3.9 Mechanical Systems and Components

The information in this section of the reference ABWR DCD, including all subsections, tables, and figures, is incorporated by reference with the following departures and supplements.

STD DEP Admin	(Table 3.9-1)
STD DEP T1 2.4-3	(Table 3.9-8, MPL# E51)
STD DEP T1 2.14-1	(Table 3.9-8, MPL # T49 and P21)
STD DEP 3.9-1	
STD DEP T1 2.4-1	(Table 3.9-8, MPL# E11)
STP DEP 9.2-5	(Table 3.9-8, MPL# P41)
STD DEP 9.3-2	(Table 3.9-8, MPL# P52 and P81)
STD DEP 1.8-1	

3.9.2 Dynamic Testing and Analysis

The following standard supplement addresses the dynamic testing and analysis of systems, components, and equipment that retain their structural and functional integrity when subjected to dynamic loads that can occur during normal operation, plant transients, and external events, such as earthquakes. This is confirmed through type tests, analyses and startup testing, which verify that the systems, components, and equipment meet the regulatory requirements for the dynamic loads that are postulated to occur during both normal plant operations and transient conditions. This section describes the general startup functional tests and the vibration and dynamic analyses to be performed on specified high-energy and moderate-energy piping and the associated piping supports and restraints, and on reactor internals to verify they meet structural and functional requirements. Section 14.2 contains test abstracts that describe in general terms the planned tests that will be performed. Section 14.2 also describes the programmatic controls that will be used to develop the individual startup tests. The individual startup tests will contain review and acceptance criteria imposed by the detailed design.

The tests, inspections, and analyses described in this section comply with the following regulations:

- GDC 1 and 10 CFR 50.55a require that systems and components important to safety be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions performed. In addition, 10 CFR 50, Appendix B addresses the issue of QA as it applies to the dynamic testing and analysis of systems, structures, and components (SSC). The vibration, thermal expansion, and dynamic effects test programs for startup functional testing of high-energy and moderate-energy piping and their supports and restraints described in this section comply with this approved QA program. Dynamic analyses methods are described in this section for Seismic Category I systems, components, equipment, and their supports (including supports for conduit and cable trays and ventilation ducts).

- GDC 2 requires that systems and components important to safety be designed to withstand the effects of expected natural phenomena, combined with effects of normal and accident conditions, without losing the ability to perform their safety functions. In addition, 10 CFR 50, Appendix S requires systems and components important to safety withstand certain vibratory ground motions associated with design basis earthquakes. This section describes vibration testing programs for safety-related systems and components and presents dynamic analysis methods for Seismic Category I systems, components, equipment, and their supports. These tests, analyses, and comparisons are in accordance with sound engineering practices and demonstrate that these systems and components are designed to withstand natural phenomena in combination with normal and accident conditions.

- GDC 4 requires that the nuclear power plant systems and components important to safety be designed to accommodate the effects of and be compatible with the environmental conditions of normal operation, maintenance, testing, and postulated accidents, including loss-of-coolant accidents (LOCAs). The test programs described herein and in Section 14.2 verify the ability of components and systems to withstand the temperatures, pressures, vibrations, and thermal expansions associated with normal plant operation and maintenance as well as the transient conditions arising from anticipated operational events, such as valve and pump actuations. Testing and analysis to confirm that the safety-related systems and components will withstand anticipated loads are described in this section, Section 3.6.2, Section 3.9.3.2, and in Appendix 3C.

- GDC 14 requires that the reactor coolant pressure boundary (RCPB) be designed, fabricated, erected, and tested to have an extremely low probability of abnormal leakage, rapidly propagating failure, or gross rupture. Dynamic testing of RCPB components is performed to demonstrate that they will withstand the applicable design-basis seismic and dynamic loads, in combination with other environmental and natural phenomena loads, without leakage, rapidly propagating failure, or gross rupture.

- GDC 15 requires that the reactor coolant system be designed with sufficient margin to ensure that the design conditions of the RCPB are not exceeded during any condition of normal operation, including anticipated operational occurrences. The RCPB is designed to resist seismic, LOCA, and other appropriate environmental loads individually and in combination. Dynamic analyses are described to confirm the structural design adequacy of the RCPB. Vibration, thermal expansion, and dynamic effects testing are also described to verify the design.

- The requirements of GDCs 1, 2, 4, 14, and 15 are also satisfied through vibration, thermal expansion, and dynamic effects testing conducted during startup functional testing for high and moderate-energy piping and their supports and restraints. The purposes of these tests are to confirm that the piping, components, restraints, and supports have been designed to withstand the dynamic loadings and operational transient conditions encountered during service and to confirm that no unacceptable restraint of normal thermal motion occurs.

3.9.2.1.1 Vibration and Dynamic Effects Testing

STD DEP 1.8-1

More specific vibration testing requirements are defined in ~~ANSI/~~ASME OM~~3~~ S/G-2007, Standards and Guides for Operation and Maintenance of Nuclear Power Plants, Part 3, *"Requirements for Preoperational and Initial Startup Vibration Testing of Nuclear Power Plant Piping Systems".*

3.9.2.1.1.1 Measurement Techniques

STD DEP 1.8-1

Application of these measurement techniques is detailed in the appropriate testing specification consistent with the guidelines contained in ~~ANSI/~~ASME OM~~3~~ S/G-2007, Standards and Guides for Operation and Maintenance of Nuclear Power Plants, Part 3.

3.9.2.1.1.2 Monitoring Requirements

STD DEP 1.8-1

Steady-state conditions and transient events to be monitored will be detailed in the appropriate testing specifications consistent with ~~OM3~~ ASME OM S/G-2007, Standards and Guides for Operation and Maintenance of Nuclear Power Plants, Part 3 *guidelines.*

3.9.2.1.2 Thermal Expansion Testing

STD DEP 1.8-1

More specific requirements are defined in ~~ANSI/~~ASME OM~~7~~ S/G-2007, Standards and Guides for Operation and Maintenance of Nuclear Power Plants, Part 7*,"Requirements for Thermal Expansion Testing of Nuclear Power Plant Piping Systems."*

3.9.2.1.3 Thermal Stratification in Feedwater Piping

STD DEP 1.8-1

This test will be performed in accordance with the general requirements of Regulatory Guide 1.68 and the more specific requirements in ~~ANSI/~~ASME OM~~7~~ S/G-2007, Standards and Guides for Operation and Maintenance of Nuclear Power Plants, Part 7.

3.9.2.2.2.7 RCIC Pump and Turbine Assembly

STD DEP T1 2.4-3

~~*The RCIC pump construction is a horizontal, multistage type and is supported on a pedestal. The RCIC pump assembly is qualified analytically by static analysis for seismic and other RBV loadings, as well as the design operating loads of pressure, temperature, and external piping loads. The results of this analysis confirm that the stresses are less than the allowable (Subsection 3.9.3.2.2).*~~

The RCIC turbine-pump *is qualified for seismic and other RBV loads via a combination of static analysis and dynamic testing (Subsection 3.9.3.2.1.5* and 3.9.3.2.2*). The turbine*-pump *assembly consists of rigid masses (wherein static analysis is utilized) interconnected with control levers and electronic control systems, necessitating final qualification via dynamic testing. Static loading analyses are employed to verify the structural integrity of the turbine*-pump *assembly and the adequacy of bolting under operating, seismic, and other RBV loading conditions. The complete turbine*-pump *assembly is qualified via dynamic testing in accordance with IEEE-344. The qualification test program includes a demonstration of startup capability, as well as operability during dynamic loading conditions.* ~~*Operability under normal load conditions is assured by comparison to the operability of similar turbines in operating plants.*~~

3.9.2.3 Dynamic Response of Reactor Internals Under Operational Flow Transients and Steady-State Conditions

The following standard supplement addresses Regulatory Guide (R.G.) 1.206, Rev. 0:

The plan to evaluate the response of the reactor internals due to operational flow transients and steady state conditions for the ABWR prototype, STP 3, is included in the STP 3 ABWR Prototype Reactor Internals Flow-Induced Vibration Assessment Program (Reference 3.9-13). For STP 4, STP 3 will be the valid prototype reactor, and STP 4 will be classified as “Non-Prototype, Category I.” The plan for evaluation of STP 4 is included in the STP 4 Reactor Internals Flow-Induced Vibration Assessment Program (Reference 3.9-14).

3.9.2.4 Preoperational Flow-Induced Vibration Testing of Reactor Internals

The following standard supplement addresses Regulatory Guide (R.G.) 1.206, Rev. 0:

As discussed in Subsection 3.9.2.3, STP 3 reactor internals are classified as Prototype, and the STP 4 reactor internals are classified as non-prototype, Category I. In accordance with the requirement of Regulatory Guide 1.206 Section C.I.3.9.2.4 for prototype, Section 3.9.2.3 identifies the assessment program for STP 3 that addresses the flow modes, vibration monitoring and sensor types and locations, procedures and methods to be used to process and interpret the measured data, planned visual inspections, and planned comparisons of test results with analytical predictions. The approach for qualification of the STP 3 reactor internals, including the steam dryer, is as described in Reference 3.9-13.

For STP 4 reactor internals components, an inspection program will be implemented in lieu of a vibration measurement program as discussed in paragraph C.3.1.3 of Regulatory Guide 1.20. Subsection 3.9.2.3 identifies the assessment program for the STP 4 non-prototype. In addition, the vibration assessment program for STP Unit 4 will include a measurement program for the steam dryer.

No later than the first refueling outage of STP 3 and STP 4, detailed inspections of the steam dryer will be performed to confirm the structural adequacy of the dryer for flow-induced vibration loads.

3.9.3.1.8 RCIC Turbine-Pump

STD DEP T1 2.4-3

~~*Although not under the jurisdiction of the ASME Code, the RCIC turbine is designed and evaluated and fabricated following the basic guidelines of*~~The RCIC turbine-pump is constructed in accordance with the requirements of ASME Code Section III for Class 2 components.

3.9.3.1.9 ECCS Pumps

STD DEP T1 2.4-3

The RHR~~, RCIC,~~ and HPCF pumps are constructed in accordance with the requirements of an ASME Code Section III, Class 2 component.

3.9.3.2 Pump and Valve Operability Assurance

The following supplement describes additional pump and valve operability assurance.

Pumps and valves that perform an active safety-related function are functionally qualified to perform their required functions. For component designs that were not previously qualified, the qualification programs meet the requirements of QME-1-2007, which is accepted in RG 1.100, Rev 3. For component designs previously qualified to standards other than ASME QME-1-2007, the following approach is used.

- The general requirements specifications include requirements related to design and functional qualification of safety-related pumps and valves that incorporate lessons learned from nuclear power plant operations and research programs.
- Qualification specifications (e.g., design specifications) consistent with Appendices QP-A, QV-I and QV-A of QME-1-2007 are prepared to ensure the operating conditions and safety functions for which the pumps and valves are to be qualified are communicated to the manufacturer or qualification facility.
- Suppliers are required to submit application reports for review and approval, as described in QME-1-2007, that describe the basis for the application of specific predictive methods and/or qualification test data to a specific application.

- The application reports provided by the suppliers for adherence to specification requirements are reviewed 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 component qualification. Each deviation is evaluated for impact on the overall component qualification. If the conclusion of the gap analysis is that the component qualification is inadequate, then the component may be qualified using a test-based methodology, as allowed by QME-1-2007.

- Independent valve sizing calculations, using bounding design parameters (such as sliding friction coefficients), are performed 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.

DCD Section 3.9.2.2 and Section 3.10 provide details on the seismic qualification of pumps, valves and snubbers, and Section 3.11 provides details on the environmental qualification (EQ).

3.9.3.2.1.5 RCIC Turbine-Pump

STD DEP T1 2.4-3

The RCIC turbine-pump *is qualified by a combination of static analysis and dynamic testing as described in Subsection 3.9.2.2.2.7. The turbine*-pump *assembly consists of rigid masses (wherein static analysis is utilized) interconnected with control levers and electronic control systems, necessitating final qualification by dynamic testing. Static loading analysis has been employed to verify the structural integrity of the turbine*-pump *assembly, and the adequacy of bolting under operating and dynamic conditions. The complete turbine*-pump *assembly is qualified via dynamic testing, in accordance* *with IEEE-344. The qualification test program includes demonstration of startup capability, as well as operability during dynamic loading conditions. Operability under normal load conditions is assured by comparison to operability of similar turbines in operating plants.*

3.9.3.2.3.1 Procedures

The following supplement describes the functionality of active pumps. Electric motors for active pumps and instrumentation, including electrical devices which must function to cause the pump to accomplish its intended function, are discussed separately in DCD Subsection 3.9.3.2.5.1.2.3.

3.9.3.2.5.1 Procedures

The following supplement describes the functionality of active pumps. Procedures for qualifying electrical and instrumentation components which are depended upon to cause the valve to accomplish its intended function are described in DCD Subsection 3.9.3.2.5.1.2.3.

3.9.3.2.5.1.2 Dynamic Load Qualification

The following supplement describes additional dynamic load qualification features.

DCD Tier 2 Subsection 3.9.2.2 and 3.9.3.2 provides details for a test or analysis of the extended structure performed for the expected dynamic loads acting on the extended structure.

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 in accordance with DCD Tier 2 Subsection 3.9.1.1 and DCD Tier 2 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 inservice valve. Additional discussion of test criteria and method is provided in DCD Tier 2 Subsection 3.9.2.2, and also in the portions of DCD Tier 2 Subsections 3.10.1 and 3.10.2 applicable to active valve assemblies.

3.9.3.4.1 Piping

The following supplement describes additional snubber features.

(3)(b) Inspection, Testing, Repair and/or Replacement of Snubbers

Snubber inspection, testing, repair and replacement are conducted in accordance with ASME OM-2004, Subsection ISTD, and RG 1.192.

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.

(3)(c) Snubber Design and Testing

(i) 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.

(ii) The codes and standards used for snubber functional qualification and production testing are as follows:

a. ASME B&PV Code Section III, Subsection NF.

b. 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.

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 assure compliance with ASME Section III Subsection NF, and other applicable codes, standards and requirements. (see DCD Subsection 3.9.1.7)

(3)(f) Snubber Inservice Examination

The program for inservice examination and testing of snubbers after construction is prepared in accordance with the requirements of ASME OM Code, 2004 Edition, Subsection ISTD, and RG 1.192. Inservice examination is initially performed not less than two months after attaining 5 percent reactor power operation and will be completed within 12 calendar months after attaining 5 percent reactor power. Subsequent examinations are performed at intervals defined by ISTD-4252, Table ISTD-4252-1, and Code Case OMN-13. Examination intervals, subsequent to the third interval, are adjusted based on the number of unacceptable snubbers identified in the then current interval.

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

Snubbers are tested inservice to determine operational readiness during each fuel cycle, beginning no sooner than 60 days before the scheduled start of the applicable refueling outage. Snubber operational readiness 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. When an in-place test or bench test cannot be performed, snubber subcomponents that control the parameters to be verified are examined and tested. Preservice examinations are performed on snubbers after reinstallation when bench testing is used (ISTD-5224), or on snubbers where individual subcomponents are reinstalled after examination (ISTD-5225).

Defined test plan groups (DTPG) are established and the snubbers of each DTPG are tested according to an established sampling plan each fuel cycle. Sample plan size and composition are determined as required for the selected sample plan, with additional sampling as may be required for that sample plan based on test failures and failure modes identified.

Snubbers that do not meet test requirements are evaluated to determine root cause of the failure, and are assigned to failure mode groups (FMG) based on the evaluation, unless the failure is considered unexplained or isolated. The number of unexplained snubber failures not assigned to an FMG determines the additional testing sample. Isolated failures do not require additional testing. For unacceptable snubbers, additional testing is conducted for the DTPG or FMG until the appropriate sample plan completion criteria are satisfied.

Unacceptable snubbers are adjusted, repaired, modified, or replaced. Replacement snubbers meet the requirements of ISTD-1600. Post-maintenance examination and testing, and examination and testing of repaired snubbers, is done to ensure that test parameters that may have been affected by the repair or maintenance activity are verified acceptable.

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

The inservice inspection and testing programs for snubbers will be completed in accordance with milestones described in Section 13.4.

(3)(g) Snubber Support Data:

A plant-specific table prepared as part of the inspection and test program for snubbers will include the following information:

- 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,
- operating environment,
- applicable codes and standards,
- list type of snubber (i.e., hydraulic, mechanical), materials of construction, standards for hydraulic fluids and lubricants, and the corresponding supplier,
- environmental, structural, and performance design verification tests,
- production unit functional verification tests and certification,
- packaging, shipping, handling, and storage requirements,
- description of provisions for attachments and installation, and
- quality assurance and assembly quality control procedures for review and acceptance by the purchaser.

3.9.3.4.4 Floor-Mounted Major Equipment (Pumps, Heat Exchangers, and RCIC Turbine-Pump)

STD DEP T1 2.4-3

Since the major active valves are supported by piping and not tied to building structures, valve "supports" do not exist (Subsection 3.9.3.4.1).

The HPCF, RHR, ~~RCIC,~~ SLC, FPCCU, SPCU, and CUW pumps; RCW, RHR, CUW, and FPCCU heat exchangers; and RCIC turbine-pump *are all analyzed to verify the adequacy of their support structure under various plant operating conditions. In all cases, the load stresses in the critical support areas are within ASME Code allowables.*

Seismic Category I active pump supports are qualified for dynamic (seismic and other RBV) loads by testing when the pump supports together with the pump meet the following test conditions:

(1) Simulate actual mounting conditions.

3.9.5.1.2.9 Incore Guide Tubes and Stabilizers

STD DEP 3.9-1

These are Safety Class 3 components. The guide tubes protect the incore instrumentation from flow of water in the bottom head plenum and provide a means of positioning fixed detectors in the core, as well as a path for insertion and withdrawl of *the calibration monitors (ATIP, Automated Traversing Incore Probe Subsystem). The incore flux monitor guide tubes extend from the top of the incore flux monitor housing to the top of the core plate. (The power range detectors for the power range monitoring units and the dry tubes for the startup range neutron monitoring and average power range monitoring (SRNM) detectors are inserted through the guide tubes). The local power range monitor (PRNM) detector assemblies and the dry tubes for the startup range monitoring (SRNM) assemblies are inserted through the guide tube.*

Two levels of ~~stainless steel~~stabilizer latticework of clamps, tie bars, and spacers give lateral support and rigidity to the guide tubes. The stabilizers are connected to the shroud and shroud support. The bolts are tack-welded after assembly to prevent loosening during reactor operation.

3.9.6 Testing of Pumps and Valves

STD DEP 1.8-1

~~For example, the periodic leak testing of the reactor coolant pressure isolation valves (See Appendix 3M for design changes made to prevent intersystem LOCAs) in Table 3.9-9 will be performed in accordance with Chapter 16 Surveillance Requirement SR 3.6.1.5.10~~

~~Inservice testing of safety-related pumps and valves will be performed in accordance with the requirements of ASME/ANSI OMa-1988 Addenda to ASME/ANSI OM-1987, Parts 1, 6, and 10. Table 3.9-8 lists the inservice testing parameters and frequencies for the safety-related pumps and valves. The reason for each code-defined testing exception or justification for each code exemption request is noted in the description of the affected pump or valve. Valves having a containment isolation function are also noted in the listing. Inservice inspection is discussed in Subsection 5.2.4 and Section 6.6.~~

~~Details of the inservice testing program, including test schedules and frequencies, will be reported in the inservice inspection and testing plan to be provided by the applicant referencing the ABWR design. The plan will integrate the applicable test requirements for safety-related pumps and valves, including those listed in the technical specifications, Chapter 16, and the containment isolation system, Subsection 6.2.4. For example, the periodic leak testing of the reactor coolant pressure isolation valves (See Appendix 3M for design changes made to prevent intersystem LOCAs) in Table 3.9-9 will be performed in accordance with Chapter 16 Surveillance Requirement SR 3.6.1.5.10. This plan will include baseline pre-service testing to support the periodic inservice testing of the components. Depending on the test results, the plan will provide a commitment to disassemble and inspect the safety-related pumps and valves when limits of the OM Code are exceeded, as described in the following paragraphs. The primary elements of this plan, including the requirements of Generic Letter 89-10 for motor operated valves, are delineated in the subsections to follow. (See Subsection 3.9.7.3 for COL license information requirements.)~~

The Section describes the functional qualification provisions and inservice testing (IST) programs for safety-related pumps and valves. The IST program includes periodic tests and inspections that demonstrate the operational readiness of pumps and valves that are required to perform a specific function in shutting down the reactor to the safe-shutdown condition, in maintaining the reactor in a safe shutdown condition, or in mitigating the consequences of an accident. The IST program also demonstrates the operational readiness of pressure relief valves that protect systems or portions of systems, and dynamic restraints used in systems, that perform one of or more of the three functions identified above.

The preservice testing (PST) and IST programs are based on the requirements of the ASME OM Code-2004, Subsections ISTA, ISTB, ISTC and (mandatory) Appendix I. The specific ASME OM Code requirements for functional testing of pumps are found in Subsection ISTB, requirements for inservice testing of valves are found in 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 Subsection ISTA.

The IST Program plan includes the following information:

- The edition and addenda of the Code that apply to the required tests and examinations
- The classification of components and the boundaries of system classification
- Identification of the components subject to tests and examination
- The Code requirements for each components and the test or examination to be performed
- The Code requirements for each component that are not being satisfied by the tests or examinations; and the justification for substitute tests and examinations (i.e., required relief requests)
- Code cases proposed for use and the extent of their application
- Test or examination frequency or a schedule for performance of tests and examinations, as applicable.

The plan includes the test requirements for containment isolation valves specified in the Technical Specifications, Chapter 16, Section 3.6.1.3, and the leak test requirements for reactor coolant isolation valves specified in Technical Specifications Section 3.4.4. Testing requirements for motor operated valves are in accordance with 10CFR50.55a(b)(3)(ii).

Tests are performed in accordance with written procedures which contain the appropriate reference values and acceptance criteria. Instrumentation and test equipment used in performance of the tests and examinations have the range and accuracy necessary to demonstrate conformance to specific examination or test requirements, and are calibrated and controlled by the QA Program.

Acceptance criteria and reference values are established during preoperational testing, when the components are known to be operating acceptably, at points of operation readily duplicated during subsequent tests. The results of tests are documented and include:

- Equipment identification and date of test
- Reason for the test and test procedure used
- Identification of test equipment, including calibration records
- Values of measure parameters, along with a comparison with allowable ranges, analysis of deviations, and requirements for corrective action
- The name and signature of person(s) responsible for conducting and analyzing the test

IST testing conforms to the following:

- IST frequency is established in accordance with requirements set forth by Reference 3.9-23, 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:
    a. Initial test interval is the 10 years following commencement of unit commercial service.
    b. Successive test intervals are 10 years following the previous test interval.
    c. The test plan for successive intervals will comply with the edition and addenda of the Code approved by the NRC 12 months prior to the start of the inservice testing 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.
- When 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.

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 Subsection 3.9.3.4.1(3).

3.9.6.1 Testing of Safety-Related Pumps

STD DEP 1.8-1

The supplemental information describes the PST and 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.

For each pump, the design basis and required operating conditions (including tests) under which the pump will be required to function will be established. These designs (design basis and required operating) conditions include flow rate and corresponding head for each system mode of pump operation and the required operating time for each mode, acceptable bearing vibration levels, seismic/dynamic loads, fluid temperature, ambient temperature, and pump motor minimum voltage as described in Subsection 3.9.3.2.

As part of the final testing program, acceptance criteria will be provided for the following design and qualification requirements. For each size, type, and model, testing encompassing design conditions will be performed that demonstrates acceptable flow rate and corresponding head, bearing vibration levels, and pump internals wear rates for the operating time specified for each system mode of pump operation. From these tests, baseline (reference) hydraulic and vibration data will be developed for evaluating the acceptability of the pump after installation. Adequate minimum flow rate and thrust bearing capacity will be verified for the pump specified for each application. With respect to minimum flow pump operation, the sizing of each minimum recirculation flow path is evaluated to assure that its use under all analyzed conditions will not result in degradation of the pump. The flow rate through minimum recirculation flow paths can also be periodically measured to verify that flow is in accordance with the design specification.

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.

Group A pumps are tested quarterly in accordance with ISTB-5121, ISTB-5221, or ISTB 5321. Group B pumps are tested quarterly in accordance with ISTB-5122, ISTB-5222, or ISTB-5322. Comprehensive tests are conducted on all pumps biennially in accordance with ISTB-5132, ISTB-5232, or ISTB-5323. 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.

An initial set of reference values are established for each pump during the PST period or before implementing IST. Reference values are established (1) after the pump is known to be operating acceptably, (2) at a point(s) of operation readily duplicated during subsequent tests, and (3) in a region of relatively stable pump flow. Reference values for comprehensive tests are within ±20% of pump design flow rate, as are reference values for Group A and Group B tests, if practicable. Parameters measured during IST program testing include pump speed (if required), discharge and differential pressures, flow rate, and vibration at IST conditions, as required by ISTB-3000 for each specific pump category. Accuracy of instruments used to measure pressure, flow rate, speed, vibration, and differential pressure comply with Table ISTB-3510-1. Instrument accuracy, range, location, fluctuations, and frequency response range meet the requirements of ISTB-3510.

Pressure measurements are performed in accordance with ISTB-3520. A differential pressure gage or transmitter is used to directly measure the difference between the pressures at points in the inlet and discharge pipes. Vibration measurements comply with the requirements of ISTB-3540. Flow rates are determined in accordance with ISTB-3550.

Following the PST, the IST commences prior to declaring the pump operable. 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 declaring the pump operable.

Data trending is performed in accordance with ISTB-6100, and appropriate corrective actions are specified in accordance with ISTB 6200. Pump data and test plans are captured as plant records in accordance with ISTB-9000, and test results and corrective actions are recorded in accordance with ISTB 9000.

The ABWR safety-related pumps and piping configurations accommodate inservice testing at a flow rate at least as large as the maximum design flow for the pump application. The safety-related pumps are provided with instrumentation to verify that the net positive suction head (NPSH) is greater than or equal to the NPSH required during all modes of pump operation.

These pumps can be disassembled for evaluation when ~~Part 6~~ ISTB *testing results in a deviation which falls within the "required action range."*

The Code provides criteria limits for the test parameters identified in Table 3.9-8. The frequency and the extent of disassembly and inspection will be established based on suspected degradation for each safety-related pumps, and will be included in a program along with the basis for the frequency and the extent of each disassembly.

The program may be revised throughout the plant life to minimize disassembly based on past disassembly experience.

3.9.6.2 Testing of Safety-Related Valves

The following supplement describes the IST of valves to assess their operational readiness, in compliance with Reference 3.9-23, 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.

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. IST program valves are classified as either active or passive. Active valves change disk 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 disk position and do not change the disk 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 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 3.9-23, Subsection ISTC, to the extent practicable. 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.

Valves within the scope of the IST program are categorized in accordance with ISTC-1300 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 3.9.6.2.1 (check valves) and Section 3.9.6.2.5 (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 valves are leak tested in accordance with ISTC-3630

Category A and Category B valves are stroke tested in accordance with ISTC-3521 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 practicable, 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 practicable 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.

Category C valves are stroke tested in accordance with ISTC-3522 as follows:

- Valves are exercised or examined during operation at power in a manner than verifies disk movement in the open and closed position.
- If valve exercising is not practicable during operation at power, then the testing shall be performed during cold shutdown. If valve exercising is not practicable in cold shutdown, it shall be performed during refueling outages.
- Valve exercising is not required if the time period since the previous 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.

During exercise testing, valve disk movement is confirmed in accordance with ISTC-3530.

Preservice testing is performed on all valves in accordance with ISTC-3100. These tests are performed under conditions as near as practicable to those expected during the IST. In accordance with ISTC-3300, valve testing uses reference values determined from the results of PST or previous IST, and these reference values are established only when the valve is known to be operating acceptably. Per ISTC-3310, 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. Deviations between the previous and new reference values are identified and analyzed in accordance with ISTC-3310. Verification that the new values represent acceptable operation is documented. The plant corrective action program documents valve failures.

In accordance with ISTC-3200, the inservice testing program will be implemented, and required valve testing will be completed, prior to first declaring the valves operable.

3.9.6.2.1 Check Valves

(1) Design and Qualification

For each check valve with an active safety-related function, the design basis and required operating conditions (including testing) under which the check valve will be required to perform will be established.

As part of the final testing program, the following design and qualification requirements will be established, along with corresponding acceptance criteria for these requirements. Testing of prototypes which represent different groups of similar design and construction (such that each size, type, and model is addressed) will ensure the design adequacy of the check valve under design (design basis and required operating) conditions.

Each prototype will be tested to demonstrate its design capability under a range of differential pressure and flow conditions up to the design conditions, using the provisions of QME-1-2007 (Reference 3.9-16). These design conditions include all the required system operating cycles to be experienced by the valve (numbers of each type of cycle and duration of each type cycle), environmental conditions under which the valve will be required to function, severe transient loadings expected during the life of the valve such as water hammer or pipe break, lifetime expectation between major refurbishments, sealing and leakage requirements, corrosion requirements, operating medium with flow and velocity definition, operating medium temperature and gradients, maintenance requirements, vibratory loading, planned testing and methods, test frequency and periods of idle operation. The design conditions may include other requirements as identified during detailed design of the plant systems.

This prototype testing shall include test data from the manufacturer, field test data for dedication, empirical data supported by test, or tests (such as prototype) of similar valves that support qualification of the required valve where similarity must be justified by technical data. Proper check valve application will be verified, including selection of the valve size and type based on the system flow conditions, installed location of the valve with respect to sources of turbulence, and correct orientation of the valve in the piping (i.e., vertical vs horizontal) as recommended or required by the manufacturer. Valve design features, material, and surface finish will be reviewed to assure they accommodate non-intrusive diagnostic testing methods available in the industry or as specified. Flow through the valve will be verified as determinable from installed instrumentation and valve disk positions will be verified as determinable without disassembly such as by use of nonintrusive diagnostic methods.

Valve internal parts are designed with self-aligning features for purpose of assured correct installation. The maximum loading on the check valve under design basis and required operating conditions will be compared to the allowable structural capability limits for the individual parts of the check valve (i.e., weak link calculations will be performed). The qualification acceptance criteria noted above will include baseline data developed during qualification testing and will be used for verifying the acceptability of the check valves after installation. See Section 3.9.3.2 for further details.

(2) Pre Operational Testing

Check valve testing requires verification that disk 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 disk moves to the full-open position. Each check valve will be tested in the in the open and close direction under all normal operating system conditions. To the extent practical, testing of the valves as described in this section will be performed under fluid temperature conditions that would exist during a cold shutdown as well as under fluid temperature conditions that would be experienced by the valve during other modes of plant operation. The testing will identify the flow needed to open the valve to the full-open position. During flow conditions, the valve disk moves to and maintains contact with the backseat without fluctuating, while allowing the flow rate and maximum differential pressure across the valve to remain within acceptable design limits for the system. When flow ceases or reverses, the valve disk moves to the valve seat to fulfill the test requirements.

Check valves are exercised in both directions, regardless of their safety function. To test functionality in the open direction, the valve is exercised by initiating flow and observing whether or not the disk moves to the full-open position. Valve closure is verified after flow ceases. To test functionality in the closed direction, the valve disk is observed traveling to at least a partial open position upon flow initiation and moving to the valve seat when flow ceases or reverses.

The testing will include the effects of rapid pump starts and stops as required by expected system operating conditions. The testing will include any other reverse flow conditions that may be required by expected system operating conditions. The disk movement will be examined during valve testing to verify the leak-tightness of valve when fully closed. By using methods such as non-intrusive diagnostic equipment, the open valve disk stability will be verified under the flow conditions during normal and other required system operating conditions.

The parameters and acceptance criteria for demonstrating that the above functional performance requirements have been met are as follows:

- During all test modes that simulate expected system operating conditions, the valve disk fully opens or fully closes as expected based on the direction of the differential pressure across the valve.
- Leak-tightness of valve when fully closed is within established limits, as applicable.
- Valve disk positions are determinable without disassembly.
- Valve testing must verify free disk movement whenever moving to and from the seat.
- The disk is stable in the open position under normal and other required system operating fluid flow conditions.
- The valve is correctly sized for the flow conditions specified, i.e., the disk is in full open position at normal full flow operating condition.
- Valve design features, material, and surfaces accommodate non-intrusive diagnostic testing methods available in the industry or as specified.
- Piping system design features accommodate all the applicable check valve testing requirements as described in Table 3.9-8.

(3) Inservice Testing

All ABWR safety-related piping systems incorporate provisions for testing to demonstrate the operability of the check valves under design conditions. Verification of safety function is accomplished by initiating flow through the valve and verifying proper movement of the valve disk in the open and closed directions in accordance with ISTC-5221(a).

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 monitoring of 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 necessary, mechanical exercisers are used in accordance with ISTC-5221(b). Tests using a valve exerciser are capable of detecting a missing disk, sticking, binding and the loss of weights. Acceptance criteria for tests using mechanical exercisers consider the design, application and historical performance of the valve.

For check valves where the test methods specified in ISTC-5221(a) and (b) are impractical, or if sufficient flow cannot be achieved or verified, a sample disassembly examination program verifies valve disk movement in accordance with ISTC-5221(c). The sample disassembly examination program groups check valves by category of similar design, application, and service condition.

During the disassembly process, the full-stroke motion of the valve disk is verified. 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 valve disk is re-verified immediately prior to completing reassembly. The frequency and the extent of disassembly and inspection will be established based on suspected degradation of all safety-related check valves, and will be included in a program along with the basis for the frequency and the extent of each disassembly. 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. The program may be revised throughout the plant life to minimize disassembly based on past disassembly experience.

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 programs and 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 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.

3.9.6.2.2 Motor-Operated Valves

For each motor-operated valve assembly (MOV) with an active safety related function, the design basis and required operating conditions (including testing) under which the MOV will be required to perform are established for the development and implementation of the design, qualification and preoperational testing.

(1) Design and Qualifications

As part of the final testing program, acceptance criteria will be provided for the following design and qualification requirements. Testing each size, type, and model will determine the torque and thrust (as applicable to the type of MOV) requirements to operate the MOV and will ensure the adequacy of the torque and thrust that the motor-operator can deliver under design (design basis and required operating) conditions. Each size, type, and model will be tested under a range of differential pressure and flow conditions up to the design conditions. These design conditions include fluid flow, differential pressure (including pipe break), system pressure, fluid temperature, ambient temperature, minimum voltage, and minimum and maximum stroke time requirements. This testing of each size, type and model shall include test data from the manufacturer, field test data for dedication, empirical data supported by test, or test (such as prototype) of similar valves that support qualification of the required valve where similarity must be justified by technical data. This testing will demonstrate that the results of testing under in situ or installed conditions can be used to ensure the capability of the MOV to operate under design conditions. The individual parts of the MOV will be verified not to exceed structural capability limits under design conditions. The valve specified for each application will be verified as not susceptible to pressure locking and thermal binding. See Section 3.9.3.2 for further details.

(2) Pre-operational Testing

Each MOV will be tested in the open and close directions under static and maximum achievable conditions using diagnostic equipment that measures torque and thrust (as applicable to the type of MOV), and motor parameters. Each MOV will be tested sufficiently, under various differential pressure and flow to maximum achievable conditions, to determine the torque and thrust requirements at design conditions. The torque and thrust requirements to close the valve, for the position at which there is diagnostic indication of hard seat contact, will be determined. The determination of design torque and thrust requirements will be made for such parameters as differential pressure, fluid flow, undervoltage, temperature and seismic dynamic effects for MOVs that must operate during these transients. The design torque and thrust requirements will be adjusted for diagnostic equipment inaccuracies. For the point of control switch trip, any loss in torque produced by the actuator, and thrust delivered to the stem, for increasing differential pressure and flow conditions (referred to as load sensitive behavior) will be determined. The design torque and thrust requirements will be compared to the control switch trip torque and thrust, subtracting margin for load sensitive behavior, control switch repeatability, and degradation. The total thrust and torque delivered by the MOV under static and dynamic conditions (including diagnostic equipment inaccuracy and control switch repeatability) will be measured to compare to the allowable structural capability limits for the individual parts of the MOV. Proper control room position indication of the MOV will be tested.

The parameters and acceptance criteria for demonstrating that the above functional performance requirements have been met are as follows:

- As required by the safety function: the valve must fully open; the valve must full close with diagnostic indication of hard seat contact.
- The control switch settings must provide adequate margin to achieve design requirements including consideration of diagnostic equipment inaccuracy, control switch repeatability, load sensitive behavior, and margin for degradation.
- The motor output capability at degraded voltage must equal or exceed the control switch setting including consideration of diagnostic equipment inaccuracy, control switch repeatability, load sensitive behavior and margin for degradation.
- The maximum torque and thrust (as applicable for the type MOV) achieved by the MOV including diagnostic equipment inaccuracies and control switch repeatability must not exceed the allowable structural capability limits for the individual parts of the MOV.
- The remote position indication testing must verify that proper disk position is indicated in the control room.
- Stroke time measurements taken during valve opening and closing must meet minimum and maximum stroke time requirements.

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 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 addressed.

(3) Inservice Testing

Inservice Testing of MOVs will satisfy OM-2004 as required by 10CFR50.55a and as supplemented by 10CFR50.55a(b)(3)(ii). The inservice testing of MOVs will rely on diagnostic techniques that are consistent with the state of the art and which will permit periodic assessment of the valve's ability to perform its safety function during design basis conditions. Periodic testing will be conducted under adequate differential pressure and flow conditions that allow a justifiable demonstration of continuing MOV capability for design basis conditions. Test frequencies are developed in accordance with "Joint Owners' Group (JOG) Motor Operated Valve Periodic Verification Program Summary," MPR-2524-B, November 2007 (Reference 3.9-17, 3.9-18, and 3.9-19), and ASME Code Case OMN-1, Rev 1, and will not exceed 10 years. According to the JOG MOV PV program guidance, testing of MOVs is performed at a frequency dependent on margin and risk significance.

Specifically:

> "A classification process is used to determine how each MOV is to be tested. Valves that are not susceptible to degradation based on JOG Program testing are identified and static PV test intervals are specified. Applications of gate and butterfly valves that are susceptible to increases or variations in required thrust or torque are identified, and users are to add margin allowances (gate valves) or to verify by DP test (butterfly and gate valves) that the valve performance is stable."

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:

(a) Risk Ranking

The MOVs risk ranking is determined by review of the valves individual Probabilistic Safety Assessment which is documented on the individual component's ranking worksheet and is reviewed and approved by the expert panel. Guidance for this process is outlined in the Joint Owners' Group (JOG) Motor Operated Valve Periodic Verification Program Summary.

(b) 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 and is determined. 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 and subsequent periodic tests measure the valve's actual actuator output capability. The difference between the two capabilities is termed "functional margin," and is determined in accordance with OMN-1 Section 6.4.3.

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

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 valves 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. A motor operated valve with an adequate functional margin is assured of being able to open and/or close under design basis conditions. 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. The test frequency will vary from two to ten years, depending on risk ranking and functional margin. Periodic testing will include the following aspects:

- Valves with similar operators, valves and service conditions will be grouped together based on results of design basis verification and preservice tests.
- All valves will be exercised at least once per year or once per refueling cycle, or more frequently is dictated by risk significance, environmental conditions, or abnormal characteristics.
- Required torque will be analyzed in accordance with OMN-1 Section 6.4.1.
- Available Stem Torque will be analyzed in accordance with OMN-1 Section 6.4.2.
- 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 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 addressed.

3.9.6.2.3 Power Operated Valves <u>(Other Than Motor Operated Valves)</u>

STD DEP 1.8-1

Motor operated valves are addressed in Section 3.9.6.2.2. The following discussion applies to other types of power-operated valves.

(1) Design and Qualification

For each power-operated (i.e, pneumatic-, hydraulic-, piston-, solenoid-operated, and explosive-actuated squib) valve assembly (POV) with an active safety-related function, the design basis and required operating conditions (including testing) under which the POV will be required to perform will be established.

As part of the final testing program, acceptance criteria will be provided for the following design and qualification requirements. Testing of prototypes which represent different groups of similar design and construction (such that each size, type, and model is addressed) will determine the force (as applicable to the type of POV) requirement to operate the POV and will ensure the adequacy of the force that the operator can deliver under design (design basis and required operating) conditions.

Each prototype will be tested to demonstrate its capability under a range of differential pressure and flow conditions up to the design conditions, using the provisions of QME-1-2007. These design conditions include fluid flow, differential pressure (including pipe break), system pressure, fluid temperature, ambient temperature, minimum air supply system (or accumulator) pressure, spring force, and minimum and maximum stroke time requirements. This prototype testing shall include test data from the manufacturer, field test data for dedication, empirical data supported by test, or test (such as prototype) of similar valves that support qualification of the required valve where similarity must be justified by technical data. This testing will demonstrate that the results of testing under in-situ conditions can be used to ensure the capability of each POV to operate under design conditions. The individual parts of the POV will be verified not to exceed structural capability limits under design conditions (i.e., weak link calculations will be performed). The packing adjustment limits specified for each valve application will be verified as not susceptible to stem binding. See Section 3.9.3.2 for further details.

(2) Pre-operational Testing

Each POV will be tested in the open and close directions under static and maximum achievable conditions using diagnostic equipment that measures or provides information to determine total friction, stroke time, seat load, spring rate, and travel under normal pneumatic or hydraulic pressure (as applicable to the type of POV), and minimum pneumatic or hydraulic pressure. Each POV will be tested sufficiently, under various differential pressure and flow up to maximum achievable conditions, to determine the force requirements at design conditions. The force requirements to close the valve, for the position at which there is a diagnostic indication of full valve closure (as required for the safety function of the applicable valves), will be determined. The determination of design force requirements will be made for such parameters as differential pressure, fluid flow, minimum pneumatic or hydraulic pressure, power supply, temperature, and seismic/dynamic effects for POVs that must operate during these transients. The design force requirements will be adjusted for diagnostic equipment inaccuracies.

The total force delivered by the POV under static and dynamic conditions (including diagnostic equipment inaccuracies) will be measured to compare to the allowable structural capability limits for the assembly and individual parts of the POV. Proper control room position indication of the POV will be verified.

The parameters and acceptance criteria for demonstrating that the above functional performance requirements have been met are as follows:

- As required by the safety function, the valve must fully open and/or the valve must fully close with diagnostic indication of hard seat contact.
- The assembly must demonstrate adequate margin to achieve design requirements including consideration of diagnostic equipment inaccuracies and margin for degradation.
- The assembly must demonstrate adequate output capability of the power-operator at minimum pneumatic or hydraulic pressure or electrical supply (or loss of motive force for fail-safe positioning) with consideration of diagnostic equipment inaccuracies and margin for degradation.
- The maximum force (as applicable for the type of POV) achieved by the POV including diagnostic equipment inaccuracies must not exceed the allowable structural capability limits for the assembly and individual part of the POV.
- The remote position indication testing must verify that proper disk position is indicated in the control room and other remote locations relied upon by operators in any emergency situation.
- Stroke-time measurements taken during valve opening and closing must meet minimum and maximum stroke-time requirements.
- For solenoid-operated valves (SOVs), the Class 1E electrical requirements are to be verified. The SOV should be verified to be capable of performing its design functions in accordance with its design requirements for energized or de-energized conditions and rated appropriately for the electrical power supply amperage and voltage.
- Provide leak-tight seating which must meet specified maximum leakage rate, or meet leakage rate to ensure an overall containment maximum leakage.

(3) Inservice Testing

All ABWR safety-related piping systems incorporate provisions for testing to demonstrate the operability of the POVs under design conditions. All active POVs are stroke tested in accordance with ISTC-3500. The guidance contained in Code Case OMN-12 may be used in lieu of the requirements of ISTC-5130 and ISTC-5140 for pneumatically and hydraulically operated valves. Limiting values for full-stroke times are established based on PST and design requirements. Reference values for full-stroke times are established in accordance with ISTC-3300.

Valves with stroke times which exceed their limiting value of full-stroke time are immediately declared inoperable. Valves with stroke times exceeding the following criteria, but within the limiting value, are retested or declared inoperable:

- Valves with reference stroke times greater than 10 seconds are limited to no more than ±25% change in stroke time when compared to the reference value.
- Valves with reference stroke times less than or equal to 10 seconds are limited to no more than ±50% change in stroke time when compared to the reference value.
- Valves with reference stroke time of less than 2 second are considered fast acting, and have a limit of 2 seconds.

If the valve is retested and does not meet the criteria above, it is immediately declared inoperable and an analysis is performed to identify the cause of the problem. Operability may be restored if the subsequent analysis demonstrates that the POV remains capable of performing its function. The parameters and acceptance criteria for applied during testing include the following:

- As required by the safety function, the valve must fully open and/or the valve must fully close with diagnostic indication of hard seat contact.
- The remote position indication testing must verify that proper disk position is indicated in the control room and other remote locations relied upon by operators in any emergency situation.
- Stroke-time measurements taken during valve opening and closing must meet minimum and maximum stroke-time requirements.
- Provide leak-tight seating which must meet specified maximum leakage rate, or meet leakage rate to ensure an overall containment maximum leakage (See Section 3.9.6.4).

Section 3.9.6.2.8 describes additional (non-Code) testing of power-operated valves as discussed in Regulatory Issue Summary 2000-03. This inservice testing will incorporate the use of advance non-intrusive techniques to periodically assess degradation and the performance characteristics of the POVs.

The ~~Part 10~~ ISTC tests will be performed, and valves that fail to exhibit the required performance can be disassembled for evaluation.

The frequency and the extent of disassembly and inspection will be established based on suspected degradation of all safety-related POVs, and included in a program along with the basis for the frequency and the extent of each disassembly. The program may be revised throughout the plant life to minimize disassembly based on past disassembly experience.

3.9.6.2.4 Isolation Valve Leak Tests

STD DEP 1.8-1

The leaktight integrity will be verified for each valve relied upon to provide a leaktight function.

These valves include:

(1) Pressure isolation valves—valves that provide isolation of pressure differential from one part of a system from another or between systems. Pressure isolation valves (PIVs) are the two normally closed valves, in series, within the RCPB that isolate the reactor coolant system from an attached low-pressure system (See Appendix 3M for design changes made to prevent intersystem LOCAs). PIVs are listed in Table 3.9-9 and are classified as A or A/C in accordance with the provisions of Subsection ISTC-1300 of Reference 3.9-23. PIV seat leakage rate tests are conducted every two years in accordance with Chapter 16 Surveillance Requirement SR 3.4.4.1and 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, when a permissible leakage rate is not otherwise specified. PIV leakage tests are described further in the Technical Specifications.

(2) Temperature isolation valves—valves whose leakage may cause unacceptable thermal loading on supports or stratification in the piping and thermal loading on supports or whose leakage may cause steam binding of pumps. Temperature isolation valves are classified as A or A/C in accordance with the provisions of Subsection ISTC-1300 of Reference 3.9-23. Seat leakage rate tests are conducted every two years 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, when a permissible leakage rate is not otherwise specified.

    During leak testing of pressure and temperature isolation valves, differential pressure is applied in accordance with ISTC-3620(b). Seat leakage determined in accordance with ISTC-3620(c) by either measuring leakage through a downstream tell-tail, measuring the feed rate required to maintain pressure, or monitoring pressure decay in the test volume.

(3) Containment isolation valves—valves that perform a containment isolation function in accordance with the Evaluation Against Criterion 54, Subsection 3.1.2.5.5.2, including valves that may be exempted from Appendix J, Type C, testing but whose leakage may cause loss of suppression pool water inventory. CIVs are leak tested in accordance with 10CFR Part 50, Appendix J.

~~Leakage rate testing for valve group (1) is addressed in Subsection 3.9.6. Valve groups (2) and (3) will be tested in accordance with Part 10, Paragraph 4.2.2.3.~~ The fusible plug valves that provide a lower drywell flood for severe accidents are described in Subsection 9.5.12. The valves are safety-related due to the function of retaining suppression pool water as shown in Figure 9.5-3. The fusible plug valve is a

nonreclosing pressure relief device and the Code requires replacement of each at a maximum of 5-year interval.

3.9.6.2.5 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 3.9-23. 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 3.9-8.

3.9.6.2.6 Inservice Testing Program for Manually Operated Valves

Manual valves are exercised at least every two years in accordance with 10CFR50.55a(b)(3)(vi). 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 3.9-8.

3.9.6.3 Inservice Testing Program Implementation

Inservice testing will be performed in accordance with the latest approved code in effect 12 months prior to fuel load. 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.

3.9.6.4 Non-Code Testing of Power-Operated Valves (Other Than Motor Operated Valves)

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. Additional testing is performed as part of the air-operated valve (AOV) program, which includes the key elements for an AOV Program as identified in the JOG AOV program document, Joint Owners Group Air Operated Valve Program Document, Revision 1, March 2001 (References 3.9-21 and 3.9-22). 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. The AOV program incorporates the attributes for a successful power-operated valve long-term periodic verification program, as discussed in RIS 2000-03, Resolution of Generic Safety Issue 158: Performance of Safety-related Power-Operated Valves Under Design Basis Conditions (Reference 3.9-20), by incorporating lessons learned from previous 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, key lessons learned addressed in the AOV program include:

- Valves are categorized according to their safety significance and risk ranking.
- Setpoints for AOVs 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 on high risk (high safety significance) valves, at a minimum, 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 AOV 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 the JOG AOV Program Document, with a minimum of 5 years (or 3 refueling cycles) of data collected and evaluated before extending test intervals.
- Post-maintenance procedures include appropriate instructions and criteria to ensure baseline testing is re-performed as necessary when maintenance on the valve, valve repair or replacement, have 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.

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 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 addressed.

3.9.6.5 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 ASME OM-2004 Code as incorporated by reference in 10CFR50.55a, except where specific relief has been granted by the NRC in accordance with 10CFR50.55a(f). Relief from the testing requirements of ASME OM Code is requested when compliance with requirements of the Code is not practical. In such cases, specific information is provided which identifies the impractical code requirement, provides justification for the relief request, and provides 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. The IST program utilizes the following code cases:

3.9.6.5.1 OMN-1, Alternative Rules for the PST and IST of Certain MOVs

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," 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 OM Code Subsection ISTC. However, RG 1.192, "Operation and Maintenance Code Case Acceptability, ASME OM Code," has not yet endorsed OMN-1, Rev. 1.

Code Case OMN-1, Rev. 0, has been determined by the NRC to provide an acceptable level of quality and safety when implemented in conjunction with the conditions imposed in RG 1.192. NUREG-1482, Revision 1, "Guidelines for Inservice Testing at Nuclear Power Plants," (Reference 3.9-24) recommends the implementation of OMN-1 by all licensees. Revision 1 to OMN-1 represents an improvement over Revision 0, as published in the ASME OM-2004 Code. Revision 1 incorporates the guidance on risk based testing of MOVs from OMN-11, "Risk-Informed Testing of Motor-Operated Valves," and provides additional guidance on design basis verification testing and functional margin, which eliminates the need for the figures on functional margin and test intervals.

The IST Program implements Case OMN-1, Rev. 1, in lieu of the stroke-time provisions specified in ISTC-5120 for MOVs, consistent with the guidelines provided in NUREG-1482, Revision 1, Section 4.2.5.

RG 1.192 states that licensees may use Code Case OMN-1, Revision 0, in lieu of the provisions for stroke-time testing in Subsection ISTC of the 1995 Edition up to and including the 2000 Addenda of the ASME OM Code when applied in conjunction with the provisions for leakage rate testing in ISTC-3600 (1998 Edition with the 1999 and

2000 Addenda). Licensees who choose to apply OMN-1 are required to apply all its provisions. The IST program incorporates those provisions as follows:

- The adequacy of the diagnostic test interval for each motor-operated valve (MOV) is evaluated and adjusted as necessary, but not later than 5 years or three refueling outages (whichever is longer) from initial implementation of OMN-1.
- The potential increase in CDF and risk associated with extending high risk MOV test intervals beyond quarterly is determine to be small and consistent with the intent of the Commission's Safety Goal Policy Statement.
- Risk insights are applied using MOV risk ranking methodologies accepted by the NRC on a plant specific or industry-wide basis, consistent with the conditions in the applicable safety evaluations.
- Consistent with the provisions specified for Code Case OMN-11, the potential increase in CDF and risk associated with extending high risk MOV test intervals beyond quarterly is determined to be small and consistent with the intent of the Commission's Safety Goal Policy Statement.

Compliance with the above items is addressed in Section 3.9.6.2.2. Code Case OMN-1, Revision 1, should be considered acceptable for use with OM Code-2004 Edition. Finally, consistent with RG 1.192, the benefits of performing any particular test are balanced against the potential adverse effects placed on the valves or systems caused by this testing.

3.9.6.5.2 OMN-12, Alternative Requirements for IST Using Risk Insights for POVs

OMN-12, "Alternative Requirements for Inservice Testing Using Risk Insights for Pneumatically- and Hydraulically-Operated Valve Assemblies in Light-Water Reactor Power Plants," provides alternatives to the requirements of ISTC-5130 and ISTC-5140 for certain POVs, and is recommended for implementation in NUREG 1482, Rev. 1. OMN-12 is acceptable for use in preservice and inservice testing programs, per RG 1.192, provided the IST program complies with certain provisions. The IST program incorporates those provisions as follows:

- The inservice testing program for High Safety Significance Valve Assemblies includes a mix of static and dynamic valve assembly performance testing.
- The diagnostic test interval for each high safety significant valve assembly is limited to not later than 5 years or three refueling outages (whichever is longer) from initial implementation of OMN-12.
- Consistent with the requirement in OMN-3 to evaluate the aggregate change in risk associated with changes in test strategies, when extending exercise test intervals for high safety significant valve assemblies beyond a quarterly frequency, the potential increase in Core Damage Frequency (CDF) and risk associated with the extension is evaluated and determined to be small and consistent with the intent of the Commission's Safety Goal Policy Statement.

- Potential degradation rates and available capability margins for each high safety significance valve assembly are evaluated and determined to provide assurance that the valve assemblies are capable of performing their design-basis functions until the next scheduled test.
- The methodologies applied provide reasonable confidence that low safety significant valve assemblies remain capable of performing their intended design-basis safety functions until the next scheduled test.
- Setpoints for low safety significant POV valve assemblies are based on direct dynamic test information or test-based methodology, or are based on grouping with dynamically tested valves, and are documented accordingly. The setpoint justification methods may be less rigorous than those provided for high risk significant valve assemblies.
- Initial and periodic diagnostic testing are performed to establish and verify the setpoints of valve assemblies categorized as low safety significant to ensure that they are capable of performing their design basis safety functions. The test and evaluation methods may be less rigorous than those applied to high safety significant valve assemblies.
- Corrective actions are initiated if the parameters monitored and evaluated for any POV do not meet the established criteria. Further, if the valve assembly does not satisfy its acceptance criteria, the operability of the valve is evaluated.

Finally, consistent with RG 1.192, the benefits of performing any particular test are balanced against the potential adverse effects placed on the valves or systems caused by this testing.

3.9.6.5.3 Alternative Testing Pursuant to 10CFR CFR 50.55a(a)(3)(i) for Testing RHR System Fill Pumps

ASME OM Code-2004, Table ISTB-3000-1, requires measurement of flow rate (Q) for all pumps during Group A, Group B and Comprehensive Tests. Specifically:

- ISTB-3300, "Reference Values," paragraph (e)(2) states, "Reference values shall be established within +20% of pump design flow for a Group A test, if practicable. If not practicable, the reference point flow rate shall be established at the highest practical flow rate."
- ISTB-3400, "Frequency of Inservice Tests," states, "An inservice test shall be run on each pump as specified in Table ISTB-3400-1." Table ISTB-3400-1, "Inservice Test Frequency," specifies that a Group A pump test shall be performed on a quarterly frequency.
- ISTB-5121 requires that Group A tests shall be conducted with the pump operating at a specified reference point. ISTB 5221(b) requires that the resistance of the system shall be varied until the flow rate equals the reference point. The differential pressure shall then be determined and compared to its reference value.

Alternatively, the flow rate shall be varied until the differential pressure equals the reference point and the flow rate determined and compared to the reference flow rate value.

The three RHR System Fill Pumps (E11-C002) are classified as Group A pumps. NINA proposes alternative measures in accordance with 10 CFR 50.55a(a)(3)(i) in lieu of the OM- 2004 ISTB-3000 requirement to measure flow rate during Group A Tests for the RHR system fill pumps, as indicated in Note (i1) in Table 3.9-8. The alternative measures discussed below provide an acceptable level of quality and safety.

As described in Section 6.3.2, the primary function of the RHR System Fill Pumps is to maintain a water solid condition in the RHR pump discharge piping, and the piping will be maintained full by a small fraction of the pump's flow capacity. The RHR System Fill Pumps are expected to run continuously providing a small makeup flow to compensate for any back leakage through the RHR system. These pumps will provide a low flow rate that is dependent on the piping system leakage characteristics at any given time. Without a constant, explicit, and definable piping system leak rate and path, the system resistance and make up requirements cannot be set. Therefore, the pump flow rate may vary considerably around a small value and these variations likely would exceed the Table ISTB-5221-1 Acceptance Criteria, but actually be due to variations in RHR system back leakage rather than the pump's hydraulic performance. Accordingly, it is impractical to perform the measurement of flow rates for the three RHR System Fill Pumps during plant operation, as designed, to obtain meaningful results.

The RHR System Fill Pumps will be monitored for degradation on a quarterly basis by observing pump discharge pressure and bearing vibration during normal operating conditions. This testing will be performed without varying the resistance of the system as discussed in ISTB-5221(b). These parameters will then be evaluated and trended to assess the pump's performance. The measurement and trending of these parameters under these conditions will provide satisfactory indication of the operational readiness of the pumps and detect degraded performance. These system fill pumps will be full flow tested every 24 months in conjunction with the comprehensive pump test performed in accordance with the requirements specified in ISTB-5223, "Comprehensive Test Procedure."

The RHR System Fill Pump will be designed so that they will normally operate in the flat region of the pump pressureflow performance curve. The pumps will be designed and analyzed to continuously operate in this low-flow regime without any significant pump degradation. Since the pump will normally be operating on the flat region of the pump performance curve, the pump differential pressure is the hydraulic parameter of interest in monitoring pump nonperformance. The ISTB-3000 requirement for measuring pump differential pressure as well as peak vibration velocity, as reflected in Table 3.9-8, will assure detection of any significant degradation in the pumps' hydraulic or mechanical performance during normal plant operation. In addition, SR 3.5.1.1 in Chapter 16 requires the physical confirmation of a water solid RHR pipeline by opening a high point vent to confirm solid water flow on a 31-day frequency and RHR system pressure is continuously monitored and alarmed in the control room.

In summary, using the provisions of this relief request as an alternative to the requirements of ISTB-3300(e)(2), ISTB-3400, and ISTB-5221(b), in accordance with 10 CFR 50.55a(a)(3)(i), provides a reasonable alternative to the ASME OM Code requirements, and an acceptable level of quality and safety. In lieu of measuring flow rate during the Group A tests, the use of pumps that are designed and analyzed to ensure that (1) the expected flow rate stays well within the flat portion of the pressure-flow curve and that (2) no significant degradation occurs with the expected continuous low flow operation, combined with the system monitoring and alarms, will provide an acceptable level of quality and safety.

3.9.7 COL License Information

3.9.7.1 Reactor Internals Vibration Analysis, Measurement and Inspection Program

The following standard supplement addresses COL License Information Item 3.27.

The results of the vibration assessment program for the first ABWR plant have been assessed and it was determined that the level of detail of the available information is inadequate to meet the level of information described in the guidance provided in RG 1.20 Rev. 3. Therefore, as described in Subsection 3.9.2.3, STP 3 is the prototype plant, and therefore a prototype reactor internals stress and vibration analysis, measurement and inspection program is provided. This program addresses the following regulatory positions of RG 1.20 Rev. 3:

C.2.1 Vibration and Stress Analysis Program

C.2.2 Vibration and Stress Measurement Program

C.2.3 Inspection Program

C.2.4 Documentation of Results

As described in Subsection 3.9.2.3, the STP 3 ABWR FIV Assessment Program (Ref. 3.9-13) provides the summary of the results of the vibration and stress analysis, and summary descriptions of the vibration and stress measurement program and inspection program. Additional detailed information on the results of the vibration and stress analysis program for the steam dryer and the non-dryer reactor internals are provided in Reference 3.9-25 and Reference 3.9-26, respectively, and steam dryer operating experience is summarized in Reference 3.9-27. Additional detailed information on the vibration and stress measurement program and inspection program are provided in Reference 3.9-28. The preliminary and final reports, which together summarize the results of the vibration analysis, measurement, and inspection programs, will be submitted to the NRC within 60 and 180 days, respectively, following the completion of vibration testing in accordance with the guidance in RG 1.20 Rev. 3.

As described in Subsection 3.9.2.3, STP 4 is considered a non-prototype category 1 plant. Based on the guidance of RG 1.20 Rev. 3 regulatory position C.3, the STP 4 FIV Assessment Program (Ref. 3.9-14) provides the summary of the results of the vibration and stress analysis, and description of the inspection program. The preliminary and final reports, which together summarize the results of the vibration analysis and inspection programs, will be submitted to the NRC within 60 and 180 days, respectively, following the completion of inspection program in accordance with the guidance in RG 1.20 Rev. 3.

3.9.7.2 ASME Class 2 or 3 or Quality Group D Components with 60-Year Design Life

The following standard supplement addresses COL License Information Item 3.28.

The ASME Class 2 or 3 or Quality Group D components that are subjected to cyclic loadings, including operating vibration loads and thermal transients effects, of a magnitude and/or duration so severe the 60-year design life cannot be assured by required Code calculations and, if similar designs have not already been evaluated, will be identified and an appropriate analysis will be available to demonstrate the required design life or designs to mitigate the magnitude or duration of the cyclic loads will be available for review prior to fuel load. (COM 3.9-2)

3.9.7.3 Pump and Valve Testing Program

The following standard supplement addresses COL License Information Item 3.29.

The plant specific environmental parameters for the equipment qualification program will be available for NRC review as part of the ITAAC for basic configuration of systems, as provided in the reference ABWR DCD Tier 1 Section 1.2.

The pump and valve inservice testing and inspection program will be provided to the NRC as specified in section 13.4S. This program will include the following:

(1) Include baseline pre-service testing to support the periodic inservice testing of the components required by technical specifications. Provisions are included to disassemble and inspect the pump, check valves, POVs, and MOVs within the Code and safety-related classification as necessary, depending on test results.

(2) Provide a study to determine the optimal frequency of the periodic verification of the continuing MOV capability for design basis conditions.

The design qualification test, inspection and analysis criteria in Subsections 3.9.6.1, 3.9.6.2.1, 3.9.6.2.2 and 3.9.6.2.3 of Tier 2 of the reference ABWR DCD will be included in the respective safety-related pump and valve design specifications prior to fuel load. (COM 3.9-3)

The design, qualification, and preoperational testing for MOVs as discussed will conform to the provisions in Subsection 3.9.6.2.2 of Tier 2 of the reference ABWR DCD. (COM 3.9-4)

SRV IST requirements are included in Table 3.9-8 (B21 Nuclear Boiler System Valves) as supplemented by the requirements contained in Table 3.9S-1 and additional SRV testing including technical specification testing is described in Section 5.2.2.10.

As is described for ISI in COL License Information item 6.6.9.1, inservice tests to verify operational readiness of pumps and valves, whose function is required for safety, conducted during the initial 120-month interval must comply with the requirements in the latest edition and addenda of the Code incorporated by reference in 10 CFR 50.55a(b) of this section on the date 12 months before the date scheduled for initial loading fuel under a combined license (or the optional ASME Code cases listed in NRC Regulatory Guide 1.192 that is incorporated by reference in 10 CFR 50.55a(b) of this section), subject to the limitations and modifications listed in 10 CFR 50.55a(b) of this section.

As is described for ISI in COL License information item 6.6.9.1, inservice tests to verify operational readiness of pumps and valves, whose function is required for safety, conducted during successive 120-month intervals must comply with the requirements of the latest edition and addenda of the Code incorporated by reference in 10 CFR 50.55a(b) of this section 12 months before the start of the 120- month interval (or the optional ASME Code cases listed in NRC Regulatory Guide 1.147, through Revision 14, or 1.192 that are incorporated by reference in 10 CFR 50.55a(b) of this section), subject to the limitations and modifications listed in 10 CFR 50.55a(b) of this section.

3.9.7.4 Audit of Design Specification and Design Reports

The following site-specific supplement addresses COL License Information Item 3.30.

The design specification and design reports required by ASME Code for vessels, pumps, valves and piping systems for the purpose of audit will be made available for NRC review.

The piping system design is consistent with the construction practices, including inspection and examination methods, of the ASME Code 1989 edition with no addenda.

ASME Code editions and addenda other than those listed in Tables 1.8-21 and 3.2-3, will not be used to design ASME Code Class 1, 2 and 3 pressure retaining components and supports.

The piping system design is consistent with the construction practices, including inspection and examination methods, of the ASME Code 1989 edition with no addenda. Consistent with ASME Code Section III NCA 2142.2, the design specifications for some SSCs may contain descriptions of transients necessary to consider in determination of some of the service loadings. In some of these cases, it may be necessary to conduct experimental testing to determine the loadings, as described in Subsection 3.9.1.3. In these cases, the details of the test procedures and their results will be included in the associated design report in accordance with Appendix II of ASME Code Section III. As an example, for the FMCRD design specification, experimental testing has been done as described in Subsections 3.9.1.3.2 and 4.6.3.1. This testing will be repeated to determine plant specific transient loads, such as P_{NSC1} - CRD pressures during a normal HCU accumulator scram (waterhammer) with normal buffer, P_{NSC2} - CRD pressures during a normal HCU accumulator scram (waterhammer) with failed buffer, M_{NB} – mechanical loading on

CRD components following a normal HCU accumulator scram (waterhammer) with normal buffer, M_{IB} - mechanical loading on CRD components following a normal HCU accumulator scram (waterhammer) with failed buffer. These loads will be combined with analytical results, such as T_{ACO} – CRD temperature with restricted or plugged purge water line, T_{LSS} – CRD temperature with leaking shaft seals or static O-rings, P_{AACC1} – CRD pressures during scram with over-charged accumulator pressures, M_{RE} – mechanical loading on CRD components during a control rod ejection event, M_{IS} – mechanical loading on CRD components due to internal blowout, P_{ASR} – CRD pressures during normal accumulator scram with stuck control rod, and the plant dynamic loadings calculated from seismic and hydrodynamic forces. The combinations will be made in accordance with Table 3.9-2, as listed in the design specification. As is the case with all ASME III Code Section III components, the results of the stress analysis based on service level load combinations will be evaluated versus the specified service limits in the design report.

3.9.8 References

3.9-13 "STP Unit 3 ABWR Prototype Reactor Internals Flow-Induced Vibration Assessment Program," WCAP-17256-P, Revision 6.

3.9-14 "STP Unit 4 Reactor Internals Flow-Induced Vibration Assessment Program," WCAP-17257-P, Revision 5.

3.9-15 Not Used

3.9-16 ASME QME-1, "Qualification of Active Mechanical Equipment Used in Nuclear Power Plants," 2007 Edition.

3.9-17 MPR-2524-B. "Joint Owners' Group (JOG) Motor Operated Valve Periodic Verification Program Summary," November 2007.

3.9-18 “Final Safety Evaluation On Joint Owners’ Group Program On Motor-Operated Valve Periodic Verification (TAC Nos. MC2346, MC2347, and MC2348),” September 22, 2006.

3.9-19 “Final Supplement To Safety Evaluation For Joint Owners’ Group Motor-Operated Valve Periodic Verification Program (TAC Nos. MD8920 and MD8921),” September 18, 2008.

3.9-20 RIS2000-03, "Resolution of Generic Safety Issue 158: Performance of Safety-Related Power-Operated Valves Under Design Basis Conditions," March 15, 2000.

3.9-21 "Joint Owners Group (JOG) Air Operated Valve Program," Limited Distribution, March 2001, NX-1018 (Revision 1) by the Nuclear Exchange (Previously submitted to NRC by NEI in a letter dated July 19, 1999).

3.9-22 NRC's Letter to NEI Dated October 8, 1999, "Nuclear Regulatory Commission Comments on Joint Owners Group Air Operated Valve Program Document," From Eugene V. Imbro of NRC to David J. Modeen of NEI.

3.9-23 ASME OM Code, "Code for Operation and Maintenance of Nuclear Power Plants," The American Society of Mechanical Engineers, 2004 edition.

3.9-24 NUREG-1482, Revision 1, "Guidelines for Inservice Testing at Nuclear Power Plants," Nuclear Regulatory Commission, January 2005.

3.9-25 “STP Unit 3 Steam Dryer Flow-Induced Vibration Assessment," WCAP-17385-P, Revision 6.

3.9-26 "South Texas Project Units 3 and 4 Reactor Internals Non-Dryer Component Flow-Induced Vibration Assessment," WCAP-17371-P, Revision 7.

3.9-27 "ABWR Dryer Operating Experience for STP Units 3 and 4," WCAP-17369-P, Revision 1.

3.9-28 “South Texas Project Unit 3 Comprehensive Vibration Assessment Program Measurement, Test, and Inspection Plan," WCAP-17370-P, Revision 7.

Table 3.9-1 Plant Events

B. Dynamic Loading Events[5]		
	ASME Code Service Limit[1]	**No. of Cycles/Events[2]**
13.Safe Shutdown Earthquake (SSE) at Rated Power Operating Conditions	D[8]	1 ~~*Cycle*~~ **Event**[4]

Table 3.9-2 Load Combinations and Acceptance Criteria for Safety-Related, ASME Code Class 1, 2 and 3 Components, Component Supports, and Class CS Structures

Plant Event	*Service Loading Combination*	*ASME Service Level*
1. Normal Operation (NO)	*N*	*A*[13]

13 For ASME Code Class 1, 2 and 3 piping, piping stresses due to differential foundation (building) settlement shall be evaluated to meet the following stress limits:

a) ASME Code Class 1 piping:

$S_{SETTLEMENT} = (C_2 \times D_O \times M_d) / (2 \times I) \leq 6 \times S_m$.

where:

$S_{SETTLEMENT}$	is the nominal value of stress due to differential settlement
M_d	is the resultant moment due to predicted differential settlement
C_2, D_O and I	are defined in ASME Code Subsection NB-3600
S_m	is material allowable stress at cold (room) temperature

$S_{SETTLEMENT}$ shall not be included in ASME Code Subsection NB-3600 Equations (10) and (11).

b) ASME Code Class 2 and 3 piping:

$S_{SETTLEMENT} = (i \times M_d) / Z \leq 3 \times S_c$.

where:

$S_{SETTLEMENT}$	is the nominal value of stress due to differential settlement
M_d	is the resultant moment due to predicted differential settlement
i and Z	are defined in ASME Code Subsections NC/ND-3600
S_c	is material allowable stress at cold (room) temperature

$S_{SETTLEMENT}$ shall not be included in ASME Code Subsections NC/ND-3600 Equations (9), (10) and (11).

Table 3.9-8 Inservice Testing Safety-Related Pumps and Valves

MPL	System	Pump Page No.	Valve Page No.
P81	Breathing Air System		3.9-132

Table 3.9-8 Inservice Testing Safety-Related Pumps and Valves (Continued)

No.	Qty	Description (h) (i)	Safety Class (a)	Code Cat. (c)	Valve Func (d)	Test Para (e)	Test Freq (f)	Tier 2 Fig. (g)
E11 Residual Heat Removal System Valves								
F014	~~2~~3	*Fuel Pool Cooling supply line inboard MOV*	*2*	*B*	*A*	*P S*	*2yr, 3 mo*	*5.4-10 sh.***3***,5,7*
F015	~~2~~3	Fuel Pool Cooling supply line outboard MOV	2	B	A	P S	2 yr,3 mo	5.4-10 sh. **3**,5,7
F016	~~2~~3	Gate valve-line from Fuel Pool Cooling (FPC)	2	B	A	S	3 mo	5.4-10 sh. 2
E51 Reactor Core Isolation Cooling System Valves								
~~F012~~	~~1~~	~~RCIC turbine accessories cooling water line MOV~~	~~2~~	~~B~~	~~A~~	~~P S~~	~~2 yr 3 mo~~	~~5.4-8 sh. 3~~
~~F013~~	~~1~~	~~RCIC turbine accessories cooling water line PCV~~	~~2~~	~~B~~	~~A~~		~~E1~~	~~5.4-8 sh. 3~~
~~F015~~	~~1~~	~~Barometric condenser condensate pump discharge line valve~~	~~2~~	~~B~~	~~P~~		~~E1~~	~~5.4-8 sh. 3~~
~~F016~~	~~1~~	~~Barometric condenser condensate pump discharge line check valve~~	~~2~~	~~C~~	~~P~~	~~P S~~	~~2 yr 3 mo~~	~~5.4-8 sh. 3~~
~~F030~~	~~1~~	~~Turbine accessories cooling water line relief valve~~	~~2~~	~~C~~	~~A~~	~~R~~	~~5 yr~~	~~5.4-8 sh. 3~~
~~F031~~	~~1~~	~~Barometric condenser condensate discharge line AOV to HCW~~	~~2~~	~~B~~	~~P~~		~~E1~~	~~5.4-8 sh. 3~~
~~F032~~	~~1~~	~~Barometric condenser condensate discharge line AOV to HCW~~	~~2~~	~~B~~	~~P~~		~~E1~~	~~5.4-8 sh. 3~~
~~F034~~	~~1~~	~~Barometric condenser condensate pump discharge line test line valve~~	~~2~~	~~B~~	~~P~~		~~E1~~	~~5.4-8 sh. 3~~
~~F044~~	~~1~~	~~Steam admission valve bypass line maintenance valve~~	~~2~~	~~B~~	~~P~~		~~E1~~	~~5.4-8 sh. 2~~
~~F045~~	~~1~~	~~Steam admission valve bypass line MOV~~	~~2~~	~~B~~	~~A~~	~~P S~~	~~2 yr 3 mo~~	~~5.4-8 sh. 2~~
~~F046~~	~~1~~	~~Barometric condenser vacuum pump discharge line check valve (h3)~~	~~2~~	~~A, C~~	~~I, A~~	~~L,S~~	~~RO~~	~~5.4-8 sh. 1~~

Table 3.9-8 Inservice Testing Safety-Related Pumps and Valves (Continued)

No.	Qty	Description (h) (i)	Safety Class (a)	Code Cat. (c)	Valve Func (d)	Test Para (e)	Test Freq (f)	Tier 2 Fig. (g)
F047	1	Barometric condenser vacuum pump discharge line MOV	2	A	I,A	L,P S	RO 3 mo	5.4-8 sh. 1
F051	1	Turbine exhaust line drain line valve	2	B	P		E1	5.4-8 sh. 3
F052	1	Turbine exhaust line drain line valve	2	B	P		E1	5.4-8 sh. 3
F059	1	Barometric condenser vacuum pump discharge line test line valve	2	B	P		E1	5.4-8 sh. 1
F712	1	Turbine accessories cooling water line instrument root valve	2	B	P		E1	5.4-8 sh. 3
F713	1	Turbine accessories cooling water line instrument root valve	2	B	P		E1	5.4-8 sh. 3
F714	1	Turbine accessories cooling water line instrument root valve	2	B	P		E1	5.4-8 sh. 3
P21 Reactor Building Cooling Water System Valves								
F037	2	Cooling water supply line to FCS room air conditioner	3	B	P		E1	9.2-1 sh. 2,5
F038	2	Cooling water return line from FCS room air conditioner	3	B	P		E1	9.2-1 sh. 2,5
T49 Flammability Control System Valves								
F001	2	Inlet line from drywell inboard isolation valve	2	A	I,A	L, P S	2 yr 3 mo	6.2-40
F002	2	Inlet line from drywell outboard isolation valve	2	A	I,A	L, P S	2 yr 3 mo	6.2-40
F003	2	Flow control valve for the FCS inlet line from drywell	3	B	A	P S	2 yr 3 mo	6.2-40
F004	2	Blower bypass line flow control valve	3	B	A	P S	2 yr 3 mo	6.2-40
F005	2	Blower discharge line to wetwell check valve (h9)	3	C	A	S	RO	6.2-40
F006	2	Discharge line to wetwell outboard isolation valve	2	A	I,A	L, P S	2 yr 3 mo	6.2-40

Table 3.9-8 Inservice Testing Safety-Related Pumps and Valves (Continued)

No.	Qty	Description (h) (i)	Safety Class (a)	Code Cat. (c)	Valve Func (d)	Test Para (e)	Test Freq (f)	Tier 2 Fig. (g)
~~F007~~	~~2~~	~~Discharge line to wetwell inboard isolation valve~~	~~2~~	~~A~~	~~I,A~~	~~L, P S~~	~~2 yr 3 mo~~	~~6.2-40~~
~~F008~~	~~2~~	~~Cooling water supply line from the RHR System MOV~~	~~3~~	~~B~~	~~A~~	~~P S~~	~~2 yr 3 mo~~	~~6.2-40~~
~~F009~~	~~2~~	~~Cooling water supply line maintenance valve~~	~~3~~	~~B~~	~~P~~		~~E1~~	~~6.2-40~~
~~F010~~	~~2~~	~~Cooling water supply line admission MOV~~	~~3~~	~~B~~	~~A~~	~~P S~~	~~2 yr 3 mo~~	~~6.2-40~~
~~F013~~	~~2~~	~~Inlet line from drywell drain line valve~~	~~3~~	~~B~~	~~P~~		~~E1~~	~~6.2-40~~
~~F015~~	~~1~~	~~Blower discharge line to wetwell pressure relief valve~~	~~2~~	~~A,C~~	~~I,A~~	~~R L~~	~~5 yr RO~~	~~6.2-40~~
~~F016~~	~~2~~	~~Blower discharge line to wetwell pressure relief line check valve (h3)~~	~~2~~	~~A,C~~	~~I,A~~	~~L, S~~	~~RO~~	~~6.2-40~~
~~F501~~	~~2~~	~~Inlet line from drywell test line valve~~	~~2~~	~~B~~	~~P~~		~~E1~~	~~6.2-40~~
~~F502~~	~~2~~	~~Discharge line to wetwell test line valve~~	~~3~~	~~B~~	~~P~~		~~E1~~	~~6.2-40~~
~~F504~~	~~2~~	~~Blower suction line test line valve~~	~~3~~	~~B~~	~~P~~		~~E1~~	~~6.2-40~~
~~F505~~	~~2~~	~~Blower discharge line test line valve~~	~~3~~	~~B~~	~~P~~		~~E1~~	~~6.2-40~~
~~F506~~	~~2~~	~~Drain line to low conductivity waste (LCW) valve~~	~~3~~	~~B~~	~~P~~		~~E1~~	~~6.2-40~~
~~F507~~	~~2~~	~~Cooling water supply line test line valve~~	~~3~~	~~B~~	~~P~~		~~E1~~	~~6.2-40~~
~~F701~~	~~2~~	~~FE-T49-FE002 upstream instrument line root valve~~	~~3~~	~~B~~	~~P~~		~~E1~~	~~6.2-40~~
~~F702~~	~~2~~	~~FE-T49-FE002 downstream instrument line root valve~~	~~3~~	~~B~~	~~P~~		~~E1~~	~~6.2-40~~
~~F703~~	~~2~~	~~Blower suction line pressure instrument line root valve~~	~~3~~	~~B~~	~~P~~		~~E1~~	~~6.2-40~~
~~F704~~	~~2~~	~~FE-T49-FE004 upstream instrument line root valve~~	~~3~~	~~B~~	~~P~~		~~E1~~	~~6.2-40~~
~~F705~~	~~2~~	~~FE-T49-FE004 downstream instrument line root valve~~	~~3~~	~~B~~	~~P~~		~~E1~~	~~6.2-40~~

Table 3.9-8 Inservice Testing Safety-Related Pumps and Valves (Continued)

No.	Qty	Description (h) (i)	Safety Class (a)	Code Cat. (c)	Valve Func (d)	Test Para (e)	Test Freq (f)	Tier 2 Fig. (g)
P41 Reactor Service Water System Valves								
F110	**6**	**RSW return to cooling tower**	**3**	**B**	**A**	**P S**	**2 yr 3mo**	**9.2-7 sh. 1,2,3**
F109	**3**	**RSW cold bypass to cooling tower basin MOV**	**3**	**B**	**A**	**P S**	**2 yr 3mo**	**9.2-7 sh. 1,2,3**
F115	**1**	**Makeup water to UHS basin MOV**	**3**	**B**	**A**	**P S**	**2 yr 3mo**	**9.2-7 sh. 1**
F113/ F116	**2**	**Makeup water to UHS basin Manual Isolation valves**	**3**	**B**	**P**		**E1**	**9.2-7 sh. 1**
F114/ F117	**2**	**Makeup water to UHS basin Check valves**	**3**	**C**	**A**	**S**	**3mo**	**9.2-7 sh. 1**
F101	**3**	**RSW line to HVAC Air Conditioning Condenser Manual Isolation valves**	**3**	**B**	**P**		**E1**	**9.2-7 sh. 1,2,3**
F102	**3**	**RSW blowdown line to Main Cooling Reservoir MOV**	**3**	**B**	**A**	**P S**	**2 yr 3mo**	**9.2-7 sh. 1,2,3**
P51 Service Air System Valves								
F132	***1***	***Inboard isolation ~~manual~~*****check** ***valve*** **(h1)**	***2***	***A*****, C**	***I, ~~P~~*****A**	***L*****, S**	***RO***	***9.3-7***
P81 Breathing Air System								
F252	**1**	**Inboard Isolation Manual valve**	**2**	**A**	**I,P**	**L**	**RO**	**9.3-10**
F251	**1**	**Outboard Isolation Manual valve**	**2**	**A**	**I,P**	**L**	**RO**	**9.3-10**