see Subsection 3.9.9) that will include the following information:

A plant specific table will be prepared in conjunction with closure of ITAAC Table 3.1-1 and include the following specific snubber information:

(i) the general functional requirement (i.e. shock, vibration, dual purpose) for each system and component using snubbers including the number and location of each snubber. If either dual-purpose or arrestor type indicate whether the snubber or component was evaluated for fatigue strength.

(ii) operating environment,

(iii) applicable codes and standards,

(iv) list type of snubber (i.e. hydraulic, mechanical), materials of construction, standards for hydraulic fluids and lubricants, and the corresponding supplier,~~.~~

(v) environmental, structural, and performance design verification tests,

(vi) production unit functional verification tests and certification,

(vii) packaging, shipping, handling, and storage requirements, ~~and~~

(viii) description of provisions for attachments and installation,~~.~~ and

(ix) quality assurance and assembly quality control procedures for review and acceptance by the purchaser.

This information will be included in the FSAR as part of a subsequent FSAR update.

(4) Struts — Struts are defined as ASME Section III, Subsection NF, Component Standard Supports. They consist of rigid rods pinned to a pipe clamp or lug at the pipe and pinned to a clevis attached to the building structure or supplemental steel at the other end. Struts, including the rod, clamps, clevises, and pins, are designed in accordance with the Code, Subsection NF-3000.

Struts are passive supports, requiring little maintenance and inservice inspection, and are normally used instead of snubbers where dynamic supports are required and the movement of the pipe due to thermal expansion and/or anchor motions is small. Struts are not used at locations where restraint of pipe movement to thermal expansion significantly increases the secondary piping stress ranges or equipment nozzle loads.

Because of the pinned connections at the pipe and structure, struts carry axial loads only. The design loads on struts may include those loads caused by thermal expansion, dead weight, and the inertia and anchor motion effects of all dynamic loads. As in the case of other supports, the forces on struts are obtained from an analysis, and are confirmed not to exceed the design loads for various operating conditions.

(5) Frame Type (Linear) Pipe Supports — Frame type pipe supports are linear supports as defined as ASME Section III, Subsection NF, Component Standard Supports. They consist of frames constructed of structural steel elements that are not attached to the pipe. They act as guides to allow axial and rotational movement of the pipe but act as rigid restraints to lateral movement in either one or two directions. Frame type pipe supports are designed in accordance with the Code, Subsection NF-3000.

Frame type pipe supports are passive supports, requiring little maintenance and inservice inspection, and are normally used instead of struts when they are more economical or where environmental conditions are not suitable for the ball bushings at the pinned connections of struts. Similar to struts, frame type supports are not used at locations where restraint of pipe movement to thermal expansion significantly increases the secondary piping stress ranges or equipment nozzle loads.

The design loads on frame type pipe supports include those loads caused by thermal expansion, dead weight, and the inertia and anchor motion effects of all dynamic loads. As ….

3.9.6 Inservice Testing

Inservice testing of certain ASME Code, Section III, Class 1, 2, and 3 pumps and valves is performed in accordance with the ASME Operations and Maintenance (OM) Code as required by 10 CFR 50.55a(f), including limitations and modifications set forth in 10 CFR 50.55a. Operability testing as required by 10 CFR 50.55a(b)(3)(ii) is performed on motor -operated valves (MOVs) that are included in the ASME OM Code inservice testing program to demonstrate that the MOVs are capable of performing their design basis safety function(s). The Inservice Testing Program does not include any non-Code Class valves. The design of the nuclear power plant structures, systems, and components will provide access for the performance of inservice testing (IST) and inservice inspection (ISI) as required by the applicable ASME Code.

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

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

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

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

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

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

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

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

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

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

The requirements for preservice and inservice examination and testing of dynamic restraints are defined in the ASME OM Code Subsection ISTD. This program is described in DCDSubsection 3.9.3.7.1.

Refer to Subsection 3.9.9 for COL information requirements. The COL applicant will provide milestones for implementation of the preservice and inservice testing programs and motor-operated valve programs.

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

3.9.6.1 Inservice Testing of Valves

Certain ASME Code Class 1, 2, and 3 valves and pressure relief devices are subject to inservice testing in accordance with the ASME OM Code Subsection ISTC and/or Appendix I, including the general requirements in ISTA. Inservice testing of valves assesses operational readiness including actuating and position-indicating systems. The valves that are subject to inservice testing include those valves that perform a specific function in shutting down the reactor to a safe shutdown condition, in maintaining a safe shutdown condition, or in mitigating the consequences of an accident. In addition, pressure relief devices used for protecting systems or portions of systems that perform a function in shutting down the reactor to a safe shutdown condition, in maintaining a safe shutdown condition, or in mitigating the consequences of an accident, are subject to inservice testing.

The inservice testing program does not require testing of non-safety related valves. Any non-safety related valves included in the Inservice Testing Program as part of regulatory treatment of non-safety systems (RTNSS, see Appendix 19A) are considered augmented components and tested commensurate with their functions.

Valves subject to inservice testing in accordance with the ASME OM Code are indicated in ~~DCD~~ Table 3.9-8.

Active valve dynamic qualification and pre-installation testing requirements to assure valve operability are addressed in Section 3.9.3.5. Periodic operability (non-ASME Code) testing for power-operated valves ~~(other than motor-operated valves)~~is described in Subsection 3.9.6.8.

3.9.6.1.1 Valve Exemptions

ASME OM Code ISTC-1200 provides exemptions from the inservice testing program for certain Code Class 1, 2, and 3 valves provided that they are not required to perform a specific function in shutting down the reactor to a safe shutdown condition, in maintaining a safe shutdown condition, or in mitigating the consequences of an accident. The following valves are exempt from Subsection ISTC:

(1) valves used only for operating convenience such as vent, test, drain and instrument valves

(2) valves used only for system control, such as pressure regulating valves

(3) valves used only for system or component maintenance

(4) skid-mounted valves provided they are justified and adequately tested

(5) valves used for external control and protection systems responsible for sensing plant conditions and providing signals for valve operation (e.g. solenoid valves on air operated valves).

3.9.6.1.2 Valve Categories

Non-exempt ASME Class 1, 2 and 3 valves are categorized in accordance with the ASME OM Code Subsection ISTC-1300 as follows:

(1) Category A – valves for which seat leakage is limited to a specific maximum amount in the closed position for fulfillment of their required function(s).

(2) Category B – valves for which seat leakage in the closed position is inconsequential for fulfillment of the required function(s).

(3) Category C – valves that are self-actuating in response to some system characteristic, such as pressure (relief valve) or flow direction (check valve) for fulfillment of the required function(s).

(4) Category D – valves that are actuated by an energy source capable of only one operation, such as rupture disks and explosively actuated valves.

When more than one distinguishing category characteristic is applicable, all requirements of each of the individual categories are applicable, although duplication or repetition of common testing requirements is not necessary.

3.9.6.1.3 Valve Functions

Valves in the IST program are classified as either active or passive in accordance with the ASME OM Code ISTA-2000 as follows:

(1) Active Valve – valves that are required to 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.

(2) Passive Valve – valves that maintain obturator position and are not required to change obturator position to accomplish the required function(s) in shutting down a reactor to the safe shutdown condition, maintaining the safe shutdown condition, or mitigating the consequences of an accident.

The Inservice Testing Program identifies the safety-related functions for safety-related valves. The following are typical safety-related functions that are identified in the Inservice Testing Program.

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

3.9.6.1.4 Valve Testing

Based on the valve category, active/passive function(s), and safety-related function(s) identified for each valve, the inservice tests to confirm the capability of the valve to perform these functions are identified in Table 3.9-8. ASME OM Code Table ISTC-3500-1, Inservice Test Requirements, specifies the required tests.

Table ISTC-3500-1 requires four basic valve tests which includes the following:

- exercise tests
- seat leakage tests
- remote position indicator tests
- special tests (i.e., fail-safe tests, explosive valve tests, rupture disc tests)

(1) Valve Exercise Tests

Active Category A valves, Category B valves, and Category C check valves are exercised periodically, except for self-actuated safety and relief valves. The ASME OM Code specifies a quarterly valve exercise frequency for all valves except power-operated safety and relief valves, which are required to be tested once per fuel cycle, and manual valves, as discussed in Subsection 3.9.6.1.5(2). Where it is not practicable to exercise a valve during normal power operation, the valve exercise test is deferred to either cold shutdown or refueling outages. Valve exercise tests and frequencies are identified in Table 3.9-8. In some cases, quarterly stroke testing is deferred to refueling outages or cold shutdown, as indicated in Table 3.9-8 Note g. The bases for deferral are consistent with NUREG 1482, Revision 1.

During valve exercise tests, the necessary valve obturator movement is determined while observing an appropriate direct indicator, such as indicating lights that signal the required changes of obturator position, or by observing other evidence or positive means, such as changes in system pressure, flow, level, or temperature that reflects change of obturator position.

Check ~~V~~valve exercise tests use direct observation or other positive means (ISTC-5221(a)) for verification of valve obturator position.

(2) Valve Leakage Tests

Active and passive Category A containment isolation valves are tested to verify their seat leakage limits in accordance with 10 CFR 50 Appendix J. Frequency of containment isolation valve seat leakage tests are in accordance with the Appendix J requirements. All containment isolation valves and seat leakage tests are identified in Table 3.9-8.

Other Category A valves are required to be seat leakage tested at least once every two years as specified by the ASME OM Code ISTC-3630. ~~The ESBWR design does not include any Category A valves except for containment isolation valves.~~

(3) Remote Position Indicator Tests

Active and passive valves that are included in the IST program and that are equipped with remote position indication require periodic verification of the remote position indication function in accordance with ISTC-3700. Valves that require remote position indication testing are observed locally during valve exercising to verify proper operation of the position indication. The frequency for this position indication test is once every two years. Where local observation is not practicable, other methods are used for verification of valve position indicator operation.

Valves with remote position indicators are identified in Table 3.9-8.

(4) Special Tests

- Valves with fail-safe actuators are tested by observing the operation of the actuator upon loss of valve actuating power (electrical power and/or pneumatic supply) in accordance with ISTC-3560. These tests are performed in conjunction with the valve exercise test. Fail-safe test requirements are identified in Table 3.9-8.

- Category D explosively actuated valves are subject to periodic test firing of the explosive actuator charges. In accordance with ASME OM Code ISTC-5260, at least 20 percent of the charges installed in the plant in explosively actuated valves are fired and replaced at least once every 2 years. If a charge fails to fire, all charges within the same batch number are removed, discarded, and replaced with charges from a different batch. The firing of the explosive charge may be performed inside the valve or outside of the valve in a test fixture.

  The maintenance and review of the service life for charges for explosively actuated valves follows the requirements in the ASME OM Code ISTC-5260. Replacement charges are from batches from which a sample charge has been tested satisfactorily, and with a service life such that the requirements of ISTC-5260(b) are met.

  Category D explosively actuated valves are identified in Table 3.9-8.

- Category D rupture disks are replaced on a 5 year frequency unless historical data indicates a requirement for more frequent replacement, in accordance with Mandatory Appendix I of the ASME OM Code.

  Category D rupture disks are identified in ~~DCD~~ Table 3.9-8.

3.9.6.1.5 Specific Valve Test Requirements

~~(1) Power Operated Valve Exercise Tests~~

~~a. Active Motor Operated Valve Tests~~

~~The inservice operability testing of active motor operated valves relies on nonintrusive diagnostic techniques to permit periodic assessment of the valve's ability to perform its safety related function during design basis conditions. MOVs upon which inservice testing is performed are identified in Table 3.9-8. Test frequencies are developed in~~

~~accordance with Generic Letter 96-05 and ASME Code Case OMN-1, Rev. 1 and will not exceed 10 years.~~

~~Inservice testing of active MOVs consists of both static and dynamic testing. The specific testing frequencies are based on the individual valve's risk ranking and functional margin. These factors are described below.~~

- ~~Risk Ranking~~

  ~~The MOV's risk ranking is determined by review of the valve's individual Probabilistic Safety Assessment (PSA) which is documented on the individual component's ranking worksheet and reviewed and approved by an expert panel. Guidance for this process is outlined in the Joint Owners' Group (JOG) Motor Operated Valve Periodic Verification Program Summary [MPR-2524-A].~~

- ~~Functional Margin~~

  ~~Functional margin is that increment by which the MOV's available capability exceeds the capability required to operate the MOV under design basis conditions. The required capability of the MOV is a known, calculated quantity, which is then compared to the valve's actual capability, a measured quantity.~~

  ~~Diagnostic equipment inaccuracies, degraded voltage, control switch repeatability, load-sensitive MOV behavior and margin for degradation are considered in the calculations used to determine the valve's capacity from the valves measured test values~~

  ~~The MOV Program utilizes guidance from Generic Letter 96-05 and the Joint Owners Group (JOG) MOV Periodic Verification (PV) study, MPR 2524-A (November 2006).~~

  ~~**Design Basis Verification Test** – Prior to power operation a design basis verification test is performed upon each active motor-operated valve to verify the capability of each valve to meet its safety-related design basis requirements. The test is performed at conditions that are as close to design basis conditions as practicable. Results from this test are used along with the valves preservice test to develop the valve's initial (periodic verification) testing frequency.~~

  ~~**Active MOV Test Frequency Determination** The ability of a valve to meet its design basis functional requirements (i.e. required capability) is verified during the valve's design basis verification test. The preservice test measures the valve's actual actuator output capability. The difference between the two capabilities is termed "functional margin." With the valves functional margin and risk ranking, a periodic verification test interval/frequency is determined. This determined test frequency is first compared to the valve's historical data to verify that any potential valve degradation during the test period would not reduce the functional margin to less than zero prior to the next scheduled periodic verification test. If the data shows that the functional margin may be reduced to less than zero, the frequency is reduced to ensure that the next periodic verification test is performed prior to a loss of functional margin. If there is not sufficient data to determine whether there will be a loss of functional margin prior to the next periodic verification test, the test frequency is limited to not exceed two (2) refueling cycles or three (3) years, whichever is longer, for high risk safety significant components, and is limited to not exceed three (3) refueling cycles or five (5) years, whichever is longer, for low risk safety significant components.~~

~~A motor-operated valve with an adequate functional margin is assured of being able to open and/or close under design basis conditions.~~

~~b. Other Power-Operated Valve Tests~~

~~Power-operated valves other than active MOVs are exercised either quarterly in accordance with ASME OM ISTC. Active passive power-operated valves upon which operability testing is performed are identified in Table 3.9-8.~~

~~**Design Basis Verification Test** – Prior to power operation a design basis verification test is performed upon each power-operated valve to verify the capability of each valve to meet it's safety-related design requirements. The test is performed at conditions that are as close to design basis conditions as practicable.~~

(1) Power-Operated Valve Tests

Power-operated valves (POV) are tested in accordance with the ASME OM Code, Subsection ISTC. Specific testing activities for each valve are listed in Table 3.9-8. Active power-operated valves will have their stroke times measured during the exercise tests. Any abnormalities or erratic actions will be documented and evaluated. Test failures (e.g., failure to fully stroke or high stroke time measurements) are~~will be~~ addressed per the OM Code by repair, replacement or analysis.

The IST program for power-operated valves will consider the guidance in the NRC Regulatory Issue Summary 2000-03, which incorporates lessons learned from motor-operated valve (MOV) analyses and tests in response to Generic Letter 89-10. The COL Applicant is responsible for describing, in the IST program description (see COL Item 3.9.9-3-A), how the IST program addresses these lessons learned.

(2) Manual Valve Exercise Tests

Active Category A and B manual valves are exercised once every two years in accordance with 10 CFR 50.55a(b)(3)(vi).

(3) Check Valve Exercise Tests

Category C check valves are exercised to both the open and closed positions regardless of safety function position in accordance with ASME OM Code ISTC-3522(a) using the methods of ISTC-5221. Check valves that have seat leakage requirements are leak tested in accordance with ISTC-3600.

During the exercise test, valve obturator position is verified by direct observation (position indicating lights) or by other positive means (i.e., changes in system pressure, temperature, flow rate, level, seat leakage or nonintrusive testing results). Nonintrusive test techniques used are dependent on system and valve configuration, design and materials, and include methods such as radiography, ultrasonic (acoustics) and use of accelerometers, to verify obturator position and/or full stroke, presence or absence of cavitation or back-tapping and valve degradation.

Check valves are exercised open with flow to either the full open position or to the position required to perform its intended open safety function. Check valve closure tests are performed by verifying that the obturator travels to the seat upon cessation of flow or reverse flow. Check valves with only an open safety function may be verified closed by other direct observations such as pressure, level, temperature, or seat leakage. This methodology meets the exercise requirements of ISTC-5221.

Check valve exercise tests and frequencies are included in Table 3.9-8.

Data acquired during check valve testing and inspections, and the maintenance history of a valve or group of valves is collected and maintained in order to establish the basis for specifying inservice testing, examination, and preventive maintenance activities that will identify and/or mitigate the failure of the check valves or groups of check valves tested. This data is also used to determine if certain check valve condition monitoring tests, such as nonintrusive tests, are feasible and effective in monitoring for these identified failure mechanisms, whether periodic disassembly and examination activities would be effective in monitoring for these failure mechanisms, as well as to determine possible valve groupings to implement in a future check valve condition monitoring program as allowed by ISTC-5222, the requirements of which are described in ASME OM Code, Appendix II.

(4) Vacuum Breaker Tests

Vacuum breakers must meet the test requirements for both a Category C check valve (ISTC-5220) and for a pressure relief device (Appendix I). Vacuum breaker tests and frequencies are included in Table 3.9-8.

(5) Pressure Relief Valve Tests

Pressure relief devices that protect systems or portions of system that are required to perform a function in shutting down the reactor to the safe shutdown condition, in maintaining the safe shutdown condition, or in mitigating the consequences of an accident, are subject to periodic inservice testing. The inservice tests for these valves are identified in ASME OM Code (mandatory) Appendix I.

The periodic inservice testing includes visual inspection, seat tightness determination, set pressure determination, and operational determination of balancing devices, alarms, and position indication as appropriate. The frequency for this inservice test is every 5 years for ASME Class 1, and every 10 years for ASME Classes 2 and 3 devices. Pressure relief valves that require inservice testing are identified in Table 3.9-8.

3.9.6.2 Inservice Testing of Pumps

The ESBWR design does not require the use of pumps to mitigate the consequences of any ~~design basis accident~~DBA, or to achieve or maintain the safe shutdown condition. Therefore, there are no pumps required to be included in the Inservice Testing Program. Table 3.9-8 does not list any pumps in the Inservice Testing Program.

3.9.6.3 Preservice Testing of Valves

Category A, B, C (check valves), and D valves that are subject to periodic inservice testing are preservice tested in accordance with ASME OM Code Subsection ISTC-3100.

Category C pressure relief valves are preservice tested in accordance with ASME OM Code, Mandatory Appendix I.

3.9.6.4 Deferred Testing Justifications

In cases where it is not practicable to exercise category A, B or C (check) valves during normal power operations (quarterly), the valve is exercised during cold shutdown or refueling as permitted by ASME OM Code Subsections ISTC-3521 and ISTC-3522.

Valve exercise tests and associated frequencies are identified in Table 3.9-8. Justifications for deferred testing are detailed in Table 3.9-8~~the Inservice Testing Program~~.

3.9.6.5 Valve Replacement, Repair and Maintenance

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

3.9.6.6 10CFR50.55a Relief Requests and Code Cases

Inservice testing of ASME Code Class 1, 2, and 3 pumps and valves is performed in accordance with the ASME Operations and Maintenance (OM) Code except where specific relief has been granted by the NRC in accordance with 10 CFR 50.55a(f). Relief from the testing requirements of ASME OM Code is requested when compliance with requirements of the ASME OM Code is not practical. In such cases, specific information is provided which identifies the impractical code requirement, justification for the relief request, and the testing method to be used as an alternative. Demonstration of the impracticality of the testing required by the Code, and justification for alternative testing proposed is provided. No relief from or alternatives to the ASME OM Code is being requested ~~beyond what is identified in the DCD~~.

~~The IST program described herein utilizes Code Case OMN-1, Revision 1, "Alternative Rules for the Preservice and Inservice Testing of Certain Electric Motor-Operated Valve Assemblies in Light-Water Reactor Power Plants." Code Case OMN-1 establishes alternate rules and requirements for preservice and inservice testing to assess the operational readiness of certain motor operated valves in lieu of the requirements set forth in ASME OM Code Subsection ISTC. Implementation of the program described will require request for relief, unless Code Case OMN-1, Revision 1 is approved by NRC in Regulatory Guide 1.147, or the case has been incorporated into the OM Code on which the IST program is based, and that code is approved in 10 CFR 50.55a(b).~~

The IST program does not invoke the use of any ~~other~~ ASME Code Cases for inservice testing of pumps and valves.

3.9.6.7 Inservice Testing Program Implementation

ASME OM Code inservice test intervals are as required by ISTA-3120; the initial 120-month test interval beginning following the start of commercial service. The duration of each 120-month test interval may be modified by as much as one year as allowed by the Code, provided these adjustments do not cause successive intervals to be altered by more than one year from the original pattern of intervals.

The COL Applicant will provide milestones for implementation of the preservice and inservice testing programs and other valve-related programs.

3.9.6.8 Non-Code ~~Power~~ Testing of ~~Other~~ Power-Operated Valves ~~Testing~~

Although the design basis capability of 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 future maintenance and trending programs performed by the COL Holder. During the testing, critical parameters needed to ensure proper valve setup are measured. Depending on the valve and actuator type, these parameters may include seat load, running torque or thrust, valve travel, actuator spring rate, bench set~~benchset~~ 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 considered appropriately. Uncertainties may be 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 considered.

~~Additional valve testing may be performed by the COL Holder, for example, as part of the plant's air-operated valve Program in response to Regulatory Issue Summary 2000-003 or as part of the plant's preventive maintenance program.~~ [THIS PARA OF DCD TEXT IS TO BE DELETED IN THE COLA AND REPLACED WITH THE TEXT BELOW TO SATISFY RG 1.206]

Additional testing is performed as part of the air-operated valve (AOV) program, which includes the key elements for an AOV Program as indentified in the JOG AOV program document, Joint Owners Group Air Operated Valve Program Document, Revision 1, December 13, 2000 (Reference 3.9-xxx and 3.9-2xy). The AOV program incorporates the attributes for a successful power-operated valve long-term periodic verification program, as discussed in Regulatory Issue Summary 2000-03, Resolution of Generic Safety Issue 158: Performance of Safety-related Power-Operated Valves Under Design Basis Conditions, (Reference 3.9-2xz) by incorporating lessons learned from previous from nuclear power plant operations and research programs as they apply to the periodic testing of air- and other power-operated valves included in the IST program. For example:

- Valves are categorized according to their safety significance and risk ranking
- Sufficient diagnostics are used, at a minimum on high risk, high safety significance valves, 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
- Post-maintenance procedures include appropriate instructions and criteria to ensure baseline testing is re-performed as necessary when maintenance on the valve 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, and
- 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.

~~Active safety-related power-operated valve assemblies are tested to verify that the valve opens and closes under static and design conditions. Where design conditions cannot be achieved, testing is performed at the maximum achievable dynamic conditions. During the testing, critical parameters needed to determine the required closing and opening loads are measured. These parameters include seat load, torque or thrust, travel, spring rate, differential pressure, system pressure, fluid flow, temperature, power supply, operating time and minimum supply pressure. The data collected during the testing on the parameters is used to determine the required operating loads for the design operating conditions in conjunction with the diagnostic equipment inaccuracies and other parameters that could result in an increase in operating loads or decrease in operating output capability. The resulting operating loads including uncertainties are then compared to the structural capabilities of the power-operated valve.~~

~~During pre-operational testing the following are verified to demonstrate the acceptability of the functional performance.~~

- ~~Valves are verified to open and close as applicable at a range of conditions up to the design conditions to perform its safety function.~~
- ~~For air-operated valves and hydraulically-operated valves the operator capability at minimum supply pressure, power supply or loss of motive force exceed the required operating loads including diagnostic equipment inaccuracies and other parameters that could result in an increase in operating loads or decrease in operator output capability.~~

- Solenoid-operated valves must be capable of opening or closing at the minimum power supply voltage.
- Air-operated valves and hydraulically-operated valves maximum operating loads including diagnostic equipment inaccuracies and other parameters that could result in an increase in operating loads are verified not to exceed the allowable structural capability limits of the power-operated valve components.
- Stroke time measurements during opening and closing must be within the design requirements for safety-related functions.
- Remote position indication is verified against the local position indication.
- Valve seat leakage when fully closed is within established limits, as applicable.

During the operational inservice testing period the following are verified to demonstrate the acceptability of the functional performance of air-operated and hydraulic-operated valves.

- Periodically assess the diagnostic methods used in the verification of valve function.
- Evaluation of lessons learned through other related programs such as the MOV Generic Letter (GL) 89-10 and (GL) 96-05 Programs

3.9.7 Risk-Informed Inservice Testing

Risk-informed inservice testing initiatives, if any, are included in the implementation plans for the inservice testing program, which is an operational program addressed in Section 13.4.

3.9.8 Risk-Informed Inservice Inspection of Piping

Risk-informed inservice inspection of piping initiatives, if any, are included in the implementation plans for the inservice inspection of piping program, which is an operational program addressed in Section 13.4.

3.9.9 COL Information

3.9.9-1-H Reactor Internals Vibration Analysis, Measurement and Inspection Program

The COL Holder shall provide the information identified in Subsection 3.9.2.4 related to position C.3 of Regulatory Guide 1.20.

3.9.9-2-H ASME Class *2 or 3 or Quality Group D Components with 60 Year Design Life*

For the piping segments identified in Subsection 3.9.3.1 that are subject to loadings that could result in thermal or dynamic fatigue, the COL Holder shall provide the analyses as required by the ASME Code, Subsection NB.

3.9.9-3-A Inservice Testing Programs

COL Applicant shall provide a full description of the inservice testing program and a milestone for full ~~valve in-service testing~~ program implementation as identified in Subsection 3.9.6.1.

3.9.9-4-A *A* **Snubber** ***Inspection and Test Program***

The Applicant shall provide a full description ~~milestone for implementation~~ of the snubber preservice and inservice inspection and testing programs, and a milestone for program implementation~~as identified in Subsection 3.9.3.7.1(3)e~~, including development of a data table identified in Subsection 3.9.3.7.1(3)f.

3.9.10 References

3.9-1 General Electric Company, "BWR Fuel Channel Mechanical Design and Deflection," NEDE-21354-P, September 1976 (GE proprietary) and NEDO-21354, September 1976 (Non-proprietary).

3.9-2 GE Nuclear Energy, "BWR Fuel Assembly Evaluation of Combined Safe Shutdown Earthquakes (SSE) and Loss-of-Coolant Accident (LOCA) Loadings (Amendment 3)," NEDE-21175-3-P-A, October 1984 (GE proprietary) and NEDO-21175-3-A, October 1984 (Non-proprietary).

3.9-3 GE Nuclear Energy, "General Electric Environmental Qualification Program," NEDE-24326-1-P, Proprietary Document, January 1983.

3.9-4 M.A. Miner, "Cumulative Damage in Fatigue," Journal of Applied Mechanics, Vol. 12, ASME, Vol. 67, pages A159-A164, September 1945.

3.9-5 American Society of Mechanical Engineers Code for Operation and Maintenance of Nuclear Power Plants, 2001 Edition with 2003 Addenda.

3.9-6 General Electric Company, "ESBWR Reactor Internals Flow Induced Vibration Program", NEDE-33259P, Class III (Proprietary), Rev. 1~~0, January 2006~~December 2007, and NEDO-33259, Class I (Non-proprietary), Rev. 1~~0, January 2006~~December 2007.

Add these AS COLA references:

3.9-2xx Joint Owners Group Air Operated Valve Program Document, Revision 1, December 13, 2000

3.9-2xy USNRC, Eugene V. Imbro, letter to Mr. David J. Modeen, Nuclear Energy Institute, Comments On Joint Owners' Group Air Operated Valve Program Document, dated October 8, 1999

3.9-2xz 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