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Valves**  
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## Document Verification

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<b>Responsible</b>	Name: Justin Morton / Edmund Elliott Job Title: Senior Piping Materials Engineer Signed:  Date: 10/02/2018
<b>Accountable</b>	Name: Stylianos Christides / Luigi Spagnolo Job Title: Lead Mechanical / Piping Engineer Signed:  Date: 11/02/18
<b>Endorsed</b>	Name: Marco Mascheroni / Harald Traa Job Title: Engineering and Technical Authority Manager Signed:  Date: 11 Feb 2018
<b>Document Owner</b> (if different from Endorsed)	Name: Job Title: Signed: Date:
<b>Consulted</b>	Name: Hans Gruntjes / Mark Crame Job Title: Lead Instrument / Control Engineer Signed:  Date: 11 FEB 2018
<b>Informed</b>	PED Technical Authority Manager(-s) PED Engineering Execution Manager(-s) PED Engineering Piping Engineer(-s) P&M Plant Integrity Assurance Superintendent(-s) P&M Mechanical Superintendent(-s) P&M Lead Vessels and Piping Mechanical Engineer(-s) P&M Field Engineering Superintendent(-s) P&M Piping Engineer(-s) Contracts and Procurement Section Head(-s) Expediting Coordinator(-s)

## **Executive Summary**

This document specifies the minimum requirements for Low Temperature Testing (LTT) of manual and actuated valves.

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## 1 PURPOSE

The purpose of this specification is to define the requirements for low temperature testing (LTT) of manual and actuated valves.

The intent of LTT is to demonstrate the acceptable performance of a given valve design (and, for actuated valves, an integrated valve and actuator design) at the specified design temperature. This is accomplished by:

- Verifying that the valve operates satisfactorily from fully open to fully closed at the specified design temperature and maximum differential pressure.
- Ensuring that the body joints and stem seals do not exceed the specified external leakage rate.
- Ensuring that the leakage through the valve seats does not exceed the specified leakage rate.

## 2 SCOPE

This specification is applicable to ball, butterfly, gate, and globe valves and any associated actuators as specified in the PR/PO. If the subject valve is an actuated valve, the test shall be conducted with the actuator fully assembled to the valve.

Similar tests performed previously (type tests) may be submitted for review in order that this requirement be waived. Type tests may be accepted if the valve and actuator tested is identical in design and material of construction to the valve and actuator being supplied from the production batch.

This procedure shall be adhered to for testing of:

- A single valve within a batch of identical valves if a previous LTT report is not in place or submitted by the Supplier and approved by Company.
- A single unique valve.

This test is not required for API 6A valves for which a valid PR2 Qualification Test certificate is provided by the Supplier. It is also not required for check valves.

## 3 REFERENCES

### Industry Codes and Standards

ANSI / FCI 70-2                      Control Valve Seat Leakage

### Company Specifications

KPO-00-ENG-SPC-00001-E	Technical Supply Requirements - Valves
KPO-00-INS-SPC-00012-E	Isolation & Shutdown Valves
KPO-00-INS-SPC-00013-E	Control Valves



## 4 PROCEDURE

### 4.1 General

This specification shall be read in conjunction with the procurement related Enquiry, Purchase Requisition (PR) or Purchase Order (PO) documentation.

In case of conflict between any requirement specified herein and the requirements of any other referenced document, the hierarchy for resolving the conflict shall be:

- i) The PR/PO.
- ii) Data Sheets.
- iii) This Specification.
- iv) Referenced Codes and Standards.

### 4.2 Selection of Test Valves

The test valve will be selected at random from a production batch by a representative of KPO. In order to fully qualify a quantity the valves selected for test shall be per manufacturer and include the range of sizes, pressure ratings, design variations, actuator types and material options in the PO.

Bi-directional valves shall only be tested in one direction unless otherwise stated in the PR/PO. The KPO Inspector shall select in which direction to test the valve.

### 4.3 Prior Testing

Prior to LTT, each valve and actuator (if present) shall have been successfully tested in accordance with the applicable design code and project design specification as follows:

- KPO-00-ENG-SPC-00001-E, Technical Supply Requirements - Valves
- KPO-00-INS-SPC-00012-E, Isolation & Shutdown Valves
- KPO-00-INS-SPC-00013-E, Control Valves

Proof of prior hydrotesting to the applicable design code and project specifications shall be by authorised certificates of test results to the satisfaction of the KPO Inspector. Due to the hazardous nature of gas testing, under no circumstances shall this pre-testing be waived.

### 4.4 Test Temperature

Unless stated otherwise in the PR/PO the test temperature shall be as follows:

Valve Body Material	Test Temperature and Tolerance
CL 150 Stainless Steel	-120°C (±10°C) (Note 1)
Low Temp. Service to be suitable for	
-120°C process condition	

CL 300 and higher Stainless Steel	-100°C (±10°C) (Note 1)
Low Temp. Service to be suitable for -100°C process condition	
All others	-45°C (±5°C) (Note 2)

Notes:

1. Valve shall have been previously tested for -40/45°C ambient condition prior to conducting this test.
2. Due to probable low temperature limitations typically associated with valve ancillaries utilising project specific IS (Intrinsic Safety) equipment, actuated valves (complete with assembled body and actuator) shall be tested at -40°C.

#### 4.5 Preparation of Test Equipment

The design and safety of the test equipment is the responsibility of the Supplier.

The Supplier may consider the following options for cooling of the valve and bonnet or stem seals:

- Controlled discharge of liquid nitrogen into an insulated container
- Alcohol / ice mixture
- Refrigerating oil bath
- Cryogenic chamber

Actuator cooling may be achieved by means of gaseous nitrogen re-circulating in an upper cabinet.

During LTT at -40/45°C, non-cryogenic valves (i.e. without extended bonnets) shall be immersed to a depth such that the level of the coolant covers at least the top of the valve body / bonnet joint and stem seals.

During LTT at -100/120°C, the test valve shall be installed in an insulated covered container, with the extended bonnet gland or stem seals outside the container cover and in ambient conditions.

The Supplier shall demonstrate the test equipment is leak free at the maximum test pressure, in the proximity of the valve.

Pressure gauges shall have a minimum dial diameter of 100mm and have a range between 1½ and twice the maximum test pressure required.

A conceptual scheme of test equipment is shown in Appendix A.

The KPO Inspector shall be allowed access to verify that the equipment used to perform, control, measure and record the test is in good condition and is properly calibrated.



## 4.6 Preparation of Test Valve

The Supplier shall confirm that the valve has been fully dried after any prior hydrotesting before commencing LTT.

If, following an earlier hydrotest, the valve internals have been protected by a preservative coating, the preservative shall be removed by disassembling the valve and dipping or spraying the valve internals with a suitable solvent. Reassembled valves shall be retested to the applicable design code and project design specification before commencing LTT.

Flanged valve body joints, including end flanges, shall be sealed with PVC tape or similar, with a small hole to detect leakage with a mass-spectrometer probe.

For manual valves, three thermocouples shall be attached to the valve as shown in Appendix A, i.e. valve body outer surface, valve body inner surface (near seating area), and bonnet near packing area. Actuated valves shall have two additional thermocouples attached as shown in Appendix A.

## 4.7 Test Medium

Except where otherwise noted in this specification, the test medium shall be a certified 99%  $N_2$  1%  $He$  (by volume) pre-mixture.

External leak testing shall be performed via mass spectrometer, with the sensitivity to detect Helium leaks equivalent to 2 scf per annum of the gas mixture.

The accuracy of the mass spectrometer shall be demonstrated by calibration in the presence of the KPO Inspector by using the test medium specified above.

## 4.8 Low Temperature Testing Sequence

### 4.8.1 Low Temperature External Leak Test

With the valve ball/gate/disc/globe in the **half open position**, the temperature of the valve (and actuator) shall be reduced until the common test temperature indicated by all thermocouples is established.

**Caution:** Due to the differing actuator and body masses, the potential exists for the actuator to be 'overcooled' ( $<-45^{\circ}C$ ) prior to reaching the required valve body temperature. When utilising a cryogenic chamber, care should be exercised during cooling of assembled valves ensuring the temperature is stabilised and common to both Actuator / Valve Body throughout the process. The valve and actuator shall then be allowed to 'soak' at the final test temperature for a minimum of 30 minutes to verify a stabilised (rate of change  $<0.5^{\circ}C$  per min.) temperature.

The valve shall be pressurised to the ambient seat test pressure stated in the valve design code. Following a 1 minute stabilising period, the leakage at each body, bonnet, end flange joint and stem seal or gland shall be measured and recorded.

#### 4.8.2 Low Temperature High Pressure Seat Test

With the valve in the **closed position** at the test temperature, pressurise one side of the valve to the maximum seat test pressure stated in the valve design code, with the other side of the valve at atmospheric pressure. Following a 1 minute stabilising period, the seat leakage shall be measured over a minimum period of 1 minute and recorded.

Note that for seat leakage testing it is not essential to use a N<sub>2</sub> He gas mixture. Nitrogen only may be used provided seat leakage is measured by total gas flow, i.e. by a suitably calibrated flow meter or manometer.

#### 4.8.3 Low Temperature Low Pressure Seat Test

The seat leakage test in Section 4.8.2 shall be repeated with the valve pressurised at 7 barg.

#### 4.8.4 Low Temperature Operating Torque Test

Cycle the valve 10 times.

With the valve at the test temperature and in the **closed** position, the valve shall be pressurised on one side to the rated working pressure with the other side at atmospheric pressure.

The valve shall be operated from closed to **open** and the torque measured and recorded at seat break-out and mid-travel (operating). For actuated valves, measure and record the stroke time during this step.

The pressure in the valve shall be re-established and the valve operated from the open to **closed**. Measure and record the torque required to move the valve from the open position and to close the valve. For actuated valves, measure and record the stroke time during this step.

Note: Nitrogen may be used for this test.

### 4.9 Inspection of Valve

A valve that has successfully passed the LTT in accordance with this procedure is not required to be dismantled for inspection.

If a valve fails the LTT, the Supplier shall dismantle the valve in the presence of the KPO Inspector to determine the cause of failure, which shall be included in the Test Report.

Following a successful investigation and fault identification into a test failure, any remedial work required on the test valve shall be actioned on the identical batch / class in question.

Any valve dismantled, then re-assembled and offered for delivery shall be re-qualified in accordance with the respective design code and project design specification and subsequently retested per this specification.

## 4.10 Acceptance Criteria

### 4.10.1 External Leakage

No leakage is allowable from body joints.

The maximum allowable leakage rate through the stem seal shall be 5scf per annum (0.27scc/min) utilizing the best available mass flow meter sensitivity for nitrogen.

### 4.10.2 Maximum Seat Leakage – Soft Seated Manual and Actuated On-Off Valves



High Pressure Seat Test (All Sizes):

Ratings up to Class 600: 60 (scc \* cm dia) / min.

Ratings Class 600 and above: 120 (scc \* cm dia) / min.

Low Pressure Seat Test (All Sizes):

Ratings up to Class 600: 60 (scc \* cm dia) / min.

Ratings Class 600 and above: 120 (scc \* cm dia) / min.

### 4.10.3 Maximum Seat Leakage – Metal Seated Manual and Actuated On-Off Valves



High Pressure Seat Test (All Sizes):

Ratings up to Class 600: 180 (scc \* cm dia) / min.

Ratings Class 600 and above: 360 (scc \* cm dia) / min.

Low Pressure Seat Test (Sizes up to NPS 10):

Ratings up to Class 900: 12 (scc \* cm dia) / min.

Ratings Class 900 and above: 24 (scc \* cm dia) / min.

Low Pressure Seat Test (Sizes NPS 12 and larger):

Ratings up to Class 900: 20 (scc \* cm dia) / min.

Ratings Class 900 and above: 30 (scc \* cm dia) / min.

### 4.10.4 Maximum Seat Leakage – Control Valves

The maximum seat leakage shall be as shown on the valve datasheet in accordance with ANSI / FCI 70-2. Note that all other requirements apply, including the requirement to conduct the test as a gas test.



### 4.10.5 Torque

The measured torques shall comply with KPO-00-ENG-SPC-00001-E.

#### **4.11 Recording and Reporting Test Results**

The LTT Report shall contain the following information:

- Reference to Applicable Hydrostatic Test Results.
- Leakage rates for body and seat tests.
- Record of valve body and actuator temperature measurements.
- Operating torques (& stroke times) at test temperature.
- Any other measurements or observations made during the test.

Failed or aborted tests shall also be reported with the actual results achieved up to the point of failure.

### **5 APPENDICES**

Appendix A Example Schematic of Low Temperature Test Rig

## Appendix A: Example Schematic of Low Temperature Test Rig

