WMTS-030:2016
Solenoid valves

WaterMark Technical Specification

2016

ABCB

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Solenoid valves

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IMPORTANT NOTICE AND DISCLAIMER

On 25 February 2013 management and administration of the WaterMark Certification Scheme transferred to the Australian Building Codes Board (ABCB). From this date all new technical specifications will be named WaterMark Technical Specifications (WMTS). Within two years all existing ATS will be renamed WMTS. During this initial period both terms may be used and accepted. All new and recertified Certificates of Conformity will reference WMTS. Certificates of Conformity that currently reference ATS will be re-issued referencing the equivalent WMTS during this initial period. The WaterMark Schedule of Specifications lists all current WMTS and, where appropriate, the former ATS name.

This Technical Specification supersedes Standards Australia ATS 5200.030–2012.

The rebranding of this Technical Specification has included additional information about the transition as well as changes to specific details including replacing references to Standards Australia and the National Plumbing Regulators Forum (NPRF) with the ABCB, changing the term Australian Technical Specification (ATS) to WaterMark Technical Specification (WMTS), replacing references to technical committees WS-014 and WS-031 with the WaterMark Technical Advisory Committee (WMTAC).

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PREFACE

WaterMark Technical Specification WMTS-030:2016 Technical Specification for plumbing and drainage products, Solenoid valves was originally prepared by Standards Australia Committee WS-031, Technical Procedures for Plumbing and Drainage Products Certification as ATS 5200.030-2012.

The objective of this Technical Specification is to enable product certification in accordance with the requirements of the Plumbing Code of Australia (PCA).

The test protocol and information in this Technical Specification was arranged by committee members to meet the authorization requirements given in the PCA.

The word 'VOID' set against a clause indicates that the clause is not used in this Technical Specification. The inclusion of this word allows a common use clause numbering system for the WaterMark Technical Specifications.

The 2012 edition varied from the previous edition by the inclusion of a torque test to measure the ability of the valve to withstand the torques that would normally be encountered in installation, as well as changes to the cycle time in the endurance test to make it more practical. Plastics-bodied valves are now included in the ultraviolet light exposure test.

The term 'normative' has been used in this Technical Specification to define the application of the appendix to which it applies. A 'normative' appendix is an integral part of a Technical Specification.

The WaterMark Schedule of Specifications and List of Exempt Products are dynamic lists and change on a regular basis. Based on this function, these lists have been removed from the WaterMark Certification Scheme document known as Technical Specification for Plumbing and Drainage Products and are now located on the ABCB website (www.abcb.gov.au). These lists will be version controlled with appropriate historic references.

ACKNOWLEDGEMENTS

Australian Technical Specification ATS 5200.030–2012, on which this technical specification is based, was prepared by Standards Australia Committee WS-031, Technical Procedures for Plumbing and Drainage Products Certification. It was approved on behalf of the Council of Standards Australia on 4 July 2012.

The following organisations were represented on Committee WS-031.

- Australian Industry Group
- Australian Stainless Steel Development Association
- Copper Development Centre—Australia
- CSIRO Manufacturing and Infrastructure Technology
- Department of the Environment, Water, Heritage and the Arts (Federal)
- National Plumbing Regulators Forum
- Plastics Industry Pipe Association of Australia
- Plumbing Products Industry Group
- South Australian Water Corporation
- Water Services Association of Australia

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1 SCOPE

This Technical Specification sets out requirements for metallic and plastics-bodied valves that are actuated by way of an electric solenoid valve and intended to be installed in the water service. The valves are generally in a range of sizes up to DN 50 and for continuous operating temperatures not exceeding 80°C.

Solenoid valves are used as a shut-off device for water supply and as prime components in sensor-activated urinal systems, electronic tap ware and the like.

Solenoid valves require certification to WaterMark Level 1.

2 APPLICATION

This Technical Specification will be referenced on the WaterMark Certification Scheme Schedule of Specifications.

Appendix A sets out the means by which compliance with this Technical Specification shall be demonstrated by a manufacturer for the purpose of product certification.

3 REFERENCED DOCUMENTS

The following documents are referred to in this Technical Specification:

AS

1006 Solid stem general purpose thermometers

1349 Bourdon tube pressure and vacuum gauges

1432 Copper tubes for plumbing, gasfitting and drainage applications

1565 Copper and copper alloys—Ingots and castings

1572 Copper and copper alloys—Seamless tubes for engineering purposes

1646 Elastomeric seals for waterworks purposes

2136 Method for detecting the susceptibility of copper and its alloys to stress corrosion cracking using the mercurous nitrate test

2345 Dezincification resistance of copper alloys

2738 Copper and copper alloys—Compositions and designations of refinery products, wrought products, ingots and castings

3565 Meters for cold and heated drinking and non-drinking water supplies

3565.1 Part 1: Technical requirements

3688 Water supply—Metallic fittings and end connectors

AS/NZS

1567 Copper and copper alloys—Wrought rods, bars and sections

1568 Copper and copper alloys—Forging stock and forgings

3500 Plumbing and drainage
Part 0: Glossary of terms
Part 1: Water supply
Part 4: Heated water services
Part 5: Domestic installation

3718 Water supply—Tap ware

4020 Testing of products for use in contact with drinking water

4 DEFINITIONS

For the purpose of this Technical Specification, the definitions given in AS/NZS 3500.0 and the one below apply.

4.1 Pitting resistance equivalent number (PREN)

Pitting Resistance Equivalent Number (PREN) is a theoretical way of comparing the pitting corrosion resistance of various types of stainless steels based on the chemical compositions and specifically chromium (Cr), molybdenum (Mo) and nitrogen (N).

The following equation is used to calculate the PREN:

PREN = %Cr + 3.3%Mo + x%N

where

x = 16 for duplex stainless steels

x = 30 for austenitic stainless steels

x = 0 for ferritic and martensite stainless steels

5 MATERIALS

5.1 General

This Clause specifies requirements for materials utilized in the construction of the product.

5.2 Metallic materials

5.2.1 *General*

Metallic materials in contact with water shall be corrosion resistant. For the purposes of this Technical Specification, the following materials are considered to be suitable:

(a) Copper, as specified in Clause 5.2.2.

(b) Copper alloy, as specified in Clause 5.2.3 and 5.2.4.

(c) Stainless steel, as specified in Clause 5.2.5.

5.2.2 *Copper*

Copper shall comply with the following:

(a) *Wrought products* AS 2738.

(b) *Tubular components* Copper tube shall comply with AS 1432.

5.2.3 *Copper alloy*

Copper alloy shall comply with the following:

(a) *Castings* AS 1565 or capable of passing the requirements of Clause 5.3 provided the alloy contains not less than 58% copper and not more than 1% aluminium.

(b) *Hot pressings* AS/NZS 1568.

(c) *Rod for machined parts* AS/NZS 1567 or an alloy complying with AS 2345.

(d) *Tubular components* Copper alloy tube shall comply with AS 1572 alloy designation C26130. Where bent or stamped in the fabrication process, the tube shall be sufficiently stress-relieved so that it is capable of passing the mercurous nitrate test specified in AS 2136 after all fabrication processes are complete.

5.2.4 *Dezincification-resistant (DR) copper alloy*

Copper alloys in contact with water shall comply with AS 2345.

5.2.5 *Stainless steel*

Stainless steel (SS) utilized in the construction of the valve and in contact with water shall have a PREN of 22 or greater.

5.3 Plastics materials

5.3.1 *General*

Under hydrostatic pressure, plastics materials shall be able to demonstrate suitability at the maximum operating pressure and temperature, for the intended life of the product.

5.3.2 *UV resistance*

For plastics-bodied valves intended for outdoor installation, the plastics material formulation shall be stabilized by suitable ultraviolet light stabilizers.

5.4 Elastomeric materials

The materials used for seals or gaskets shall comply with the relevant requirements of AS 1646.

6 MARKING

Each solenoid valve shall be permanently and legibly marked with the following:

(a) Manufacturer's name, brand or trademark.

(b) WaterMark.

(c) Certificate number.

(d) The number of this Technical Specification, i.e., WMTS-030.

(e) Nominal size (DN).

Each solenoid valve shall be marked directly on the valve or packaging with the following:

(i) Maximum operating temperature (MOT).

(ii) Maximum operating pressure (MOP).

(iii) Suitability for outdoor exposure.

NOTE: Where space is limited, the number of this Technical Specification may be in abbreviated form, i.e., S030.

7 VOID

8 DESIGN

8.1 End connectors

Threaded end connectors for connection to either pipes or fittings shall comply with AS 3688. Other connection ends shall comply with the requirements relevant to the connection.

9 PERFORMANCE REQUIREMENTS AND TEST METHODS

9.1 Products in contact with drinking water

Products in contact with drinking water shall comply with AS/NZS 4020. A scaling factor, determined in accordance with AS/NZS 4020, shall be applied as either ‘end of line’ or ‘in-line’ product depending on the specified application.

9.2 Resistance to ultraviolet light exposure (valves with plastics bodies or external plastics components)

When tested in accordance with Appendix B, external plastics components shall not exhibit any cracking, crazing or other failures. Following exposure in accordance with Appendix B, plastics-bodied valves shall be tested in accordance with the requirements of the hydraulic strength test (type test) of Appendix D and comply with the requirements of Clause 9.4.

9.3 Torque test

When tested in accordance with Appendix C, the valve shall show no signs of splitting, cracking, distortion or thread damage.

9.4 Hydraulic strength test

When a valve is tested in accordance with Appendix D, and under the following conditions, it shall not leak:

(a) Pressure—3 MPa or twice the maximum operating pressure, whichever is the lesser.

(b) Temperature—80°C or the nominated maximum operating temperature, whichever is the lesser.

9.5 Watertightness test

For batch release purposes, each valve shall be tested in accordance with the determination of watertightness test of AS/NZS 3718 and shall not exhibit leakage or other failure.

9.6 Endurance test

When a valve is tested in accordance with Appendix E, and subjected to the following number of cycles, the operating mechanism shall remain intact and the valve shall not leak:

(a) For end-of-line draw-off valves.....a minimum of 50 000 cycles.

(b) For in-line isolating valves.....a minimum of 10 000 cycles.

10 VOID

11 PRODUCT DOCUMENTATION

11.1 Product data

Product data, which identifies critical product characteristics such as pressure, temperature or other limitations, shall be available.

11.2 Installation and maintenance instructions

Installation and maintenance instructions shall be provided, which shall include the following:

(a) Reference to installation in accordance with AS/NZS 3500.1, AS/NZS 3500.4 and AZ/NZS 3500.5.

(b) Step-by-step installation instructions.

(c) Commissioning procedures and adjustments required.

(d) Troubleshooting guide.

(e) Contact details for after-sales service.

11.3 Warranty

All products shall be supplied with a manufacturer's warranty in the form of a statement as per the requirements of the PCA. The warranty may be attached to the product, printed on the packaging or included as part of the installation instruction.

NOTE: A material or product displaying a certification mark but without the required warranty is not an authorised product.

Appendix A MEANS FOR DEMONSTRATING COMPLIANCE WITH THIS TECHNICAL SPECIFICATION

(Normative)

A.1 SCOPE

This Appendix sets out the means by which compliance with this Technical Specification is to be demonstrated by a manufacturer under the WaterMark Certification Scheme.

A.2 RELEVANCE

The long-term performance of plumbing systems is critical to the durability of building infrastructure, protection of public health and safety, and protection of the environment.

A.3 PRODUCT CERTIFICATION

The purpose of product certification is to provide independent assurance of the claim by the manufacturer that products comply with this Technical Specification.

The certification scheme serves to indicate that the products consistently conform to the requirements of this Technical Specification.

The sampling and testing plan, as detailed in Paragraph A5 and Table A1, shall be used by the WaterMark Conformity Assessment Body. Where a batch release testing program is required it shall be carried out by the manufacturer as detailed in Paragraph A5 and Table A2.

A.4 DEFINITIONS

A.4.1 Batch release test

A test performed by the manufacturer on a batch of components, which has to be satisfactorily completed before the batch can be released.

A.4.2 Production batch

Clearly identifiable collection of units, manufactured consecutively or continuously under the same conditions, using material or compound to the same specification.

A.4.3 Sample

One or more units of product drawn from a batch, selected at random without regard to quality.

NOTE: The number of units of product in the sample is the sample size.

A.4.4 Sampling plan

A specific plan that indicates the number of units of components or assemblies to be inspected.

A.4.5 Type test batch

Schedule of units of the same type, identical dimensional characteristics, all the same nominal diameter and wall thickness, from the same compound. The batch is defined by the manufacturer.

A.4.6 Type testing (TT)

Testing performed to demonstrate that the material, component, joint or assembly is capable of conforming to the requirements given in the Technical Specification.

A.5 TESTING

A.5.1 Type testing

Table A1 sets out the requirements for type testing and frequency of re-verification.

A.5.2 Batch release testing

Table A2 sets out the minimum sampling and testing frequency plan for a manufacturer to demonstrate compliance of product(s) to this Technical Specification on an ongoing basis. However, where the manufacturer can demonstrate adequate process control to the WaterMark Conformity Assessment Body, the frequency of the sampling and testing nominated by the manufacturer's quality plan and/or documented procedures shall take precedence for the purposes of WaterMark product certification.

A.5.3 Retesting

In the event of a test failure, the products within the batch shall be tested at an appropriate acceptable quality level (AQL) and only those batches found to comply may be claimed and/or marked as complying with this Technical Specification.

Table A1—TYPE TESTS

Characteristic	Clause	Requirement	Test method	Frequency
Materials	5	Composition, temper, etc.	Review materials parts lists and compliance certificates	At any change in material specification
Marking	6	Marking	Visual inspection	At any change in material specification
Design	8.1	End connectors	Design review	At any change in the design
Performance	9.1	Products in contact with drinking water	AS/NZS 4020	At any change in materials, formulation or design or every five years, whichever occurs first
	9.2	Resistance to ultraviolet light exposure	Appendix B	
	9.3	Torque test	Appendix C	At any change in design or manufacturing process
	9.4	Hydraulic strength test	Appendix D	
	9.6	Endurance test	Appendix E	
Product documentation	11.1	Product data	Visual inspection	At any change in design or any factor that requires a change in documentation, e.g. amendments to AS/NZS 3500 series of Standards

Table A2—BATCH RELEASE TESTS

Characteristic	Clause	Requirement	Test method	Frequency
Materials	5	Composition, temper, etc.	Delivery acceptance tests or supplier's quality certificate	Each delivery batch
Marking	6	Marking	Visual examination	One per batch
Design	8.1	End connectors	Go and no – go gauges	One per batch
Performance	9.5	Watertightness (see Note)	AS/NZS 3718 determination of watertightness test	100%

NOTE: an alternative method may be permitted by the WaterMark Conformity Assessment Body provided such test is capable of demonstrating equivalent effectiveness.

Appendix B ULTRAVIOLET LIGHT EXPOSURE TEST

(Normative)

B.1 SCOPE

This Appendix sets out the method for exposing plastic components of valves to ultraviolet light, to check for cracking, crazing or other failure.

NOTE: This test is based on the test given in AS 3565.1.

B.2 PRINCIPLE

The valve is positioned under two ultraviolet sunlamps and exposed to ultraviolet light for 10 d with the lamps cycle on for 12 h and off for 12 h. The external plastics components are then visually inspected for cracking, crazing or any other failure.

B.3 APPARATUS

The following apparatus is required:

(a) Two sunlamps and a lamp stand. Each sunlamp shall be an ultraviolet lamp F/28, 220 240 V, 300 ±50 W, or equivalent.

NOTE: Ultraviolet radiation may cause conjunctivitis. The lamps should not be viewed directly without protecting the eyes with suitable dark sunglasses. Screens may be placed above the test assembly during the exposure, but should not restrict airflow nor cause the test specimen to overheat.

(b) Two cylindrical lampshades, 300 ±10 mm diameter, constructed of aluminium foil, and held by the lamp stand, capable of being mounted 300 +0, −25 mm from the top surface of the valve under test.

(c) A black panel thermometer consisting of a completely blackened metal plate at least 1 mm thick and at least 1000 mm^2 in area with a suitable thermometer or thermocouple making good thermal contact.

(d) A small fan.

NOTE: A test rig is shown in Figure B1.

B.4 PROCEDURE

The procedure shall be as follows:

(a) Assemble the apparatus, as shown in Figure B1, on a suitable bench so that a small fan can cool the valve, if necessary.

(b) Fill the valve completely with water, with lid open and ends capped.

(c) Centrally position the valve under the test lamps with its longitudinal length parallel to the test lamps (see Figure B1).

(d) Energize the lamps for a period of 12 +2, −0 h, and ensure that the mains voltage to the lamps is maintained at 240 ±5 V. Place a small fan near the valve and operate it so as to maintain the temperature measured by the black panel thermometer within the range of 45°C to 55°C. Place the black panel thermometer on the top surface of the valve for a period of 15 min. Then take a reading and remove the thermometer.

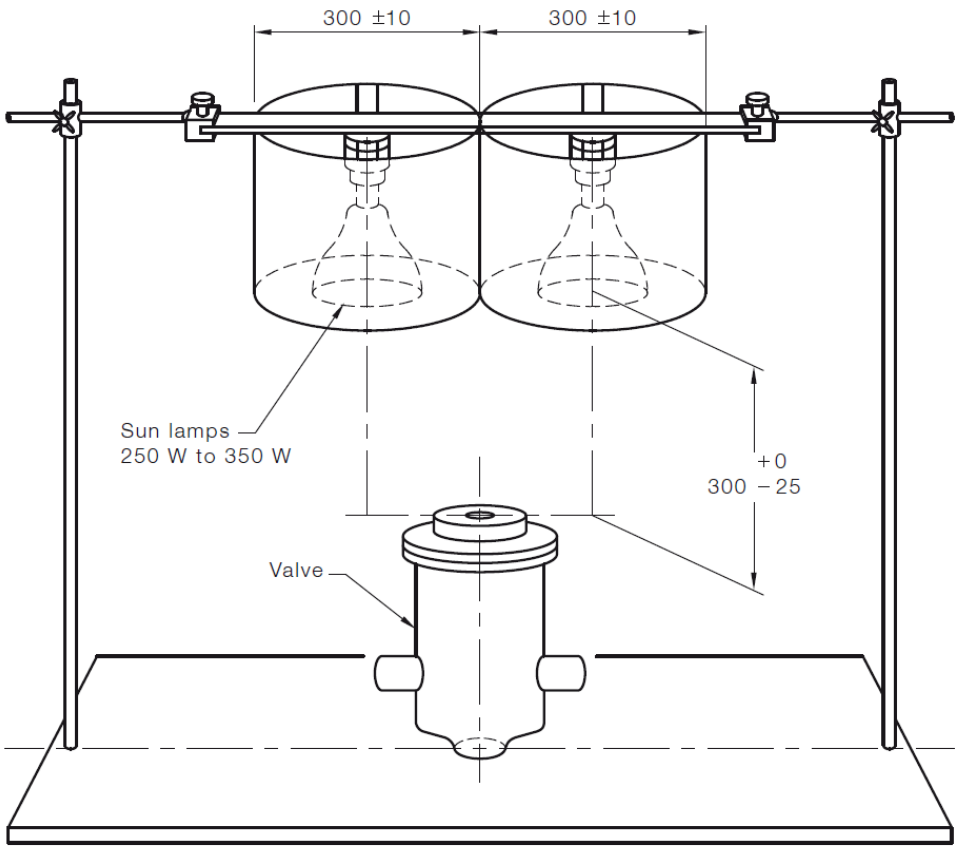
If necessary, adjust the exposure temperature by changing the position or the speed of the fan.

(e) Expose the valve to the 10 d cycle of 12 h on and 12 h off.

(f) At the end of the exposure period of 10 d +2, −0 h, switch off the lamps.

(g) Visually inspect the plastic components of the valve for cracking, crazing or any other failures.

Plastics-bodied valves shall be subjected to the hydraulic strength test of Appendix D utilising the type test conditions of Clause 9.4.



DIMENSIONS IN MILLIMETRES

FIGURE B1 TEST RIG FOR ULTRAVIOLET LIGHT EXPOSURE TEST

B.5 REPORT

The following shall be reported:

(a) For each valve—

i. manufacturer, model, type and size of valve or component;

ii. any observed cracking, crazing or other failures; and

iii. for plastics-bodied valves, the results of testing to Appendix D.

(b) Reference to this test method, i.e., Appendix B, WMTS-030.

Appendix C TORQUE TEST

(Normative)

C.1 SCOPE

This Appendix sets out the method of torque testing metallic and non-metallic valve bodies and threaded end connectors. It measures the ability of the valve to withstand the torques that would normally be encountered to ensure a seal during installation.

C.2 PRINCIPLE

The valve assembly is held in a fixing jig and a predetermined torque is applied to the threaded end connectors. The assembly is then inspected for damage.

C.3 TESTING CONDITIONS

Valves shall be tested in their normal operating position at ambient temperature conditions and with all components assembled.

During the testing, the threaded section of the component under test shall not be supported in any way as to influence the results of the test.

C.4 APPARATUS

The following apparatus is required:

(a) A fixing jig to hold the valve assembly firmly.

(b) Adaptors having internal or external threads of the appropriate thread series designation to mate with the end connections of the valve assembly on test.

(c) A torque wrench with accuracy within ±5%. Alternatively a lever arm may be used with a known force applied at its end at 90° ±5° to the radii between the centre of rotation and the centre point of the application of the force. The lever arm method that is used shall be, as a minimum, of the same accuracy as the torque wrench.

C.5 PROCEDURE

The procedure shall be as follows:

(a) Mount the valve assembly into a fixing jig that is designed to hold the valve assembly firmly.

(b) Apply the torque loading to the end connection in the same manner as that normally applied in field conditions.

(c) Apply the torque as identified in Table C1 for a period of 10 to 20 s.

(d) Remove the torque and repeat Steps (a), (b) and (c) on the other end connections, if any.

(e) Remove the valve assembly from the jig and inspect all components for cracking. Record any breakage or thread damage.

TABLE C1
TORQUE LOADINGS

Inlet nominal size, DN	Metallic valve body Torque, N.m, + 1, –0%	Non-metallic valve body Torque, N.m, +1, –0%
15	60	12
20	85	15
25	120	20
32	150	25
40	180	35
50	210	40

C.6 REPORT

The following shall be reported:

(a) Manufacturer, model, type and size of valve.

(b) Torque applied and duration of application.

(c) Any splitting, cracking, distortion or thread damage or other failure.

(d) Reference to this test method, i.e. Appendix C, WMTS-030.

Appendix D HYDRAULIC STRENGTH TEST

(Normative)

D.1 SCOPE

This Appendix sets out the method for evaluating a valve's ability to withstand hydraulic pressure after a conditioning period at an applied temperature.

D.2 PRINCIPLE

The valve under test is mounted in a rig, subjected to a hydrostatic pressure and assessed for leaks.

D.3 TESTING CONDITIONS

End-of-line valves that are used for draw-off shall be tested in the closed position only.
In-line valves shall be tested in both the open and closed positions.

D.4 APPARATUS

The following apparatus is required:

(a) A hydraulic system capable of producing the required pressure and temperature without shock or pulsations.

NOTE: The system should be capable of maintaining the pressure flow conditions that occur during the test.

(b) Test rig to support the valve under test and its connection ends so that no external force is applied to them.

(c) Test pressure gauges complying with AS 1349, each fitted with an air-bleed attachment.

(d) A thermometer complying with AS 1006 and capable of indicating the temperature within ±2% of true value or digital or analogue gauges of equal accuracy.

(e) A timing device capable of reading to 0.1 s.

D.5 PROCEDURE

The procedure shall be as follows:

(a) Connect the valve under test to the water supply and purge the air from the test rig.

(b) Open the valve and run hot water at 80 ±2°C, or the nominated maximum operating temperature specified by the manufacturer, through it at a low flow rate until the valve assembly reaches the required test temperature.

(c) Close the valve and apply the test pressure of 3 +0.1, –0 MPa, or the nominated maximum operating pressure as specified by the manufacturer, for a period of 60 +5, –0 min. Allow the valve to cool down.

(d) Observe and record any leakage or other failure.

D.6 REPORT

The following shall be reported:

(a) Manufacturer, model, type and size of valve.

(b) Any leakage or other failure.

(c) Test pressure, temperature and duration of application.

(d) Reference to this test method, i.e., Appendix D, WMTS-030.

Appendix E ENDURANCE TEST

(Normative)

E.1 SCOPE

This Appendix sets out the method by which a solenoid valve assembly is tested for the endurance of its operating mechanism. The test measures the ability of the valve assembly to operate satisfactorily with normal opening and closing operations on hot and cold applications during the expected life of the valve.

E.2 PRINCIPLE

The valve under test is held in a jig and connected to a hot water supply and an ambient temperature water supply. The valve is cycled open to close, and inspected during this period for wear or failure of the operating mechanism. To simulate temperature changes that occur in actual operation, the valve is also subjected to alternate supplies of hot and ambient water.

E.3 APPARATUS

The following is required:

(a) A rig to support the test valve, and a purpose-built control system to enable the full opening and full closing of the valve, timing of durations between operations and counting of the number of full cycles.

(b) A water supply system that can provide the following:

i. Up to 99°C for valves designed for hot water systems.

ii. 55 ±2°C for valves designed for warm water systems.

iii. 40 ±2°C for valves designed for cold water systems.

iv. The maximum operating temperature where the manufacturer specifies an operating temperature greater than 40°C.

v. The cold water supply at ambient temperature.

vi. Static operating pressure of 400 ±20 kPa, or the maximum operating pressure specified by the manufacturer. The pressure during the flow conditions shall be sufficient to give a flow rate not less than the nominal flow rating of the valve where specified by the manufacturer or 30 L/min, whichever is the lesser.

(c) Timing and control equipment to achieve the following cycles:

i. Valve opens and remains open for 1 +0.5, –0 s.

ii. Valve closes and remains fully closed for 2 +0.5, –0 s.

E.4 PROCEDURE

The procedure shall be as follows:

(a) Mount the valve under test in the test rig.

(b) Connect the solenoid valve to the control system.

(c) Adjust the heated and ambient water supplies to the maximum static operating pressure of 400 ±20 kPa or as specified by the manufacturer. Adjust the flow conditions to give a flow rate not less than the nominal flow rating of the valve, where specified by the manufacturer.

(d) Adjust the water supply temperature to that required.

(e) Determine the cycle period by—

(i) measuring the length of time required to fully open the solenoid valve; and

(ii) measuring the length of time required to fully close the solenoid valve.

(f) Set the controller to open and close the solenoid valve with a cycle period to allow for the following:

(i) Opening time, as determined in Step (e)(i) above.

(ii) Valve opens and remains open for 1 +0.5, −0 s.

(iii) Closing-time, as determined in Step (e) (ii) above.

(iv) Valve closes and remains fully closed for 2 +0.5, −0 s.

(g) Reset the cycle counter to zero.

(h) Run test for 55 cycles.

(i) Change the water supply from ambient to maximum operating temperature.

(j) Run test for 55 cycles.

(k) Change the water supply from maximum operating temperature to ambient temperature.

(l) Repeat Steps (h) to (m) until the cycles specified in Clause 9.6 have been completed

(m) Monitor the valve throughout the test for leakage of the operating mechanism.

(n) At the completion of the endurance test, conduct the watertightness test of Clause 9.5 and check for leakage or other failure.

E.5 REPORT

The following shall be reported for each test valve:

(a) Manufacturer, model, type and size of valve.

(b) The number of cycles completed.

(c) Any leakage or other failure.

(d) Compliance or non-compliance with this Technical Specification.

(e) Reference to this test method, i.e., Appendix E, WMTS-030.

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