Throughout the following sections of QV, it should be noted that the actuator used when testing the performance of the valve does not need to be the actuator that was tested for the actuator portions of the testing. Use of other than a qualified actuator for valve testing does, however, require special attention be paid to the valve and actuator interface as discussed below in QV-7461.3, QV-7462.3, and QV-7463.3.

QV-7420 Environmental and Aging. Friction of valve internal sliding surfaces can increase with age until a plateau is reached. Further, inspections and disassembly/reassembly of valves that expose valve internal surfaces to air can result in a temporary reduction in friction coefficients. Qualification of functional capability must address these phenomena when establishing valve operating requirements.

Environmental Qualification of actuators is performed in accordance with IEEE Std 323 and IEEE Std 382. Qualification of other nonmetallic parts, critical to valve assembly performance, may be performed in accordance with Nonmandatory Appendix QR-B.

QV-7430 Sealing Capability

QV-7431 Main-Seat Leakage. For measurement of main-seat leakage, a valve closure shall be effected by the actuator using minimum motor power, and the maximum seat-sealing differential test pressure shall be established. Pressure on one side of the closure shall be relieved to establish a differential pressure in the specified flow direction or in the most adverse direction for bidirectional valves (e.g., a globe valve with an unbalanced disk, where the design is such that flow tends to open the valve disk) shall be seat-leak tested with pressure applied on the upstream side of the disk. Leakage shall be collected from the low-pressure side of the closure or otherwise measured by appropriate means. The test shall be as long as required to determine the leakage rate but not fewer than 5 min. For double-disk gate valves, the selected seat-sealing test pressure may be performed after fully cycling the valve assembly ten times. The test shall be as long as required to determine the leakage rate but not fewer than 5 min. Document the relationship between stem-seal leakage and pressure. The qualification plan shall consider whether temperature and fluid conditions for the application of the valve assembly result in the need for further qualification testing.

QV-7440 End Loading. The pressure-containing portions of valves that are to be qualified to this document shall be designed to the applicable code selected by the facility Owner.

End-loading qualification is not required if

(a) the intended application for the valve does not impose significant end-load reactions (e.g., a drain valve with piping attached to one end of the valve does not impose significant loading) or

(b) the valve is designed to be installed in piping by bolting the valve between pipe flanges, and the valve body has a generally cylindrical cross section (except for through bolting holes and a provision for actuator mounting and entrance of the valve stem/shaft) of such proportions that the length of the valve body parallel to the pipe run is equal to or less than the inside diameter of the valve (e.g., a wafer style butterfly valve)

QV-7441 End-Loading Qualification for QV Category A Valve Assemblies. For QV Category A valve assemblies, one of the following is required:

(a) Qualify analytically the maximum load (forces and moments) that can be placed on the valve body such that operation is not adversely affected. In turn, this load is to be supplied to the piping system designer who must design his system such that the load cannot be exceeded.

(b) Qualify by test for the maximum load that can be placed on the valve body such that operation is not adversely affected. In turn, this load is to be supplied to the piping system designer who must design his system such that the load cannot be exceeded.

(c) Require that the maximum stress intensity in the attached piping at the pipe to valve junction resulting from the combination of the primary or local membrane stress ($P_M$ or $P_L$) plus the bending stress ($P_b$) plus the expansion stress ($P_e$) shall be limited to a value of ($G_b/F_b$) × $S_y$ ($G_b$ defined below). That is,

$$F_b ≤ \frac{G_b}{F_b} S_y$$

If $G_b$ is unknown, then $\left(\frac{G_b}{F_b}\right)$ may be taken as 1.
QV-7463.2 Production Actuator

(a) Verify applicability of the production actuator type, size, and rating (including internal parts and materials); orientation; lubricants; and any corrosion inhibitor to the qualified actuator.

(b) Perform an internal inspection of the Production Actuator for material, surface condition, and critical internal dimensions (including verifying that internal dimensions, clearances, and edge radii are within manufacturing tolerances) to establish applicability to the qualified actuator.

(c) Verify applicability of environmental conditions, stroke-time requirements, and motive power source conditions (such as air pressures for air-powered actuators and motor current and voltage for motor-powered actuators) of the production actuator to the qualified actuator.

(d) While collecting diagnostic test data (including stem thrust and/or torque; environmental conditions; stroke time; motor torque, voltage, and current for motor-powered actuators; and operating air pressures and current signals for air-powered actuators, as applicable), cycle the production actuator under nominal motive power source conditions throughout the actuator stroke to verify proper assembly.

(e) Verify applicability of the functional capability (including stroke time) of the production actuator for opening and closing under environmental and power conditions to the qualified actuator through the use of specific test data or a test-based qualification methodology.

QV-7463.3 Production Valve and Actuator Interface

(a) Verify applicability of the production valve and production actuator interface to the qualified valve assembly.

(b) Verify that the thrust and/or torque output of the production actuator equals or exceeds the required thrust and/or torque demands of the production valve throughout the valve assembly stroke.

(c) For a motor-powered actuator with a rising stem valve, do the following:

(1) Verify that the lubricants used are applicable to the qualified valve assembly.

(2) Verify applicability of the stem-to-stem-nut coefficient of friction and the load sensitive behavior of the production valve assembly to the qualified valve assembly through the use of specific test data or a test-based qualification methodology.

(3) Cycle the production valve assembly under static conditions throughout the valve stroke to verify proper assembly.

QV-7470 Post-Installation Verification and IST Baseline. After the production valve assembly has been installed in the facility, it shall be cycled under representative fluid conditions as necessary to collect diagnostic data (including valve stem thrust and torque; fluid pressure and temperature; stroke time; MOV motor torque, voltage, and current; and AOV operating air pressures and current signals, as applicable) throughout the valve stroke to verify the production valve assembly meets the functional requirements of the Qualification Specification. The requirements of QV-7470 are the responsibility of the Owner.

QV-7500 Qualification Requirements for Self-Actuated Check Valves

QV-7510 Initial Considerations. The ranges of the test pressure, temperature, and flow for the maximum test seat-sealing differential pressure shall be defined in the qualification plan and the functional qualification report. The valve body and seat-sealing test pressures used in this test may be equal to or less than the rated pressure of the valve, but in any event, these test pressures determine the qualification pressure rating for the valve assembly. Where production valve assemblies may have different operating pressure requirements, the qualification of the qualified valve assembly must include a range of test pressures encompassing the requirements for the production valve assemblies.

Those check valves with actuating means involving external weights, springs, or a power actuator whose purpose is to provide positive closure or to assist in closure may be qualified by analysis that verifies that the actuating device cannot degrade the function or operability during and after a seismic event. Additionally, those check valves with an external actuating device whose sole purpose is to provide positive closure or to assist in seating may be qualified by analysis that verifies the actuating device cannot degrade the function or operability during and after a seismic event.

QV-7520 Environmental and Aging Considerations. The qualification of nonmetallic parts that are critical to valve assembly operability may be performed in accordance with Nonmandatory Appendix QR-B.

QV-7530 Sealing Capability

QV-7531 Main-Seat Leakage. The valve shall be pressurized in the flow direction tending to seat the disk. Leakage shall be collected from the opposite side of the closure or otherwise measured by appropriate means. The test shall be a minimum of 5 min or a longer period deemed adequate to measure the leakage rate.

QV-7532 Shaft-Seal Leakage. For check valves having sealed shafts, shaft-seal leakage shall be observed at cold working pressure applied to the seal. For valves with leak-off connections, leakage at the leak-off connection shall be measured and recorded. For valves without leak-off connections, shaft-seal leakage shall be observed...
and the leak rate estimated. If the sealed shaft is a moving part, the initial shaft-seal leakage test shall be performed after fully cycling the valve assembly ten times. The leakage rate test duration shall be adequate to measure the leakage rate but not fewer than 5 min.

(12) **QV-7540 End Loading.** The pressure-containing portions of valves that are to be qualified to this document shall be designed to the applicable code selected by the facility Owner.

The end-loading test is not required if
(a) the intended application for the valve does not impose significant end-load reactions (e.g., a drain valve with piping attached to one end of the valve does not impose significant loading) or
(b) the valve is designed to be installed in piping by bolting the valve between pipe flanges, and the valve body has a generally cylindrical cross section (except for through bolting holes and a provision for actuator mounting and entrance of the valve stem/shaft) of such proportions that the length of the valve body parallel to the pipe run is equal to or less than the inside diameter of the valve (e.g., a wafer style butterfly valve)

**QV-7541 End Loading for QV Category A Valve Assemblies.** For QV Category A valve assemblies, one of the following is required:

(a) Qualify analytically the maximum load (forces and moments) that can be placed on the valve body such that operation is not adversely affected. In turn, this load is to be supplied to the piping system designer who must design his system such that the load cannot be exceeded.

(b) Qualify by test for the maximum load (forces and moments) that can be placed on the valve body such that operation is not adversely affected. In turn, this load is to be supplied to the piping system designer who must design his system such that the load cannot be exceeded.

(c) Require that the maximum stress intensity in the attached piping, at the pipe-to-valve junction resulting from the combination of the primary or local membrane stress \(P_M\) or \(P_L\) plus the bending stress \(P_b\) plus the expansion stress \(P_e\), shall be limited to a value of \((G_b/F_b) \times S_y\) \((G_b/F_b) \times S_y\) defined below). That is,

\[
F_b (P_M + P_L) + P_b + P_e \leq \frac{G_b}{F_b} S_y
\]

If \(G_b\) is unknown, then \(\frac{G_b}{F_b}\) may be taken as 1.0 when
- \(F_b\) = bending modulus of connecting pipe
- \(G_b\) = valve body section modulus at the crotch region
- \(P_b\) = bending stress
- \(P_e\) = expansion stress
- \(P_L\) = local primary membrane stress
- \(P_M\) = primary membrane stress

The determination of the maximum stress intensity shall be based on the highest combination of concurrent loads considering all concurrent loads defined in the Qualification Specification. The value of \(S_y\) shall be taken at the highest metal temperature of the attached piping for the concurrent load combination under consideration.

**QV-7542 End Loading for QV Category B Valve Assemblies.** End-loading qualification is not required for QV Category B valve assemblies.

**QV-7550 Seismic Qualification.** Seismic qualification of check valves is not required under this Standard and may be covered by applicable design codes.

Those check valves with actuating means involving external weights, springs, or a power actuator whose purpose is to provide positive closure or to assist in closure may be qualified by analysis that verifies the actuating device cannot degrade the function or operability during and after a seismic event. Additionally, those check valves with an external actuating device whose sole purpose is to provide a means for in-service testing of operability may be qualified by analysis that verifies the actuating device cannot degrade the function or operability during and after a seismic event.

**QV-7560 Functional Qualification**

**QV-7561 Valve Assembly to Be Qualified.** The valve functional qualification establishes key performance parameters necessary for the evaluation of proper valve sizing to maintain the valve disk in the full open position under normal flow conditions and the evaluation of valve adequacy for service applications involving flow reversal and resulting pressure surge produced by valve closure. The following activities shall be performed to justify the qualification for functional capability of the valve assembly:

(a) Identify manufacturer, type, size, material (including internal parts), and rating; stem packing; and corrosion inhibitor (as applicable).

(b) Establish orientation and system piping application.

(c) Establish applicable fluid and system flow conditions.

(d) Establish sealing capability requirements for valve.

(e) Establish stem shaft leakage limitations for valve. Test-based methodologies that have been demonstrated to reliably predict valve assembly performance may be used to supplement valve-specific testing to minimize the range of flow testing in qualifying the valve assembly.

**QV-7561.1 Valve Qualification for Forward Flow.** Perform internal inspection of the valve assembly to be qualified for material and surface condition and critical
internal dimensions (including valve internal clearances) to assess valve predictable behavior and to establish applicability to its qualified valve assembly.

(c) Verify applicability of fluid and environmental conditions, for the production valve assembly to conditions for which its qualified valve assembly was qualified.

(d) Verify applicability of sealing capability requirements for the production valve to its qualified valve assembly.

(e) Cycle the production valve under static conditions with collection of diagnostic data (disk position, etc.) to verify proper assembly and establish baseline parameters.

(f) Verify applicability of functional capability (including stroke time) of the production valve assembly for opening and closing under fluid, environmental, and system flow conditions to its qualified valve assembly through use of specific test data or a test-based qualification methodology.

QV-7564 Post-Installation Verification and IST Baseline. After the valve has been installed in the facility, the valve shall be cycled under representative fluid flow conditions as necessary to collect diagnostic data (disk position, etc., as applicable) for use in future performance monitoring. The requirements of QV-7564 are the responsibility of the Owner.

QV-7650 Seismic Qualification

(a) Seismic qualification is intended to demonstra the ability of a valve assembly to withstand loading representative of the specified seismic load qualification level.

(b) Qualification of valve assemblies shall be in accordance with IEEE Std 344 as addressed in NRC Regulatory Guide 1.100 (Revision 2) or Nonmandatory Appendix QR-A.

(c) All essential-to-function accessories shall be attached to the valve assembly. The essential-to-function accessories that have not been previously qualified in accordance with IEEE Std 344 as part of the actuator assembly shall be seismically qualified in accordance with IEEE Std 344 or Nonmandatory Appendix QR-A.

QV-7660 Functional Qualification. Functional qualification for pressure relief valve assemblies shall be as delineated in ASME Boiler and Pressure Vessel Code Section III, Subsections NB, NC, or ND 7000. The rules of Section III also govern the extrapolation of test results, as well as the extension of test results to production valves.

QV-7661 Tests Prior to Initial Operation. Valve assemblies shall be tested prior to initial installation as delineated in ASME OM Code OM-1, Appendix 1, Subsection 1-3100, or 1-7100.

QV-7662 Post-Installation Verification and IST Baseline. After the valve assembly has been installed in the facility, the valve shall be tested as required by ASME OM Code OM-1, Appendix 1, Subsection 1-3200, or 1-7200. The requirements of QV-7662 are the responsibility of the Owner.

QV-8000 DOCUMENTATION REQUIREMENTS

QV-8100 Documentation Scope

(a) Qualification documentation is intended to verify that each valve assembly used in a nuclear facility application is qualified to perform its designated function when used for its intended service. Qualification is substantiated by showing and explaining the relationship between the service requirements and the testing and analysis that is conducted as part of the qualification program.

(b) A Qualification Plan, as described in QV-8200, is required to translate the Qualification Specification into a step-by-step qualification program and the testing and analysis that is conducted as part of the qualification program.

(c) A Functional Qualification Report, as described in QV-8310, is required to document compliance of the qualified valve assembly and its production valve assemblies with Section QV.

(d) An Application Report, as described in QV-8320, is required to document the suitability of any qualified...
provided that a satisfactory justification for the worst-case orientation decision is presented in the Qualification Report.

(e) Design limiting orientation may be different based on various qualification attributes, e.g., seismic capability versus functional capability.

(f) Specific aspects of the qualification of the valve and actuator may be performed separately.

QV-7720 Environmental and Aging.  

(a) Environmental qualification of actuators shall be performed in accordance with IEEE Std 323 and IEEE Std 382, or a methodology justified by the user.

(b) As part of this qualification, the actuator squib and propellant shall undergo environmental qualification, including aging, to demonstrate the capability of the actuator to provide the necessary force to operate the valve under the full range of seismic, dynamic, environmental, and aged conditions consistent with the reliability assumptions for the pyrotechnic-actuated valve.

(c) Qualification of other nonmetallic parts, critical to valve assembly performance, may be performed in accordance with Nonmandatory Appendix QR-B.

(d) Based on their specific application, pyrotechnic-actuated valve assemblies shall be evaluated and qualified for submergence, including actuator electrical system functionality, potential leakage into the actuator squib and propellant areas, and potential leakage into valve mechanical operation areas.

QV-7730 Sealing Capability.

(a) For sealing qualification if applicable, a maximum differential test pressure shall be established for the measurement of leakage.

(b) Pressure on one side of the valve shall be relieved to establish a differential pressure in the specified flow direction or in the most adverse direction for bidirectional valves.

(c) Leakage shall be collected from the low-pressure side of the valve.

(d) The test shall be as long as required to determine the leakage rate but not fewer than 5 min.

(e) The Qualification Plan shall consider whether temperature and fluid conditions for the application of the valve assembly result in the need for further qualification testing.

QV-7740 End Loading.

(a) The pressure-containing portions of valves shall be designed to the applicable Code selected by the plant Owner.

(b) All pyrotechnic-actuated valves shall undergo end-loading qualification.

(c) The end-loading qualification shall include evaluation of the pyrotechnic loads when the propellant charge is fired, and the fluid reaction loads when the valve is opened.
valve assembly and its production valve assemblies for a specific nuclear facility application.

**QV-8200 Qualification Plan**

A Qualification Plan, which may be part of the Functional Qualification Report, shall be prepared with appropriate inspection and test record forms to define test objectives, test fluids, test instrumentation, conditions of the test, orientation, permissible maintenance or adjustments, and acceptance criteria. The plan shall also specify the activities to ensure that production valve assemblies will perform consistently with their applicable qualified valve assembly. See Guide to ASME QME-1 Standard, Section QV, “Determination of Valve Assembly Performance Characteristics,” for information on preparing the section of a Qualification Plan addressing functional capability demonstration for valve assemblies to be qualified and their production valve assemblies.

**QV-8300 Reports**

**QV-8310 Functional Qualification Report**

A Functional Qualification Report shall be prepared for each qualified valve assembly qualified in accordance with this Section of the standard directly or by extrapolation. This Functional Qualification Report shall provide complete identification of the valve by type, size, pressure rating, actuator type and size, and other data as appropriate, including the Qualification Plan, test results, and inspection data. The Functional Qualification Report shall also contain a summary of the parameters established by the functional qualification testing and analysis for both the qualified valve assembly and its production valve assemblies. Any specific limitations that restrict qualification shall be stated. See Guide to ASME QME-1 Standard, Section QV, “Determination of Valve Assembly Performance Characteristics,” for information on preparing the section of a Functional Qualification Report addressing functional capability demonstration of the qualified valve assembly and its production valve assemblies.

(b) Where prequalified components of the valve assembly (i.e., valve, actuator, solenoids, limit switches, etc.) are utilized as part of the valve assembly qualification, the Functional Qualification Report shall reference the report(s) upon which such prequalification is based. In addition, it must be shown that the mounting and integration of this prequalified component on the valve assembly does not degrade or otherwise interfere with the prequalification of the part.

(c) Each Functional Qualification Report shall be certified to be correct and complete and to be in compliance with this Standard by one or more registered professional engineers representing the organization responsible for the functional qualification.

**QV-8320 Application Report**

(a) An Application Report is required to demonstrate the suitability of any qualified valve assembly and its associated production valve assemblies to meet the requirements of a specific application. An Application Report is required for each serial-numbered valve assembly, except that valve assemblies whose constructions and service conditions are identical, differing only in serial numbers and tag numbers, may be combined into one Application Report.

(b) The Application Report shall reference the appropriate Functional Qualification Report and shall further show how each of the specific application requirements of the Qualification Specification are appropriately addressed by the Functional Qualification Report or other tests and analysis as outlined in this Section.

(c) Where prequalified parts of the valve assembly (i.e., valve, actuator, solenoids, limit switches, etc.) are utilized as part of the valve assembly qualification, the Application Report shall reference the report(s) upon which such prequalification is based. In addition, it must be shown that the mounting and integration of this prequalified part on the valve assembly does not degrade or otherwise interfere with the prequalification of the part.

(d) The Application Report shall contain the following, as applicable:

1. Serial number, tag number, or other unique identification of the valve assembly.
2. Complete description of the valve assembly construction configuration, including an assembly drawing. This description shall include a complete identification of the valve by type, size, pressure rating, and actuator type and size.
3. A summary of the functional parameters and how they are met by the valve assembly.
4. Reference to the Functional Qualification Report(s) upon which qualification is based.
5. All test results and analyses used to show that the valve assembly satisfies the requirements of the specific application.
6. Reference to the qualification reports for all prequalified components used per above.
7. Any specific limitations that restrict application shall be stated.
8. Additional information as may be necessary to support the demonstration of functional capability for the qualified valve assembly and its production valve assemblies. See Section QV-G for information on preparing the section of an Application Report addressing functional capability demonstration.

(e) Each Application Report shall be certified by one or more registered professional engineers to be correct and complete and to be in compliance with Section QV of this Standard.

"Section QV"