



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

NRC INSPECTION MANUAL

EMEB

INSPECTION PROCEDURE 73756

INSERVICE TESTING OF PUMPS AND VALVES

PROGRAM APPLICABILITY: 2515

SALP FUNCTIONAL AREA: Maintenance (MAINT)

73756-01 INSPECTION OBJECTIVE

To determine whether inservice testing regulatory requirements and licensee commitments are being met.

73756-02 INSPECTION REQUIREMENTS

02.01 Verify that the licensee has assigned responsibilities to persons and organizations for:

- a. Preparation, review, and approval of inservice testing (IST) procedures.
- b. Scheduling of IST for normal and increased frequency testing.
- c. Performance of testing per approved procedures.
- d. Performance of post-maintenance and post-modification IST.
- e. Proper certification and calibration of IST instruments.
- f. Training for those personnel responsible for implementing IST procedures.

02.02 Select Sample Systems to Review. Select three to five ASME Code Class 1, 2, or 3 systems to review and assess for the IST of certain components in the systems.

02.03 General IST Program Review. Review the following aspects of IST for applicable pumps and valves in the selected systems.

- a. Verify that the pumps and valves that perform a safety-related function(s) in the selected systems are in the IST program.
- b. Verify tests performed for the pumps and valves of 02.03a above meet the Code test method and frequency requirements, except where NRC has granted relief or approved alternatives.

- c. Verify that requests for relief or approval for alternative testing have been submitted to the NRC. When the requests are not based on an impractical condition, verify that the alternative is not implemented in lieu of the code requirements prior to NRC approval.
- d. Review the basis for requests for relief and alternatives and assess the adequacy of the implementation of the alternative testing.
- e. Review the justification for deferring testing to cold shutdowns or refueling outages.
- f. Review administrative controls for tracking tests performed quarterly, on a cold shutdown frequency, or during refueling outages.
- g. Review the test plan, implementing procedures, or test records to ensure reference values and acceptance criteria are identified and are in accord with Code limits.
- h. Review program controls and IST procedures for reverifying or establishing reference values after component maintenance, replacement, or modification.
- i. Review controls for post-maintenance testing to ensure that a component is tested prior to its return to service.
- j. Review evaluation process for instruments found out-of-calibration to determine the affect on previous test results.

02.04 Testing Conducted During Inspection. Review ongoing testing activities, if any, for components in the selected systems.

- a. Observe and evaluate any testing conducted for pumps and valves in the IST program, especially in the selected systems.
- b. Verify the instruments used for the test meet the code-specified range and calibration accuracies and that the calibration is current.

02.05 Test Results. Evaluate test results for a sample of pumps and valves in the selected systems, with a minimum of four pumps and six valves.

- a. Review at least one fuel cycle of test data for selected pumps and valves.
- b. Ensure that the code-specified corrective actions were taken for any test results in the "Alert Range" or "Required Action Range" or where acceptance criteria were otherwise exceeded.
- c. Verify compliance with applicable technical specification ACTION statements and applicable reporting requirements when components are declared inoperable as a result of IST.
- d. Review method of test data comparison to previous tests and actions taken on components indicating a degrading condition or a repetitive problem.
- e. Review the documented results of engineering evaluations performed for inoperable components for a minimum of two fuel cycles, particularly root cause analysis of the problem and the bases for returning the components to operable status.

- f. Review administrative controls for design modifications or replacement of safety-related pumps and valves to ensure IST is identified, where appropriate.
- g. Verify completed test documents require appropriate review and are maintained as quality controlled records.

02.06 Valve Testing. Evaluate the following areas for testing of a sample of valves in the selected systems.

- a. Evaluate the test method, acceptance criteria (including the limiting value for stroke time), and corrective action for stroke timing power-operated valves in the test procedures.
- b. Verify that valves with remote position indication, including passive and manual valves, are subject to position indication verification once every two years in accord with the code requirements.
- c. Evaluate leak rate testing of Category A valves.
- d. Evaluate the adequacy check valve testing, including disassembly and inspection where applicable.
- e. Verify that manual valves in the program are periodically exercised in accord with the code requirements.
- f. Review the set pressure testing for safety and relief valves.
- g. Review the adequacy of non-reclosing pressure relief device (rupture disc) testing/replacement.

02.07 Pump Testing. Evaluate the following areas for testing of a sample of pumps in the selected systems.

- a. Review pump testing methods, acceptance criteria, and corrective action in the test procedures.
- b. Review pump testing for the selected systems in cases where minimum-flow recirculation flow paths are used during testing to ensure testing conforms with guidance in GL 89-04, Position 9.
- c. Verify the ranges and calibration accuracies of test instruments meet code requirements.
- d. Verify that pumps are declared inoperable in completed test procedures when test results are in the "Required Action Range" or that the test frequency is doubled when the test results are in the "Alert Range."
- e. Ensure that testing is performed at established reference values.

73756-03 INSPECTION GUIDANCE

General Guidance

Certain pumps and valves are subject to inservice testing requirements of 10 CFR 50.55a. Those pumps and valves that are designated American Society of Mechanical Engineers (ASME) Code Class 1, 2, or 3, and per the ASME Boiler and

Pressure Vessel Code (BPV Code) or the ASME Operations and Maintenance Standards or Code (OM Code) are required to perform a specific function in shutting down a reactor to the safe shutdown condition, in maintaining the safe shutdown condition, in mitigating the consequences of an accident, or in providing overpressure protection. Only pumps performing these functions which are provided with an emergency power source, other than solely for operating convenience, are included in the scope. In addition to the ASME BPV Code and OM Code, guidance has been issued by the NRC in Generic Letter (GL) 89-04 and NUREG-1482.

The inspector shall review the licensee's IST program for compliance with the regulatory requirements of 10 CFR 50.55a, and the ASME BPV Code, Section XI, or the OM Standards or OM Code, as appropriate to the edition used by the licensee for developing the IST program, to the extent outlined in this inspection procedure. It is recommended that the inspection be announced to (1) enable the licensee to assemble documents for inspection prior to arrival of the inspector(s) at the plant site, and (2) schedule testing during the week of inspection, as the schedule allows.

Inspection Preparation. The inspector(s) should request the licensee to assemble materials that will be necessary for conducting the inspection, including a copy of the following: (1) all current NRC IST safety evaluations; (2) the IST program document(s) which may include administration procedures and the current revision of the IST program; (3) any submittal to the NRC that includes revisions to the current documents; (4) piping and instrument diagrams for the selected systems; (5) at least one fuel cycle of completed pump and valve test procedures for the selected systems; and (6) trended hydraulic and bearing vibration data for pumps in the selected systems (if applicable). Other materials that should be available for the inspector's use include plant technical specifications, Safety Analysis Report, Individual Plant Examination reports, any component or system design bases documentation, licensee's response to NRC Bulletin 88-04, and procedures for the design change process and the evaluations for 10 CFR 50.59. The inspector(s) should review the most recent IST program available at the region and select systems for potential detailed review. The applicable edition of the ASME Code should be reviewed for familiarity.

Inspection. The inspection may be conducted by Resident Inspectors or by Regional Inspectors familiar with IST, GL 89-04, and NUREG-1482. Staff from the Division of Engineering of NRR may provide support for the inspection. The inspection need not be conducted by a "team" as described in IMC 2515, Section 06.02.

Specific Guidance

03.01 The overall programmatic aspects of the development, maintenance, and scheduling of the inservice testing program should be included in a number of administrative procedures. Procedures for implementing the testing will generally be operating procedures or surveillance procedures specific to a component or a group of components (e.g., one procedure may test only a pump, while another may test a pump and a group of valves, or may be limited to a group of valves). The calibration of the instruments will generally be performed onsite, though some instruments (e.g., vibration monitoring) may be calibrated at an offsite facility. Training for the individuals conducting the testing will generally be included in special classes or as part of a broader course on various surveillance requirements.

03.02 Select Sample Systems to Review. There are many components in an IST program and limited time for inspection; therefore, the inspection should focus

on components in only a few important systems. The selection process should consider plant risk (associated with failures of pumps or valves), maintenance, identified programmatic weaknesses, and testing scheduled for performance during the inspection. The selected systems should contain a variety of pump and valve types. Where possible, the inspector should maximize the inspection effectiveness evaluating areas involving multiple inspection requirements as follows:

- System Risk. The results of an individual plant evaluation or a probabilistic risk assessment (PRA) might reveal insights on important systems and components. Another tool is a facility risk-based inspection guide (RIG), if one exists. An RIG considers the PRA results and shows the relative importance of some systems and components. IMC 2515, Appendix C, "Risk-Based Inspection Guides," lists the RIGs that have been issued. Plant IST program correspondence may identify programmatic weaknesses for particular systems or components.
- System Maintenance. Pumps or valves with a high incidence of corrective maintenance are good candidates for selection. The inspector might identify these components through discussions with the Resident Inspector, plant maintenance or operations personnel, a review of previous inspection reports, or through a search of licensee event reports (LERs) or the Nuclear Plant Reliability Data System database.
- Testing Activities. The inspector should evaluate any ongoing testing activities and consider selecting systems with tests scheduled during the inspection period.

03.03 General IST Program Review. Using the regulations and the applicable ASME Code, and the NRC guidance in GL 89-04 and NUREG-1482, determine if the licensee's actions are adequate in the identified areas.

- a. The pumps and valves within the scope of the IST program are those that are in ASME Code Class 1, 2, or 3 systems and are required to perform a specific function in shutting down a reactor to the safe shutdown condition, in maintaining the safe shutdown condition, in mitigating the consequences of an accident, or in providing overpressure protection. Only pumps performing these functions and which are provided with an emergency power source, other than solely for operating convenience, are within the scope of IST.
- b. An example of appropriate test method and frequency is a Category A, air-operated valve with remote position indication which should be full-stroke exercised, fail-safe tested, and stroke timed quarterly. Valve position indication should be checked at least every two years. The valve should be leak rate tested at least every two years. If quarterly exercising is impractical during power operations, testing may be deferred to cold shutdown or refueling outages, as justified.
- c. The implementation of relief requests and requests for approval of alternatives is discussed in Section 6 of NUREG-1482.
- d. The basis for relief and alternatives should be confirmed by verifying that the design limitation or the equivalent testing is as stated by the licensee. Ensure that the licensee is implementing the alternative as stated in the request with any provisions imposed in the NRC's safety evaluation approving the request.

- e. The justification for deferral of testing to the cold shutdown or refueling outage conditions should adequately state the impracticalities of performing the testing during power operations, or cold shutdown conditions, as appropriate. If a partial-stroke exercise is practical, the testing should be performed as appropriate, with deferral of full-stroke exercising. Guidance is given in Section 3.1 of NUREG-1482.
- f. The administrative controls should be adequate to ensure testing meets the code requirements. Guidance is given in Section 3.1 of NUREG-1482.
- g. The reference values should be in the test procedures as they are necessary to perform testing. The acceptance criteria should be readily available such that a determination of operational readiness can be made in an expeditious manner.
- h. The procedures for accomplishing maintenance, replacement, or modification should address IST to establish new or reconfirm previous reference values.
- i. Post-maintenance testing will generally require performance of the IST procedures used for quarterly or cold shutdown or refueling outage testing. For check valves disassembled and inspected or repaired, a partial-stroke exercise following reassembly, in addition to other required testing, should be performed if practical. Documentation of post-maintenance testing may be included in either completed inservice test procedures or maintenance records.
- j. Review at least one example (if one exists) of an instrument that was found to be out-of-calibration during an inservice test.

03.04 Testing Conducted During Inspection

- a. Tests should satisfy the applicable code requirements.
- b. Instruments used for pump tests should meet the code accuracy and range requirements and be within calibration.

03.05 Test Results

- a. Review results from completed tests of pumps and valves performed during
- b. at least one fuel cycle. Appropriate action should have been taken for
- c. test results in the "Alert Range." The component should have been declared inoperable in a timely manner and appropriate actions taken for test results in the "Required Action Range." For components addressed by plant technical specifications that, if declared inoperable, would result in entering an ACTION statement, verify appropriate information is in the test plans or test records such that those responsible for the test can make a timely determination whether the data meets the acceptance criteria and the component is operable. Determine if the licensee is complying with applicable reporting requirements of the code and of 10 CFR 50.72 and 50.73.
- d. Evaluate the test data trending, if the licensee trends the data, and
- e. actions taken for components found to be degraded or that require frequent corrective maintenance. For these components, determine if an engineering evaluation was performed that adequately addressed the root cause. Assess the licensee's actions if the components represent a generic class of components at the plant or if the mode of degradation is

likely to affect other components in the system. Review any engineering evaluations which were performed to return a component to operable status in lieu of other corrective actions.

- f. The licensee's controls should consider the system design basis and code-required test provisions as part of the modification or replacement process.
- g. The test documents should be reviewed by the appropriate supervisor(s) responsible for determining operability. Followup review should include the IST coordinator review for including the data in a data base for trending (if applicable).

03.06 Valve Testing

- a. The licensee should determine changes in stroke times of power-operated valves by comparing measurements to either a reference stroke time value or the previous test measurement. If stroke time measurements are compared to reference values this method of comparison should be documented in the program.

The inspector should evaluate a sample of the bases for assigning limiting values to full-stroke times of power-operated valves. Ensure limiting values are based on stroke times measured when the valve is in good condition and operating properly. The limiting value should represent a reasonable deviation from the reference stroke time. Verify that limiting stroke times do not exceed any design values. Ensure stroke time limits are readily accessible during testing and that instructions are provided for actions to take if criteria is exceeded. However, rapid-acting valves can have a limiting stroke time of 2 seconds (reference Position 6 of GL 89-04).

- b. Guidance on position indication verification is given in Sections 4.2.5 and 4.2.6 of NUREG-1482.
- c. Valves that have a specific leakage limit are designated as "Category A" valves. The leakage test may be of an individual valve or a group of valves. For pressure isolation valves, generally an individual leakage test is required. See Sections 4.4.5, 4.4.7, and 4.4.8 of NUREG-1482.
- d. Check valves are tested by ensuring the capability to full-stroke to the position(s) required to fulfil the safety function(s) of the valve. Guidance on testing check valves is given in Section 4.1 of NUREG-1482.
- e. Guidance on manual valves is given in Section 4.4.6 of NUREG-1482.
- f. Guidance on testing safety and relief valves is given in Section 4.3 of NUREG-1482.

Valves which provide an overpressure protection function but do not have their own safety function are the subject of recent Code action which may eliminate the requirements for additional valve testing for certain types of pressure relief devices. See Section 4.3.9 of NUREG-1482.

- g. Replacement frequency should satisfy the applicable code requirements.

03.07 Pump Testing

- a. Test procedures should include all steps necessary to comply with code requirements and to ensure repeatable test conditions. Acceptance criteria should be included in the test procedure with instructions for actions to take if the criteria is exceeded.
- b. Evaluate cases where the minimum-flow line is the only pump test flow path and verify the installation of flow rate instruments. Ensure the code requirements are met. Evaluate the basis for determining that the flow rate through pumps tested in a low flow condition is sufficient to prevent pump damage.

Determine if there are cases where flow can be established only through a non-instrumented minimum-flow path during quarterly pump testing, but a path exists that could be used for testing during cold shutdown or refueling outage conditions. In these cases, an increased interval between tests is acceptable. Ensure that pump differential pressure, flow rate, and bearing vibration are measured during cold shutdown or refueling outage testing. Verify at least pump differential pressure and pump bearing vibration are measured quarterly. Ensure data is recorded. Trending of test data is desirable. Ensure that pumps tested in this manner are identified in the IST program.

NRC Bulletin 88-04 requested that licensees investigate and correct two potential design concerns in safety-related pump minimum flow systems: (1) strong - weak pump interaction, and (2) installed minimum flow capacity. The inspector should review the response(s) made by the licensee to address the bulletin and determine if the concerns identified at the plant (if any) have been addressed. The inspector should assess plant and procedure modifications (if any) as a result of the licensee's evaluation.

- c. Pump test instrument ranges and calibration accuracies must meet the code requirements. Guidance is given in Section 5.5 of NUREG-1482.
- d. The code requires that a pump be declared inoperable when the required action limits are exceeded. If a problem with instrumentation is suspected, instruments may be re-calibrated and the test rerun. If a pump exceeds the alert limits, the test frequency is to be doubled (i.e., for a quarterly pump test, the test would be performed once every six weeks).
- e. For systems with constantly changing demand, the licensee might establish multiple sets of reference values per the code. The use of a reference curve does not meet the code requirements. Guidance on the use of pump curves is given in Section 5.2 of NUREG-1482.

73756-04 INSPECTION RESOURCE ESTIMATE

Completion of this inspection procedure is expected to take, on the average, 80 hours of direct inspection effort at the site.

American Society of Mechanical Engineers:

Boiler and Pressure Vessel Code, Section XI, Subsections IWP and IWV, various editions.

Operations and Maintenance Standards, Parts 6 and 10, OMa-1988 Addenda.

Operations and Maintenance Code, 1990 Edition.

U. S. Nuclear Regulatory Commission:

Bulletin 88-04, "Potential Safety-Related Pump Loss," May 5, 1988.

Code of Federal Regulations, Title 10, Part 50, Section 50.55a, "Codes and Standards."

Generic Letter 89-04, "Guidance on Developing Acceptable Inservice Testing Programs," April 3, 1989.

NUREG-1482, "Guidelines for Inservice Testing at Nuclear Power Plants," April 1995.

END