ASME OM-2–2024

Component Testing Requirements at Nuclear Facilities

AN AMERICAN NATIONAL STANDARD

The American Society of Mechanical Engineers

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The American Society of Mechanical Engineers

150 Clove Road • Little Falls, NJ • 07424 USA

Date of Issuance: October 30, 2024

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The American Society of Mechanical Engineers
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FOREWORD

Inservice testing (IST) is used at nuclear facilities to examine, test, and monitor pumps, valves, and dynamic restraint devices. ASME OM-2, Component Testing Requirements at Nuclear Facilities, is a component code intended to be used for IST at nuclear facilities of various designs. ASME OM, Operation and Maintenance of Nuclear Power Plants, provides requirements for the performance of IST at water-cooled nuclear power plants. The purpose of IST is to test, examine, and monitor pumps, valves, and dynamic restraint devices to ensure the operational readiness of the component to perform its specified functions. Both ASME OM and ASME OM-2 accomplish this by trending degradation so that such degradation can be detected and remedied prior to the component being incapable of performing its specified functions. ASME prepared ASME OM specifically for light water reactors (LWRs). Additionally, ASME made several accommodations in ASME OM in the testing of components because many components cannot be fully tested with the nuclear power plant online. A reason for this is that ASME prepared ASME OM after many of those plants were built and operating.

With the expansion and evolution of the nuclear industry to facilities that are significantly different than the currently operating LWRs, ASME recognized that another code, ASME OM-2, for IST of components in new and advanced reactors was needed. ASME designed ASME OM-2 with the basic prerequisite that components that are to be part of the IST program for these new facilities are appropriate for the functions that they are to provide, that they are correctly sized and specified for the parameters of the system in which they are to be installed and operating, and that the materials of their construction are compatible with the system fluid conditions, pressures, temperature, and chemistry.

As a prerequisite, components that are to be in the IST program shall have been qualified by ASME QME-1, prior to their installation, or by a qualification method justified by the Owner to the applicable regulatory authority. At the time of preparing ASME OM-2, ASME prepared a reformatted edition of ASME QME-1 to allow its more effective application for nuclear facilities with various designs. As part of that qualification, the Owner is to provide the parameters of the component that need to be periodically monitored to ensure the operational readiness of the component to perform its specified functions. In addition to the periodic and condition-monitoring frequencies specified in this Code, manufacturer-specified inservice activities and associated frequencies shall be met, or alternatives justified by the Owner, and, if required by the applicable regulatory authority, submitted for the regulator's review and acceptance.

With the large number of different types of reactor systems being planned, and those that will be developed in the future, ASME OM-2 does not identify the specific components and specified functions that are to be tested in accordance with this Code. The selection of those specific components and specified functions is required to be completed by agreement between the system and facility designers, the component manufacturer, and the applicable regulatory authority. Once identified, those components must comply with ASME OM-2 unless an alternative is justified by the Owner and, if required by the applicable regulatory authority, submitted for the regulator's review and acceptance.

This Code does not include specific requirements for the application of risk insights. An applicant may use risk insights that takes into consideration the reactor design and planned operation in proposing its IST Program Plan for review and acceptance as required by the applicable regulatory authority.

The ASME Committee on Operation and Maintenance (OM Committee) of Nuclear Power Plants is tasked to ensure that standardized component test requirements contain the general and specific requirements necessary for those components that are selected to be tested. ASME OM-2 is one of these OM Committee codes available for inservice testing of components in nuclear facilities. While ASME prepared ASME OM-2 with nuclear facilities as the focus, non-nuclear facilities may use ASME OM-2 for IST of components in their facilities.

This publication, the 2024 edition of Operation and Maintenance of Nuclear Power Plants, was approved by the ASME Board on Nuclear Codes and Standards. ASME OM-2–2024 was approved by the American National Standards Institute on October 11, 2024.

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Revisions and Errata. The committee processes revisions to this Code on a continuous basis to incorporate changes that appear necessary or desirable as demonstrated by the experience gained from the application of the Code. Approved revisions will be published in the next edition of the Code.

In addition, the committee may post errata on the committee web page. Errata become effective on the date posted. Users can register on the committee web page to receive email notifications of posted errata.

This Code is always open for comment, and the committee welcomes proposals for revisions. Such proposals should be as specific as possible, citing the paragraph number, the proposed wording, and a detailed description of the reasons for the proposal, including any pertinent background information and supporting documentation.

Cases

(a) The most common applications for cases are

(1) to permit early implementation of a revision based on an urgent need

(2) to provide alternative requirements

(3) to allow users to gain experience with alternative or potential additional requirements prior to incorporation directly into the Code

(4) to permit the use of a new material or process

(b) Users are cautioned that not all jurisdictions or owners automatically accept cases. Cases are not to be considered as approving, recommending, certifying, or endorsing any proprietary or specific design, or as limiting in any way the freedom of manufacturers, constructors, or owners to choose any method of design or any form of construction that conforms to the Code.

(c) A proposed case shall be written as a question and reply in the same format as existing cases. The proposal shall also include the following information:

(1) a statement of need and background information

(2) the urgency of the case (e.g., the case concerns a project that is underway or imminent)

(3) the Code and the paragraph, figure, or table number

(4) the editions of the Code to which the proposed case applies

(d) A case is effective for use when the public review process has been completed and it is approved by the cognizant supervisory board. Approved cases are posted on the committee web page.

Interpretations. Upon request, the committee will issue an interpretation of any requirement of this Code. An interpretation can be issued only in response to a request submitted through the online Inquiry Submittal Form at https://go.asme.org/InterpretationRequest. Upon submitting the form, the inquirer will receive an automatic email confirming receipt.

ASME does not act as a consultant for specific engineering problems or for the general application or understanding of the Code requirements. If, based on the information submitted, it is the opinion of the committee that the inquirer should seek assistance, the request will be returned with the recommendation that such assistance be obtained. Inquirers can track the status of their requests at https://go.asme.org/Interpretations.

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Interpretations are published in the ASME Interpretations Database at https://go.asme.org/Interpretations as they are issued.

Committee Meetings. The OM Standards Committee regularly holds meetings that are open to the public. Persons wishing to attend any meeting should contact the secretary of the committee. Information on future committee meetings can be found on the committee web page at https://go.asme.org/OMcommittee.

PREFACE

GENERAL

In 2022, the ASME OM Committee directed that two separately published ASME codes be considered. ASME OM-2, Component Testing Requirements at Nuclear Facilities, is the second published ASME OM Committee code. The first ASME OM Committee code is ASME OM, Operation and Maintenance of Nuclear Plants.

ASME prepared ASME OM-2 to specify provisions for IST programs that will be appropriate for all types of nuclear facilities. Components within the scope of ASME OM-2 include those that perform one of the following functions:

(a) generate, allow, throttle, or isolate fluid flow

(b) provide pressure relief

(c) establish dynamic restraint to ensure the structural integrity of piping systems and their components

To simplify ASME OM-2 language, the components that perform these functions are referred to as pumps, valves, and dynamic restraint devices in ASME OM-2. However, the components performing these functions in certain new or advanced nuclear facilities might have significantly different designs than components performing those functions in current water-cooled reactors. The IST provisions in ASME OM-2 may be specified for application to components that perform the functions within the scope of ASME OM-2 for all types of nuclear facilities, regardless of the design of the components.

ORGANIZATION

ASME OM-2 has a General Requirements section followed by sections that address program and testing requirements for dynamic restraint devices, pumps, and valves. The last two sections are a glossary and a list of references, respectively.

Section GR, General Requirements
Section DRD, Dynamic Restraint Devices
Section CP, Centrifugal Pumps
Section PDP, Positive Displacement Pumps
Section AOV, Air-Operated Valves
Section CV, Check Valves
Section HOV, Hydraulically Operated Valves
Section MOV, Motor-Operated Valves
Section MV, Manual Valves
Section PAV, Pyrotechnic-Actuated Valves
Section PRD, Pressure Relief Devices
Section SOV, Solenoid-Operated Valves
Section VLT, Requirements for Valve Leak Testing
Section GL, Glossary
Section REF, References

BASIS FOR INITIAL CODE SECTIONS

Section GR

In this Code, Section GR describes general requirements related to the purpose, scope, Owner responsibilities, component qualification, IST Program approval, IST equipment, IST Program Plan contents, IST examination and test frequency grace periods, corrective action, and records to assess the operational readiness of components in the IST Program to perform their specified functions at nuclear facilities. In contrast to ASME OM, Section GR indicates that the user of this Code will develop a proposed IST Program, including its scope, for review and acceptance as required by the regulatory authority as part of the licensing process for the nuclear facility. To implement this Code, the user is required to provide for the qualification of components in the IST Program to perform their specified functions in accordance with ASME QME-1 as accepted by the applicable regulatory authority or by another method justified by the applicant as part of the licensing process for the nuclear facility based on review and acceptance by the applicable regulatory authority. Section GR indicates that the periodic and condition-monitoring frequencies specified in this Code may be adjusted based on recommendations for periodic IST that are included within the ASME QME-1 Qualification Report that was prepared by the manufacturer. Section GR allows alternatives to this Code to be applied, provided the alternatives established by the Owner are submitted for review and acceptance as required by the applicable regulatory authority.

Section DRD

Section DRD specifies that dynamic restraint devices (DRDs) within the scope of this Code shall meet the requirements specified in Section GR and this section. Section DRD includes provisions for examination and testing of dynamic restraints that are based on provisions provided in Section ISTD of ASME OM. Changes were made to facilitate use in advanced reactor facilities and include the scope of Section DRD, which differs from Section ISTD in regard to types of restraints that are to be tested in accordance with ASME OM-2.

Sections CP and PDP

Section CP specifies that centrifugal pumps (CPs) within the scope of this Code shall meet the requirements of Section GR and this section. Section PDP specifies that positive displacement pumps (PDPs) within the scope of this Code shall meet the requirements of Section GR and this section. Sections CP and PDP include provisions for pump testing from Sections ISTB and ISTF of ASME OM with improvements based on lessons learned from the implementation of the ASME OM Code Case on pump condition-monitoring program that is applicable to current nuclear power plants. For example, these sections include provisions for condition monitoring of pumps or equivalent components to be used in advanced reactor facilities.

Sections AOV, CV, HOV, MOV, MV, PAV, PRD, and SOV

Sections AOV, CV, HOV, MOV, MV, PAV, PRD, and SOV specify that valves within the scope of this Code shall meet the requirements of Section GR and the applicable section of this Code. These sections include provisions for valve testing from Section ISTC of ASME OM with improvements based on lessons learned from the implementation of ASME OM at current nuclear power plants. Section PRD includes provisions for testing pressure relief devices (PRDs) based on ASME OM, Mandatory Appendix I. Section CV includes provisions for condition monitoring of check valves (CVs) allowed by ASME OM, Mandatory Appendix II. Section MOV includes provisions for diagnostic testing of motor-operated valves (MOVs) from ASME OM, Mandatory Appendix III. Section AOV includes provisions for diagnostic testing of air-operated valves (AOVs) from ASME OM, Mandatory Appendix IV. Sections HOV and SOV include provisions for diagnostic testing of hydraulic-operated valves (HOVs) and solenoid-operated valves (SOVs), respectively, based on lessons learned from ASME OM, Mandatory Appendix IV. Section MV includes provisions for testing of manual valves (MVs) in light of the reliance of manual operation of valves in some instances to perform specified functions in nuclear facilities. Section PAV specifies provisions for testing pyrotechnic-actuated valves (PAVs) based on provisions in ASME OM for nuclear facilities that use this valve type for specific functions, such as gravity-driven reactor cooling systems.

Section VLT

Section VLT specifies that leak testing of valves within the scope of this Code shall meet the requirements of Section GR and this section. Section VLT includes provisions from ASME OM for leak testing of valves in the IST Program with improvements based on lessons learned from the implementation of ASME OM at current nuclear power plants.

Section GL

Section GL provides a glossary to ensure a uniform understanding of selected terms used in this Code. Section GL notes that definitions of related pressure relief device terms can be found in ASME PTC 25.

Section REF

Section REF provides a list of publications referenced in this Code.

PROGRAM AND TESTING REQUIREMENTS

Each section contains general program requirements common to all components and specific program and testing requirements to be applied to components as required by Owners and as accepted by the applicable regulatory authority.

Sections are generally component specific, but the section on valve leak testing is to be applied to any of the valve types for which leakage is to be limited or monitored as specified by the Owner and required by the applicable regulatory authority.

CROSS-REFERENCING IN ASME OM-2

ASME OM-2 uses the following structural and stylistic conventions to aid users in navigating the contents:

Hierarchy of Subparagraph Breakdowns

- First-level breakdowns are designated as (a), (b), (c), etc.
- Second-level breakdowns are designated as (1), (2), (3), etc.
- Third-level breakdowns are designated as (-a), (-b), (-c), etc.
- Fourth-level breakdowns are designated as (-1), (-2), (-3), etc.

Cross-References

The cross-references within a paragraph do not include the alphanumeric designator of that paragraph. The cross-references to a subparagraph breakdown follow the hierarchy of the designators under which the breakdown appears. The following examples illustrate the format:

- If DRD-1(a) is referenced in DRD-1(b), it is referenced as (a).
- If DRD-2.2.1(a)(1) is referenced in DRD-2.2.1(a)(2), it is referenced as (1).
- If DRD-2.2.1(a)(1) is referenced in DRD-2.2.1(b), it is referenced as (a)(1).
- If DRD-2.2.1(a)(1) is referenced in DRD-2.2.2, it is referenced as DRD-2.2.1(a)(1).

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Section GR
General Requirements

GR-1 INTRODUCTION

GR-1.1 Purpose

This Code provides requirements for inservice testing (IST) program activities to assess the operational readiness of certain components to perform specified functions at nuclear facilities. IST Program activities include baseline testing, which might also be referred to as preservice testing, periodic and condition-based IST, examination, and monitoring, and are designed to assess the operational readiness of the components to perform specified functions.

GR-1.2 Scope

(a) The components and component functions within the scope of this Code is specified as part of the plant licensing process.

(b) The requirements of this Code shall be met for the pumps, valves, and dynamic restraint devices specified as within the scope of this Code.

(c) An applicant or licensee may apply risk insights in developing and implementing its IST Program. This Code does not include specific requirements for the application of risk insights. An applicant may use risk insights that takes into consideration the reactor design and planned operation in proposing its IST Program Plan for review and acceptance, as required by the applicable regulatory authority.

(d) This Code also applies to components with other names that perform similar functions identified by the applicant.

(e) The components within the scope of this Code whose operational readiness will be assessed by demonstrating that they are capable of performing specified functions, which includes the following:

(1) generate, allow, throttle, or isolate fluid flow

(2) provide pressure relief capability

(3) provide dynamic restraint within established acceptance limits

(f) This Code applies to the components' specified functions, including any associated leakage criteria, as determined by (a).

(g) Selection of components to be specified as within the scope of this Code shall include review of IST activities and recommendations from the system and facility designers and component manufacturers.

(h) This Code uses information obtained relative to electrical equipment solely to evaluate the condition of components within the scope of this Code. It is not a requirement of this Code to provide an evaluation of electrical equipment.

GR-1.3 Definitions

See Section GL for a glossary of terms necessary to understand the intent of the Code and that are specific to the Code.

GR-2 OWNER REQUIREMENTS

GR-2.1 General

It is the Owner's responsibility to

(a) have documentation available for review by the applicable regulatory authority that

(1) demonstrates components within the scope of this Code are capable of performing their specified functions under design-basis conditions in accordance with GR-2.2

(2) supports the implementation of this Code to identify degradation when assessing the operational readiness of the applicable components to perform their specified functions

(b) include in the facility design any necessary flow control devices, instrumentation, test loops, required fluid inventory, or other testing provisions to comply with the requirements of this Code

(c) make available design and operating information necessary for the performance of IST Programs

(d) prepare plans, instructions, and procedures for IST activities

(e) qualify personnel who perform and evaluate IST activities

(f) provide access for personnel and equipment necessary to perform IST activities

(g) establish the means to measure the parameters identified for evaluation of the operational readiness of each component to perform its specified function

(h) retain IST Program records for the service lifetime of the component

(i) provide documentation of a Quality Assurance Program that is acceptable to the applicable regulatory authority

(j) list the Owner's specified acceptance criteria for IST activities in the facility records

(k) ensure that the application, method, and capability of each nonintrusive technique is qualified

GR-2.2 Qualification

GR-2.2.1 Prior to installation, components within the scope of this Code shall be qualified to perform their specified functions in accordance with ASME QME-1 as accepted by the applicable regulatory authority or by another method justified by the applicant as part of the licensing process for the nuclear facility.

GR-2.2.2 If an installed component undergoes modification, repair, or maintenance or experiences a condition beyond the qualification of the component, the component shall be requalified to perform its specified functions in accordance with ASME QME-1. If the modification, repair, maintenance, or experience is within the qualification, then prior to installation or return to service, the component shall demonstrate operational readiness.

GR-2.2.3 The qualified life, as defined in ASME QME-1, of a particular equipment item may be changed during its installed life when justified in accordance with ASME QME-1.

GR-2.3 IST Program Plans

GR-2.3.1 IST Program Plan Approval. The Owner shall

(a) submit the IST Program Plan for the initial IST Program interval for review and acceptance as required by the applicable regulatory authority as part of the plant licensing process

(b) propose a periodic update interval for the IST Program Plan for implementing revised editions of this Code to the applicable regulatory authority during the licensing process for the nuclear facility

(c) identify planned alternatives to any provisions of this Code in the initial plan for review and acceptance as required by the applicable regulatory authority

GR-2.3.2 IST Program Plan Contents. Each IST Program Plan for IST activities, including baseline activities, shall include the following:

(a) the edition of this Code that applies to the IST activities

(b) identification of the components and specified functions within the scope of this Code

(c) qualification description for each component within the scope of this Code

(d) IST activities for each component and the interval for each IST activity

(e) Code Cases proposed for use and the extent of their application

(f) alternative methodologies to be used for IST activities when the design or type of component does not fit into one of the types of components delineated in the specific sections of this Code

(g) the applicable revision of the plan

(h) the name and address of the Owner

(i) the name and address of the facility

(j) the name and number designation of the facility

(k) the commercial service date of the facility

(l) grace periods for testing and examination intervals

GR-2.4 IST Equipment

GR-2.4.1 Range and Accuracy. Equipment used in performing IST activities shall have the range and accuracy necessary to demonstrate conformance to the IST requirements in this Code.

GR-2.4.2 Calibration. Equipment used in performing IST activities shall have accuracy verified or be calibrated in accordance with the Owner's Quality Assurance Program.

GR-2.5 IST Program Requirements

(a) Following initial qualification of each component and its installation in the nuclear facility

(1) Postinstallation testing shall be performed as required.

(2) IST baseline testing shall be completed for each component within the period specified in the applicable sections.

(3) An inservice test shall be current within the established frequency prior to a component being relied on to perform its specified function.

(b) The periodic and condition-monitoring frequencies specified in this Code may be adjusted based on the provisions of this Code and recommendations for periodic IST that are included within the ASME QME-1 Qualification Report that was prepared by the manufacturer.

(c) The Sections in this Code applicable to specific components impose additional IST Program requirements for those components.

GR-2.6 Inservice Examination and Test Frequency Grace

This Code specifies component test frequencies.

(a) Components whose test frequencies are based on elapsed time periods such as quarterly (or every 3 months) shall be tested with a specified time period between tests as shown in Table GR-2.6-1. The specified time period between tests may be reduced or extended as follows:

(1) For periods specified as less than 2 yr, the period may be extended by up to 25% for any given test.

Table GR-2.6-1
Test Frequency and Time Between Tests

Frequency	Specified Time Between Tests
Quarterly (or every 3 months)	92 days
Semiannually (or every 6 months)	184 days
Annually (or every year)	366 days
x years	*x* calendar years where *x* is a whole number of years ≥ 2

(2) For periods specified as greater than or equal to 2 yr, the period may be extended by up to 6 months for any given test.

(3) All periods specified may be reduced at the discretion of the Owner (i.e., there is no minimum period requirement).

(4) Frequencies can be modified or changed based on condition or performance monitoring that could include manufacturer recommendations that are provided by the ASME QME-1 Qualification Report, where the condition or performance-monitoring method to be used has been accepted by the applicable regulatory authority.

(b) Period extension is to facilitate test scheduling and considers plant operating conditions that might not be suitable for performance of the required testing (e.g., performance of the test would cause an unacceptable increase in the plant risk profile due to transient conditions or other ongoing surveillance, test, or maintenance activities). Period extensions are not intended to be used repeatedly merely as an operational convenience to extend test intervals beyond those specified.

(c) Period extensions may also be applied to accelerated test frequencies (e.g., pumps in alert range) and other test frequencies less than 2 yr not specified in Table GR-2.6-1.

(d) Components whose test frequencies are based on the occurrence of plant conditions or events may not have the period between tests extended except as allowed by this Code.

GR-3 CORRECTIVE ACTIONS

Corrective actions shall be performed in accordance with the Owner's Quality Assurance Program. Component-specific corrective action requirements are specified in individual sections of this Code.

GR-4 RECORDS

GR-4.1 Qualification Records

The Owner shall maintain records confirming qualification of all components within the scope of this Code and any requalification determined to be necessary.

GR-4.2 IST Program Plan Records

The Owner shall maintain records of the initial IST Program Plan and each revision of the IST Program Plan to demonstrate compliance with this Code.

GR-4.3 IST Activity Records

The Owner shall maintain records of IST activities, including the following as a minimum:

(a) component identification

(b) date of IST activities

(c) description of each IST activity (e.g., postmaintenance, baseline or periodic IST testing, establishing reference values, etc.)

(d) baseline or IST procedure used

(e) identification of equipment used

(f) calibration records or traceability to calibration records

(g) values of measured parameters

(h) comparison with acceptance criteria for the baseline or IST values, and analysis of deviations

(i) documentation of the persons responsible for conducting and independently analyzing the baseline or IST activity per the Owner's Quality Assurance Program

GR-4.4 Corrective Action Records

The Owner shall maintain records of corrective actions in accordance with the Owner's Quality Assurance Program.

GR-4.5 Record Maintenance

The Owner shall file records, maintain records in a retrievable format, and provide adequate protection from deterioration and damage for all records related to the implementation of this Code in accordance with the Owner's Quality Assurance Program.

Section DRD
Dynamic Restraint Devices

DRD-1 INTRODUCTION

Dynamic restraint devices within the scope of this Code shall meet the requirements specified in Section GR and this Section.

(a) Dynamic restraint devices such as mechanical and hydraulic snubbers are within the scope of this Code and shall meet all requirements for inservice examination, testing, and service life monitoring as specified herein.

(b) Dynamic restraint devices such as wire energy-absorbing rope, gap restraints, energy absorber restraints, and viscoelastic dampers are not within the scope of this Code and shall only be required to meet the applicable requirements of the Code selected for inservice inspection of components by the Owner.

DRD-2 DYNAMIC RESTRAINT DEVICE REQUIREMENTS

DRD-2.1 General Requirements

(a) Modification, repair, or replacement activities performed on dynamic restraint devices shall be performed in accordance with the requirements of the Code selected for inservice inspection of components by the Owner.

(b) Dynamic restraint devices shall not be adjusted, maintained, or repaired before an examination or test specifically to meet the examination or test requirements.

(c) Dynamic restraint devices that are maintained or repaired by removing or adjusting a device part that can affect the results of operational readiness tests shall be retested in accordance with this Section before returning the device to service. Additionally, the visual examination requirements of this Section shall also be met prior to returning the device to service.

(d) If an unanticipated transient dynamic event that might affect dynamic restraint device operational readiness occurs and is identified outside the scope and performance of scheduled visual examination or operational readiness testing, then the affected device and systems shall be reviewed and any appropriate corrective action taken. Any action so taken shall be evaluated independent of the requirements of the visual examination and operational readiness testing requirements of this Section.

(e) When a dynamic restraint device is determined to be unacceptable, it is the responsibility of the Owner to identify the extent to which any systems, structures, or components (SSCs) might be affected by the unacceptable condition. An evaluation shall be performed to determine potential effects and any required corrective actions.

(f) Dynamic restraint device operational readiness testing shall meet DRD-2.1.2, DRD-2.3, and DRD-2.4.

DRD-2.1.1 General Examination Requirements

(a) Examination Boundary. The examination boundaries shall include the dynamic restraint device assembly from the connection point of the building or support structure to the connecting point of the pipe or equipment, pin-to-pin inclusive (if so equipped).

(b) Visual Examination. Dynamic restraint devices shall be visually examined as specified in DRD-2.2.

(c) Visual Examination Acceptance Criteria. The Owner shall establish and document visual examination acceptance criteria for each applicable baseline examination and IST parameter specified in this Section. Devices not meeting the established criteria shall be deemed unacceptable, unless evaluated otherwise in accordance with the Owner's Quality Assurance Program.

DRD-2.1.2 General Testing Requirements

(a) Operational Readiness Testing Loads. Dynamic restraint devices shall be tested at a load sufficient to verify the test parameters specified in this Section. Testing at less-than-rated load must be correlated to test parameters at the rated load, as applicable.

(b) Test Parameters and Methods. Guidelines for establishing operational readiness test methods may be applied from other sources, where justified.

(c) Operational Readiness Test Acceptance Criteria. The Owner shall establish and document test acceptance criteria for each applicable baseline test and IST parameter specified in this Section, including those items discussed in (a) and (b). Devices not meeting the established criteria shall be deemed unacceptable.

DRD-2.1.3 General Service Life-Monitoring Requirements

(a) Service Life Monitoring. Service life monitoring of the dynamic restraint population shall be based on knowledge of the operating environment, snubber design limits, and service records.

(b) Service Life-Monitoring Reevaluation. Service life monitoring of the dynamic restraint population shall be reevaluated at least every service cycle.

(c) Separate Service Life-Monitoring Populations. Depending on the significance of the environmental extremes from one area in the plant to another, separate and distinct service life-monitoring populations shall be established.

DRD-2.2 Specific Examination Requirements

DRD-2.2.1 Baseline Examination

(a) Baseline Examination Requirements. An initial baseline examination shall be performed on all dynamic restraint devices prior to or during initial plant startup. The initial baseline examination shall, as a minimum, verify the following:

(1) No visible signs of damage or impaired operational readiness exist as a result of storage, handling, or installation.

(2) The device load rating, location, orientation, position setting, and configuration (e.g., attachments and extensions) are in accordance with design drawings and specifications.

(3) Adequate swing clearance is provided to allow movement of the device in accordance with design requirements.

(4) If applicable, fluid is at the recommended level, and no fluid leakage from the device is observed.

(5) Structural connections, such as pins, bearings, studs, fasteners, lock nuts, tabs, wire, and cotter pins, are installed correctly.

(6) For dynamic restraint devices placed in new or modified systems, baseline examinations shall be performed prior to declaring the supported system to be operationally ready to perform its function.

(b) Baseline Examination Corrective Action. Dynamic restraint devices that are installed incorrectly or otherwise fail to meet the requirements of this Section shall be reinstalled correctly, adjusted, repaired, or replaced. The installation-corrected, adjusted, repaired, or replacement device shall be examined in accordance with this Section. Replacement devices shall meet the requirements of this Section.

(c) Reexamination. If construction in the area of the restraint occurs after the initial baseline examination and conditions warrant a new baseline examination, then a reexamination shall be performed in accordance with this Section to establish a new baseline for future inservice examinations.

(d) Baseline Thermal Movement Examination Requirements. Thermal movement allowances required by design shall be verified as required by this Section.

(1) Incremental Movement Verification. During system heat-up and cooldown at temperature plateaus specified by the Owner, verify that the device movement during the thermal movement of the system is within the design-specified range. Any discrepancies or inconsistencies shall be evaluated to determine the movement acceptability before proceeding to the next specified heat-up plateau.

(2) Swing Clearance. Verify that swing clearance exists at specified heat-up and cooldown plateaus.

(3) Total Movement Verification. The total thermal movement from cold to hot at full operating temperature shall be recorded. This value shall be measured directly if maximum operating temperature was attained or extrapolated from lower temperature readings. The cold or hot position setting shall be evaluated and adjusted, if necessary, to ensure adequate clearance exists for the device to move from cold to hot positions.

DRD-2.2.2 Inservice Examination. Dynamic restraint devices shall be visually examined on the required schedule and evaluated to determine operational readiness.

(a) Method and Objective. Inservice examination shall be a visual examination to identify physical damage, leakage, corrosion, or degradation that might have been caused by environmental exposure or service conditions. External characteristics that might indicate operational readiness of the device shall be examined.

(b) Dynamic Restraint Device Categorization

(1) All of the dynamic restraint devices shall be categorized as one population for examination or categorized as separate populations based on significant attributes.

(2) The decision to categorize the devices as one population or as separate populations may be made before the examination period begins or during the examination period.

(3) If combining different categories into one population, the shortest category interval of the combined categories shall be used for subsequent examination.

DRD-2.2.3 Visual Examination Requirements. Dynamic restraint device installations shall meet all of the requirements of this Section.

(a) Restrained Movement. Dynamic restraint devices shall be installed so when activated, devices are capable of restraining movement. Examinations shall include observations for adverse conditions, and, when observed, the conditions shall be evaluated. Dynamic restraint devices evaluated to be incapable of restraining movement shall be deemed unacceptable. Adverse conditions to be observed include the following:

(1) loose fasteners or members that are corroded or deformed

(2) disconnected components or other conditions that might interfere with the proper restraint of movement

(b) Thermal Movement. Dynamic restraint device installations shall not restrain thermal movement to an extent that unacceptable stresses could develop in the device, the pipe, or other equipment that the device is designed to protect or restrain. This requirement is satisfied if no indication of binding, misalignment, or deformation of the device is observed.

(c) Design-Specific Characteristics. Dynamic restraint devices shall be free of defects that might be generic to particular designs as might be detected by visual examination. For example, fluid supply or content for devices that contain fluid shall be observed. If the fluid level is outside of the acceptance range, the installation shall be deemed unacceptable, unless a test establishes that the performance of the device is within specified limits.

DRD-2.2.4 Operational Readiness Evaluation, Acceptance by Test. A dynamic restraint device that requires further evaluation or is deemed unacceptable during visual examination shall be tested in accordance with the requirements of this Section. Results that satisfy the operational readiness test criteria shall be used to accept the device, provided the test demonstrates that the unacceptable condition did not affect operational readiness to perform the function.

DRD-2.2.5 Inservice Examination Intervals. The Program Plan shall specify the inservice examination intervals established by the Owner in accordance with GR-2.3.

*(a) Initial Examination Interval***.** The initial examination interval of dynamic restraint devices shall begin no sooner than 2 months after attaining 5% reactor power operation and shall not extend longer than 24 months after attaining 5% reactor power operation.

(b) Subsequent Examination Intervals

(1) Subsequent examination intervals shall begin at the end of the previous examination interval and shall take into account the number of unacceptable dynamic restraint devices in accordance with Table DRD-2.2.5-1.

(2) All dynamic restraint devices within the scope of this Section shall be examined and evaluated at least once every 10 yr in accordance with Table-DRD-2.2.5-1, provided the following requirements are satisfied:

(-a) If at any time during an examination interval the cumulative number of unacceptable dynamic restraint devices in any category as defined in DRD-2.2.2(b) exceeds the applicable value from Table-DRD-2.2.5-1, the current 10-yr examination interval for that category shall end, and all remaining examinations in the category must be completed within the current service cycle.

(-b) The duration of the subsequent examination interval for that category shall be reduced to 48 months maximum.

(-c) The visual examination interval for that category shall not return to 10 yr until there are no unacceptable visual examinations for that category for the current visual examination interval.

(-d) No grace period extension is applicable to extend any specified visual examination interval.

(-e) While using a 10-yr examination interval, snubber operational testing shall not be more than one service cycle as described in DRD-2.3.2.

(3) Interpolation between the population of category sizes and the number of unacceptable dynamic restraint devices is permissible. The next lower integer shall be used when interpolation results in a fraction.

DRD-2.2.6 Inservice Examination Failure Evaluation. Dynamic restraint devices that do not meet examination requirements shall be evaluated to determine the cause of the unacceptability.

DRD-2.2.7 Inservice Examination Corrective Action. Unacceptable dynamic restraint devices shall be adjusted, repaired, modified, or replaced. Additional action regarding the examination interval shall be taken as indicated in the Program Plan.

DRD-2.3 Specific Testing Requirements

DRD-2.3.1 Baseline Operational Readiness Testing

(a) General. Baseline operational readiness testing shall be performed on all dynamic restraint devices. Testing may be performed at the manufacturer's facility.

(b) Test Parameters. Tests shall verify the following:

(1) Activation is within the specified range of velocity or acceleration in tension and in compression. For devices that do not have an activation function, this parameter is not applicable.

(2) Release rate, when applicable, is within the specified range in tension and compression. For devices specifically required not to displace under continuous load, the ability of the device to withstand load without displacement shall be verified.

(3) For mechanical snubbers, drag force is within specified limits in tension and compression.

Table DRD-2.2.5-1
Visual Examination Table

Population of Category	Number of Unacceptable Dynamic Restraint Devices
1	1
80	2
100	4
150	8
200	13

(4) For hydraulic snubbers, if required to verify proper assembly, drag force is within specified limits in tension and compression.

(c) Baseline Operational Readiness Testing Failures Corrective Action

(1) Test Failure Evaluations. Dynamic restraint devices that fail the baseline operational readiness test shall be evaluated for the cause of the failure.

(2) Design Deficiency. If a design deficiency in a dynamic restraint device is found, it shall be corrected by modifying the design or specification or justified by corrective action.

(3) Other Deficiencies. Other deficiencies shall be resolved by adjustment, modification, repair, replacement, or justified corrective action.

(4) Retest Requirements. Adjusted, modified, repaired, or replacement devices shall be tested to meet the requirements of this Section.

DRD-2.3.2 Inservice Operational Readiness Testing. Dynamic restraint devices shall be tested for operational readiness during each service cycle. Test campaigns are the series of actions required to complete testing of dynamic restraint devices performed in accordance with a specified sampling plan as described in the Program Plan. Testing shall be performed during normal system operation or during system or plant outages.

(a) Test Parameters. Operational readiness tests shall verify the following:

(1) Activation is within the specified range of velocity or acceleration in tension and compression. For devices that do not have an activation function, this parameter is not applicable.

(2) Release rate, when applicable, is within the specified range in tension and compression. For devices specifically required not to displace under continuous load, the ability of the device to withstand load without displacement shall be verified.

(3) For mechanical snubbers, drag force is within specified limits, in tension and compression.

(b) Test Methods

(1) Test as Found. Dynamic restraint devices shall be tested in their as-found condition regarding the parameters to be tested within specified limits.

(2) Restriction. Test methods shall not alter the condition of a dynamic restraint device to the extent that the results do not represent the as-found condition of the device.

(3) In-Place Test. Dynamic restraint devices may be tested in their installed location by using documented test methods and equipment.

(4) Bench Test. Dynamic restraint devices may be removed and bench tested in accordance with documented procedures. After reinstallation, the applicable visual examination requirements of this Section shall be met. Also, the position setting shall be verified.

(5) Subcomponent Test. When using this method, dynamic restraint device subcomponents that control the parameters to be verified can be examined and tested in accordance with documented test methods. Reassembly shall be in accordance with documented procedures that include the applicable visual examination requirements of this Section.

(6) Additional Requirements. Additional requirements for hydraulic snubbers that are tested without applying a load to the snubber piston rod shall include the following:

(-a) monitoring the particulate, viscosity, and moisture content of one or more samples of hydraulic fluid from the main cylinder of the snubber. This may be accomplished using snubbers of the same design in a similar or more severe environment.

(-b) monitoring of piston seal, piston rod seal, and cylinder seal integrity. If seal integrity is monitored by pressurization, pressures less than the snubber's rated load pressure may be used.

(c) Correlation of Indirect Measurements. When test methods are used that either measure parameters indirectly, or measure parameters other than those specified, the results shall be correlated with specified parameters through established methods.

(d) Parallel and Multiple Installations. Each dynamic restraint device in a parallel or multiple installation shall be identified and counted individually.

(e) Fractional Sample Sizes. Fractional sample sizes shall be rounded up to the next integer.

(f) Test Frequency. An inservice test campaign shall be conducted every scheduled service cycle. Testing associated with each test campaign shall begin no earlier than 92 days before the beginning of a scheduled service cycle and shall be completed prior to returning the reactor to power generation.

(g) Defined Test Plan Group (DTPG)

(1) The DTPGs shall include all dynamic restraint devices except replacement devices and devices repaired or adjusted as a result of not meeting the examination acceptance requirements of this Section. These devices shall be exempt for the concurrent test interval.

(2) The total dynamic restraint device population shall be grouped as one DTPG or, alternatively, differences in significant attributes evaluated in establishing DTPGs. DTPGs shall not be changed after initiating testing in a test campaign.

(3) Large capacity snubbers (50,000 lb or more) shall be at least one separate DTPG.

(h) Testing Sample Plans

(1) The Program Plan shall specify one of the following plans:

(-a) Test, or replace, all snubbers within each DTPG every 10 yr or at the service life expiration date, whichever comes first.

(-b) Snubbers may be selected for testing on a rotational basis.

(2) When the sample plan requires additional samples due to unacceptable operational readiness test results within a DTPG, the additional sample shall be at least one-half the size of the initial sample from that DTPG. As practicable, the additional sample shall include the following:

(-a) devices of the same manufacturer's design

(-b) devices immediately adjacent to those found unacceptable

(-c) devices from the same piping system

(-d) devices from other piping systems that have similar operating conditions such as temperature, humidity, vibration, and radiation

(3) If operational readiness test failures occur within the additional samples, all remaining devices within that DTPG that have not been operational readiness tested during the service cycle shall be tested.

(i) Retests of Previously Unacceptable Dynamic Restraint Devices. Dynamic restraint devices placed in the same location as devices that failed during the previous test campaign shall be retested at the time of the subsequent test campaign, unless the cause of the failure is clearly established and corrected so as to preclude reoccurrence. Any retest in accordance with this subparagraph shall not be assumed a part of the test campaign sample selection requirements of (h). In addition, failures found by these retests shall not require additional testing in accordance with (h) but shall be evaluated for appropriate corrective action.

(j) Corrective Action. Unacceptable devices shall be deemed to not be operationally ready to perform their function. Unacceptable devices shall be adjusted, repaired, modified, or replaced to demonstrate their operational readiness prior to reliance on the capability to perform their function.

DRD-2.4 Service Life Monitoring

DRD-2.4.1 Predicted Service Life. Initial service life shall be predicted based on the manufacturer's specification or design review.

DRD-2.4.2 Service Life Evaluation. The service life for each location where a dynamic restraint device is installed shall be reevaluated at least once each service cycle. Reevaluation shall be based on examination, maintenance, performance, and operating service-life history data associated with representative devices that have been in service in the plant, as well as other information related to service life. Completion of this reevaluation shall be documented. Based on the results of the reevaluation, the service life of each device shall be increased, decreased, or left unchanged. If the reevaluated service life of any device will be exceeded before the next scheduled system or plant outage, one of the following actions shall be taken prior to the start of the cycle:

(a) The device shall be replaced with a device of the same design for which the service life will not be exceeded before the next scheduled system or plant outage.

(b) Technical justification shall be documented for extending the service life to or beyond the next scheduled system or plant outage.

(c) The device shall be reconditioned such that its service life is extended to or beyond the next scheduled system or plant outage.

DRD-2.4.3 Cause Determination. Causes for any dynamic restraint device failures shall be determined, documented, and applied in establishing or reestablishing service life.

DRD-2.4.4 Testing for Service Life-Monitoring Purposes. If testing is conducted specifically for service life-monitoring purposes, the results of such testing shall be evaluated for appropriate corrective action.

DRD-2.4.5 Review of Operational Readiness Test Data. All inservice test data shall be evaluated for indications of device degradation or other anomalies. This includes a review of test traces, where available. The results of this evaluation shall be used

(a) to identify devices that are subject to progressive degradation

(b) to identify severe operating environments not previously identified

DRD-2.4.6 Examination During Disassembly. Dynamic restraint devices and device parts that are disassembled (during failure evaluation, refurbishment, etc.) shall be examined for indications of degradation and severe operating environments.

DRD-2.4.7 Snubber Maintenance and Repair. Snubber repair activities shall be performed in accordance with the requirements of the Code selected for inservice inspection of components by the owner.

DRD-3 CORRECTIVE ACTIONS

Corrective actions shall be performed as specified in GR-3 and this Section.

DRD-4 RECORDS

DRD-4.1 Records

Dynamic restraint device records shall be maintained in accordance with GR-4 and as specified in this Section. The records shall include the following information:

(a) name of the manufacturer and the manufacturer's model and serial numbers or other unique identification number

(b) manufacturer's acceptance test report, baseline test report, and current IST report

DRD-4.2 Test Plans

In addition to the applicable requirements of Section GR, the Owner shall maintain a record of examination and test plans for all dynamic restraint devices.

DRD-4.3 Record of Tests

(a) In addition to the requirements of Section GR, the results of examination and test data shall include the manufacturer's model number, serial number, type, and unique location identification or the Owner's identification of the device, as applicable.

(b) Records of predicted service life of all dynamic restraint devices and service life reevaluations shall be maintained.

Section CP
Centrifugal Pumps

CP-1 INTRODUCTION

Centrifugal pumps within the scope of this Code shall meet the requirements specified in Section GR and this Section.

CP-2 INSERVICE TESTING REQUIREMENTS

CP-2.1 General Requirements

CP-2.1.1 Testing Parameters. The hydraulic and mechanical condition of a pump relative to a previous condition can be determined by attempting to duplicate by test a set of reference values. Deviations detected are symptoms of changes and, depending on the degree of deviation, indicate need for further tests or corrective action. The parameters to be measured during baseline testing and IST are specified in Table CP-2.1.1-1.

CP-2.1.2 Baseline Testing

(a) The parameters to be measured are specified in Table CP-2.1.1-1.

(b) Flow rate and differential pressure shall be measured at a minimum of five points, which encompasses the best efficiency point. These points shall be from pump minimum flow to the pump's maximum design flow. A pump curve shall be established based on the measured points. At least one point shall be designated as the reference point or reference points if there is more than one reference point. Data taken at the reference point shall be used to compare the results of inservice tests.

(c) Vibration measurements are required to be taken only at the reference point or reference points if there is more than one reference point.

(d) A baseline test may be substituted for any inservice test.

Table CP-2.1.1-1
Inservice Test Parameters for Centrifugal Pumps

Quantity	Baseline Test	Inservice Test
Speed, N [Note (1)]	X	X
Differential pressure, ΔP	X	X
Flow rate, Q	X	X
Vibration [Note (2)]		
Displacement, V_d	X	X
Velocity, V_v	X	X

NOTES:
(1) If variable speed.
(2) Measure either peak-to-peak displacement, V_d, or peak velocity, V_v.

CP-2.1.3 Baseline Testing Frequency. A baseline test shall be performed and an initial set of reference values established in accordance with CP-2.1.6.2 prior to the pump being relied on to perform its specified functions. Except as specified in CP-2.1.7.1, only one baseline test is required for each pump.[1]

CP-2.1.4 Inservice Testing Interval

(a) An inservice test shall be performed on each pump quarterly. Optional adjustment of this interval is provided in CP-2.4.

(b) An inservice test shall be current within the established frequency prior to the pump being relied on to perform its specified functions.

CP-2.1.5 Pumps in Regular Use. Pumps that are operated more frequently than every 3 months need not be run or stopped for a special test, provided the plant records show the pump was operated at least once every 3 months at the reference conditions, and the quantities specified were determined, recorded, and analyzed per CP-2.3.

CP-2.1.6 Data Collection

CP-2.1.6.1 General

(a) Instrument Location. The sensor location shall be established by the Owner, documented in the plant records, and appropriate for the parameter being measured. The same location shall be used for subsequent tests. Instruments that are position sensitive shall be either permanently mounted, or provision shall be made to duplicate their position during each test.

(b) Fluctuations. Symmetrical damping devices or averaging techniques may be used to reduce instrument fluctuations. Hydraulic instruments may be damped by using gage snubbers or by throttling small valves in instrument lines.

[1] The baseline test should be performed soon after completion of installation activities and prior to significant runtime of the pump.

Table CP-2.1.6.1-1
Required Instrument Accuracy — Hydraulic

Quantity	Baseline and Inservice Tests, % of Indicated Value
Pressure	±1½
Flow rate	±6
Differential pressure	±1½

(c) Instrument Loop. Instrument loop is when two or more instruments or components work together to provide a single output.

(d) Instrument Loop Accuracy. Instrument loop accuracy describes the accuracy of an instrument loop based on the square root of the sum of the squares of the inaccuracies of each instrument or component in the loop when considered separately. Alternatively, the allowable inaccuracy of the instrument loop may be based on the output for a known input into the instrument loop.

(e) Flow, Pressure, and Differential Pressure Measurement

(1) Accuracy. Analog or digital instruments may be used, provided they are calibrated within the limits specified in Table CP-2.1.6.1-1 at the expected indicated values (e.g., reference values).

(2) Range. The analog or digital instrument shall be designed and calibrated for use at the expected indicated values (e.g., reference values) to be measured or recorded during the test.

(3) Analytical Methods. If a parameter is determined by analytical methods instead of measurement (e.g., lake level for pressure or change in tank level over time for flow), then the determination shall meet the parameter accuracy requirement of Table CP-2.1.6.1-1. The method used to determine the parameter shall be included in the record.

(4) Gage Lines. If the presence or absence of liquid in a gage line could produce a difference of more than 0.25% in the indicated value of the measured pressure, means shall be provided to ensure or determine the presence or absence of liquid as required for the static correction used.

(5) Differential Pressure. When determining differential pressure across a pump, a differential pressure gage or a differential pressure transmitter that provides direct measurement of the pressure difference or the difference between the pressure at a point in the inlet and the pressure at a point in the discharge pipe shall be used.

(f) Rotational Speed Measurement — Variable Speed Pumps Only

(1) Range. Digital instruments shall be selected such that the reference value does not exceed 90% of the calibrated range of the instrument.

(2) Accuracy. Instrument accuracy shall be within the limits of Table CP-2.1.6.1-2.

(3) Rotational Speed Measurement. Rotational speed measurements of variable speed pumps shall be taken by a method that meets the requirements of Table CP-2.1.6.1-2.

(g) Vibration Measurement

(1) For pumps operating at or above 600 rpm, the frequency response range of the vibration-measuring transducers and their readout system shall be from one-third minimum pump shaft rotational speed to at least 1,000 Hz.

(2) For slow speed pumps operating below 600 rpm, the frequency response range of the vibration-measuring transducers and their readout system shall be no lower than 1 Hz to at least 1,000 Hz.

(3) Instrument accuracy shall be within the limits of Table CP-2.1.6.1-2.

(4) Measurements shall be taken in a plane approximately perpendicular to the rotating shaft in two approximately orthogonal directions on each accessible pump bearing housing. Measurement shall also be taken in the axial direction on each accessible pump thrust-bearing housing.

(5) If a portable vibration indicator is used, the measurement points shall be clearly identified on the pump to permit subsequent duplication in both location and plane.

(6) Pumps that will use the "minimum reference" value for one or more vibration points shall use trending analysis of measured vibration amplitudes in the frequency domain to assess performance at these locations. The Owner shall document the conclusion of the performance analysis prior to the subsequent test with a conclusion of acceptable, degrading but acceptable, or unacceptable. Corrective action shall be initiated when an unacceptable trend in performance is identified.

Table CP-2.1.6.1-2
Required Instrument Accuracy — Mechanical

Quantity	Baseline and Inservice Tests, %
Speed	±2
Vibration	
>4 Hz to 1,000 Hz [Note (1)]	±5
1 Hz to 4 Hz [Note (2)]	±15

NOTES:
(1) ±5% accuracy from >4 Hz or one-third pump shaft rotation speed to at least 1,000 Hz in native units (accelerometers in acceleration, velocity transducers in velocity, etc.)
(2) Transducers used on slow speed running pumps under 600 RPM: ±15% accuracy in native units (accelerometers in acceleration, velocity transducers in velocity, etc.) from 1 Hz to 4 Hz and ±5% > 4 Hz to a minimum of 1,000 Hz.

CP-2.1.6.2 Reference Values

(a) Reference values for the pump inservice test shall be obtained as follows:

(1) Initial reference values shall be determined from the results of testing meeting the requirements of CP-2.1.2, baseline testing, or from the results of the first inservice test.

(2) New or additional reference values shall be established as required by CP-2.1.7, CP-2.1.8, or CP-2.3.2(c).

(3) Reference values shall be established only when the pump is known to be operating acceptably.

(4) Reference values shall be established at a point of operation (or points of operation if there is more than one reference point) readily duplicated during subsequent tests.

(5) Reference values shall be established at the inservice test flow rate. The best efficiency point, system flow rates, and any other plant-specific flow rates shall be evaluated.

(6) For smooth running pump-measured vibration reference values less than 0.050 ips/0.00127 mps, the owner may use 0.050 ips/0.00127 mps as the minimum reference value for one or more of the vibration points. In such cases, the minimum reference value of 0.050 ips/0.00127 mps shall be used to define acceptable pump performance in accordance with CP-2.3.

(b) All subsequent test results shall be compared to the initial reference values established per (a)(1) through (a)(5) or to new reference values established as required by CP-2.1.7, CP-2.1.8, or CP-2.3.2(c).

(c) Related conditions that can significantly influence the measurement or determination of the reference value shall be analyzed in accordance with CP-2.3.4.

CP-2.1.7 Effect of Pump Replacement, Repair, and Maintenance on Reference Values

CP-2.1.7.1 Replacement and Major Maintenance. Following replacement, major maintenance, or routine servicing (e.g., impeller replacement), such that the existing baseline test data and reference values do not represent the installed pump, the following shall be performed before declaring the pump operationally ready:

(a) A baseline test shall be performed in accordance with CP-2.1.2.

(b) A new set of reference values shall be established in accordance with CP-2.1.6.2 from the results of the baseline test.

(c) Verification that the new reference values represent acceptable pump operation shall be placed in the record of tests.

CP-2.1.7.2 Routine Maintenance and Repair. When a reference value or set of reference values might have been affected by repair or routine maintenance other than that covered under CP-2.1.7.1, the following shall be performed before declaring the pump operationally ready:

(a) An inservice test shall be performed and the previous reference values reconfirmed, or a new reference value, or set of reference values, shall be determined in accordance with CP-2.1.6.2.

(b) If new reference values are determined, deviations from the previous and new reference values shall be evaluated, and verification that the new values represent acceptable pump operation shall be placed in the record of tests.

CP-2.1.8 Establishment of Additional Set of Reference Values. If it is necessary or desirable, for some reason other than stated in CP-2.1.7, to establish an additional set of reference values, an inservice test shall be run at the conditions of an existing set of reference values and the results analyzed. If operation is acceptable per CP-2.3.2, an additional set of reference values may be established as follows:

(a) For centrifugal and vertical line shaft pumps, the additional set of reference values shall be determined from the pump curve established in CP-2.1.2.

(b) Vibration acceptance criteria shall be established by an inservice test at the new reference point. If vibration data were taken at all points used in determining the pump curve, an interpolation of the new vibration reference value is acceptable.

(c) A test shall be run to verify the new reference values before their implementation. Whenever an additional set of reference values is established, the reasons for so doing shall be justified and documented in the record of tests. The requirements of CP-2.1.6.2 apply.

CP-2.1.9 Duration of Tests. For all pump baseline tests and inservice tests, after pump conditions are as stable as the system permits, each pump shall be run at least 2 min. At the end of this time, at least one measurement or determination of each of the quantities required by Table CP-2.1.1-1 shall be made and recorded.

CP-2.2 Specific Inservice Testing Requirements

CP-2.2.1 Inservice Test of Centrifugal Pumps (Except Vertical Line Shaft Pumps). Inservice tests shall be conducted with the pump operating at a specified reference point and within the variances from the reference point as described in this paragraph. The test parameters shown in Table CP-2.1.1-1 shall be determined and recorded as required by this paragraph. The test shall be conducted as follows:

(a) The pump shall be operated at nominal motor speed for constant speed drives or at a speed adjusted to the reference point (±1%) for variable speed drives.

(b) The resistance of the system shall be varied until the flow rate is the reference point with the variance not to exceed +2% or −1% of the reference point. The differential

Table CP-2.2.1-1
Centrifugal Pump Test Acceptance Criteria

Test Type	Pump Speed	Test Parameter	Acceptable Range	Alert Range	Required Action Range	
					Low	High
Inservice test [Notes (1), (2)]	N/A	Q	$0.94Q_r$ to $1.06Q_r$	$0.90Q_r$ to $<0.94Q_r$	$<0.90Q_r$	$>1.06Q_r$
	N/A	ΔP	$0.93\Delta P_r$ to $1.06\Delta P_r$	$0.90\Delta P_r$ to $<0.93\Delta P_r$	$<0.90\Delta P_r$	$>1.06\Delta P_r$
	<600 rpm	V_v [Note (3)]	≤0.125 in./sec (≤0.3 cm/s)	>0.125 in./sec to 0.300 in./sec (>0.3 cm/s to 0.7 cm/s)	None	>0.300 in./sec (>0.7 cm/s)
		V_d or V_v	$\leq 2.5V_r$	$>2.5V_r$ to $6V_r$ or >10.5 mils to 22 mils (>266.7 μm to 558.8 μm)	None	$>6Vr$ or >22 mils (>558.8 μm)
	≥600 rpm	V_v [Note (3)]	≤0.125 in./sec (≤0.3 cm/s)	>0.125 in./sec to 0.300 in./sec (>0.3 cm/s to 0.7 cm/s)	None	>0.300 in./sec (>0.7 cm/s)
		V_d or V_v	$\leq 2.5V_r$	$>2.5V_r$ to $6V_r$ or >0.325 in./sec to 0.7 in./sec (>0.8 cm/s to 1.7 cm/s)	None	$>6V_r$ or >0.7 in./sec (>1.7 cm/s)

GENERAL NOTE: The subscript *r* denotes reference value, the subscript *v* denotes vibration velocity reference value, and the subscript *d* denotes displacement.

NOTES:
(1) Vibration parameter, V_r, is the vibration reference value in the selected units.
(2) Refer to Figure CP-2.2.1-1 to establish displacement limits for pumps with speeds ≥600 rpm or velocity limits for pumps with speeds <600 rpm.
(3) Pumps that will use the "minimum reference" value for one or more vibration points shall use trending analysis of measured vibration amplitudes in the frequency domain to assess performance at these locations [see CP-2.1.6.2(a)(6)].

pressure shall then be determined and compared to its reference value. Alternatively, the flow rate shall be varied until the differential pressure is the reference point with the variance not to exceed +1% or −2% and the flow rate determined and compared to its reference value.

(c) Vibration (displacement or velocity) shall be determined and compared with corresponding reference values. Vibration measurements are to be an overall value, without filtering, of velocity or displacement. If velocity measurements are used, measurements shall be peak. If displacement amplitudes are used, measurements shall be peak-to-peak.

(d) All deviations from the reference values shall be compared with the ranges of Table CP-2.2.1-1 and corrective action taken as specified in CP-2.3.2. The vibration measurements shall be compared to both the relative and absolute criteria shown in the alert and required action ranges of Table CP-2.2.1-1. For example, if vibration exceeds either 6 V_r or 0.7 in./sec (1.7 cm/s), the pump is in the required action range.

CP-2.2.2 Inservice Test of Vertical Line Shaft Pumps. Tests shall be conducted with the pump operating at a specified reference point and within the variances from the reference point as described in this paragraph. The test parameters shown in Table CP-2.1.6.1-1 shall be determined and recorded as required by this paragraph. The test shall be conducted as follows:

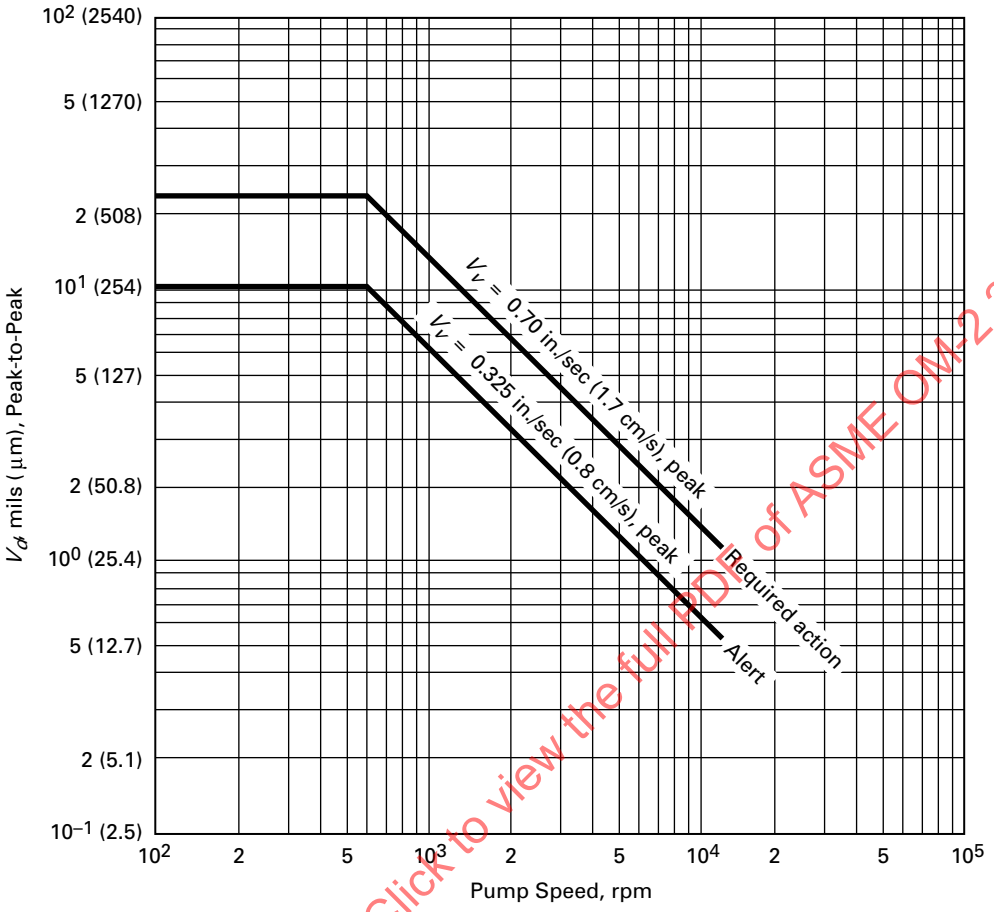
(a) The pump shall be operated at nominal motor speed for constant speed drives or at a speed adjusted to the reference point (±1%) for variable speed drives.

(b) The resistance of the system shall be varied until the flow rate is set to within +2% or −1% of 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 is the reference point with the variance not to exceed +1% or −2% and the flow rate determined and compared to its reference value.

(c) Vibration (displacement or velocity) shall be determined and compared with corresponding reference values. Vibration measurements are to be an overall value, without filtering, of velocity or displacement. If velocity measurements are used, measurement shall be peak. If displacement amplitudes are used, measurement shall be peak-to-peak.

(d) All deviations from the reference values shall be compared with the ranges of Table CP-2.2.2-1 and corrective action taken as specified in CP-2.3.2. The vibration measurements shall be compared to both the relative and absolute criteria shown in the alert and required action ranges of Table CP-2.2.2-1. For example, if vibration exceeds either 6Vr or 0.7 in./sec (1.7 cm/s), the pump is in the required action range.

Figure CP-2.2.1-1
Centrifugal Pump Vibration Limits



CP-2.3 Monitoring, Analysis, and Evaluation

CP-2.3.1 Trending. Test parameters shown in Table CP-2.1.6.1-1, except for fixed values, shall be trended.

CP-2.3.2 Corrective Action

(a) Alert Range. If the measured test parameter values fall within the alert range of Table CP-2.2.1-1 or Table CP-2.2.2-1, as applicable, the frequency of testing shall be at least once every 45 days until the cause of the deviation is determined and the condition is corrected, or an analysis of the pump is performed in accordance with (c).

(b) Action Range. If the measured test parameter value falls within the required action range of Tables CP-2.2.1-1 and CP-2.2.2-1, as applicable, the pump's operational readiness is not verified until either the cause of the deviation has been determined and the condition is corrected, or an analysis of the pump is performed in accordance with (c).

(c) Analysis. In cases where the pump's test parameters are within either the alert or required action ranges of Tables CP-2.2.1-1 and CP-2.2.2-1, as applicable, an analysis may be performed that supports the pump's continued use at the changed values. This analysis shall include verification of the pump's operational readiness at both the pump level and a system level, the cause of the change in pump performance, and an evaluation of all trends indicated by available data. The analysis shall confirm the current reference value or establish a new reference value. The results of this analysis shall be documented in the record of tests.

CP-2.3.3 Systematic Error. When a test shows measured parameter values that fall outside of the acceptable range of Tables CP-2.2.1-1 and CP-2.2.2-1, as applicable, that have resulted from an identified systematic error, such as improper system lineup or inaccurate instrumentation, the test shall be rerun after correcting the error.

Table CP-2.2.2-1
Vertical Line Shaft Pump Test Acceptance Criteria

Test Type	Pump Speed	Test Parameter	Acceptable Range	Alert Range	Required Action Range	
					Low	High
Inservice test [Notes (1), (2)]	N/A	Q	$0.95Q_r$ to $1.06Q_r$	$0.93Q_r$ to $<0.95Q_r$	$<0.93Q_r$	$>1.06Q_r$
	N/A	ΔP	$0.95\Delta P_r$ to $1.06\Delta P_r$	$0.93\Delta P_r$ to $<0.95\Delta P_r$	$<0.93\Delta P_r$	$>1.06\Delta P_r$
	<600 rpm	V_v [Note (3)]	≤0.125 in./sec (≤0.3 cm/s)	>0.125 in./sec to 0.300 in./sec (>0.3 cm/s to 0.7 cm/s)	None	>0.300 in./sec (>0.7 cm/s)
		V_d or V_v	$\leq 2.5V_r$	$>2.5V_r$ to $6V_r$ or >10.5 mils to 22 mils (>266.7 µm to 558.8 µm)	None	$>6V_r$ or >22 mils (>558.8 µm)
	≥600 rpm	V_v [Note (3)]	≤0.125 in./sec (≤0.3 cm/s)	>0.125 in./sec to 0.300 in./sec (>0.3 cm/s to 0.7 cm/s)	None	>0.300 in./sec (>0.7 cm/s)
		V_v or V_d	$\leq 2.5V_r$	$>2.5V_r$ to $6V_r$ or >0.325 in./sec to 0.7 in./sec (>0.8 cm/s to 1.7 cm/s)	None	$>6V_r$ or >0.7 in./sec (>1.7 cm/s)

GENERAL NOTE: The subscript *r* denotes reference value, the subscript *v* denotes vibration velocity reference value, and the subscript *d* denotes displacement.

NOTES:
(1) Vibration parameter, V_r, is the vibration reference value in the selected units.
(2) Refer to Figure CP-2.2.1-1 to establish displacement limits for pumps with speeds ≥600 rpm or velocity limits for pumps with speeds <600 rpm.
(3) Pumps that will use the "minimum reference" value for one or more vibration points shall use trending analysis of measured vibration amplitudes in the frequency domain to assess performance at these locations [see CP-2.1.6.2(a)(6)].

CP-2.3.4 Analysis of Related Conditions

(a) If the reference value of a particular parameter being measured or determined can be significantly influenced by other related conditions, then these conditions shall be analyzed and documented in the record of tests.

(b) Vibration measurements of pumps might be foundation, driver, or piping dependent. Therefore, if initial vibration readings are high and have no obvious relationship to the pump, then additional vibration measurements shall be taken as necessary (e.g., at the driver, at the foundation, and on the piping) and analyzed to ensure that the reference vibration measurements are representative of the pump, and the measured vibration levels will not prevent the pump from fulfilling its function. This analysis shall be documented in the record of tests.

CP-2.4 Condition-Monitoring Program

CP-2.4.1 Condition-Monitoring Purpose

(a) The alternative requirements for condition monitoring of pumps (see CP-2.4) establish testing and monitoring requirements for the implementation and maintenance of a condition-monitoring program for pumps, pump drivers, and associated pump electrical system components. The intended purpose of the pump condition-monitoring program is to provide additional technologies for monitoring the condition of pumps and associated components, which will allow

(1) performance improvement activities through enhanced detection of degradation and machine faults

(2) optimization of pump condition-monitoring activities

(b) The alternative requirements for condition monitoring of pumps (see CP-2.4) shall be used in conjunction with inservice testing requirements when the Owner wishes to adjust the frequency of testing pumps as specified in CP-2.1.4. In addition, the purpose of the pump condition-monitoring program is to improve both pump performance and optimize testing, monitoring, and preventive maintenance activities to maintain the continued acceptable performance of a Code-tested pump. If the pump condition-monitoring program for a pump is discontinued, then all the requirements of CP-2 through CP-2.3.4 shall apply.

(c) The frequency of testing pumps as specified in CP-2.1.4 may be adjusted, provided alternative requirements for condition monitoring of pumps are applied. Except for adjustment to testing frequency specified in CP-2.1.4, the alternative requirements for condition monitoring of pumps (see CP-2.4) do not alter or exempt any other requirement.

(d) The alternative requirements for condition monitoring of pumps (see CP-2.4) address information regarding pump drivers and associated equipment for the sole purpose of using such information to evaluate the condition of pumps and not to provide any evaluation of those drivers and associated equipment.

CP-2.4.2 Condition-Monitoring Analysis

(a) The Owner shall perform an analysis of the design, test history, and maintenance history of a pump, a pump driver, and the pump electrical system to determine those additional pump condition-monitoring technologies, acceptance criteria, and equipment to be included in the pump condition-monitoring program that will enhance detection of degradation and machine set faults.

(b) In addition to the testing required by CP-2.2, the analysis shall include condition-monitoring technologies and parameters for vibration analysis, lube oil analysis[2], thermography, motor current signature analysis, motor electrical parameters, and process and equipment parameters.

(1) Vibration Analysis. Vibration analysis involves the Owner utilizing instrumentation capable of collecting and analyzing spectral vibration data to monitor machine condition. Vibration analysis is the primary technology, along with lube oil analysis, used in a condition-monitoring program. The emphasis on utilizing equipment capable of collecting and analyzing spectral vibration is to ensure that the resulting vibration analysis can identify the many types of equipment faults and characterize, and trend, the machinery condition in a manner that supports accurate and reliable fault detection, maintenance, planning, and long-term equipment reliability.

(2) Lube Oil Analysis[2]. Lube oil analysis involves analyzing oil properties, including those of the base oil and its additives, and identifying the presence of contaminants and wear debris.

(3) Thermography. Thermography is used for detecting and measuring variations in the heat emitted by various regions of a body and transforming them into visible signals that can be recorded photographically. Thermography can be used as a tool for identifying potential equipment faults, performing post-maintenance retests, and trending the condition of equipment components subject to temperature degradation. For example, thermography can be used to monitor switchgear, breakers, and control relays providing electrical power to equipment and can also be used to detect mechanical equipment faults.

(4) Motor Current Signature Analysis. Motor current signature analysis involves analyzing motor current data in the frequency domain. Motor current signature analysis shall be collected and utilized to verify proper mechanical and electrical characteristics and loading, as well as help troubleshoot and identify equipment faults and problems. Demodulated current spectra are typically more effective for identifying mechanical characteristics.

(5) Motor Electrical Parameters. Motor electrical operating parameters, including current, voltage, and stator winding temperatures, shall be monitored in accordance with the manufacturer's recommendations, industry standards and practices, and plant experience. Current, phase balance, and winding temperatures can provide an indication of degradation to predict impending failure.

(6) Process and Equipment Parameters. Process and equipment parameter variations might impact condition-monitoring results. Applicable process and equipment data shall be collected in conjunction with the equipment condition-monitoring data. This includes any specific plant condition or operating parameters that might or does affect equipment-operating characteristics. As applicable and available, when doing walkdowns of the equipment or during operator rounds and data collection, visual, auditory, olfactory, and tactile observations of equipment sounds, smells, discoloration, casing, and bearing housing temperature changes or leaks can identify potential equipment problems that, left unattended, could lead to equipment failure.

(c) The analysis shall include identification of any common failure or maintenance patterns. These patterns shall be analyzed to determine their significance and to identify potential failure mechanisms. The analysis shall determine whether

(1) certain preventive maintenance activities or a periodic pump run to verify it starts and is capable of achieving the expected flow, or differential pressure (bump test) would mitigate the risk of failure or identify a need to change maintenance patterns

(2) application of condition-monitoring technologies and parameters are feasible and effective in monitoring for and detecting these failure mechanisms

(3) periodic disassembly and examination activities would be effective in monitoring for and detecting these failure mechanisms

CP-2.4.3 Condition-Monitoring Program Activities

CP-2.4.3.1 Performance Improvement Activities

(a) If sufficient information is not currently available to complete the analysis required in CP-2.4.2, or if the analysis is inconclusive, then the following activities shall be performed at sufficient intervals over an interim period to determine a pending cause of failure or the acceptability of the maintenance patterns. This interim period shall continue until multiple and acceptable additional condition-monitoring data points are obtained. All CP-2.2 test requirements shall be met during this interim period.

(1) Identify interim tests (e.g., application of condition-monitoring technologies and parameters) to assess the performance of the pump, pump drivers and associated pump electrical components, and enhanced detection of degradation and machine faults.

(2) Identify interim application of condition-monitoring technologies and parameters to evaluate potential degradation mechanisms.

[2] For components that do not have lube oil, lube oil analysis is not required.

(3) Identify other types of analysis that will be performed to assess pump condition.

(4) Identify the interval of each activity or if continuous monitoring will be performed.

(b) Identify attributes that will be trended. Trending and evaluation of existing data must be used as the basis to reduce or increase the frequency of a CP-2.2 test and pump condition-monitoring test (CMT). Note that the CMT may be a test or an activity such as, but not limited to, continuous monitoring when the pump set is online or obtaining a spectral analysis data set periodically on a standby pump.

(c) Complete or revise the pump condition-monitoring program test plans to document the pump program performance improvement activities and their associated frequencies.

(d) Perform the pump condition-monitoring activities at the identified associated frequencies until either of the following conditions is reached:

(1) Enough information is obtained to permit an adequate evaluation of the specific application.

(2) The interim period ends.

(e) After completion of (a)(1) through (a)(4), review the attributes that were selected for trending, along with the results of each activity, and trends to determine whether any changes to the performance improvement program are required. If needed based on the results of the last scheduled CMT, the program shall be revised in accordance with the site corrective action program prior to performing additional program improvement CMTs, and the applicable requirements of CP-2.4.2 and CP-2.4.3 shall be repeated.

CP-2.4.3.2 Optimization of Pump Condition-Monitoring Activities

(a) If sufficient information is available to assess the performance adequacy of the pump, then the following activities shall be performed:

(1) Identify the applicable preventive maintenance activities, including their associated intervals, that are required to maintain the continued acceptable performance of the pump.

(2) Identify the applicable examination activities, including their associated intervals, that will be used to periodically assess the condition of the pump.

(3) Identify the applicable CMT activities, including their associated intervals, that will be used to periodically verify the acceptable performance of the pump. For CMT activities with continuous monitoring capability, establish appropriate analysis intervals.

(4) Identify the interval of each activity, unless a CMT activity is conducted or available continuously. Initial intervals shall be established using optimization of pump condition-monitoring activities, provided that the CMT and examination intervals evaluate plant safety and are supported by the trending and evaluation of generic and plant-specific performance data. Trending and evaluation shall be used to support the conclusion that the pump is capable of performing its intended function or functions over the entire interval.

(b) Quarterly test frequency intervals may be extended, provided a CMT is performed at a minimum of every 6 months. The interval between CP-2.2 testing may be extended another quarter when CMT requirements are determined to be appropriate in CP-2.4.3.1(a)(1) through CP-2.4.3.1(a)(4) and provided all manufacturer recommendations, such as shaft rotation, oil change, etc., are met.

(1) When implementing adequate CMT, the interval between CP-2.2 testing may be extended using quarterly interval extensions up to a maximum of 5 yr.

(2) For those pumps that have six or more sets of CMT data that support interval extensions, that data may be utilized to determine the initial pump condition-monitoring program extension.

(c) Identify attributes that will be trended. Trending and evaluation of existing data must be used to reduce or extend the time interval between tests or examinations.

(d) Revise the test plans (see CP-2.4.5) to document the optimized pump condition-monitoring program activities and the associated intervals of each activity.

(e) Perform these activities at their associated intervals.

(f) After performance of the optimized pump condition-monitoring activities, review the results of each activity to determine whether any changes to the optimized pump condition-monitoring program are required. If significant changes are required, the program shall be revised prior to the performance of the next activity, and the applicable requirements of CP-2.4.4 and CP-2.4.5 shall be repeated.

(g) Changes to IST intervals must evaluate plant safety and be supported by trending and evaluating both generic and plant-specific performance data to ensure the component is capable of performing its intended function or functions over the entire interval.

(h) In addition to CP-2.2 testing acceptance criteria, the Owner shall develop specific acceptance criteria for each trendable CMT attribute and implement corrective action in accordance with CP-2.4.4 if acceptance criteria are not met.

CP-2.4.4 Condition-Monitoring Program Corrective Action

(a) If corrective maintenance is performed on a pump, or a similar pump, the analysis used to formulate the basis of the pump condition-monitoring activities shall be reviewed to determine whether any changes are required. If significant changes are required, the program shall be revised, and the applicable requirements of CP-2.4.2 and CP-2.4.3 shall be repeated.

(b) The hydraulic and mechanical condition of a pump relative to a previous condition can be determined by trending CP-2.2 and CMT testing and condition-monitoring testing results. Deviations detected are symptoms of changes and, depending on the degree of deviation, indicate the need for further tests or corrective action. The Owner shall develop the following:

(1) CMT results that shall include documented evaluation of deviations detected and why further testing and corrective action is, or is not, needed

(2) corrective actions to be performed in accordance with the Owner's Quality Assurance Program

(c) Corrective actions requiring repair or replacement activities shall be performed in accordance with the Owner's Quality Assurance Program.

(d) If a supplemental monitoring activity identifies a parameter outside the normal operating range or identifies a trend toward an unacceptable degraded state, the following actions shall be taken:

(1) Identify and document the condition in the corrective action program established in accordance with the Owner's Quality Assurance Program.

(2) Increase monitoring to establish the rate of change of the monitored parameter.

(3) Review component-specific information to identify the degradation cause.

(4) Develop a plan to remove the pump from an operationally ready condition to perform maintenance prior to significant performance degradation.

(5) Address potential generic concerns applicable to other pumps based on the results of the analysis of the specific pump performance.

CP-2.4.5 Condition-Monitoring Program Documentation. The pump condition-monitoring program shall be documented and shall include the following information:

(a) list of pumps in the program and the critical design and performance attributes of the pumps, their drivers, and associated electrical system components

(b) dates pumps were added and/or deleted to the program and the reason for their inclusion and/or deletion, including pertinent performance, repair, or refurbishment history

(c) analysis forming the basis for the program

(d) identified failure or maintenance history patterns for each pump

(e) pump condition-monitoring program activities, including the trended attributes and the bases for the associated intervals for each pump

(f) records of required corrective action

CP-3 CORRECTIVE ACTIONS

Corrective actions shall be performed as specified in GR-3 and this Section. If the pump performance is unacceptable, as established in this Section, the pump's operational readiness is not verified, and corrective action shall be taken in accordance with the Owner's corrective action requirements. Prior to returning the pump to an operationally ready condition, corrective action shall be completed with either

(a) testing to demonstrate that the pump can perform its specified functions until the next scheduled test, or

(b) performance of an analysis that supports the pump's continued use at the changed values

This analysis shall include verification of the pump's operational readiness at both the pump level and a system level, the cause of the change in pump performance, and an evaluation of all trends indicated by available data. The analysis shall confirm the current reference values or establish new reference values. The results of this analysis shall be documented in the record of tests.

CP-4 RECORDS

(a) Pump records shall be maintained in accordance with GR-4 and as specified in this subsection.

(b) The Owner shall maintain a record that shall include the following for each pump covered by this Section:

(1) the name of the manufacturer and the manufacturer's model and serial numbers or other identification number

(2) a copy or summary of the manufacturer's acceptance test report, if available

(3) a copy of the pump manufacturer's operating limits

(4) test parameters (e.g., flow rate and associated differential pressure, or flow rate and associated discharge pressure, and speed for variable speed pumps) and their basis

Section PDP
Positive Displacement Pumps

PDP-1 INTRODUCTION

Positive displacement pumps within the scope of this Code shall meet the requirements specified in Section GR and this Section.

PDP-2 INSERVICE TESTING REQUIREMENTS

PDP-2.1 General Requirements

PDP-2.1.1 Testing Parameters. The hydraulic and mechanical condition of a pump relative to a previous condition can be determined by attempting to duplicate by test a set of reference values. Deviations detected are symptoms of changes and, depending on the degree of deviation, indicate the need for further tests or corrective action. The parameters to be measured during baseline testing and IST are specified in Table PDP-2.1.1-1.

PDP-2.1.2 Baseline Testing

(a) The parameters to be measured are specified in Table PDP-2.1.1-1.

(b) Reference values shall be taken at or near pump design pressure for the parameters specified in Table PDP-2.1.1-1.

(c) Vibration measurements are only required to be taken at the reference point or points.

(d) A baseline test may be substituted for any inservice test.

Table PDP-2.1.1-1
Inservice Test Parameters
for Positive Displacement Pumps

Quantity	Baseline Test	Inservice Test
Speed, N [Note (1)]	X	X
Discharge pressure, P	X	X
Flow rate, Q	X	X
Vibration [Note (2)]		
Displacement, V_d	X	X
Velocity, V_v	X	X

NOTES:
(1) If variable speed.
(2) Measure either peak-to-peak displacement, V_d, or peak velocity, V_v.

PDP-2.1.3 Baseline Testing Frequency. A baseline test shall be performed and an initial set of reference values established in accordance with PDP-2.1.6.2 prior to the pump being relied on to perform its specified functions. Except as specified in PDP-2.1.7.1, only one baseline test is required for each pump.[1]

PDP-2.1.4 Inservice Testing Interval

(a) An inservice test shall be performed on each pump quarterly. Optional adjustment of this interval is provided in PDP-2.4.

(b) An inservice test shall be current within the established frequency prior to the pump being relied on to perform its specified functions.

PDP-2.1.5 Pumps in Regular Use. Pumps that are operated more frequently than every 3 months need not be run or stopped for a special test, provided the plant records show the pump was operated at least once every 3 months at the reference conditions, and the quantities specified were determined, recorded, and analyzed per PDP-2.3.

PDP-2.1.6 Data Collection

PDP-2.1.6.1 General

(a) Instrument Location. The sensor location shall be established by the Owner, documented in the plant records, and appropriate for the parameter being measured. The same location shall be used for subsequent tests. Instruments that are position sensitive shall be either permanently mounted, or provision shall be made to duplicate their position during each test.

(b) Fluctuations. Symmetrical damping devices or averaging techniques may be used to reduce instrument fluctuations. Hydraulic instruments may be damped by using gage snubbers or by throttling small valves in instrument lines.

(c) Instrument Loop. Two or more instruments or components working together to provide a single output.

(d) Instrument Loop Accuracy. Accuracy of an instrument loop is based on the square root of the sum of the squares of the inaccuracies of each instrument or component in the loop when considered separately.

[1] It is recommended, though not required, that the baseline test be performed soon after completion of installation activities and prior to significant runtime of the pump.

Table PDP-2.1.6.1-1
Required Instrument Accuracy — Hydraulic

Quantity	Baseline and Inservice Tests, % of Indicated Value
Pressure	±1½
Flow rate	±6

Alternatively, the allowable inaccuracy of the instrument loop may be based on the output for a known input into the instrument loop.

(e) Flow and Pressure Measurement

(1) Accuracy. Analog or digital instruments may be used, provided they are calibrated within the limits specified in Table PDP-2.1.6.1-1 at the expected indicated values (e.g., reference values).

(2) Range. The analog or digital instrument shall be designed and calibrated for use at the expected indicated values (e.g., reference values) to be measured or recorded during the test.

(3) Analytical Methods. If a parameter is determined by analytical methods instead of measurement (e.g., lake level for pressure or change in tank level over time for flow), then the determination shall meet the parameter accuracy requirement of Table CP-2.1.6.1-1. The method used to determine the parameter shall be included in the record.

(4) Gage Lines. If the presence or absence of liquid in a gage line could produce a difference of more than 0.25% in the indicated value of the measured pressure, means shall be provided to ensure or determine the presence or absence of liquid as required for the static correction used.

(f) Rotational Speed Measurement — Variable Speed Pumps Only

(1) Range. Digital instruments shall be selected such that the reference value does not exceed 90% of the calibrated range of the instrument.

(2) Accuracy. Instrument accuracy shall be within the limits of Table PDP-2.1.6.1-2.

(3) Rotational Speed Measurement. Rotational speed measurements of variable speed pumps shall be taken by a method that meets the requirements of Table PDP-2.1.6.1-2.

(g) Vibration Measurement

(1) For pumps operating at or above 600 rpm, the frequency response range of the vibration-measuring transducers and their readout system shall be from one-third minimum pump shaft rotational speed to at least 1,000 Hz.

(2) For slow speed pumps operating below 600 rpm, the frequency response range of the vibration-measuring transducers and their readout system shall be no lower than 1 Hz to at least 1,000 Hz.

(3) Instrument accuracy shall be within the limits of Table PDP-2.1.6.1-2.

(4) Measurements shall be taken in a plane approximately perpendicular to the rotating shaft in two approximately orthogonal directions on each accessible pump-bearing housing. Measurement shall also be taken in the axial direction on each accessible pump thrust-bearing housing.

(5) If a portable vibration indicator is used, the measurement points shall be clearly identified on the pump to permit subsequent duplication in both location and plane.

(6) Pumps that will use the "minimum reference" value for one or more vibration points shall use trending analysis of measured vibration amplitudes in the frequency domain to assess performance at these locations. The Owner shall document the conclusion of the performance analysis prior to the subsequent test with a conclusion of acceptable, degrading but acceptable, or unacceptable. Corrective action shall be initiated when an unacceptable trend in performance is identified.

PDP-2.1.6.2 Reference Values

(a) Reference values for the pump inservice test shall be obtained as follows:

(1) Initial reference values shall be determined from the results of testing meeting the requirements of baseline testing or from the results of the first inservice test.

(2) New or additional reference values shall be established as required by PDP-2.1.7, PDP-2.1.8, or PDP-2.3.2(c).

(3) Reference values shall be established only when the pump is known to be operating acceptably.

(4) Reference values shall be established at a point or points of operation (reference point) readily duplicated during subsequent tests.

(5) Reference values shall be established at the inservice test flow rate. The best efficiency point, system flow rates, and any other plant-specific flow rates shall be evaluated.

Table PDP-2.1.6.1-2
Required Instrument Accuracy — Mechanical

Quantity	Baseline and Inservice Tests, %
Speed	±2
Vibration	
>4 Hz to 1,000 Hz [Note (1)]	±5
1 Hz to 4 Hz [Note (2)]	±15

NOTES:

(1) ±5% accuracy from >4 Hz or one-third pump shaft rotation speed to at least 1,000 Hz in native units (accelerometers in acceleration, velocity transducers in velocity, etc.).

(2) Transducers used on slow speed running pumps under 600 RPM: ±15% accuracy in native units (accelerometers in acceleration, velocity transducers in velocity, etc.) from 1 Hz to 4 Hz and ±5% > 4 Hz to a minimum of 1,000 Hz.

(6) For smooth running pump-measured vibration reference values less than 0.050 ips/0.00127 mps, the owner may use 0.050 ips/0.00127 mps as the minimum reference value for one or more of the vibration points. In such cases, the minimum reference value of 0.050 ips/0.00127 mps shall be used to define acceptable pump performance in accordance with PDP-2.3.

(b) All subsequent test results shall be compared to these initial reference values or to new reference values established as required by PDP-2.1.7, PDP-2.1.8, or PDP-2.3.2(c).

(c) Related conditions that can significantly influence the measurement or determination of the reference value shall be analyzed in accordance with PDP-2.3.4.

PDP-2.1.7 Effect of Pump Replacement, Repair, and Maintenance on Reference Values

PDP-2.1.7.1 Replacement and Major Maintenance. Following replacement, major maintenance, or routine servicing (e.g., piston replacement), such that the existing baseline test data and reference values do not represent the installed pump, the following shall be performed before declaring the pump operationally ready:

(a) A baseline test shall be performed in accordance with PDP-2.1.2.

(b) A new set of reference values shall be established in accordance with PDP-2.1.6.2 from the results of the baseline test.

(c) Verification that the new reference values represent acceptable pump operation shall be placed in the record of tests.

PDP-2.1.7.2 Routine Maintenance and Repair. When a reference value or set of reference values might have been affected by repair or routine maintenance, other than that covered under PDP-2.1.7.1, the following shall be performed before declaring the pump operationally ready:

(a) An inservice test shall be performed and the previous reference values reconfirmed, or a new reference value, or set of reference values, shall be determined in accordance with PDP-2.1.6.2.

(b) If new reference values are determined, deviations from the previous and new reference values shall be evaluated, and verification that the new values represent acceptable pump operation shall be placed in the record of tests.

PDP-2.1.8 Establishment of Additional Set of Reference Values. If it is necessary or desirable, for some reason other than stated in PDP-2.1.7, to establish an additional set of reference values, an inservice test shall be run at the conditions of an existing set of reference values and the results analyzed. If operation is acceptable per PDP-2.3.2, an additional set of reference values may be established as follows:

(a) The additional set of reference values shall be established per PDP-2.1.6.2. A test shall be run to verify the new reference values before their implementation.

(b) A test shall be run to verify the new reference values before their implementation. Whenever an additional set of reference values is established, the reasons for so doing shall be justified and documented in the record of tests. The requirements of PDP-2.1.6.2 apply.

PDP-2.1.9 Duration of Tests. For all pump baseline tests and inservice tests, after pump conditions are as stable as the system permits, each pump shall be run at least 2 min. At the end of this time, at least one measurement or determination of each of the quantities required by Table PDP-2.1.1-1 shall be made and recorded.

PDP-2.2 Specific Inservice Testing Requirements

Tests shall be conducted with the pump operating at a specified reference point and within the variances from the reference point as described in this paragraph. The test shall be conducted as follows:

(a) The pump shall be operated at nominal motor speed for constant speed drives or at a speed adjusted to the reference point (±1%) for variable speed drives.

(1) The resistance of the system shall be varied until the discharge pressure is the reference point with the variance not to exceed +1% or −2% of the reference point. The flow rate shall then be determined and compared to its reference value.

(2) Vibration (displacement or velocity) shall be determined and compared with corresponding reference values. Vibration measurements are to be an overall value, without filtering, of velocity or displacement. If velocity measurements are used, measurement shall be peak. If displacement amplitudes are used, measurement shall be peak-to-peak.

(3) All deviations from the reference values shall be compared with the ranges of Table PDP-2.2-1 or Table PDP-2.2-2, as applicable, and corrective action taken as specified in PDP-2.3.2. For reciprocating positive displacement pumps, vibration measurements shall be compared to the relative criteria shown in the alert and required action ranges of Table PDP-2.2-2. For all other positive displacement pumps, vibration measurements shall be compared to both the relative and absolute criteria shown in the alert and required action ranges of Table PDP-2.2-1. For example, if vibration exceeds either $6V_r$ or 0.7 in./sec (1.7 cm/s), the pump is in the required action range.

PDP-2.3 Monitoring, Analysis, and Evaluation

PDP-2.3.1 Trending Test parameters shown in Table PDP-2.1.6.1-1, except for fixed values, shall be trended.

Table PDP-2.2-1
Positive Displacement Pump (Except Reciprocating) Test Acceptance Criteria

Test Type	Pump Speed	Test Parameter	Acceptable Range	Alert Range	Required Action Range	
					Low	High
Inservice test [Notes (1), (2)]	N/A	Q	$0.95Q_r$ to $1.06Q_r$	$0.93Q_r$ to $<0.95Q_r$	$<0.93Q_r$	$>1.06Q_r$
	N/A	P	$0.93P_r$ to $1.06P_r$	$0.90P_r$ to $<0.93P_r$	$<0.90P_r$	$>1.06P_r$
	<600 rpm	V_v [Note (3)]	≤0.125 in./sec (≤0.3 cm/s)	>0.125 in./sec to 0.300 in./sec (>0.3 cm/s to 0.7 cm/s)	None None	>0.300 in./sec (>0.7 cm/s)
		V_d or V_v	$\leq 2.5V_r$	$>2.5V_r$ to $6V_r$ or >10.5 mils to 22 mils (>266.7 μm to 558.8 μm)		$>6V_r$ or >22 mils (>558.8 μm)
	≥600 rpm	V_v [Note (3)]	≤0.125 in./sec (≤0.3 cm/s)	>0.125 in./sec to 0.300 in./sec (>0.3 cm/s to 0.7 cm/s)	None None	>0.300 in./sec (>0.7 cm/s)
		V_v or V_d	$\leq 2.5V_r$	$>2.5V_r$ to $6V_r$ or >0.325 in./sec to 0.7 in./sec (>0.87 cm/s to 1.7 cm/s)		$>6V_r$ or >0.7 in./sec (>1.7 cm/s)

GENERAL NOTE: The subscript *r* denotes reference value, the subscript *v* denotes vibration velocity reference value, and the subscript *d* denotes displacement.

NOTES:
(1) Vibration parameter V_r is vibration reference value in the selected units.
(2) Refer to Figure PDP-2.2-1 to establish displacement limits for pumps with speeds ≥600 rpm or velocity limits for pumps with speeds <600 rpm.
(3) Pumps that will use the "minimum reference" value for one or more vibration points shall use trending analysis of measured vibration amplitudes in the frequency domain to assess performance at these locations.

Table PDP-2.2-2
Reciprocating Positive Displacement Pump Test Acceptance Criteria

Test Type	Pump Speed	Test Parameter	Acceptable Range	Alert Range	Required Action Range	
					Low	High
Inservice test	N/A	Q	$0.95Q_r$ to $1.06Q_r$	$0.93Q_r$ to $<0.95Q_r$	$<0.93Q_r$	$>1.06Q_r$
	N/A	P	$0.93P_r$ to $1.06P_r$	$0.90P_r$ to $<0.93P_r$	$<0.90P_r$	$>1.06P_r$
	N/A	V_v [Note (1)]	≤0.125 in./sec (≤0.3 cm/s)	>0.125 in./sec to 0.300 in./sec (>0.3 cm/s to 0.7 cm/s)	None	>0.300 in./sec (>0.7 cm/s)
	N/A	V_v or V_d	$\leq 2.5V_r$	$>2.5V_r$ to $6V_r$	None	$>6V_r$

GENERAL NOTE: The subscript *r* denotes reference value, the subscript *v* denotes vibration velocity reference value, and the subscript *d* denotes displacement.

NOTE: (1) Pumps that will use the "minimum reference" value for one or more vibration points shall use trending analysis of measured vibration amplitudes in the frequency domain to assess performance at these locations [see PDP-2.1.6.2(a)(6)].

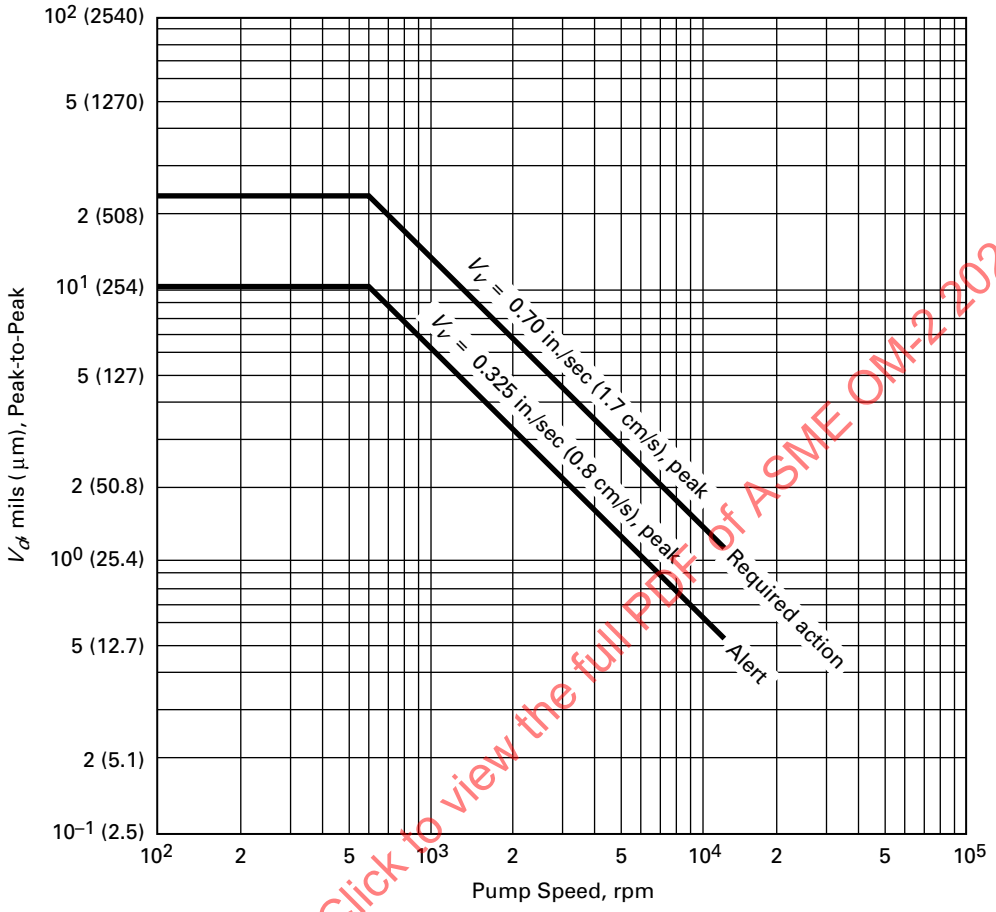
PDP-2.3.2 Corrective Action

(a) Alert Range. If the measured test parameter values fall within the alert range of Table PDP-2.2-1 or Table PDP-2.2-2, as applicable, the frequency of testing shall be at least once every 45 days until the cause of the deviation is determined and the condition is corrected or an analysis of the pump is performed in accordance with (c).

(b) Action Range. If the pump periodic verification test flow or pressure parameter is not met or a measured test parameter value falls within the required action range of Table PDP-2.2-1 or Table PDP-2.2-2, as applicable, the pump's operational readiness is not verified until either the cause of the deviation has been determined and the condition is corrected or an analysis of the pump is performed in accordance with (c).

(c) Analysis. In cases where the pump's test parameters are within either the alert or required action ranges of Table PDP-2.2-1 or Table PDP-2.2-2, as applicable, an analysis may be performed that supports the pump's continued use at the changed values. This analysis shall include verification of the pump's operational readiness. The analysis shall include both a pump level and system level evaluation of operational readiness, the cause of the change in pump performance, and an

Figure PDP-2.2-1
Positive Displacement Pump Vibration Limits



evaluation of all trends indicated by available data. The analysis shall confirm the current reference value or values or establish a new reference value or values. The results of this analysis shall be documented in the record of tests.

PDP-2.3.3 Systematic Error. When a test shows measured parameter values that fall outside of the acceptable range of Table PDP-2.2-1 or Table PDP-2.2-2, as applicable, that have resulted from an identified systematic error, such as improper system lineup or inaccurate instrumentation, the test shall be rerun after correcting the error.

PDP-2.3.4 Analysis of Related Conditions

(a) If the reference value of a particular parameter being measured or determined can be significantly influenced by other related conditions, then these conditions shall be analyzed and documented in the record of tests (see PDP-4).

(b) Vibration measurements of pumps might be foundation, driver, or piping dependent. Therefore, if initial vibration readings are high and have no obvious relationship to the pump, then additional vibration measurements shall be taken as necessary (e.g., at the driver, at the foundation, and on the piping) and analyzed to ensure that the reference vibration measurements are representative of the pump, and the measured vibration levels will not prevent the pump from fulfilling its function. This analysis shall be documented in the record of tests.

PDP-2.4 Condition-Monitoring Program

PDP-2.4.1 Condition-Monitoring Purpose

(a) The alternative requirements for condition monitoring of pumps (see PDP-2.4) establishes testing and monitoring requirements for the implementation and maintenance of a condition-monitoring program for pumps, pump drivers, and associated pump electrical system components. The intended purpose of the pump condition-monitoring program is to provide

additional technologies for monitoring the condition of pumps and associated components, which will allow

(1) performance improvement activities through enhanced detection of degradation and machine faults

(2) optimization of pump condition-monitoring activities

(b) The alternative requirements for condition monitoring of pumps (see PDP-2.4) shall be used in conjunction with inservice testing requirements when the Owner wishes to adjust frequency of testing pumps as specified in PDP-2.1.4. In addition, the purpose of the pump condition-monitoring program is to improve both pump performance and optimize testing, monitoring, and preventive maintenance activities to maintain the continued acceptable performance of a Code-tested pump. If the pump condition-monitoring program for a pump is discontinued, then all the requirements of PDP-2 through PDP-2.3 shall apply.

(c) The frequency of testing pumps as specified in PDP-2.1.4 may be adjusted, provided alternative requirements for condition monitoring of pumps are applied. Except for adjustment to testing frequency specified in PDP-2.1.4, the alternative requirements for condition monitoring of pumps (see PDP-2.4) do not alter or exempt any other requirement.

(d) The alternative requirements for condition monitoring of pumps (see PDP-2.4) address information regarding pump drivers and associated equipment for the sole purpose of using such information to evaluate the condition of pumps and not to provide any evaluation of those drivers and associated equipment.

PDP-2.4.2 Condition-Monitoring Analysis

(a) The Owner shall perform an analysis of the design, test history, and maintenance history of a pump, a pump driver, and the pump electrical system to determine those additional pump condition-monitoring technologies, acceptance criteria, and equipment to be included in the pump condition-monitoring program that will enhance detection of degradation and machine set faults.

(b) In addition to the testing required by PDP-2.2, the analysis shall include condition-monitoring technologies and parameters for vibration analysis, lube oil analysis,[2] thermography, motor current signature analysis, motor electrical parameters, and process and equipment parameters.

(1) Vibration Analysis. Vibration analysis involves the Owner utilizing instrumentation capable of collecting and analyzing spectral vibration data to monitor machine condition. Vibration analysis is the primary technology, along with lube oil analysis, used in a condition-monitoring program. The emphasis on utilizing equipment capable of collecting and analyzing spectral vibration is to ensure that the resulting vibration analysis can identify the many types of equipment faults and characterize, and trend, machinery conditions in a manner that supports accurate and reliable fault detection, maintenance, planning, and long-term equipment reliability.

(2) Lube Oil Analysis.[2] Lube oil analysis involves analyzing oil properties, including those of the base oil and its additives, and identifying the presence of contaminants and wear debris.

(3) Thermography. Thermography is used for detecting and measuring variations in the heat emitted by various regions of a body and transforming them into visible signals that can be recorded photographically. Thermography can be used as a tool for identifying potential equipment faults, performing post-maintenance retests, and trending the condition of equipment components subject to temperature degradation. For example, thermography can be used to monitor switchgear, breakers, and control relays providing electrical power to equipment and can also be used to detect mechanical equipment faults.

(4) Motor Current Signature Analysis. Motor current signature analysis involves analyzing motor current data in the frequency domain. Motor current signature analysis shall be collected and utilized to verify proper mechanical and electrical characteristics and loading, as well as to help troubleshoot and identify equipment faults and problems. Demodulated current spectra are typically more effective for identifying mechanical characteristics.

(5) Motor Electrical Parameters. Motor electrical operating parameters, including current, voltage, and stator winding temperatures, shall be monitored in accordance with manufacturer's recommendations, industry standards and practices, and plant experience. Current, phase balance, and winding temperatures can provide an indication of degradation to predict impending failure.

(6) Process and Equipment Parameters. Process and equipment parameter variations might impact condition-monitoring results. Applicable process and equipment data shall be collected in conjunction with the equipment condition-monitoring data. This includes any specific plant condition or operating parameters that might or does affect equipment-operating characteristics. As applicable and available, when doing walkdowns of the equipment or during operator rounds and data collection, visual, auditory, olfactory, and tactile observations of equipment sounds, smells, discoloration, casing, and bearing housing temperature changes or leaks can identify potential equipment problems that left unattended could lead to equipment failure.

(c) The analysis shall include identification of any common failure or maintenance patterns. Analyze these patterns to determine their significance and identify potential failure mechanisms. The analysis shall determine whether

[2] For components that do not have lube oil, lube oil analysis is not required.

(1) certain preventive maintenance activities or a periodic pump run to verify it starts and is capable of achieving the expected flow or differential pressure (bump test) would mitigate the risk of failure or identify need to change maintenance patterns

(2) application of condition-monitoring technologies and parameters are feasible and effective in monitoring for and detecting these failure mechanisms

(3) periodic disassembly and examination activities would be effective in monitoring for and detecting these failure mechanisms

PDP-2.4.3 Condition-Monitoring Program Activities

PDP-2.4.3.1 Performance Improvement Activities

(a) If sufficient information is not currently available to complete the analysis required in PDP-2.4.2, or if the analysis is inconclusive, then the following activities shall be performed at sufficient intervals over an interim period to determine a pending cause of failure or the acceptability of the maintenance patterns. This interim period shall continue until multiple and acceptable additional condition-monitoring data points are obtained. All PDP-2 test requirements shall be met during this interim period.

(1) Identify interim tests (e.g., application of condition-monitoring technologies and parameters) to assess the performance of the pump, pump drivers, and associated pump electrical components and the enhanced detection of degradation and machine faults.

(2) Identify interim application of condition-monitoring technologies and parameters to evaluate potential degradation mechanisms.

(3) Identify other types of analysis that will be performed to assess pump condition.

(4) Identify the interval of each activity or if continuous monitoring will be performed.

(b) Identify attributes that will be trended. Trending and evaluation of existing data must be used as the basis to reduce or increase the frequency of the PDP-2.2 test and pump condition-monitoring test (CMT). Note that the CMT may be a test or an activity such as, but not limited to, continuous monitoring when pump set is online or obtaining a spectral analysis data set periodically on a standby pump.

(c) Complete or revise the pump condition-monitoring program test plans to document the pump program performance improvement activities and their associated frequencies.

(d) Perform the pump condition-monitoring activities at the identified associated frequencies until either of the following conditions is reached:

(1) Enough information is obtained to permit an adequate evaluation of the specific application.

(2) The interim period ends.

(e) After completion of (a)(1) through (a)(4), review the attributes that were selected for trending, along with the results of each activity and trends to determine whether any changes to the performance improvement program are required. If needed based on the results of the last scheduled CMT, the program shall be revised in accordance with the site corrective action program prior to performing additional program improvement CMTs, and the applicable requirements of PDP-2.4.2 and PDP-2.4.3 shall be repeated.

PDP-2.4.3.2 Optimization of Pump Condition-Monitoring Activities

(a) If sufficient information is available to assess the performance adequacy of the pump, then the following activities shall be performed:

(1) Identify the applicable preventive maintenance activities, including their associated intervals that are required to maintain the continued acceptable performance of the pump.

(2) Identify the applicable examination activities, including their associated intervals that will be used to periodically assess the condition of the pump.

(3) Identify the applicable CMT activities, including their associated intervals that will be used to periodically verify the acceptable performance of the pump. For CMT activities with continuous monitoring capability, establish appropriate analysis intervals.

(4) Identify the interval of each activity, unless a CMT activity is conducted or available continuously. Initial intervals shall be established using optimization of pump condition-monitoring activities, provided that the CMT and examination intervals evaluate plant safety and are supported by the trending and evaluation of generic and plant-specific performance data. Trending and evaluation shall be used to support the conclusion that the pump is capable of performing its intended function or functions over the entire interval.

(b) Quarterly test frequency intervals may be extended, provided a CMT is performed at a minimum of every 6 months. The interval between PDP-2.2 testing may be extended another quarter when CMT requirements are determined to be appropriate in PDP-2.4.3.1(a)(1) through PDP-2.4.3.1(a)(4) and provided all manufacturer recommendations, such as shaft rotation, oil change, etc., are met.

(1) When implementing adequate CMT, the interval between PDP-2 testing may be extended using quarterly interval extensions up to a maximum of 5 yr.

(2) For those pumps that have six or more sets of CMT data that support interval extensions, that data may be utilized to determine the initial pump condition-monitoring program extension.

(c) Identify attributes that will be trended. Trending and evaluation of existing data must be used to reduce or extend the time interval between tests or examinations.

(d) Revise the test plans (see PDP-2.4.5) to document the optimized pump condition-monitoring program activities and the associated intervals of each activity.

(e) Perform these activities at their associated intervals.

(f) After performance of the optimized pump condition-monitoring activities, review the results of each activity to determine whether any changes to the optimized pump condition-monitoring program are required. If significant changes are required, the program shall be revised prior to the performance of the next activity, and the applicable requirements of PDP-2.4.3 and PDP-2.4.4 shall be repeated.

(g) Changes to IST intervals must evaluate plant safety and be supported by trending and evaluating both generic and plant-specific performance data to ensure the component is capable of performing its intended function or functions over the entire interval.

(h) In addition to PDP-2.2 testing acceptance criteria, the Owner shall develop specific acceptance criteria for each trendable CMT attribute and implement corrective action in accordance with PDP-2.4.4 if acceptance criteria are not met.

PDP-2.4.4 Condition-Monitoring Program Corrective Action

(a) If corrective maintenance is performed on a pump, or a similar pump, the analysis used to formulate the basis of the pump condition-monitoring activities shall be reviewed to determine whether any changes are required. If significant changes are required, the program shall be revised, and the applicable requirements of PDP-2.4.2 and PDP-2.4.3 shall be repeated.

(b) The hydraulic and mechanical condition of a pump relative to a previous condition can be determined by trending PDP-2.2 and CMT testing and condition-monitoring testing results. Deviations detected are symptoms of changes and, depending on the degree of deviation, indicate a need for further tests or corrective action. The Owner shall develop

(1) CMT results that shall include documented evaluation of deviations detected and why further testing and corrective action is, or is not, needed

(2) corrective actions to be performed in accordance with the Owner's Quality Assurance Program

(c) Corrective actions requiring repair or replacement activities shall be performed in accordance with Owner's Quality Assurance Program.

(d) If a supplemental monitoring activity identifies a parameter outside the normal operating range or identifies a trend toward an unacceptable degraded state, action shall be taken to

(1) identify and document the condition in the corrective action program established in accordance with the Owner's Quality Assurance Program

(2) increase monitoring to establish the rate of change of the monitored parameter

(3) review component-specific information to identify the degradation cause

(4) develop a plan to remove the pump from an operationally ready condition to perform maintenance prior to significant performance degradation

(5) address potential generic concerns applicable to other pumps based on the results of the analysis of the specific pump performance

PDP-2.4.5 Condition-Monitoring Program Documentation. The pump condition-monitoring program shall be documented and shall include the following information:

(a) a list of pumps in the program and the critical design and performance attributes of the pumps, their drivers, and associated electrical system components

(b) dates pumps were added and/or deleted to the program and the reason for their inclusion and/or deletion, including pertinent performance, repair, or refurbishment history

(c) analysis forming the basis for the program

(d) identified failure or maintenance history patterns for each pump

(e) pump condition-monitoring program activities, including the trended attributes and the bases for the associated intervals for each pump

(f) records of required corrective action

PDP-3 CORRECTIVE ACTIONS

Corrective actions shall be performed as specified in GR-3 and this subsection. If the pump performance is unacceptable, as established in this Section, the pump's operational readiness is not verified, and corrective action shall be taken in accordance with the Owner's corrective action requirements. Prior to returning the pump to an operationally ready condition, corrective action shall be completed with either

(a) testing to demonstrate that the pump can perform its specified functions until the next scheduled test, or

(b) performance of an analysis that supports the pump's continued use at the changed values

This analysis shall include verification of the pump's operational readiness at both the pump level and a system level, the cause of the change in pump performance, and an evaluation of all trends indicated by available data. The analysis shall confirm the current reference value or establish a new reference value or values. The results of this analysis shall be documented in the record of tests.

PDP-4 RECORDS

(a) Pump records shall be maintained in accordance with GR-4 and as specified in this Section.

(b) The Owner shall maintain a record that shall include the following for each pump covered by this Section:

(1) the name of the manufacturer and the manufacturer's model and serial numbers or other identification number

(2) a copy or summary of the manufacturer's acceptance test report, if available

(3) a copy of the pump manufacturer's operating limits

(4) test parameters (e.g., flow rate and associated discharge pressure, and speed for variable speed pumps) and their basis

Section AOV
Air-Operated Valves

AOV-1 INTRODUCTION

Air-operated valves (AOVs) within the scope of this Code shall meet the requirements specified in Section GR and this Section.

AOV-2 INSERVICE TESTING REQUIREMENTS

AOV-2.1 General Requirements

AOV-2.1.1 Baseline Testing

(a) Each AOV shall be tested prior to the initial IST interval as required by this Section. Testing that meets the requirements of this Code but was performed before implementation of this Code may be used. A baseline test of each valve shall be conducted within 1 yr of the initial IST.

(b) Each of the following baseline tests shall be performed for each AOV:

(1) performance assessment test
(2) stroke test
(3) fail-safe test, as applicable
(4) leak testing, as applicable
(5) position verification testing for valves with remote position indicators

(c) Any AOV that has undergone maintenance that could affect its performance after the baseline test shall be tested in accordance with AOV-2.1.3.

AOV-2.1.2 Inservice Testing. Inservice testing shall commence when the AOV is relied on to be capable of performing its specified functions. The following inservice tests shall be performed for each AOV:

(a) performance assessment test
(b) stroke test
(c) fail-safe test, as applicable
(d) leak testing, as applicable
(e) position verification testing for valves with remote position indicators

AOV-2.1.3 Effect of AOV Replacement, Repair, Modification, or Maintenance. When an AOV is replaced, repaired, or modified or undergoes maintenance that could affect the valve's performance, new inservice test values shall be determined. The previously established inservice test values shall be reconfirmed, or the activities performed shall be evaluated, along with the results of post-replacement, repair, modification, and maintenance testing to determine if new inservice test values are warranted before the AOV is returned to service. If the AOV was not removed from service, inservice test values shall be immediately determined or confirmed. This testing is intended to demonstrate that test parameters, which could be affected by the replacement, repair, modification, or maintenance, are within acceptable limits. The Owner's program shall define the level of testing required prior to and after replacement, repair, modification, or maintenance activities. Other attributes, such as functional margin, shall be evaluated when defining the level of testing required prior to and after replacement, repair, modification, or maintenance activities, where the basis is properly justified and documented by an engineering evaluation. Deviations between the previous and new inservice test values shall be identified and analyzed. Verification that the new inservice test values represent acceptable operation shall be documented as described in AOV-4.

AOV-2.1.4 AOV Inservice Testing Requirements. Inservice testing shall be performed on each AOV as specified in this Section.

(a) Valve Obturator Movement. The necessary valve obturator movement shall be determined by exercising the valve while observing an appropriate indicator, such as indicating lights that signal the required changes of obturator position, or by observing other evidence, such as changes in system pressure, flow rate, level, or temperature, that reflects change of obturator position.

(1) AOVs in Regular Use. AOVs that operate in the course of plant operation at a frequency that would satisfy the exercising requirements of this Section need not be additionally exercised, provided that the observations otherwise required for testing are made and analyzed during such operation and recorded in the plant record at intervals no greater than specified in AOV-2.5.3(a).

(2) AOVs Out of Service. For an AOV that is out of service, the exercising test schedule need not be followed. Before placing the valve in service, the valve shall meet the requirements of this Section.

(b) Position Verification Testing. AOVs with remote position indicators shall be observed at least once every 5 yr to verify that valve operation is accurately

indicated by indications such as use of flow meters or other suitable instrumentation to verify obturator position.

(c) Leak Testing Requirements. Seat leakage testing shall be in accordance with Section VLT.

AOV-2.2 Instrumentation and Test Equipment

Instrumentation and test equipment accuracy shall be included when establishing AOV test acceptance criteria.

AOV-2.3 Specific Inservice Testing Requirements

AOV-2.3.1 Performance Assessment Testing. Performance assessment testing shall be performed to assess functional margin. An initial performance assessment test shall be performed to assess functional margin of each AOV prior to reliance on its capability to perform the specified functions. Baseline performance assessment test may be used to meet this requirement.

(a) The interval for periodic performance assessment tests shall be determined to demonstrate that an adequate functional margin exists between valve-operating requirements and the available actuator output capability to satisfy the acceptance criteria per AOV-2.4.1.

(b) In addition to meeting the acceptance criteria, the performance assessment test interval shall be set such that an adequate functional margin shall exist to provide reasonable assurance that changes in AOV-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.

(c) Testing shall be sufficient to assess changes in AOV functional margin consistent with (a). These tests shall be conducted under conditions as near as practicable to those expected during subsequent Inservice testing.

(d) If insufficient test data exist from an applicable AOV or AOV group to determine the performance assessment test interval in accordance with (a), then performance assessment testing shall be conducted every 6 yr until sufficient data exist, from an AOV or AOV group, to justify a longer inservice test interval.

(e) If maintenance activities are scheduled concurrent with an AOV's periodic performance assessment test, then the performance assessment test shall be conducted prior to the maintenance activity, where practicable. See AOV-2.1.3 for guidance on the effects of AOV replacement, repair, modification, or maintenance.

(f) For AOVs that operate in the course of plant operation, periodic performance assessment testing may be satisfied by the following, provided that:

(1) The conditions during exercise of the AOV meet or exceed the worst-case licensed design operating conditions.

(2) The required observations are made and analyzed during such operation and recorded in the plant record.

(3) The observation is performed at least once every 24 months.

(4) The valve exhibits the required change in obturator position.

(5) A stroke test can be performed quarterly.

(6) Credit may be taken for operation at less than design conditions with proper justification. The basis shall be documented by engineering evaluation. The engineering evaluation shall be reviewed and updated, as required, if an AOV application is changed, the AOV is physically modified, or the system is modified in a manner that invalidates the evaluation.

(g) The periodic performance assessment test interval shall not exceed 10 yr for each AOV.

(h) Any abnormality or erratic action shall be recorded (AOV-4), and an evaluation shall be made regarding the need for corrective action.

(i) The Owner shall document an evaluation of the need for more frequent performance assessment testing for AOVs in any of the following categories:

(1) AOVs with severe service conditions (temperature, radiation, fluid process, etc.)

(2) AOVs with any abnormal characteristics (operating, design, or maintenance conditions)

(3) AOVs with low margin according to the Owner's program

AOV-2.3.2 Performance Assessment Test Methods

(a) Performance Assessment 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.

(b) Performance Assessment Test Conditions. Performance assessment test conditions shall be sufficient to determine the AOV's functional margin per AOV-2.3.1(a). Test conditions shall be recorded for each test per AOV-4.

(c) Limits and Precautions. Performance assessment testing limits and precautions include the following:

(1) Manufacturer or vendor limits and precautions associated with the AOV and with the test equipment shall be incorporated into limits and precautions under this Section.

(2) Plant-specific operational precautions, design precautions, operational limits, and design limits shall be followed. Items shall include, but are not limited to, water hammer and intersystem relationships.

(3) The benefits of performing a particular test should be balanced against the potential increase in risk for damage caused to the AOV by the particular testing performed.

AOV-2.3.3 Performance Assessment Test Parameters. Sufficient performance assessment test parameters shall be selected for measurement to meet the requirements of AOV-2.4.

AOV-2.4 Performance Assessment Test Analysis and Evaluation

AOV-2.4.1 Performance Assessment Test Criteria

(a) Acceptance criteria shall be established for applicable AOVs within the scope of this Section. Applicable test parameters (as defined in Section GL) shall be used. Instrumentation and test equipment accuracy shall be incorporated in accordance with AOV-2.2 when establishing the test acceptance criteria.

(b) Acceptance criteria shall be reviewed and updated, as required, if an AOV application is changed, the AOV is physically modified, or the system is modified in a manner that invalidates the acceptance criteria.

AOV-2.4.2 Performance Assessment Test Data Analysis

(a) Data obtained from a test required by this Section shall be analyzed to determine if the AOV performance is acceptable. The Owner shall determine which methods are suitable for analyzing necessary parameters for each AOV and provide the necessary instructions for performance of the analyses.

(b) Whenever data are analyzed, all relevant operating and test conditions shall be evaluated.

(c) The Owner shall compare performance test data to the acceptance criteria.

(d) Performance assessment test 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, in accordance with AOV-2.4.4.

AOV-2.4.3 Performance Assessment Test Data Evaluation

(a) The Owner shall determine which methods are suitable for evaluating performance assessment test data for each AOV and application.

(b) The Owner shall develop procedural guidelines to establish the methods and timing for evaluating AOV performance assessment test data.

(c) Where periodic performance assessment testing is being performed, evaluations shall determine the loss of functional margin that occurred over time and shall evaluate the influence of past maintenance and test activities to establish appropriate intervals for future performance assessment test activities.

AOV-2.4.4 Performance Assessment Test Corrective Action. If the AOV performance is unacceptable, as established in AOV-2.4.2, operational readiness is not verified, and corrective action shall be taken in accordance with the Owner's corrective action requirements. Prior to returning the AOV to an operationally ready condition, corrective action shall be completed with performance testing to demonstrate that the AOV can perform its specified functions until the next scheduled test.

AOV-2.5 Stroke Test and Fail-Safe Test

AOV-2.5.1 Stroke Test Reference Values

(a) Stroke test reference values shall be determined from the results of baseline testing. These tests shall be performed under conditions as near as practicable to those expected during subsequent inservice testing.

(b) Reference values shall be established only when the valve is known to be operating acceptably. If the particular parameter being measured can be significantly influenced by other related conditions, then these conditions shall be analyzed.

AOV-2.5.2 Establishment of Additional Set of Inservice Stroke Test Reference Values. If it is necessary or desirable for some reason, other than stated in AOV-2.1.3, to establish additional stroke test reference values, an inservice stroke test shall first be performed at the conditions of an existing set of reference values, or at the conditions for which the new reference values are required, and the results analyzed. If operation is acceptable in accordance with the applicable requirements of AOV-2.5.4 and AOV-2.5.6, a second test shall be performed under the new conditions as soon as practicable. The results of the second test shall establish the additional reference values. Whenever additional reference values are established, the basis shall be justified and documented in the record of tests (see AOV-4).

AOV-2.5.3 AOV Stroke Testing

(a) Stroke testing shall be performed on each AOV quarterly.

(b) Stroke testing includes stroke time measurement as follows:

(1) The limiting value or values of full-stroke time of each valve shall be specified by the Owner.

(2) The stroke time of all valves shall be measured to, at least, the nearest second.

(3) Any abnormality or erratic action shall be recorded (see AOV-4), and an evaluation shall be made regarding the need for corrective action.

(c) Stroke testing shall be performed prior to performance assessment testing when these tests are scheduled concurrently.

(d) Remote position-indicating lights may be used for quarterly stroke testing with verification of position verification lights performed under separate requirements and interval specified in this Code.

AOV-2.5.4 Stroke Test Acceptance Criteria. Test results shall be compared to the reference values established in accordance with AOV-2.1.3, AOV-2.5.2, and AOV-2.5.3.

(a) Valves with reference stroke times of greater than 10 sec shall exhibit no more than ±25% change in stroke time when compared to the reference value.

(b) Valves with reference stroke times of less than or equal to 10 sec shall exhibit no more than ±50% change in stroke time when compared to the reference value.

(c) Valves that stroke in less than 2 sec may be exempted from (b). In such cases, the maximum limiting stroke time shall be 2 sec.

AOV-2.5.5 Fail-Safe Test. All AOVs with fail-safe actuators, within the scope of this Code, shall have a fail-safe test performed in accordance with the interval in AOV-2.5.3(a). The fail-safe test shall verify the valve exercises to the safe position upon loss of valve actuating power.

AOV-2.5.6 Stroke Test and Fail-Safe Action

(a) If a valve fails to exhibit the required change of obturator position or exceeds the limiting values of full stroke time [see AOV-2.5.3(b)(1)], the valve's operational readiness is not verified, and corrective action shall be taken in accordance with the Owner's corrective action requirement..

(b) Valves with measured stroke times that do not meet the acceptance criteria of AOV-2.5.4 shall be immediately retested, or the valve's operational readiness is not verified, and corrective action shall be taken in accordance with the Owner's corrective action requirement.

(c) If the second set of data meets the acceptance criteria, the cause of the initial deviation shall be analyzed and the results documented in the record of tests (see AOV-4).

(d) If a valve fails to meet the acceptance criteria, the valve's operational readiness is not verified, and corrective action shall be taken in accordance with the Owner's corrective action requirements. The valve shall be repaired or replaced or the data analyzed to determine the cause of the deviation. The repaired valve, evaluated valve, or replacement valve shall be demonstrated to be operating acceptably prior to placing the valve in an operationally ready condition.

(e) Valves determined to be acceptable based on analysis shall have the results of the analysis recorded in the record of tests (see AOV-4).

(f) See AOV-2.1.3 for requirements regarding the return of a repaired or replacement valve to an operationally ready condition.

AOV-3 CORRECTIVE ACTIONS

Corrective actions shall be performed as specified in GR-3 and this Section. If the AOV performance is unacceptable, as established in this Section, the AOV's operational readiness is not verified, and corrective action shall be taken in accordance with the Owner's corrective action requirements. Prior to returning the AOV to an operationally ready condition, corrective action shall be completed with diagnostic testing to demonstrate that the AOV can perform its specified functions until the next scheduled test.

AOV-4 RECORDS AND TEST PLANS

AOV-4.1 AOV Records

The Owner shall maintain a record that shall include the following:

(a) records as required by Section GR and this Section

(b) documentation showing that legacy AOV program activities met requirements within this Section, if used to satisfy AOV-2.3.1

(c) documentation of engineering evaluation per AOV-2.3.1(f)

(d) any abnormal or erratic action in accordance with AOV-2.3.1 and AOV-2.5.3

(e) documentation of engineering evaluation as applicable per AOV-2.1.3

(f) documentation of performance assessment test acceptance criteria per AOV-2.4.1

(g) summary of analysis, evaluation, and functional margin required per AOV-2.4.2, AOV-2.4.3, AOV-2.5.4, and AOV-2.5.6

AOV-4.2 Record of Tests

The Owner shall maintain a record of test plans that shall include the following:

(a) test plans as required by Section GR and this Section

(b) values of test data, parameters, and information established by AOV-2.3.2

(c) performance assessment test methods and conditions, described in AOV-2.3.2, including description of valve lineups, process equipment, and type of test

AOV-4.3 Record of Corrective Action

See AOV-3.

AOV-4.4 Test Plans

(a) Approved plant documents shall be established for all performance assessment tests specified in this Section and shall provide the following:

(1) methodical, repeatable, and consistent performance testing

(2) collection of performance assessment data required to analyze and evaluate the AOV functional margin in accordance with AOV-2.3.1(a), where applicable

Section CV
Check Valves

CV-1 INTRODUCTION

Check Valves (CVs) within the scope of this Code shall meet the requirements specified in Section GR and this Section.

CV-2 INSERVICE TESTING REQUIREMENTS

CV-2.1 General Requirements

CV-2.1.1 Baseline Testing

(a) Each valve shall be tested in accordance with the provisions in this Section prior to the initial IST interval as required by this Section. Testing that meets the requirements of this Code but was performed before implementation of this Code may be used. A baseline test of each valve shall be conducted within 1 yr of the initial IST.

(b) Any valve that has undergone maintenance that could affect its performance after the baseline test shall be tested in accordance with CV-2.1.4.

CV-2.1.2 Inservice Testing. Inservice testing in accordance with this Section shall commence when the valve is needed to be capable of performing its specified functions.

CV-2.1.3 Reference Values

CV-2.1.3.1 Reference values shall be determined from the results of baseline testing, including data from the QME-1 Qualification Report or from the results of inservice testing. Reference values for check valves depend on the test features of the valve. If the valve has an actuator to move the obturator, a reference value would be the force or torque required. If IST is to be performed by the use of flow, the flowrate required to open the valve would be its reference value.

CV-2.1.3.2 Reference values shall be established only when the valve is known to be operating acceptably. If the particular parameter being measured can be significantly influenced by other related conditions, then these conditions shall be analyzed.

CV-2.1.4 Effects of Valve Repair, Replacement, or Maintenance on Reference Values. When a valve has been replaced or repaired or has undergone maintenance that could affect the valve's performance, a new reference value shall be determined or the previous value reconfirmed by an inservice test performed before the time it is returned to service or immediately if not removed from service. This test is to demonstrate that performance parameters that could be affected by the replacement, repair, or maintenance are within acceptable limits. Deviations between the previous and new reference values shall be identified and analyzed. Verification that the new values represent acceptable operation shall be documented in the record of tests [see CV-4(b)].

CV-2.1.5 Establishment of Additional Set of Reference Values. If it is necessary or desirable for some reason, other than stated in CV-2.1.4, to establish additional reference values, an inservice test shall first be performed at the conditions of an existing set of reference values, or at the conditions for which the new reference values are required, and the results analyzed. If operation is acceptable in accordance with the applicable requirements of CV-2.3.1, a second test shall be performed under the new conditions as soon as practicable. The results of the second test shall establish the additional reference values. Whenever additional reference values are established, the reasons for doing so shall be justified and documented in the record of tests.

CV-2.1.6 Valve Inservice Testing Requirements

(a) Exercising Test Interval. All CVs within the scope of this Code shall be full cycle exercised at least once every 24 months, except as provided by (1), (2), and CV-2.3.

(1) Valves in Regular Use. Valves that operate in the course of plant operation at a frequency that would satisfy the exercising requirements of this Section need not be additionally exercised, provided that the observations otherwise required for testing are made and analyzed during such operation and recorded in the plant record at intervals no greater than specified in (a).

(2) Valves Out of Service. For a valve that is out of service, the exercising test schedule need not be followed. Before placing the valve in service, the valve shall meet the requirements of this Section.

(b) Position Verification Testing. Valves with remote position indicators shall be observed at least once every 5 yr to verify that valve operation is accurately indicated by indications such as use of flow meters or other suitable instrumentation to verify obturator position.

(c) Leak Testing Requirements. Seat leakage testing shall be in accordance with Section VLT.

CV-2.2 Instrumentation and Test Equipment

Instrumentation and test equipment accuracy shall be included when establishing valve test acceptance criteria.

CV-2.3 Specific Inservice Testing Requirements

CV-2.3.1 Check Valve Obturator Movement

(a) The necessary valve obturator movement during exercise testing shall be demonstrated by performing both an open and a close test.

(b) For those valves with an external lever or piston to open the valve, the force or forces, or torque or torques, required to move the obturator and pass the design required flow rate shall meet the acceptance criteria justified by the Owner.

NOTE: The force or forces, or torque or torques, required to move the obturator and fulfill its specified function shall be evaluated to detect abnormality or erratic action for corrective action.

(c) For valves that are to be opened using flow, the reference flow rate shall be that flowrate determined during qualification and reported in the QME-1 Qualification Report that is required.

(d) Exercise test or tests shall detect a missing obturator, sticking (closed or open), binding (throughout obturator movement), and the loss or movement of any weight or weights.

(e) Acceptance criteria shall include the specific design, application, data from the required QME-1 Qualification Report, and historical performance.

(f) As an alternative to detect a missing obturator or the loss or movement of any weight or weights using a mechanical exerciser, other positive means may be used (e.g., seat leakage tests and visual observations to detect obturator loss and the loss or movement of external weight or weights, respectively).

CV-2.3.2 Corrective Action. If a valve fails to exhibit the required change of obturator position, the valve's operational readiness is not verified, and corrective action shall be taken in accordance with the Owner's corrective action requirements. A retest showing acceptable performance shall be performed following any required corrective action before the valve is returned to an operationally ready condition.

CV-2.3.3 Condition-Monitoring Program Alternative. As an alternative to the testing or examination requirements of CV-2.1.2 through CV-2.3.2, the Owner may establish a condition-monitoring program. The purpose of this program is both to improve valve performance and optimize testing, examination, and preventive maintenance activities in order to maintain the continued acceptable performance of a select group of valves. The Owner may implement this program on a valve or a group of similar valves. If the condition-monitoring program for a valve or valve group is discontinued, then the requirements of CV-2.1.2 through CV-2.3.2 shall apply.

CV-2.4 Check Valve Condition-Monitoring Program

CV-2.4.1 Purpose. This section establishes the requirements for implementing and maintaining a check valve condition-monitoring program.

CV-2.4.2 Groupings

CV-2.4.2.1 Groupings shall be determined by the Owner. Groupings shall be technically justified and shall be based on

(a) the intended purpose of the condition-monitoring program (e.g., improve performance or optimize testing, examination, and preventive maintenance activities)

(b) analysis of test results and maintenance history

(c) design characteristics, application, and service conditions

CV-2.4.2.2 The Owner shall assess the significance to plant safety if an extended test or examination interval is planned.

CV-2.4.3 Analysis. The Owner shall perform an analysis of the test and maintenance history of a valve or group of valves in order to establish the basis for specifying inservice testing, examination, and preventive maintenance activities. The analysis shall include the following:

(a) Identify any common failure or maintenance patterns.

(b) Analyze the following patterns to determine their significance and identify potential failure mechanisms:

(1) determine whether certain preventive maintenance activities would mitigate the failure or maintenance patterns

(2) determine whether certain condition-monitoring tests, such as nonintrusive testing, are feasible and effective in monitoring for these failure mechanisms

(3) determine whether periodic disassembly and examination activities would be effective in monitoring for these failure mechanisms

(4) determine whether changes in the valve groupings are required

CV-2.4.4 Condition-Monitoring Activities. Valve obturator movement during applicable test or examination activities shall be sufficient to determine the bidirectional functionality of the moving parts.

(a) Performance Improvement Activities

(1) If sufficient information is not currently available to complete the analysis required in CV-2.4.3, or if this analysis is inconclusive, then the following activities shall be performed at sufficient intervals over an interim period of the next 5 yr to determine the cause of the failure or the maintenance patterns:

(-a) Identify interim tests (e.g., nonintrusive tests) to assess the performance of the valve or the group of valves.

(-b) Identify interim examinations to evaluate potential degradation mechanisms.

(-c) Identify other types of analysis that will be performed to assess valve condition.

(-d) Identify which of these activities will be performed on each valve in the group.

(-e) Identify the interval of each activity.

(2) Identify trendable attribute or attributes that will be trended and evaluated. Trending and evaluation of existing data must be used as the basis to reduce or extend the time interval between tests or examinations.

(3) Complete or revise the condition-monitoring program test plans (see CV-2.4.7) to document the valve program performance improvement activities and their associated intervals.

(4) Perform these activities at their associated intervals until

(-a) sufficient information is obtained to permit an adequate evaluation of the specific application or

(-b) until the end of the interim period

(5) After completion of the requirements in (1) through (4), review those attributes that were selected for trending, along with the results of each activity, and trends to determine whether any changes to the performance improvement program are required. If needed based on the results of the last scheduled test or examination, the program shall be revised in accordance with the site corrective action program prior to the performance of any activity on the next valve in the group, and applicable requirements of CV-2.4.2 through CV-2.4.4 shall be repeated.

(b) Optimization of Condition-Monitoring Activities

(1) If sufficient information is available to assess the performance adequacy of the valve or the group of valves, then the following activities shall be performed:

(-a) Identify the applicable preventive maintenance activities, including their associated intervals that are required to maintain the continued acceptable performance of the valve or group of valves.

(-b) Identify the applicable examination activities, including their associated intervals that will be used to periodically assess the condition of each valve or group of valves.

(-c) Identify the applicable test activities, including their associated intervals that will be used to periodically verify the acceptable performance of each valve or group of valves.

(-d) Identify which of these activities will be performed on each valve in the group.

(-e) Identify the interval of each activity. Initial intervals shall be established using (b), provided that the condition-monitoring test and examination intervals evaluate plant safety and are supported by the trending and evaluation of generic and plant-specific performance data. Trending and evaluation shall be used to support the conclusion that the valve or group of valves is capable of performing its intended function or functions over the entire interval. At least one of the identified activities for a valve group shall be performed on each valve of the group at approximately equal intervals not to exceed the maximum interval shown in Table CV-2.4.4-1.

(-f) Interval extensions shall be limited to 2 yr per extension. All valves in a group-sampling plan must be tested or examined again, before the interval can be extended again, or until the extension exceeds the maximum interval.

(-g) Intervals shall not exceed the maximum intervals shown in Table CV-2.4.4-1.

(2) Identify attributes that will be trended. Trending and evaluation of existing data must be used to reduce or extend the time interval between tests or examinations.

(3) Revise the test plans (see CV-2.4.7) to document the optimized condition-monitoring program activities and the associated intervals of each activity.

(4) Perform these activities at their associated intervals.

(5) After completion of the requirements in (1) through (4), review those attributes that were selected for trending, along with the results of each activity and trends to determine whether any changes to the optimized program are required. If needed based on the results of the last scheduled test or examination, the program shall be revised in accordance with the site corrective action program prior to the performance of any activity on the next valve in the group, and applicable requirements of CV-2.4.2 through CV-2.4.4 shall be repeated.

CV-2.4.5 Changes to IST intervals must evaluate plant safety and be supported by trending and evaluating both generic and plant-specific performance data to ensure the component is capable of performing its intended function or functions over the entire interval.

Table CV-2.4.4-1
Maximum Intervals for Use When Applying Internal Extensions

Group Size	Maximum Interval Between Activities of Member Valves in the Groups, yr [Note (1)]	Maximum Interval Between Activities of Each Valve in the Groups, yr
≥4	4.5	16
3	4.5	12
2	6.0	12
1	N/A	10

NOTE: (1) These intervals shall not exceed intervals imposed by other station programs where activities are credited for meeting the requirements of condition monitoring (e.g., Containment Leakage Rate Testing Program).

CV-2.4.6 Condition-Monitoring Corrective Maintenance. If check valve condition-monitoring results or performance is unacceptable, corrective action shall be taken in accordance with the Owner's corrective action requirements. Prior to returning the valve to an operationally ready condition, corrective action shall be completed with performance testing to demonstrate that the valve can perform its specified functions until the next scheduled test or monitoring activity. If corrective maintenance is performed on a valve, the analysis used to formulate the basis of the condition-monitoring activities for that valve and its associated valve group shall be reviewed to determine whether any changes are required. If significant changes are required, the program shall be revised, and the applicable requirements of CV-2.4.2 through CV-2.4.4 shall be repeated.

CV-2.4.7 Condition-Monitoring Documentation. The condition-monitoring program shall be documented and shall include the following information:

(a) list of valves in the program

(b) list of valves in each valve group

(c) dates valves were added and/or deleted to the program and the reason for their inclusion and/or deletion

(d) analysis forming the basis for the program

(e) identified failure or maintenance history patterns for each valve

(f) condition-monitoring program activities, including the trended attributes and the bases for the associated intervals for each valve or valve group

CV-3 CORRECTIVE ACTIONS

Corrective actions shall be performed as specified in GR-3 and this subsection. If the valve performance is unacceptable, as established in this Section, the valve's operational readiness is not verified, and corrective action shall be taken in accordance with the Owner's corrective action requirements. Prior to returning the valve to an operationally ready condition, corrective action shall be completed with testing to demonstrate that the valve can perform its specified functions until the next scheduled test.

CV-4 RECORDS

Valve records shall be maintained in accordance with GR-4 and as specified in this Section.

(a) Valve Records. The Owner shall maintain a record that shall include the following for each valve covered by this Section:

(1) the manufacturer and manufacturer's model and serial or other unique identification number

(2) a copy or summary of the manufacturer's acceptance test report if available

(3) baseline test results

(b) Record of Tests. See GR-4.3 and as specified in this Section.

(c) Record of Corrective Action. See GR-4.4 and as specified in this Section.

(d) Test Plans. In addition to the requirements of GR-2.3.2, the Owner shall maintain a record of test plans that shall include details and bases of the valve sample disassembly examination program, such as grouping characteristics and frequencies.

Section HOV
Hydraulically Operated Valves

HOV-1 INTRODUCTION

Hydraulically operated valves (HOVs) within the scope of this Code shall meet the requirements specified in Section GR and this Section.

HOV-2 INSERVICE TESTING REQUIREMENTS

HOV-2.1 General Requirements

HOV-2.1.1 Baseline Testing

(a) Each HOV shall be tested prior to the initial IST interval as required by this Section. Testing that meets the requirements of this Code but was performed before implementation of this Code may be used. A baseline test of each valve shall be conducted within 1 yr of the initial IST.

(b) Each of the following baseline tests shall be performed for each HOV:

(1) performance assessment test
(2) stroke test
(3) fail-safe test, as applicable
(4) leak testing, as applicable
(5) position verification testing for valves with remote position indicators

(c) Any HOV that has undergone maintenance that could affect its performance after the baseline test shall be tested in accordance with HOV-2.1.2. Inservice testing shall commence when the HOV is relied on to be available to perform its specified functions.

HOV-2.1.2 Inservice Testing. Inservice testing shall commence when the HOV is needed to be capable of performing its specified functions. Each of the following tests shall be performed for each HOV:

(a) performance assessment test
(b) stroke test
(c) fail-safe test, as applicable
(d) leak testing, as applicable
(e) position verification testing for valves with remote position indicators

HOV-2.1.3 Effect of HOV Replacement, Repair, Modification, or Maintenance. When an HOV is replaced, repaired, modified, or undergoes maintenance that could affect the valve's performance, new inservice test values shall be determined. The previously established inservice test values shall be reconfirmed, or the activities performed shall be evaluated along with the results of post-replacement, repair, modification, and maintenance testing to determine if new inservice test values are warranted before the HOV is returned to service. If the HOV was not removed from service, inservice test values shall be immediately determined or confirmed. This testing is intended to demonstrate that test parameters, which could be affected by the replacement, repair, modification, or maintenance, are within acceptable limits. The Owner's program shall define the level of testing required prior to and after replacement, repair, modification, or maintenance activities. Other attributes, such as functional margin, shall be evaluated when defining the level of testing required prior to and after replacement, repair, modification, or maintenance activities, where the basis is properly justified and documented by an engineering evaluation. Deviations between the previous and new inservice test values shall be identified and analyzed. Verification that the new inservice test values represent acceptable operation shall be documented as described in HOV-4.

HOV-2.1.4 HOV Inservice Testing Requirements. Inservice testing shall be performed on each HOV as specified in this Section.

(a) Valve Obturator Movement. The necessary valve obturator movement shall be determined by exercising the valve while observing an appropriate indicator, such as indicating lights that signal the required changes of obturator position, or by observing other evidence, such as changes in system pressure, flow rate, level, or temperature, that reflects changes of obturator position.

(b) HOVs in Regular Use. HOVs that operate in the course of plant operation at a frequency that would satisfy the exercising requirements of this Section need not be additionally exercised, provided that the observations otherwise required for testing are made and analyzed during such operation and recorded in the plant record at intervals no greater than specified in HOV-2.4.3(a).

(c) HOVs Out of Service. For a HOV that is out of service, the exercising test schedule need not be followed. Before placing the valve in service, the valve shall meet the requirements of this Section.

(d) Position Verification Testing. HOVs with remote position indicators shall be observed at least once every 5 yr to verify that valve operation is accurately indicated by indications such as use of flow meters or other suitable instrumentation to verify obturator position.

HOV-2.1.5 Instrumentation and Test Equipment. Instrumentation and test equipment accuracy shall be applied when establishing HOV test acceptance criteria (see GR-2.4).

HOV-2.2 Specific Inservice Testing Requirements

HOV-2.2.1 Performance Assessment Testing. Performance assessment testing shall be performed to assess the functional margin. An initial performance assessment test shall be performed to assess the functional margin of each HOV prior to reliance on its capability to perform the specified functions. A baseline performance assessment test may be used to meet this requirement.

(a) The interval for periodic performance assessment tests shall be determined to demonstrate that adequate functional margin exists between valve-operating requirements and the available actuator output capability to satisfy the acceptance criteria per HOV-2.3.1.

(b) In addition to meeting the acceptance criteria, the performance assessment test interval shall be set such that an adequate functional margin shall exist to provide reasonable assurance that changes in HOV-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.

(c) Testing shall be sufficient to assess changes in HOV functional margin consistent with (a). These tests shall be conducted under conditions as near as practicable to those expected during subsequent inservice testing.

(d) If insufficient test data exist from an applicable HOV or HOV group to determine the performance assessment test interval in accordance with (a), then performance assessment testing shall be conducted every 6 yr until sufficient data exist, from an HOV or HOV group, to justify a longer inservice test interval.

(e) If maintenance activities are scheduled concurrent with an HOV's periodic performance assessment test, then the performance assessment test shall be conducted prior to the maintenance activity, where practicable. See HOV-2.1.3 for guidance on the effects of HOV replacement, repair, modification, or maintenance.

(f) For HOVs that operate in the course of plant operation, periodic performance assessment testing may be satisfied by the following, provided that:

(1) The conditions during exercise of the HOV meet or exceed the worst-case operating conditions.

(2) The required observations are made and analyzed during such operation and recorded in the plant records.

(3) The observation is performed at least once every 24 months.

(4) The valve exhibits the required change in obturator position.

(5) A stroke test can be performed quarterly.

(6) Credit may be taken for operation at less than design conditions with proper justification. The basis shall be documented by engineering evaluation. The engineering evaluation shall be reviewed and updated, as required, if an HOV application is changed, the HOV is physically modified, or the system is modified in a manner that invalidates the evaluation.

(g) The periodic performance assessment test interval shall not exceed 10 yr for each HOV.

(h) Any abnormality or erratic action shall be recorded [see HOV-4(d)], and an evaluation shall be made regarding the need for corrective action.

(i) The Owner shall document an evaluation of the need for more frequent performance assessment testing for HOVs in any of the following categories:

(1) HOVs with severe service conditions (temperature, radiation, fluid process, etc.)

(2) HOVs with any abnormal characteristics (operating, design, or maintenance conditions)

(3) HOVs with low margin according to the Owner's program

HOV-2.2.2 Performance Assessment Test Methods

HOV-2.2.3 Performance Assessment 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.

HOV-2.2.4 Performance Assessment Test Conditions. Performance assessment test conditions shall be sufficient to determine the HOV's functional margin per HOV-2.2.1(a). Test conditions shall be recorded for each test per HOV-4(d).

HOV-2.2.5 Limits and Precautions. Performance assessment testing limits and precautions include the following:

(a) Manufacturer or vendor limits and precautions associated with the HOV and test equipment shall be incorporated into limits and precautions under this Section.

(b) Plant-specific operational precautions, design precautions, operational limits, and design limits shall be followed. Items shall include, but are not limited to, water hammer and intersystem relationships.

(c) The benefits of performing a particular test should be balanced against the potential increase in risk for damage caused to the HOV by the particular testing performed.

HOV-2.2.6 Performance Assessment Test Parameters. Sufficient performance assessment test parameters shall be selected for measurement to meet the requirements of HOV-2.3.

HOV-2.3 Performance Assessment Test Analysis and Evaluation

HOV-2.3.1 Performance Assessment Test Criteria

(a) Acceptance criteria shall be established for applicable HOVs within the scope of this Section. Applicable test parameters (as defined in Section GL) shall be used. Instrumentation and test equipment accuracy shall be incorporated in accordance with GR-2.4 when establishing the test acceptance criteria.

(b) Acceptance criteria shall be reviewed and updated, as required, if an HOV application is changed, the HOV is physically modified, or the system is modified in a manner that invalidates the acceptance criteria.

HOV-2.3.2 Performance Assessment Test Data Analysis

(a) Data obtained from a test required by this Section shall be analyzed to determine if the HOV performance is acceptable. The Owner shall determine which methods are suitable for analyzing necessary parameters for each HOV and provide the necessary instructions for performance of the analyses.

(b) Whenever data are analyzed, all relevant operating and test conditions shall be evaluated.

(c) The Owner shall compare performance test data to the acceptance criteria.

(d) Performance assessment test 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, in accordance with HOV-2.3.4.

HOV-2.3.3 Performance Assessment Test Data Evaluation

(a) The Owner shall determine which methods are suitable for evaluating performance assessment test data for each HOV and application.

(b) The Owner shall develop procedural guidelines to establish the methods and timing for evaluating HOV performance assessment test data.

(c) Where periodic performance assessment testing is being performed, evaluations shall determine the loss of functional margin that occurred over time and shall evaluate the influence of past maintenance and test activities to establish appropriate frequencies for future performance assessment test activities.

HOV-2.3.4 Performance Assessment Test Corrective Action. If the HOV performance is unacceptable, as established in HOV-2.3.2, operational readiness is not verified, and corrective action shall be taken in accordance with the Owner's corrective action requirements. Prior to returning the HOV to an operationally ready condition, corrective action shall be completed with performance testing to demonstrate that the HOV can perform its specified functions until the next scheduled test.

HOV-2.4 Stroke Test and Fail-Safe Test

HOV-2.4.1 Stroke Test Reference Values

(a) Stroke test reference values shall be determined from the results of baseline testing. These tests shall be performed under conditions as near as practicable to those expected during subsequent inservice testing.

(b) Reference values shall be established only when the valve is known to be operating acceptably. If the particular parameter being measured can be significantly influenced by other related conditions, then these conditions shall be analyzed.

HOV-2.4.2 Establishment of Additional Set of Inservice Stroke Test Reference Values. If it is necessary or desirable for some reason, other than stated in HOV-2.1.3, to establish additional stroke test reference values, an inservice stroke test shall first be performed at the conditions of an existing set of reference values, or at the conditions for which the new reference values are required, and the results analyzed. If operation is acceptable in accordance with the applicable requirements of HOV-2.4.4 and HOV-2.4.6, a second test shall be performed under the new conditions as soon as practicable. The results of the second test shall establish the additional reference values. Whenever additional reference values are established, the basis shall be justified and documented in the record of tests [see HOV-4(b)].

HOV-2.4.3 HOV Stroke Testing

(a) Stroke testing shall be performed on each HOV quarterly.

(b) Stroke testing includes stroke time measurement as follows:

(1) The limiting value or values of full-stroke time of each valve shall be specified by the Owner.

(2) The stroke time of all valves shall be measured to, at least, the nearest second.

(3) Any abnormality or erratic action shall be recorded [see HOV-4(d)], and an evaluation shall be made regarding the need for corrective action.

(c) Stroke testing shall be performed prior to performance assessment testing when these tests are scheduled concurrently.

(d) Remote position-indicating lights may be used for quarterly stroke testing with verification of position verification lights performed under separate requirements and intervals specified in this Code.

HOV-2.4.4 Stroke Test Acceptance Criteria. Test results shall be compared to the reference values established in accordance with HOV-2.1.3, HOV-2.4.2, and HOV-2.4.3.

(a) Valves with reference stroke times of greater than 10 sec shall exhibit no more than ±25% change in stroke time when compared to the reference value.

(b) Valves with reference stroke times of less than or equal to 10 sec shall exhibit no more than ±50% change in stroke time when compared to the reference value.

(c) Valves that stroke in less than 2 sec may be exempted from the requirement in (b). In such cases, the maximum limiting stroke time shall be 2 sec.

(d) Instrumentation and test equipment accuracy shall be incorporated in accordance with GR-2.4.

HOV-2.4.5 Fail-Safe Test. All HOVs with fail-safe actuators, within the scope of this Section, shall have a fail-safe test performed in accordance with the interval in HOV-2.4.3(a). The fail-safe test is performed by observing the operation of the actuator upon loss of valve-actuating power.

HOV-2.4.6 Stroke Test and Fail-Safe Corrective Action

(a) If a valve fails to exhibit the required change of obturator position or exceeds the limiting values of full stroke time [see HOV-2.4.3(b)(1)], the valve's operational readiness is not verified, and corrective action shall be taken in accordance with the Owner's corrective action requirements.

(b) Valves with measured stroke times that do not meet the acceptance criteria of HOV-2.4.4 shall be immediately retested, or the valve's operational readiness is not verified, and corrective action shall be taken in accordance with the Owner's corrective action requirements.

(c) If the second set of data meets the acceptance criteria, the cause of the initial deviation shall be analyzed and the results documented in the record of tests [see HOV-4(b)].

(d) If a valve fails to meet the acceptance criteria, the valve's operational readiness is not verified, and corrective action shall be taken in accordance with the Owner's corrective action requirements. The valve may be repaired or replaced or the data may be analyzed to determine the cause of the deviation. The repaired valve, the evaluated valve, or a replacement valve shall be shown to be operating acceptably prior to placing the valve in an operationally ready condition.

(e) Valves determined to be acceptable based on analysis shall have the results of the analysis recorded in the record of tests [see HOV-4(c)].

(f) See HOV-2.1.3 for guidance on returning a repaired or replacement valve to an operationally ready condition.

HOV-3 CORRECTIVE ACTIONS

Corrective actions shall be performed as specified in GR-3 and this Section. If the HOV performance is unacceptable, as established in this Section, the HOV's operational readiness is not verified, and corrective action shall be taken in accordance with the Owner's corrective action requirements. Prior to returning the HOV to an operationally ready condition, corrective action shall be completed with diagnostic testing to demonstrate that the HOV can perform its specified functions until the next scheduled test.

HOV-4 RECORDS

(a) General. HOV records shall be maintained in accordance with GR-4 and as specified in this Section.

(b) Valve Records. The Owner shall maintain a record that shall include the following for each valve covered by this Section:

(1) the manufacturer and manufacturer's model and serial or other unique identification number

(2) a copy or summary of the manufacturer's acceptance test report, if available

(3) baseline test results

(4) limiting value of full stroke time specified in HOV-2.4.3(b)(1)

(c) Record of Tests. See GR-4.3 and as specified in this Section.

(d) Record of Corrective Action. See GR-4.4 and as specified in this Section.

(e) Test Plans. See GR-2.3.2.

Section MOV
Motor-Operated Valves

MOV-1 INTRODUCTION

Motor-operated valves (MOVs) within the scope of this Code shall meet the requirements specified in Section GR and this Section.

MOV-2 INSERVICE TESTING REQUIREMENTS

MOV-2.1 Baseline Testing

Baseline testing of MOVs include the following requirements:

(a) Each MOV shall be baseline tested within 1 yr before implementing IST activities.

(b) Each of the following tests shall be performed for each MOV as part of the baseline activities:

(1) exercise test

(2) fail-safe test, as applicable

(3) position verification testing for valves with remote position indicators

(4) leak testing, as applicable

(5) diagnostic test

(6) stroke time, as applicable

(c) Baseline tests shall be performed in accordance with the requirements specified in the IST paragraphs of this Section.

(d) Any MOV that has undergone repair, replacement, or maintenance, or experienced conditions that could affect its performance following the baseline activities, shall be retested to demonstrate its operational readiness in preparation for reliance on its capability to perform its specified function. If qualification of the MOV has been undermined, the MOV shall be requalified in accordance with ASME QME-1 as accepted by the applicable regulatory authority, or an alternative method shall be reviewed and approved by the applicable regulatory authority.

MOV-2.2 Inservice Testing

MOV-2.2.1 General. Inservice testing of MOVs include the following requirements:

(a) Inservice testing in accordance with this Section shall commence when the MOV is relied upon to be capable of performing its specified functions.

(b) Each of the following IST activities shall be performed for each MOV:

(1) exercise test

(2) fail-safe test, as applicable

(3) position verification testing for valves with remote position indicators

(4) leak testing, as applicable

(5) diagnostic test

(c) Inservice tests shall be conducted in the as-found condition.

(d) For an MOV that is out of service, the MOV shall meet the requirements of this Section before the MOV is returned to service.

MOV-2.2.2 MOV Exercise Test

MOV-2.2.2.1 Normal Exercising Requirements. All MOVs within the scope of this Code shall be full cycle exercised at least once every 24 months. Full cycle operation of an MOV, as a result of normal facility operations or Code requirements, may be credited for an exercise of the MOV, if documented.

MOV-2.2.2.2 Exercising Corrective Action. Corrective action requirements are specified in Section GR and this Section, including the following:

(a) If a valve fails to exhibit the required change of obturator position during exercising, the valve's operational readiness is not verified, and corrective action shall be taken in accordance with the Owner's correction action requirements.

(b) Valves with stroke-time limits or that reveal abnormal performance that do not meet the exercise acceptance criteria shall be immediately retested, or the valve's operational readiness is not verified, and corrective action shall be taken in accordance with the Owner's corrective action requirements.

(c) If the second set of data meets the acceptance criteria, the cause of the initial deviation shall be analyzed and the results documented in the record of tests.

(d) The requirements for maintenance, repair, replacement, and operating experience of MOVs shall be met as specified in this Section.

MOV-2.2.3 MOV Fail-Safe Testing. Each MOV shall undergo fail-safe testing with the exercise test where applicable to the MOV design.

MOV-2.2.4 MOV Position Verification Testing. For MOVs with remote position indicators, primary remote position indicators shall be verified for the MOV obturator for both open and close positions with each exercise test. MOV obturator position open and closed shall be verified

during diagnostic testing conducted per MOV-2.2.6. If MOV design and operation are not sufficient to verify MOV obturator position open and closed during diagnostic testing, MOVs with remote position indicators shall be observed at least once every 5 yr to verify that valve operation is accurately indicated by indications such as use of flow meters or other suitable instrumentation to verify obturator position.

MOV-2.2.5 MOV Leak Testing. MOV seat leakage testing shall be performed in accordance with the Section VLT.

MOV-2.2.6 MOV Diagnostic Testing. MOV diagnostic testing shall be performed in accordance with the requirements in Section GR and this Section.

MOV-2.2.6.1 Diagnostic Test Methods. Diagnostic test methods shall meet the following requirements:

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

(b) Test conditions shall be sufficient to determine the MOV's functional margin per this Section. Test conditions shall be recorded for each test per MOV-4.

(c) Testing limits and precautions shall include the following:

(1) MOV exposure to dust, moisture, or other adverse conditions shall be minimized when normally enclosed compartment covers are removed while performing tests.

(2) Manufacturer or vendor limits and precautions associated with the MOV and test equipment shall be incorporated into the limits and precautions under this Section, including the structural thrust and torque limits of the MOV.

(3) Facility-specific operational and design precautions and limits shall be followed, including, but not limited to, potential water hammer impacts and intersystem relationships.

(d) Sufficient test parameters shall be selected for measurement to meet the requirements of MOV-2.2.6.4 in determining the MOV functional margin.

MOV-2.2.6.2 Diagnostic Test Acceptance Criteria. The Owner shall establish documented methods to determine acceptance criteria for the operational readiness of each MOV within the scope of this Code. Acceptance criteria shall be based on 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 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, the following sources of uncertainty shall be included:

(a) test measurement and equipment accuracy

(b) valve and actuator repeatability (e.g., torque switch repeatability)

(c) analysis, evaluation, and extrapolation method

MOV-2.2.6.3 Analysis of Data. The analysis for MOV test data shall meet the following requirements:

(a) Procedures shall specify the methods for analyzing MOV test data.

(b) Data obtained from a test required by this Code shall be analyzed to determine if the MOV performance is acceptable.

(c) Whenever data are analyzed, all relevant operating and test conditions shall be evaluated.

(d) Data shall be compared to the acceptance criteria. If the functional margin determined per MOV-2.2.6.8 does not meet the acceptance criteria, the MOV's operational readiness is not verified, and correction action shall be taken in accordance with the Owner's corrective action requirements.

(e) Data analysis shall include identification of anomalous behavior, determination of the cause of the anomalous behavior, and completion of corrective actions before the MOV is returned to an operationally ready condition.

(f) Data analysis shall be independently verified by individuals qualified through the Owner's qualification requirements.

MOV-2.2.6.4 Evaluation of Data. The evaluation of MOV test data shall meet the following requirements:

(a) Procedures shall specify the methods for evaluating MOV test data.

(b) Evaluations shall determine the amount of degradation in functional margin that occurred over time.

(c) Evaluations shall include the influence of past maintenance and test activities to establish appropriate time intervals for future test activities.

(d) Evaluations shall apply changes in functional margin to other applicable MOVs to establish appropriate time intervals for future test activities.

(e) Test evaluation shall be independently verified by individuals qualified through the Owner's qualification requirements.

MOV-2.2.6.5 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 operational readiness of the MOV to perform its specified functions. 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.

MOV-2.2.6.6 Determination of Valve-Operating Requirements. Design-basis, valve-operating requirements, including stem factor for rising stem valves, shall be determined from one of the following:

(a) measurements taken during testing at design-basis conditions during qualification or installed in the facility

(b) analytical methods using valve parameters determined from testing at conditions that may be extrapolated to design-basis conditions

(c) application of justified industry methodologies

MOV-2.2.6.7 Determination of Actuator Output Capability. The determination of MOV actuator output capability shall be determined by one of the following methods:

(a) For available output based on motor capabilities, available actuator output shall be determined based on motor capabilities at the motor's design-basis conditions, including the following:

(1) rated motor start torque

(2) minimum voltage conditions

(3) elevated ambient temperature conditions

(4) operator efficiency

(5) other appropriate factors

(b) For available output based on torque switch setting, the available actuator output shall be determined based on the current torque switch setting, including the following:

(1) calibration of the torque switch spring pack

(2) current torque switch setting

(3) repeatability of torque switch operation

MOV-2.2.6.8 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 one of the following:

(a) design-basis motor operator capability for limit switch controlled strokes

(b) the lesser of design-basis motor operator capability or motor operator capability at the current torque switch setting for torque switch-controlled strokes

MOV-2.2.6.9 Diagnostic Test Interval. The diagnostic test interval shall be determined by the following:

(a) The diagnostic test interval shall be determined by the evaluation required in this Section.

(b) If insufficient data exist to determine the diagnostic test interval in accordance with the evaluation specified in this MOV-2.2.6.4, then MOV diagnostic testing shall be conducted every 3 yr until sufficient data exist.

(c) Not later than 5 yr after initial implementation of this Code, the Owner shall evaluate the adequacy of the MOV diagnostic test interval as described in this Section.

(d) The maximum diagnostic test interval shall not exceed 10 yr.

(e) 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 evaluated. The diagnostic test interval shall be set such that the MOV functional margin does not decrease below the acceptance criteria.

MOV-2.3 Preventive Maintenance

Changes to preventive maintenance activities and their schedules shall be evaluated when establishing acceptance criteria in MOV-2.2.6.2, evaluating potential degradation per MOV-2.2.6.4, and establishing MOV test intervals per MOV-2.2.6.9. For example, changes to stem lubrication procedures, including the lubricant type and application schedule, might impact the engineering evaluations performed in this Section and shall be evaluated.

MOV-2.4 Effect of MOV Replacement, Repair, Maintenance, or Operating Conditions

When an MOV or its control system is replaced, repaired, or undergoes maintenance,[1] or experiences a condition that could affect the MOV's performance, new baseline or IST values shall be determined, or the previously established baseline or IST values shall be confirmed by testing before the MOV is returned to service. If the MOV was not removed from service, baseline or IST values shall be immediately determined, or confirmed, by testing. Deviations between the previous and new IST values shall be identified and analyzed. Verification that the new values represent acceptable operation shall be documented as described in this Code and MOV-4. If an MOV undergoes replacement, repair, or maintenance, or experiences a condition that undermines the qualification of the component, the MOV shall be requalified as specified in GR-2.2 to perform its specified functions in accordance with ASME QME-1 as accepted by the applicable regulatory authority or by another method justified by the Owner based on review and acceptance by the applicable regulatory authority.

MOV-3 CORRECTIVE ACTIONS

Corrective actions shall be performed as specified in GR-3 and this Section. If the MOV performance is unacceptable, as established in this Section, the MOV's operational readiness is not verified, and corrective action shall be taken in accordance with the Owner's corrective action requirements. Prior to returning the MOV to an operationally ready condition, corrective action shall be completed with diagnostic testing to demonstrate that the MOV can perform its specified functions until the next scheduled test.

[1] Adjustment or replacement of stem packing, limit switches, or control system valves, and removal of the bonnet, stem assembly, actuator, obturator, or control system components, are examples of maintenance that could affect valve performance parameters.

MOV-4 RECORDS

MOV-4.1 Test Plans

Approved facility documents shall be established for all tests specified in this Code and shall provide for collection of data required to analyze and evaluate the MOV functional margin in accordance with this Section.

MOV-4.2 MOV Test Records

MOV records shall be maintained in accordance with GR-4 and as specified below:

(a) MOV facility-specific unique identification number

(b) motor, valve, and actuator nameplate data

(c) test equipment unique identification numbers and equipment calibration dates

(d) test method and conditions, per MOV-2.2.6.1, including description of valve lineups, process equipment, and type of test, with identification of the valve body, valve stem, electric motor-operator orientation, and piping configuration near the MOV

(e) breaker setting and/or fuse size and motor starter thermal overload size, as applicable

(f) MOV torque and limit switch configuration and settings

(g) MOV performance test procedure and other approved facility documents containing acceptance criteria

(h) names of test performer and reviewer and applicable dates

(i) system flow, system pressure, differential pressure, system fluid temperature, system fluid phase, and ambient temperature

(j) significant observations, including comments pertinent to the test results, remarks regarding abnormal or erratic MOV action during recent or preceding performance testing, and other pertinent design information

MOV-4.3 MOV Analysis and Evaluation

The documentation of MOV performance, which has been analyzed and evaluated in accordance MOV-2.2.6.3, shall include the following:

(a) values of test data, parameters, and information established in accordance with MOV-2.2.6.1(d) and MOV-4.2

(b) summary of analysis and evaluation required per MOV-2.2.6.3 and MOV-2.2.6.4

(c) functional margin determined per this Section

(d) signatures and dates of individuals qualified through the Owner's qualification requirements performing test analysis and evaluations and independently verifying the analysis and evaluation

Section MV
Manual Valves

MV-1 INTRODUCTION

Manual valves (MVs) within the scope of this Code shall meet the requirements specified in Section GR and this Section.

MV-2 INSERVICE TESTING REQUIREMENTS

MV-2.1 General Requirements

MV-2.1.1 Baseline Testing

(a) Each valve shall be baseline tested as required by this Section. A baseline test of each valve shall be conducted within 1 yr of the initial IST test.

(b) Each of the following baseline tests shall be performed for each MV:

(1) manual stroke test

(2) leak testing, as applicable

(3) position verification testing for valves with remote position indicators

(c) Seat leakage testing shall be in accordance with Section VLT.

MV-2.1.2 Inservice Testing. Inservice testing in accordance with this Section shall commence when the valve is relied on to be available to perform its specified functions. Each of the following inservice tests shall be performed for each MV:

(a) manual stroke test

(b) leak testing, as applicable

(c) position verification testing for valves with remote position indicators

MV-2.1.3 Effect of MV Replacement, Repair, Modification or Maintenance. When an MV is replaced, repaired, or modified or undergoes maintenance that could affect the valve's performance, a new baseline test shall be performed in accordance with MV-2.1.1.

MV-2.1.4 Valve Exercise. Manual valves shall be full-stroke exercised at least once every 2 yr, except where adverse conditions require the valve to be tested more frequently to ensure operational readiness.

MV-2.1.5 Valve Obturator Movement. The necessary valve obturator movement shall be determined by exercising the valve while observing an appropriate indicator, such as indicating lights that signal the required changes of obturator position, or by observing other evidence, such as changes in system pressure, flow rate, level, or temperature, that reflects change of obturator position. The valve shall exhibit the required change of obturator position within the time limit specified for the worst-case licensing design-operating condition.

MV-2.1.6 Valves in Regular Use. Valves that operate in the course of plant operation at a frequency that would satisfy the exercising requirements of this Section need not be additionally exercised, provided that the observations otherwise required for testing are made and analyzed during such operation and recorded in the plant records at intervals no greater than specified in MV-2.1.3.

MV-2.1.7 Valves Out of Service. For a valve that is out of service, the exercising test schedule need not be followed. Before placing the valve in service, the valve shall meet the requirements of this Section.

MV-2.1.8 Position Verification Testing. Valves with remote position indicators shall be observed at least once every 5 yr to verify that valve operation is accurately verified by indications such as use of flow meters or other suitable instrumentation to verify obturator position.

MV-2.1.9 Leak Testing Requirements. Seat leakage testing shall be in accordance with Section VLT.

MV-2.2 Instrumentation and Test Equipment

Instrumentation and test equipment accuracy shall be included when establishing valve test acceptance criteria.

MV-2.3 Specific Inservice Testing Requirements

MV-2.3.1 Valve testing shall be in accordance with MV-2.1.4.

MV-2.3.2 If a valve fails to exhibit the required change of obturator position, the valve's operational readiness is not verified, and corrective action shall be taken in accordance with the Owner's corrective action requirements.

MV-2.3.3 Prior to returning the MV to an operationally ready condition, corrective action shall be completed with exercise testing to demonstrate that the MV can perform its specified functions until the next scheduled test.

MV-3 CORRECTIVE ACTIONS

Corrective actions shall be performed as specified in GR-3 and this Section. If the MV performance is unacceptable, as established in this Section, the MV's operational readiness is not verified, and corrective action shall be taken in accordance with the Owner's corrective action requirements. Prior to returning the MV to an operational condition, corrective action shall be completed with testing to demonstrate that the MV can perform its specified functions until the next scheduled test.

MV-4 RECORDS

(a) General. MV records shall be maintained in accordance with GR-4 and as specified in this Section.

(b) Valve Records. The Owner shall maintain a record that shall include the following for each valve covered by this Section:

(1) the manufacturer and manufacturer's model and serial or other unique identification number

(2) a copy or summary of the manufacturer's acceptance test report, if available

(3) baseline test results

(c) Record of Tests. See GR-4.3 and as specified in this Section.

(d) Record of Corrective Action. See GR-4.4 and as specified in this Section.

(e) Test Plans. See GR-2.3.2.

Section PAV
Pyrotechnic-Actuated Valves

PAV-1 INTRODUCTION

Pyrotechnic-actuated valves (PAVs) within the scope of this Code shall meet the requirements specified in Section GR and this Section.

PAV-2 INSERVICE TESTING REQUIREMENTS

PAV-2.1 General Testing Requirements

PAV-2.1.1 Baseline Testing

(a) Each PAV shall be inspected and tested prior to the initial IST interval as required by this Section. Baseline activities that meet the requirements of this Code but performed before implementation of this Code may be used. The baseline activities for each PAV shall be conducted within 1 yr of the initial IST activity.

(b) Conduct an internal inspection of each PAV as part of the baseline test prior to commencement of the IST period.

(c) Verify the operational readiness of the actuation logic and associated electrical circuits for each valve with its pyrotechnic charge removed from the PAV. This must include confirmation that sufficient electrical parameters (voltage, current, and resistance) are available at the valve from each circuit that is relied upon to actuate the PAV.

(d) Select a sample of at least 20% of the pyrotechnic charges for each group of PAVs based on manufacturer, type, and size. Test each selected charge either in the PAV or a qualified test fixture to confirm the capability of each sampled charge to provide the necessary motive force to operate the PAV to perform its intended function without damage to the valve body or connected piping. The sampling must include at least one PAV from each redundant safety train.

(e) Resolve any deficiencies identified in the operational readiness of the actuation logic or associated electrical circuits or the capability of a pyrotechnic charge. If a charge fails to fire or its capability is not confirmed, all charges with the same batch number shall be removed, discarded, and replaced with charges from a different batch number that has demonstrated successful 20% sampling of the charges.

(f) Any PAV that has undergone maintenance that could affect its performance after the baseline test shall be tested or inspected.

PAV-2.1.2 Inservice Testing.

Inservice testing in accordance with this Section shall commence when the PAV is needed to be capable of performing its specified functions.

PAV-2.1.3 Effect of PAV Replacement, Repair, Modification, or Maintenance.

When a PAV is replaced, repaired, or modified or undergoes maintenance that could affect the valve's performance, new inservice test values shall be determined. The previously established inservice test values shall be reconfirmed, or the activities performed shall be evaluated along with the results of post-replacement, repair, modification, and maintenance testing to determine if new inservice test values are warranted before the PAV is returned to service. If the PAV was not removed from service, inservice test values shall be immediately determined or confirmed. This testing is intended to demonstrate that test parameters, which could be affected by the replacement, repair, modification, or maintenance, are within acceptable limits. The Owner's program shall define the level of testing required prior to and after replacement, repair, modification, or maintenance activities. Other attributes, such as functional margin, shall be evaluated when defining the level of testing required prior to and after replacement, repair, modification, or maintenance activities, where the basis is properly justified and documented by an engineering evaluation. Deviations between the previous and new inservice test values shall be identified and analyzed. Verification that the new inservice test values represent acceptable operation shall be documented.

PAV-2.2 PAV Inservice Testing Requirements

(a) A record of the service life of each charge in each PAV shall be maintained. This record shall include the date of manufacture, batch number, installation date, and the date when service life expires based on the manufacturer's recommendations. In no case shall the service life exceed 10 yr.

(b) Concurrent with the first test and at least once every 2 yr, the service life records of each PAV shall be reviewed to verify that the service lives of the charges have not been exceeded. The Owner shall take appropriate actions to ensure charge service lives are not exceeded.

(c) At least 20% of the charges in PAVs shall be fired and replaced at least once every 2 yr. If a charge fails to fire, all charges with the same batch number shall be removed, discarded, and replaced with charges from a different batch.

(d) Replacement charges shall be from batches from which a sample charge shall have been tested satisfactorily and with a service life such that the requirements of (b) are met.

(e) At least once every 2 yr, each PAV shall undergo visual examination of external surfaces and internal surfaces and parts with the following additional provisions:

(1) Visual examination shall include documentation of the presence of fluids or other contaminants.

(2) Any identified fluids or other contaminants within the internal mechanism that could potentially interfere with the function of the PAV shall be removed, and their presence shall be evaluated to determine the impact on the operational readiness of the valve and its actuator.

(3) This examination shall include verification of the initial operating position of the internal actuating mechanism.

(4) Proper operation of remote position indicators shall be confirmed.

(f) At least once every 2 yr, one PAV of each size shall be disassembled for internal examination of the valve and actuator with the following provisions:

(1) This examination will verify the operational readiness of the PAV assembly by evaluating the internal components for their operational functionality, ensuring the integrity of individual components, and removing any foreign material, fluid, or corrosion in accordance with the Owner's examination procedures.

(2) All PAVs shall be disassembled for internal examination at least once every 10 yr.

(g) For the PAVs selected in the test sample for (c), the operational readiness of the actuation logic and associated electrical circuits must be verified for each sampled valve following removal of its charge. This verification must include confirmation that sufficient electrical parameters (voltage, current, and resistance) are available for each actuation circuit.

(h) For the PAVs selected in the test sample for (c), the sampling must select at least one PAV from each redundant safety train every 2 yr. Each sampled pyrotechnic charge shall be tested in the PAV or a qualified test fixture to confirm the capability of the charge to provide the necessary motive force to operate the PAV to perform its intended function without damage to the valve body or connected piping.

(i) Corrective action shall be taken in accordance with the Owner's corrective action requirements to resolve any deficiencies identified

(1) during examinations with post-maintenance testing conducted in accordance with PAV-2.1.1

(2) in the capability of a pyrotechnic charge in accordance with PAV-2.1.1, or

(3) in the actuation logic or associated electrical circuits

(j) If deficiencies are identified that would prevent specified operation, the PAV shall be declared not operationally ready in accordance with the Owner's requirements. Deficiencies shall be addressed for other PAVs, such as by internal examination or pyrotechnic charge and circuitry testing, as applicable, with appropriate actions based on those findings. Post-maintenance testing shall be conducted in accordance with PAV-2.1.1.

(k) Valve Obturator Movement. The necessary valve obturator movement shall be determined (either during installed testing of the valve or during internal inspections) while observing an appropriate indicator, such as indicating lights that signal the required changes of obturator position, or by observing other evidence, such as changes in system pressure, flow rate, level, or temperature, that reflects a change of the obturator position.

(l) Position Verification Testing. PAVs with remote position indicators shall be observed at least once every 5 yr during installed testing or internal inspections to verify that valve operation is accurately verified by indications such as flow meters or other suitable instrumentation to verify obturator position.

(m) Leak Testing Requirements. Seat leakage testing shall be performed in accordance with Section VLT.

PAV-3 CORRECTIVE ACTIONS

Corrective actions shall be performed as specified in GR-3 and this Section.

PAV-4 RECORDS

(a) General. PAV records shall be maintained in accordance with GR-4 and as specified in this Section.

(b) PAV Records. The Owner shall maintain a record that shall include the following for each PAV covered by this Section:

(1) the manufacturer and manufacturer's model and serial or other unique identification number

(2) a copy or summary of the manufacturer's acceptance test report, if available

(3) baseline test results

(c) Record of Tests. See GR-4.3 and as specified in this Section.

(d) Record of Corrective Action. See GR-4.4 and as specified in this Section.

(e) Test Plans. See GR-2.3.2.

Section PRD
Pressure Relief Devices

PRD-1 INTRODUCTION

Pressure relief devices (PRDs) within the scope of this Code shall meet the requirements specified in Section GR and this Section. In addition, the following shall apply:

(a) The requirements of this Code apply to valves that are capacity certified and used to perform a pressure or vacuum relief function.

(b) Valves used for pressure or vacuum relief protection that are not capacity certified shall be tested by the section or sections for that valve type.

(c) The requirements of this Code recognize differences between the installed operating conditions and the conditions under which a PRD might be tested. For a specific PRD design, if the parameter to be tested is dependent on conditions not specifically addressed by these requirements, the installed operating condition and the test condition shall be comparable, or proven correlations shall be applied.

(d) The requirements of this Code apply only to PRDs required for overpressure protection.

(e) The requirements of this Code are not intended to demonstrate conformance to design specification requirements.

(f) The requirements of this Code are not intended to verify or demonstrate all aspects of PRD operation.

(g) Test equipment (e.g., gages, transducers, load cells, and calibration standards) used to determine valve set-pressure shall have an overall combined accuracy not to exceed ±1% of the indicated (measured) set-pressure.

PRD-2 INSERVICE TESTING REQUIREMENTS

PRD-2.1 General

(a) Operation and Maintenance Instructions. Complete operation and maintenance instructions shall be available for each device. This Code shall be supplemented by these operating and maintenance instructions.

(b) Valve Testing Frequency. A frequency for valve testing is required by this Code to provide verification of the valve operational readiness to perform its specified functions.

(c) Visual Examination. Visual examinations shall be performed in accordance with the examination procedures and shall be documented.

(d) Acceptance Criteria. The Owner, based upon system and valve design basics, license basis code of record for plant design requirements for overpressure protection, or technical specification, shall establish test acceptance criteria for overpressure protection.

(e) Position Verification Testing. PRDs with remote position indicators shall be observed at the test interval specified in PRD-2.3.1 to verify that valve operation is accurately indicated by indications such as use of flow meters or other suitable instrumentation to verify obturator position.

PRD-2.1.1 Test Frequencies — Pressure Relief Valves

(a) Test Interval

(1) Pressure relief valves shall be tested at least once every 10 yr, starting with reliance on their capability to perform their specified functions. The 10-yr test interval shall begin from the date of the as-left set-pressure test for each valve.

(2) Valves shall be tracked by the manufacturer's serial number or a unique alphanumeric identification assigned by the Owner.

(3) The initial test interval for a new or an overhauled valve is 48 months where qualified for this test interval or longer in accordance with QME-1.

(4) Valves that fail the as-found set-pressure test shall have their test interval reduced by 24 months. The minimum required time between tests is at least once every 24 months.

(5) Valves that pass the as-found set-pressure test may have their test interval increased by 24 months. The maximum required time allowed between tests is at least once every 10 yr.

(b) Replacement With Pretested Valves. The Owner may satisfy testing requirements by installing pretested valves to replace valves that have been in service, provided that

(1) for replacement of a partial group of valves, the valves removed from service shall be tested prior to reliance on the installed valves to perform their specified functions, or

(2) for replacement of a full group of valves, the valves removed from service shall be tested within 12 months of removal from the system

PRD-2.1.2 Test Frequency — Nonreclosing PRDs. Nonreclosing PRDs shall be replaced every 5 yr, unless historical data indicate a requirement for more frequent replacement.

PRD-2.1.3 Test Frequency — Pressure Relief Valves That Are Used for Thermal Relief Application. Tests shall be performed on relief devices used in thermal relief application every 10 yr, unless performance data indicate more frequent testing is necessary. In lieu of tests, the Owner may replace the relief devices at a frequency of every 10 yr, unless performance data indicate more frequent replacements are necessary.

PRD-2.1.4 Test Frequency — Primary Containment Vacuum Relief Valves

(a) Tests shall be performed on all containment vacuum relief valves every 2 yr. Test intervals may be adjusted using the requirements of PRD-2.1.1(a).

(b) Additional leakage rate testing in accordance with Section VLT or other regulatory specified primary containment leakage rate testing programs may be required as determined by GR-1.2(a) and GR-2.3.1.

PRD-2.1.5 Test Frequency — Vacuum Relief Valves, Except for Primary Containment Vacuum Relief Valves. All vacuum relief valves shall be tested every 2 yr. Test intervals may be adjusted using the requirements of PRD-2.1.1(a).

PRD-2.2 PRD Testing

PRD-2.2.1 Testing Before Initial Installation. Before initial installation, each PRD within the scope of this Code shall be qualified as required in Section GR.

PRD-2.2.2 Main Steam Pressure Relief Valves with Auxiliary Actuating Devices. Tests shall be performed in the following sequence, or manufacturer's production tests may be accepted for (b) through (d), provided the valve passes visual examination in accordance with the examination procedures:

(a) visual examination
(b) set-pressure determination
(c) testing of accessories
(d) determination of compliance with the seat tightness criteria

PRD-2.2.3 Safety Valves. Tests shall be performed in the following sequence, or manufacturer's production tests may be accepted for (b) through (d), provided the valve passes visual examination in accordance with the examination procedures:

(a) visual examination
(b) set-pressure determination
(c) testing of accessories
(d) determination of compliance with seat tightness criteria

PRD-2.2.4 Power-Actuated Relief Valves. Tests shall be performed in the following sequence, or manufacturer's production tests may be accepted for (b) through (d), provided the valve passes visual examination in accordance with the examination procedures:

(a) visual examination
(b) determination of functional capability
(c) testing of accessories
(d) determination of compliance with the seat tightness criteria

PRD-2.2.5 Pressure Relief Valves. Tests shall be performed in the following sequence, or manufacturer's production tests may be accepted for (b) and (c), provided the valve passes visual examination in accordance with the examination procedures:

(a) visual examination
(b) set-pressure determination
(c) determination of compliance with the seat tightness criteria

PRD-2.2.6 Nonreclosing PRDs. The device shall pass visual examination in accordance with the examination procedures.

PRD-2.2.7 Vacuum Relief Valves. The valves shall pass visual examination in accordance with the examination procedures.

PRD-2.3 Baseline Testing

PRD-2.3.1 Main Steam Pressure Relief Valves with Auxiliary Actuating Devices. After installation, safety valves and pilot-operated pressure relief valves equipped with auxiliary actuating devices shall be remotely actuated at reduced or normal system operating pressure to verify open and close capability before relied on to perform their specified functions. Set-pressure verification is not required. Actuation pressure of the auxiliary actuating device-sensing element, where applicable, and electrical continuity shall have been verified.

PRD-2.3.2 Safety Valves. Within 1 yr before relied upon to perform its specified function, each valve shall have its set pressure verified.

PRD-2.3.3 Power-Actuated Relief Valves. After installation, each valve shall be remotely actuated at normal system operating pressure to verify open and close capability before relied upon to perform its specified function.

PRD-2.3.4 Other Pressure Relief Valves. Within 1 yr before relied upon to perform its specified function, each valve shall have its set pressure verified.

PRD-2.3.5 Nonreclosing PRDs. The device shall pass visual examination in accordance with the examination procedures before relied upon to perform its specified function.