Inquiry: What alternative rules, to those of OM Code, Subsection ISTC, may be used for preservice and inservice testing to assess the operational readiness of active electric motor-operated valve assemblies in light water reactor power plants?

Reply: It is the opinion of the Committee that, in lieu of the rules for preservice and in-service testing to assess the operational readiness of active electric motor-operated valve assemblies in light water reactor power plants in the OM Code, subsection ISTC except for leakage rate testing, the following alternative requirements may be applied. Electric motor-operated valves for which seat leakage is limited to a specific maximum amount in the closed position for fulfillment of their required function (Category A) must also be seat leakage rate tested in accordance with the requirements of the OM Code.

Applicability: See Applicability Index

NOTE: The terms “shall consider” and “shall be considered” are used in paras. 3.6.2, 3.7.1, and 9.1 of this Code Case. The Code Case does not dictate how the considerations in the paragraphs are implemented or documented. Users of the Code Case will determine the best methods based on their programs, which may include procedures, checklists, training, or other methods.

1 INTRODUCTION

1.1 Scope

This Code Case establishes the requirements for preservice and inservice testing to assess the operational readiness of active motor-operated valves (MOVs) in light water reactor (LWR) power plants.

The MOVs covered are those required to perform an active function in shutting down a reactor to the safe shutdown condition, in maintaining the safe shutdown condition, or in mitigating the consequences of an accident.

This Code Case establishes test methods, test intervals, parameters to be measured and evaluated, acceptance criteria, corrective actions, and records requirements.

1.2 Exclusions

See para. ISTC-1200.

2 SUPPLEMENTAL DEFINITIONS

full cycle exercise: full stroke of the valve from and back to its initial position.

motor-operated valve (MOV): a valve and its associated electric motor driven mechanism for positioning the valve, including components that control valve action and provide position output signals.

MOV functional margin: the increment by which an MOV’s available capability exceeds the capability required to operate the MOV under design basis conditions.

stem factor: the ratio of stem torque to stem thrust in rising-stem valves.

3 GENERAL REQUIREMENTS

3.1 Design Basis Verification Test

A one-time test shall be conducted to verify the capability of each MOV to meet its safety-related design basis requirements. This test shall be conducted at conditions as close to design basis conditions as practicable. Requirements for a design basis verification test are specified in applicable regulatory documents. Testing that meets the requirements of this Code Case but conducted before implementation of this Code Case may be used.

(a) Design basis verification test data shall be used in conjunction with preservice test data as the basis for inservice test criteria.

(b) Design basis verification testing shall be conducted in situ or in a prototype test facility that duplicates applicable design basis conditions. If a test facility is used, an engineering analysis shall be documented that supports applicability to the in situ conditions.

(c) Justification for testing at conditions other than design basis conditions and for grouping like MOVs shall be documented by an engineering evaluation, alternate testing techniques, or both. Where design basis testing of the specific MOV being evaluated is impractical, or not meaningful (provides no additional useful data), data from other MOVs may be used if justified by engineering evaluation. Sources for the data include other plant MOVs or test data published in industry testing programs. Where analytical techniques are used...
to verify design basis capability, those techniques shall be justified by an engineering evaluation.

(d) For certain valve types (e.g., ball, plug, and diaphragm valves) where the need for design basis verification testing has not been previously identified, an engineering evaluation of operating experience may be used to verify design basis capability.

(e) The design basis verification test shall be repeated if an MOV application is changed, the MOV is physically modified, or the system is modified in a manner that invalidates its current design basis verification test results or data. A determination that a design basis verification test is still valid shall be justified by an engineering evaluation, alternative testing techniques, or both.

3.2 Preservice Test

Each MOV shall be tested during the preservice test period or before implementing inservice testing. These tests shall be conducted under conditions as near as practicable to those expected during subsequent inservice testing. Testing that meets the requirements of this Code Case but conducted before implementation of this Code Case may be used. Only one preservice test of each MOV is required unless, as described in para. 3.4, the MOV has undergone maintenance that could affect its performance.

3.3 Inservice Test

Inservice testing shall commence when the MOV is required to be operable to fulfill its required function(s), as described in para. 1.1, and shall be sufficient to assess changes in MOV functional margin consistent with section 6.

(a) MOVs may be grouped for inservice testing as described in para. 3.5.

(b) Inservice tests shall be conducted in the as-found condition. Activities shall not be conducted if they invalidate the inservice test results. If maintenance is needed between the inservice tests, see para. 3.4. As-found testing is not required prior to maintenance activities as long as the MOV is not due for an inservice test. If maintenance activities are scheduled concurrently with an MOV’s inservice test, then the inservice test shall be conducted in the as-found condition, prior to the maintenance activity.

(c) The inservice testing program will include a mix of static and dynamic MOV performance testing. The mix of MOV performance testing may be altered when justified by an engineering evaluation of test data.

(d) Dynamic MOV performance testing is not required for certain valve types (e.g., ball, plug, and diaphragm valves), with acceptable operating experience.

(e) Remote position indication shall be verified locally during inservice testing or maintenance activities.

3.3.1 Inservice Test Interval

(a) The inservice test interval shall be determined in accordance with para. 6.4.4.

(b) If insufficient data exist to determine the inservice test interval in accordance with para. 6.4.4, then MOV inservice testing shall be conducted every two refueling cycles or 3 yr (whichever is longer) until sufficient data exist, from an applicable MOV or MOV group, to justify a longer inservice test interval.

(c) The maximum inservice test interval shall not exceed 10 yr. MOV inservice tests conducted per para. 3.4 may be used to satisfy this requirement.

3.4 Effect of MOV Replacement, Repair, or Maintenance

When an MOV or its control system is replaced, repaired, or undergoes maintenance that could affect the valve’s performance, new inservice test values shall be determined, or the previously established inservice test values shall be confirmed before the MOV is returned to service. If the MOV was not removed from service, inservice test values shall be immediately determined or confirmed. This testing is intended to demonstrate that performance parameters, which could be affected by the replacement, repair, or maintenance, are within acceptable limits. The Owner’s program shall define the level of testing required after replacement, repair, or maintenance. Deviations between the previous and new inservice test values shall be identified and analyzed. Verification that the new values represent acceptable operation shall be documented as described in section 9, Records and Reports.

3.5 Grouping of MOVs for Inservice Testing

Grouping MOVs for inservice testing is permissible. Grouping MOVs shall be justified by an engineering evaluation, alternative testing techniques, or both. The following shall be satisfied when grouping MOVs:

(a) MOVs with identical or similar motor-operators and valves and with similar plant service conditions may be grouped together based on the results of design basis verification and preservice tests. Functionality of all groups of MOVs shall be validated by appropriate inservice testing of one or more representative valves.

(b) Test results shall be evaluated and justified for all MOVs in the group.

3.6 MOV Exercising Requirements

3.6.1 Normal Exercising Requirements. All MOVs, within the scope of this Code Case, shall be full cycle exercised at least once per refueling cycle with the maximum time between exercises to be not greater than 24 mo. Full cycle operation of an MOV, as a result of normal plant operations or Code requirements, may be considered an exercise of the MOV, if documented. If full stroke exercising of an MOV is not practical during
plant operation or cold shutdown, full stroke exercising shall be performed during the plant’s refueling outage.

3.6.2 Additional Exercising Requirements. The Owner shall consider more frequent exercising requirements for MOVs in any of the following categories:
   (a) MOVs with high risk significance
   (b) MOVs with adverse or harsh environmental conditions or
   (c) MOVs with any abnormal characteristics (operational, design, or maintenance conditions)

3.7 Risk-Informed MOV Inservice Testing

Risk-informed MOV inservice testing that incorporates risk insights in conjunction with performance margin to establish MOV grouping, acceptance criteria, exercising requirements, and testing interval may be implemented.

3.7.1 Risk-Informed Considerations. The Owner shall consider the following when incorporating risk insights in the inservice testing of MOVs:
   (a) Develop an acceptable risk basis for MOV risk determination.
   (b) Develop MOV screening criteria to determine each MOV’s contribution to risk.
   (c) Finalize risk category by a documented evaluation from a plant expert panel.

3.7.2 Risk-Informed Criteria. Each MOV shall be evaluated and categorized using a documented risk ranking methodology. This Code Case provides test requirements for high and low safety significant component (HSSC/LSSC) categories. If an Owner established more than two risk categories, then the Owner shall evaluate the intermediate SSCs and select HSSC or LSSC test requirements for those intermediate SSCs.

3.7.2.1 HSSC MOVs. HSSC MOVs shall be tested in accordance with para. 3.3 of this Code Case and exercised in accordance with para. 3.6 of this Code Case. HSSC MOVs that can be operated during plant operation shall be exercised quarterly, unless the potential increase in core damage frequency (CDF) and large early release (LER) associated with a longer exercise interval is small.

3.7.2.2 LSSC MOVs. In meeting the provisions of this Code Case, including exercising in accordance with para. 3.6 and the determination of proper MOV test interval in section 6, risk insights shall be applied to inservice testing of LSSC MOVs by the following:
   (a) LSSC grouping shall be technically justified, but the provision for similarity in subpara. 3.5(a) may be relaxed. The provisions in subpara. 3.5(b) related to evaluation of test results for MOVs in that group continue to be applicable to all MOVs within the scope of this Code Case.
   (b) LSSC MOVs may be associated with an established group of other MOVs. When a member of that group is tested, the test results shall be analyzed and evaluated in accordance with section 6, and applied to all LSSC MOVs associated with that group.
   (c) LSSC MOVs that are not associated with an established group shall be inservice tested in accordance with para. 3.3 using an initial test interval of three refueling cycles or 5 yr (whichever is longer) until sufficient data exist to determine a more appropriate test interval as described in para. 6.4.4.
   (d) LSSC MOVs shall be inservice tested at least every 10 yr in accordance with para. 3.3.1.

4 TO BE PROVIDED AT A LATER DATE

5 TEST METHODS

5.1 Test Prerequisites

All testing shall be conducted in accordance with plant-specific technical specifications, installation details, acceptance criteria, and maintenance, surveillance, operation, or other applicable procedures.

5.2 Test Conditions

Inservice test conditions shall be sufficient to determine the MOV’s functional margin per para. 6.4. Test conditions shall be recorded for each test per section 9.

5.3 Limits and Precautions

(a) MOV exposure to dust, moisture, or other adverse conditions shall be minimized when normally enclosed compartment covers are removed while performing tests.
   (b) Manufacturer or vendor limits and precautions associated with the MOV and with the test equipment shall be considered, including the structural thrust and torque limits of the MOV.
   (c) Plant-specific operational and design precautions and limits shall be followed. Items to be considered include, but are not limited to, water hammer and intersystem relationships.
   (d) The benefits of performing a particular test should be balanced against the potential increase in risk for damage caused to the MOV by the particular testing performed.

5.4 Test Documents

Approved plant documents shall be established for all tests specified in this Code Case and shall provide for
   (a) methodical, repeatable, and consistent performance testing
   (b) collection of data required to analyze and evaluate the MOV functional margin in accordance with section 6

5.5 Test Parameters

Sufficient test parameters shall be selected for measurement to meet the requirements of section 6 in determining the MOV functional margin.
6 ANALYSIS AND EVALUATION OF DATA

6.1 Acceptance Criteria

The Owner shall establish methods to determine acceptance criteria for the operational readiness of each MOV within the scope of this Code Case. Acceptance criteria shall be based upon the minimum amount by which available actuator output capability must exceed the valve operating requirements. Thrust, torque, or other measured engineering parameters correlated to thrust or torque consistent with paras. 6.1 through 6.5 may be used to establish the acceptance criteria. Motor control center testing is acceptable if correlation with testing at the MOV has been established. When determining the acceptance criteria, consider the following sources of uncertainty:

(a) test measurement and equipment accuracy
(b) valve and actuator repeatability (e.g., torque switch repeatability)
(c) analysis, evaluation, and extrapolation method
(d) grouping method

6.1.1 MOV margins may be expressed in terms of stem force or other parameters, if those parameters are consistent with paras. 6.1 through 6.5.

6.2 Analysis of Data

Data obtained from a test required by this Code Case shall be analyzed to determine if the MOV performance is acceptable. The Owner shall determine which methods are suitable for analyzing necessary parameters for each MOV and application. Whenever data are analyzed, all relevant operating and test conditions shall be considered. The Owner shall compare performance test data to the acceptance criteria. If the functional margin, determined per para. 6.4.3, does not meet the acceptance criteria, the MOV shall be declared inoperable, in accordance with the Owner’s requirements.

Data analysis shall include a qualitative review to identify anomalous behavior. If indications of anomalous behavior are identified, the cause of the behavior shall be analyzed and corrective actions completed, if required.

6.3 Evaluation of Data

The Owner shall determine which methods are suitable for evaluating test data for each MOV and application. The Owner shall have procedural guidelines to establish the methods and timing for evaluating MOV test data. Evaluations shall determine the amount of degradation in functional margin that occurred over time. Evaluations shall consider the influence of past maintenance and test activities to establish appropriate time intervals for future test activities.

The evaluations shall apply changes in functional margin to other applicable MOVs to establish appropriate time intervals for future test activities.

6.4 Determination of MOV Functional Margin

The Owner shall demonstrate that adequate margin exists between valve operating requirements and the available actuator output capability to satisfy the acceptance criteria for MOV operational readiness. In addition to meeting the acceptance criteria, adequate margin shall exist to ensure that changes in MOV operating characteristics over time do not result in reaching a point at which the acceptance criteria are not satisfied before the next scheduled test activity.

6.4.1 Determination of Valve Operating Requirements. Design basis valve operating requirements, including stem factor for rising stem valves, must be determined from one of the following:

(a) measurements taken during testing at design basis conditions
(b) analytical methods using valve parameters determined from testing at conditions that may be extrapolated to design basis conditions or
(c) application of justified industry methodologies

6.4.2 Determination of Actuator Output Capability

6.4.2.1 Available Output Based on Motor Capabilities. Available actuator output shall be determined based on motor capabilities at the motor’s design basis conditions. Considerations shall include:

(a) rated motor start torque
(b) minimum voltage conditions
(c) elevated ambient temperature conditions
(d) operator efficiency
(e) other appropriate factors

6.4.2.2 Available Output Based on Torque Switch Setting. Where applicable, the available output shall be determined based on the current torque switch setting. For MOVs where in-service testing does not sufficiently load the MOV to cause torque switch trip (e.g., butterfly and ball valves), available output based on the current torque switch setting shall be determined analytically from test data. Considerations shall include:

(a) calibration of the torque switch spring pack
(b) the current torque switch setting
(c) repeatability of torque switch operation

6.4.3 Calculation of MOV Functional Margin. MOV functional margin shall be calculated as the difference between the available actuator output and valve operating requirements. Available actuator output is determined as either of the following:

(a) design basis motor operator capability for limit switch controlled strokes, or
(b) the lesser of design basis motor operator capability or motor operator capability at the current torque switch setting for torque switch controlled strokes
6.4.4 Determination of MOV Test Interval. Calculations for determining MOV functional margin shall account for potential performance-related degradation. Maintenance activities and associated intervals can affect test intervals and shall be considered. The in-service test interval shall be set such that the MOV functional margin does not decrease below the acceptance criteria.

6.5 Corrective Action

If the MOV performance is unacceptable, as established in para. 6.4, corrective action shall be taken in accordance with Owner’s corrective action requirements.

6.5.1 Record of Corrective Action. The Owner shall maintain records of corrective action that shall include a summary of the corrections made, the subsequent in-service tests, confirmation of operational adequacy, and the signature of the individual responsible for corrective action and verification of results.

7 TO BE PROVIDED AT A LATER DATE
8 TO BE PROVIDED AT A LATER DATE
9 RECORDS AND REPORTS

9.1 Test Information

Pertinent test information shall be recorded or verified for MOV testing, described in section 3. The following information shall be considered:

(a) MOV plant-specific unique identification number.
(b) Motor, valve, actuator nameplate data.
(c) Test equipment unique identification numbers and equipment calibration dates.
(d) Test method and conditions, described in section 5, including description of valve lineups, process equipment, and type of test. Descriptions shall include valve body, valve stem, electric motor-operator orientation, and piping configuration near the MOV.

(c) Breaker setting/fuse size and motor starter thermal overload size, if used.
(f) MOV torque and limit switch configuration and settings.
(g) MOV performance test procedure and other approved plant documents containing acceptance criteria.
(h) Name of test performer and date of test.
(i) System flow, system pressure, differential pressure, system fluid temperature, system fluid phase, and ambient temperature.
(j) Significant observations: any comments pertinent to the test results that otherwise may not be readily identified by other recorded test data shall be recorded. Observations shall include any remarks regarding abnormal or erratic MOV action noted during or preceding performance testing and any other pertinent design information that can be verified at the MOV.

9.2 Documentation of Analysis and Evaluation of Data

The documentation of acceptable MOV performance, which has been analyzed and evaluated in accordance with section 6, shall include, as a minimum

(a) Values of test data, test parameters, and test information established by paras. 5.5 and 9.1.
(b) Summary of analysis and evaluation required per paras. 6.2 and 6.3.
(c) Statement(s), by an individual qualified to make such a statement through the Owner’s qualification requirements, confirming that the MOV is capable of performing its intended safety function.
(d) Test results and analysis shall be evaluated by qualified individuals and documented to include signature and date. Independent verification shall be by individuals qualified to verify those specific analyses and evaluations through the Owner’s qualification requirements.