



General Electric Company  
175 Carter Avenue, San Jose, CA 95125

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Docket No. STN 52-001

Chet Poslusny, Senior Project Manager  
Standardization Project Directorate  
Associate Directorate for Advanced Reactors  
and License Renewal  
Office of the Nuclear Reactor Regulation

Subject: **Submittal Supporting Accelerated ABWR Review Schedule - Testing of Pumps and Valves**

Dear Chet:

Enclosed is a proposed SSAR markup of Subsection 3.9.6 (Testing of Pumps and Valves) and Subsection 3.9.7 (COL License Information).

Please provide a copy of this transmittal to Ted Sullivan.

Sincerely,

Jack Fox  
Advanced Reactor Programs

cc: Norman Fletcher (DOE)  
Bernie Genetti (GE)

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### 3.9.5.3.6 Stress, Deformation, and Fatigue Limits for Safety Class and Other Reactor Internals (Except Core Support Structures)

For safety class reactor internals, the stress deformation and fatigue criteria listed in Tables 3.9-4 through 3.9-7 are based on the criteria established in applicable codes and standards for similar equipment, by manufacturers standards, or by empirical methods based on field experience and testing. For the quantity  $SF_{min}$  (minimum safety factor) appearing in those tables, the following values are used:

Service Level	Service Condition	$SF_{min}$
A	Normal	2.25
B	Upset	2.25
C	Emergency	1.5
D	Faulted	1.125

Components inside the reactor pressure vessel such as control rods which must move during accident condition have been examined to determine if adequate clearances exist during emergency and faulted conditions. No mechanical clearance problems have been identified. The forcing functions applicable to the reactor internals are discussed in Subsection 3.9.2.5.

The design criteria, loading conditions, and analyses that provide the basis for the design of the safety class reactor internals other than the core support structures meet the guidelines of NG-3000 and are constructed so as not to adversely affect the integrity of the core support structures (NG-1122).

The design requirements for equipment classified as non-safety (other) class internals (e.g., steam dryers and shroud heads) are specified with appropriate consideration of the intended service of the equipment and expected plant and environmental conditions under which it will operate. Where Code design requirements are not applicable, accepted industry or engineering practices are used.

## 3.9.6 Testing of Pumps and Valves

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 6.6.

Details of the inservice testing program, including test schedules and frequencies will be reported in the inservice inspection and testing plan which will 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 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 in-service 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).

### 3.9.6.1 Testing of Safety-Related Pumps

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 design (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.

The COL holder will establish the following

design and qualification requirements and will provide acceptance criteria for these requirements. For each size, type, and model the COL holder will perform testing encompassing design conditions that demonstrate 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 the COL holder will also develop baseline (reference) hydraulic and vibration data for evaluating the acceptability of the pump after installation. The COL holder will ensure that the pump specified for each application is not susceptible to inadequate minimum flow rate and inadequate thrust bearing capacity with respect to minimum flow pump operation.

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 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. A program will be developed by the COL applicant to establish the frequency and the extent of disassembly and inspection based on suspected degradation of all safety-related pumps, including 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. (See Subsection 3.9.7.3(1) for COL license information requirements.)

### 3.9.6.2 Testing of Safety-Related Valves

#### 3.9.6.2.1 Check Valves

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*3.9.6.2.1* All ABWR safety-related piping systems incorporate provisions for testing to demonstrate the operability of the check valves under design conditions. Inservice testing will incorporate the use of advance non-intrusive techniques to periodically assess degradation and the performance characteristics of the check valves. The Part 10 tests will be performed, and check

valves that fail to exhibit the required performance can be disassembled for evaluation. The Code provides criteria limits for the test parameters identified in Table 3.9-8. A program will be developed by the COL applicant to establish the frequency and the extent of disassembly and inspection based on suspected degradation of all safety-related pumps, including 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. (See Subsection 3.9.7.3(1) for COL license information requirements.)

*check valves*

#### 3.9.6.2.2 Motor Operated Valves

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

##### *(1) Design and Qualification*

The COL holder will establish the following design and qualification requirements and will provide acceptance criteria for these requirements. By testing each size, type, and model the COL holder 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. The COL holder will also test each size type and model 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. *From this* testing the COL holder 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 COL holder will ensure that the structural capability limits of the individual parts of the MOV will not be exceeded under design conditions. Additional guidelines to justify prototype qualification testing are contained in Generic Letter 89-10, Supplement 1, Questions 22 and 24 through 28. The COL holder will ensure that the valve specified for each application is not susceptible to pressure locking and thermal

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binding.

The concerns and issues identified in Generic Letter 89-10 for MOVs will be addressed prior to plant startup. The following testing requirements and acceptance criteria are applicable to each motor operated valve assembly (MOV) with an active safety-related function.

*(2) Preoperational Testing*

The COL holder will test each MOV 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. The COL holder will test the MOV under various differential pressure and flow up to maximum achievable conditions and perform a sufficient number of tests to determine the torque and thrust requirements at design conditions. The COL holder will determine the torque and thrust requirements to close the valve for the position at which there is diagnostic indication of hard seat contact. 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, the COL holder will determine 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). The COL holder will compare the design torque and thrust requirements to the control switch trip torque and thrust subtracting margin for load sensitive behavior, control switch repeatability, and degradation. The COL holder will measure the total thrust and torque delivered by the MOV under static and dynamic conditions (including diagnostic equipment inaccuracy and control switch repeatability) to compare to the allowable structural capability limits for the individual parts of the MOV. The COL holder will test for proper control room position indication of the MOV.

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

- (a) As required by the safety function: the valve must fully open; the valve must fully close with diagnostic indication of hard seat contact.
- (b) 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.
- (c) 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.
- (d) The maximum torque and thrust (as applicable for the type of MOV) achieved by the MOV including diagnostic equipment inaccuracy and control switch repeatability must not exceed the allowable structural capability limits for the individual parts of the MOV.
- (e) The remote position indication testing must verify that proper disk position is indicated in the control room.
- (f) Stroke time measurements taken during valve opening and closing must meet minimum and maximum stroke time requirements.

The inservice testing of MOVs will rely on diagnostic techniques that are consistent with the state of the art and which will permit an assessment of the performance of the valve under actual loading. Periodic testing per GL89-10 Paragraphs D and J will be conducted under adequate differential pressure and flow conditions that allow a justifiable demonstration of continuing MOV capability for design basis conditions. The COL applicant will determine the optimal frequency of this periodic verification. The frequency and test conditions will be sufficient to demonstrate continuing design basis and required operating capability (See Subsection 3.9.7.3 (2) for COL license information requirements). The Code provides criteria limits for the test parameters identified in Table 3.9-8 for Code inservice testing.



A program will be developed by the COL applicant to establish the frequency and the extent of disassembly and inspection based on suspected degradation of all safety-related "MOV's", including 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. (See Subsection 3.9.7.3(1) for COL license information requirements.)

3.9.6.2.3 Power Operated Valves  
3.9.6.2.3 Isolation Valve Leak Tests

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3.9.6.2.3 and the following

The leak tight integrity will be verified for each valve relied upon to provide a leak tight 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;
- (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; and
- (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.

POV

POV

All ABWR safety-related piping systems incorporate provisions for testing to demonstrate the operability of the check valves under design conditions. In-service testing will incorporate the use of advance non-intrusive techniques to periodically assess degradation and the performance characteristics of the check valves. The Part 10 tests will be performed, and check valves that fail to exhibit the required performance can be disassembled for evaluation. The Code provides criteria limits for the test parameters identified in Table 3.9-8. A program will be developed by the COL applicant to establish the frequency and the extent of disassembly and inspection based on suspected degradation of all safety-related pumps including 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. (See Subsection 3.9.7.3(1) for COL license information requirements.)

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 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. These special valves are noted here and not in Table 3.9-8. The fusible plug valve is a nonreclosing pressure relief device and the Code requires replacement of each at a maximum of 5 year intervals.

### 3.9.7 COL License Information

#### 3.9.7.1 Reactor Internals Vibration Analysis, Measurement and Inspection Program

The first COL applicant will provide, at the time of application, the results of the vibration assessment program for the ABWR prototype internals. These results will include the following information specified in Regulatory Guide 1.20.

<u>R. G. 1.20</u>	<u>Subject</u>
C.2.1	Vibration Analysis Program
C.2.2	Vibration Measurement Program
C.2.3	Inspection Program
C.2.4	Documentation of Results

NRC review and approval of the above information on the first COL applicant's docket will complete the vibration assessment program requirements for prototype reactor internals.

In addition to the information tabulated above, the first COL applicant will provide the information on the schedules in accordance with the applicable portions of position C.3 of Regulatory Guide 1.20 for non-prototype internals.

Subsequent COL applicants need only provide the information on the schedules in accordance with the applicable portions of position C.3 of Regulatory Guide 1.20 for non-prototype internals. (See Subsection 3.9.2.4).

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

COL applicants will identify 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 can not be assured by required Code calculations and, if similar designs have not already been evaluated, either provide an appropriate analysis to demonstrate the required design life or provide design to mitigate the magnitude or duration of the cyclic loads. (See

Subsection 3.9.3.1.)

#### 3.9.7.3 Pump and Valve <sup>a</sup>Inservice Testing Program

COL applicants will provide a plan for the detailed pump and valve inservice testing and inspection program. This plan will

- (1) Include baseline pre-service testing to support the periodic in-service testing of the components required by technical specifications. Provisions are included to disassemble and inspect the pump, check valves, and MOVs within the Code and safety-related classification as necessary, depending on test results. (See Subsections 3.9.6, 3.9.6.1, 3.9.6.2.1, ~~and~~ 3.9.6.2.2)   
 *POV*   
 *and 3.9.6.2.3*
- (2) Provide a study to determine the optimal frequency for valve stroking during inservice testing. (See Subsection 3.9.6.2.2)   
 *3.9.6.2.2 and 3.9.6.2.3*
- (3) Address the concerns and issues identified in Generic Letter 89-10; specifically the method of assessment of the loads, the method of sizing the actuators, and the setting of the torque and limit switches. (See Subsection 3.9.6.2.2)

#### *INSERT 3.9.7.3*

#### 3.9.7.4 Audit of Design Specification and Design Reports

COL applicants will make available to the NRC staff design specification and design reports required by ASME Code for vessels, pumps, valves and piping systems for the purpose of audit. (See Subsection 3.9.3.1)

*OPEN*  
*3.9.6.3-2*

### 3.9.8 References

1. BWR Fuel Channel Mechanical Design and Deflection, NEDE-21354-P, September 1976.
2. BWR/6 Fuel Assembly Evaluation of Combined Safe Shutdown Earthquake (SSE) and Loss-of-Coolant Accident (LOCA) Loadings, NEDE-21175-P, November 1976.
3. NEDE-24057-P (Class III) and NEDE-24057 (Class I) Assessment of Reactor Internals. Vibration in BWR/4 and BWR/5 Plants,

November 1977. Also NEDO-24057-P, Amendment 1, December 1978, and NEDE-2-P 24057 Amendment 2, June 1979.

4. *General Electric Company, Analytical Model for Loss-of-Coolant Analysis in Accordance with 10CFR50, Appendix K, NEDE-20566P, Proprietary Document, November 1975.*
5. *BWR Feedwater Nozzle and Control Rod Drive Return Line Nozzle Cracking, NUREG-0619.*
6. *Deleted*  
*General Electric Environmental Qualification Program, NEDE-24326-1-P, Proprietary Document, January 1983.*
7. *Functional Capability Criteria for Essential Mark II Piping, NEDO-21985, September 1978, prepared by Battelle Columbus Laboratories for General Electric Company.*
8. *Generic Criteria for High Frequency Cutoff of BWR Equipment, NEDO-25250, Proprietary Document, January 1980.*

*Insert 3.9.7.3*

*The col applicant will include the 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 in the development of the respective safety related pump and valve design specifications.*

INSERT 3.9.6.2.1

Acceptable Method for Meeting the ITAAC for Check Valves(1) Design and Qualification Requirements

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.

The licensee will establish the following design and qualification requirements and will provide acceptance criteria for these requirements. By testing each size, type, and model the licensee will ensure the design adequacy of the check valve under design (design basis and required operating conditions). 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 waterhammer or pipe break, life-time 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. The licensee will ensure that valve INSERT 3.9.6.2.1A design features, material, and surface finish will accommodate non-intrusive diagnostic testing methods available in the industry or as specified. The licensee will also ensure that flow through the valve is determinable from installed instrumentation and that valve disk positions are determinable without disassembly such as by use of non-intrusive diagnostic methods. Valve internal parts are designed with self-aligning features for purposes of assured correct installation. The licensee will compare the maximum loading on the check valve under design basis and the required operating conditions to the allowable structural capability limits for the individual parts of the check valve. Prior to delivery, the manufacturer will test each valve to demonstrate the adequacy of the check valve to perform under design conditions. 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.

(2) Pre-operational Test Check Valves

The following testing requirements and acceptance criteria are applicable to each safety related check valve.

The licensee will test each check valve in the open and/or close direction, as required by the safety function, 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 shut down 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. The testing will include the effects of rapid pump starts and stops as



## INSERT 3.9.6.2.1

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 licensee will examine the disk movement during valve testing and verify the leak-tightness of valve when fully closed. By using methods such as non-intrusive diagnostic equipment, the licensee will examine the open valve disk stability 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.

- (1) <sup>a</sup> 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.
- (2) <sup>b</sup> Leak-tightness of valve when fully closed is within established limits, as applicable.
- (3) <sup>c</sup> Valve disk positions are determinable without disassembly.
- (4) <sup>d</sup> Valve testing must verify free disk movement whenever moving to and from the seat.
- (5) <sup>e</sup> The disk is stable in the open position under normal and other required system operating fluid flow conditions.
- (6) <sup>f</sup> The valve is correctly sized for the flow conditions specified, i.e., the disk is in the full open position at normal full flow operating condition.
- (7) <sup>g</sup> Valve design features, material, and surfaces accommodate non-intrusive diagnostic testing methods available in the industry or as specified.
- (8) <sup>h</sup> Piping system design features accommodate all the applicable check valve testing requirements as described in SSAR Table 3.9-8.

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This testing shall include each valve size when there is no prior basis for acceptance or where operating experience and/or diagnostic testing has indicated the need. In situations where the valve performance is known, understood, and predictable based on prior tests and operating history; qualification of an individual valve size may be achieved by tests of representative sizes in combination with analysis or dedication methods used to extend such tests.

INSERT 3.9.6.2.3

Chapter 3.9.6

(1) Design and Qualification Requirements for Power-Operated Valves

For each power-operated (includes pneumatic-, hydraulic-, piston-, and solenoid-operated) 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.

The licensee will establish the following design and qualification requirements and will provide acceptance criteria for these requirements.

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By testing each size, type, and model the licensee will determine the force (as applicable to the type of POV) requirements 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.

NO R

The licensee will also test each size, type, and model 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 air supply system (or accumulator) pressure, spring force, and minimum and maximum stroke time requirements. From this testing, the licensee will demonstrate that the results of testing under in-situ conditions can be used to ensure the capability of the POV to operate under design conditions. The licensee will ensure that the structural capability limits of the assembly and the individual parts of the POV will not be exceeded under design conditions. The licensee will ensure that packing adjustment limits are specified for the valve for each application such that it is not susceptible to stem binding.

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(2) Pre-Operational Testing of Power-Operated Valves

The following testing requirements and acceptance criteria are applicable to each power-operated valve assembly (POV) with an active safety-related function and referenced by Chapter 14:

The licensee will test each POV 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. The licensee will test the POV under various differential pressure and flow up to maximum achievable conditions and perform a sufficient number of tests to determine the force requirements at design conditions. The licensee will determine 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). 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

INSERT 3.9.6.2.3

requirements will be adjusted for diagnostic equipment inaccuracies.

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

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

- (a) 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.
- (b) The assembly must demonstrate adequate margin to achieve design requirements including consideration of diagnostic equipment inaccuracies and margin for degradation.
- (c) 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.
- (d) 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 parts of the POV.
- (e) 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.
- (f) Stroke-time measurements taken during valve opening and closing must meet minimum and maximum stroke-time requirements.
- (g) For SOVs, the Class 1E electrical requirements are to be verified. The SOV should be verified to be capable of performing for design requirements for energized or deenergized and rated appropriately for the electrical power supply amperage and voltage.
- (h) Provide leak-tight seating which must meet a specified maximum leakage rate, or meet a leakage rate to ensure an overall containment maximum leakage.