BSMI	**Technical Specification of Type Approval for Water Meters**	S/N	CNPA 49
		Rev	3

1. This Technical Specification is developed pursuant to Paragraph 3, Articles 25 of the Weights and Measures Act.
2. The date of promulgation, document number, date of enforcement and content of amendment are listed as follows:

Rev.	Date of Promulgation	Document No. (Ching-Piao-Szu-Tsu)	Date of Enforcement	Content of Amendment
1	12.06.2003	No. 09240005480	01.07.2003	
2	08.12.2005	No. 09440004630	01.07.2006	Revised according to CNS 14866
3	11.03.2014	No. 10340009830	01.01.2015	Due to the CNS could be revised when correspondence international standards or recommendation revised, third edition will no longer refer to CNS. In addition, there are appendixes added to this edition.

3. The reference standards of this technical specification are as follows:

CNS14866-1	Measurement of water flow in closed conduits-Meters for cold potable water-Part 1: Specification (Oct 20, 2004)
CNS14866-2	Measurement of water flow in closed conduits-Meters for cold potable water-Part 2: Installation requirements and Selection (Oct 20, 2004)
CNS14866-3	Measurement of water flow in closed conduits-Meters for cold potable water-Part 3: Test Methods and Equipment (Oct 20, 2004)
CNS 13979	Vortex Flow Meter (Jun.28, 1999)

Date of Promulgation	**Bureau of Standards, Metrology and Inspection,**	Date of Enforcement
03.11.2014	**Ministry of Economic Affairs**	**01.01.2015**

1. Scope: this specification applies to volumetric and velocity (Woltmann type, single-jet and multi-jet) waters meters and the vortex water meters.
2. Definitions of Terms
   2.1 Volumetric meter: Device, fitted into a closed conduit, which consists of chambers of known volume and a mechanism driven by the flow, whereby these chambers are successively filled with water and then emptied. By counting the number of these volumes passing through the device, the indicating device totals the volume flow.
   2.2 Velocity meter: Device, fitted into a closed conduit which consists of a moving element set in motion directly by the velocity of the water flow. The movement of the moving element is transmitted by mechanical or other means to the indicating device, which totals the volume flow.
      2.2.1 Woltmann meter: Device consisting of a helical blade that rotates about the axis of flow in the meter.
      2.2.2 Single-jet and multi-jet meters: Devices consisting of a turbine rotor rotating about the axis perpendicular to the flow of water in the meter. The meter is called a single-jet meter if the jet impinges at a single place on the rotor's periphery, and a multi-jet if the jet impinges simultaneously at several points around the periphery of the rotor.
   2.3 Vortex meters: Devices comprising a bluff body in the water flow to detect the vortices frequency after the bluff body continuously and integrating an indicator which total the volume flow.
   2.4 Flow-rate: Quotient of the volume of water passing through the water meter and the time taken for this volume to pass through the water meter. Flow-rate is expressed in cubic meters per hour, m^3/h.
   2.5 Permanent flow-rate, q_p: Applying to volumetric and velocity meters only, flow-rate at which the meter is required to operate in a satisfactory manner under normal conditions of use, e.g. under steady and/or intermittent flow conditions.
   2.6 Maximum flow-rate, q_{max}: Applying to vortex meters only, the maximum flow-rate that the meter still be able to measure the volume of water precisely and the error of the indicating not over the maximum permissible errors.
   2.7 Overload flow-rate, q_s: Applying to volumetric and velocity meters only, flow-rate at which the water meter is required to operate in a satisfactory manner for a short period of time without deteriorating; its value is twice the value of q_p.
   2.8 Minimum flow-rate, q_{min}: To volumetric and velocity meters, the lowest flow-rate at which the meter is required to give indications within the maximum permissible error tolerance and is determined in relation with the numerical value of the meter designation, to vortex meters, the minimum flow-rate that the meter still be able to measure the volume of water precisely and the error of the indicating not over the maximum permissible errors.
   2.9 Flow-rate range: To volumetric and velocity meters, range limited by the overload flow-rate, q_s, and the minimum flow-rate, q_{min}, in which the meter indications must not be subject to an error in excess of the maximum permissible error and this range is divided into two zones called "upper" and "lower" zones, separated by the transitional flow-rate, to vortex meters, range limited by the maximum flow-rate, q_{max}, and the minimum flow-rate, q_{min}.
   2.10 Transitional flow-rate, q_t: Applying to volumetric and velocity meters only, flow-rate value that

occurs between overload and minimum flow-rate, at which the flow-rate range is divided into two zones, the "upper zone" and "lower zone", each characterized by a maximum permissible error in this zone.

2.11 Large flow-rate, q_a: Applying to vortex meters only, the flow-rate using for the verification on vortex meters with faster velocity of water flow, equaling to the three-fifths of maximum flow-rate, q_{max}.

2.12 Small flow-rate, q_b: Applying to vortex meters only, the flow-rate using for the verification on vortex meters with slower velocity of water flow, equaling to the one-fifths of maximum flow-rate, q_{max}.

2.13 Nominal size, DN: Numerical designation common to all the components of a pipe system, excluding those designation their external diameter or by the thread dimension. It is a whole number used for reference only, approximating the constructional dimensions.

2.14 Nominal loss, PN: Numerical designation which is a rounded number for reference purposes. All equipment of the same nominal size (DN) and designated by the same PN number shall have compatible mating dimensions.

2.15 Pressure loss: Pressure loss cased by the presence of a water meter in the pipeline at a given flow-rate.

2.16Meter designation N: Numerical value, preceded by the capital letter N, to designate the meter in relation to tabulated values of dimensions.

2.17 Indicating device: Device displaying the volume flowing.

2.18 Measurement error: meter error, conventionally expressed as relative error, calculated as a percentage, and equal to:

$$\frac{V_i - V_c}{V_c} \text{X100}$$

V_c is the value accepted as the true volume passed;

V_i is the volume indicated by the water meter at the time of measurement of the same volume, both expressed in the same units.

2.19 Test flow-rate: mean flow-rate calculated from the indication of the calibrated reference device.

3. Appearance: A water meter shall be marked with the following matters clearly.

3.1 The water meter size should be marked on the lid exterior center and the side of water meter.

3.2 The direction of flow (→) shall be marked on both sides of the water meter.

3.3 Name or trademark of the manufacturer shall be marked on one side of water meter exterior or on the indicating device.

3.4 The serial number should be marked on the edge of meter exterior.

3.5 The indication range (maximum capacity of accumulation) and numbers of a volumetric or velocity meter shall be marked on the indicating device according to Section A.1 of Appendix A.

The maximum capacity of accumulation and numeral of vortex water meter shall be marked on the dial according to Section B.1 of Appendix B.

3.6 For a water meter with a price indicating device, the unit price and the total amount shall be displayed in an obvious position on the price indicating device.

3.7 The model number shall be marked on the indicating device clearly.

3.8 A position for marking the type approval number shall be reserved in an obvious position on the indicating device.

3.9 The validity period of verification shall be marked on the edge of the upper shell.

3.10 The installation direction (V or H) shall be marked on both sides of water meter or on the indicating device of water meter. However, this shall not apply to vortex water meters.

3.11 The metrological classes, meter designation, pressure loss, permanent flow-rate and nominal pressure of volumetric and velocity meters shall be marked according to Section A.2 of Appendix A.

4. Structure

4.1 Major scale

4.1.1 The meter size and overall dimensions of volumetric and velocity water meters shall be in accordance with Section A.3 of Appendix A.

4.1.2 The meter size and overall dimensions of vortex water meters shall be in accordance with Section B.2 of Appendix B.

4.2 The top lid of the water meter shall be opened more than 120 degrees.

4.3 For volumetric and velocity meters, the use of an accelerating device for increasing the speed of the meter below q_{min} is prohibited.

4.4 For a water meter with pointers, the pointers must not be loosened when slightly drawn by hand.

4.5 The transparent lid of a water meter shall be transparent and clear, and must not be loosened when pressed by hand.

4.6 Indicating device

4.6.1 The indicating device of a volumetric or velocity water meter shall be in accordance with Section A.1of Appendix A.

4.6.2 The indicating device of a vortex water meter shall be in accordance with Section B.1 of Appendix B.1.

4.7 Volumetric and velocity multi-jet meters shall be equipped with strainers.

4.8 After verified and sealed, the measurement errors or zero-setting of water meters shall not be able to be adjusted by external methods or devices. If the meter is provided with a zero-setting device for special purposes, the zeroing position shall be zeroed upon operation, but the totaling device shall not be zeroed.

4.9 The shell of a water meter should not be coated with wax, soluble glass or any other leak proof material; the shell of a water meter should be free of sags, crests, scratches or any traces of repair. A position shall be reserved for the lead seal. However, the interior and exterior of the shell of a big water meter with a nominal size of not less than 50 mm may be coated with rustproof paint or powder coating.

5. Performance Test

5.1 For volumetric and velocity meters, test samples of water meters shall be according to the numbers prescribed in Table 1. The number of water meters in Table 1 shall be regarded as the minimum to be tested. For vortex waters, test samples of water meters shall be two. The authority responsible for type approval may request testing of additional water meters.

Table 1

Meter Designation N	Number of Meters
N ≦ 5(threaded connection)	3
15(Flanged connection) ＜ N ≦600	2

5.2 The material of volumetric and velocity water meters shell shall be in accordance with Section A.4 of Appendix A.

The materials for vortex water meters shall be in accordance with Section B.3 of Appendix B.

5.3 Pressure Tests

5.3.1 For volumetric and velocity water meters, the pressure tests shall be conducted for in accordance with Section A.5 of Appendix A.

5.3.2 For vortex water meters, the pressure tests shall be conducted in accordance with Section B.4 of Appendix B.

5.3.3 After the pressure test, tested meters shall be free of leakage and sweating and the parts shall be free of damage or deformation.

For water meters with a dry indicating device, water shall not immerse into the upper level gear chamber and indicating device.

5.4 Indicating error tests

5.4.1 The indication error of volumetric type and velocity type meters shall be tested in accordance with Section A.6 of Appendix A. The values of q_{min}, q_t and q_s are given in Table A.2, Table A.3 and Table A.4 of Appendix A, and according to the measuring classes of the meter, indication error tests shall be tested in accordance with the following flow-rates.

(1) Between q_{min} and 1.1 q_{min}, maximum permissible errors are ±5 %.

(2) Between 0.5 (q_{min}＋q_t) and 0.55 (q_{min}＋q_t), maximum permissible errors are ±5 %.

(3) Between q_t and 1.1$q_{t,}$ maximum permissible errors are ±2 %.

(4) Between 0.25 (q_t＋q_p) and 0.3 (q_t＋q_p), maximum permissible errors are ±2 %.

(5) Between 0.45 q_p and 0.5 $q_{p,}$ maximum permissible errors are ±2 %.

(6) Between 0.9 q_p and q_p, maximum permissible errors are ±2 %.

(7) Between 0.9q_s and q_s, maximum permissible errors are ±2 %.

5.4.2 For vortex water meters, indication error tests shall be tested in accordance with the following flow-rates.

(1) Between q_{min} and 1.1 q_{min}, maximum permissible errors are ±2 %.

(2) Between 0.5 (q_{min}＋q_b) and 0.55 (q_{min}＋q_b), maximum permissible errors are ±2 %.

(3) Between 0.95q_b and 1.05$q_{b,}$ maximum permissible errors are ±2 %.

(4) Between 0.45 (q_a＋q_b) and 0.5 (q_a＋q_b), maximum permissible errors are ±2 %.

(5) Between 0.95 q_a and 1.05 $q_{a,}$ maximum permissible errors are ±2 %.

(6) Between 0.9 q_{max} and q_{max}, maximum permissible errors are ±2 %.

5.4.3 Test methods:

(1) For volumetric and velocity water meters, indication error tests shall be tested in accordance with A.6 of Appendix A.

(2) For vortex water meters, indication error tests shall be tested in accordance with B.5 of Appendix B.

5.4.4 The errors observed for each the seven flow-rates shall not exceed the maximum permissible errors. If the error observed greater than maximum permissible error at one flow-rate only, the test at that flow-rate shall be repeated. The test shall be declared satisfactory if the two out of three results lie within the maximum permissible error and arithmetic mean of the results for the three tests at that flow-rate is less than or equal to the maximum permissible error.

5.5 Antimagnetic function

5.5.1 Antimagnetic function tests shall be performed on water meters with magnet driven closed or with electronic devices in accordance with the requirements of Section A.7 of Appendix A at flow rate q_{min}. The metrology characteristics shall meet the requirement of Section A.8 of Appendix A.

5.5.2 The magnetic field source for the test may be a permanent magnet or electric magnet and the intensity of the magnetic field shall be 1500 Gauss at the shell of meter. In a free space, the range of the values shall be within maximum permissible errors listed in Table 2.

Table 2: Quantified Intensity Distance Relation

Distance from Maximum Intensity Point (mm)	Ratio to 1500 Gauss Intensity (%)
0	≧100
10	≧58.1
20	≧36.0
30	≧23.7
40	≧16.4
50	≧11.8
60	≧8.7
70	≧6.7

5.5.3 The test points of a water meter tested are all located on the meter shell. Centered on the sensing magnet inside the meter as the reference point, test points are distributed in a radial pattern as shown in Fig.1 and Fig.1. There are two adjacent test points and a central reference point. Points to be measured are at 45-degree angle. There are 6 test points in total.

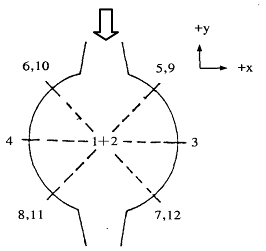


Fig.1: Top View of Tested Meter

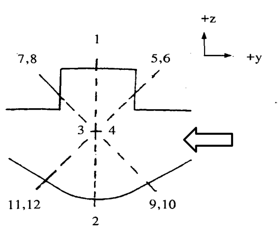


Fig.2: Side View of Tested Meter

5.5.4 Antimagnetic function tests shall be performed according to above method and conditions and one for each symmetric test point. If there is any test point at which the indication errors of the tested meter exceed the maximum permissible errors for the flow-rate, the meter is failed in the test.

5.5.5 The vortex water meter shall perform antimagnetic function test as 5.5.1and 5.5.2. However, the test flow-rate shall be q_b.

5.6 Pressure Loss Tests

Volumetric and velocity water meters shall be tested according to Section A.9.3 of Appendix A. The pressure loss values of the meter shall be classified according to Section A.9.1 of Appendix A.

A water meter is failed in the test when the pressure loss values exceed the maximum value in Section A.9.1 of Appendix A.

5.7 Accelerated wear tests

5.7.1. For volumetric and velocity water meters, the accelerated wear test shall be performed according to Section A.10 of Appendix A. After the test, the indication errors shall be tested at seven flow-rates prescribed in Section 5.4.1. The errors observed for each the seven flow-rates shall not exceed the maximum permissible errors. If the error observed greater than maximum permissible error at one flow-rate only, the test at that flow-rate shall be repeated. The test shall be declared satisfactory if the two out of three results lie within the maximum permissible error and arithmetic mean of the results for the three tests at that flow-rate is less than or equal to the maximum permissible error..

5.7.2. After a vortex water meter runs under the conditions prescribed in Table 3, the indication errors shall be verified according to the verification method. The indication errors shall conform to the requirements of the Technical Specification for Verification and Inspection of Water Meters.

Table 3

Type / Nominal Size (mm)	Flow-rate (m^3/h)	Total Running Hours
50	30	800
	60	200
75	80	800
	160	200
100	125	800
	250	200

Appendix A Volumetric and Velocity Water Meter

Contents

A.1 Indicating devices

A.1.1 General requirements

A.1.1.1 Function: the indicating devices shall provide an easily read, reliable and unambiguous visual indication of the volume flow. The device shall include means for verification and calibration. The device may include additional elements for verification and calibration by other methods, e.g. automatic.

A1.1.2 Unit of measurement, symbol and its location: the volume of water measured shall be expressed in cubic mete. The unit symbol (m^3) shall appear on the dial or immediately adjacent to the numbered display.

A.1.1.3 Indicator range: the indicating device shall be able to record, without passing zero, the volume expressed min cubic meters, corresponding to at least 1999 h of operation at the permanent flow-rate.

A.1.1.4 Colour coding: The colour black shall be used to indicate cubic meters and its multiples. The colour red shall be used to indicate sub-multiples of cubic meters. This provision is formulated in table A.1.

Table 3 Indicator range

q_p m^3	Indicator range m^3 (min)
$q_p \leqq 5$	9 999
$5 < q_p \leqq 50$	99 999
$50 < q_p \leqq 500$	999 999
$500 < q_p \leqq 4000$	9 999 999

A.1.1.5 Direction of indicator movement: Rotational movement of pointer or circular scales shall be clockwise. Linar movement of pointers or scales shall be left to right. Movement of numbered roller indicators shall be upwards.

A.1.1.6 Electronic digital indicator: The incremental change in electronic digital indication shall be instantaneous. If the indicator is liquid crystal type, the digits shall be block, and digital fonts for cubic meters should be larger digits while smaller digits for sub-multiples cubic meters. The liquid crystal type indicator shall equip with a flowing signal and low battery alarm.

A.1.2 Types of indicating device

A.1.2.1 Type Ⅰ Analog device: The volume of water is given by continuous movement of (a) and (b).

(a) One or more pointers moving relative to graduated scales.

(b) One or more circular scales or drum each passing a pointer.

The volume expressed in cubic meters for each scale division shall be of the form 10^n, where n is a positive or negative whole number or zero, thereby establishing a system of consecutive decades. Each scale shall be:

- either graduated in values expressed in cubic meters,
- or accompanied by a multiplying factor(x 0.001; x 0.01; x0.1; x 10; x 100; x 1000, etc.).

A.1.2.2 Type Ⅱ Digital device: The volume is given by a line of adjacent digits appearing in one or more apertures. The advance of any given digital unit shall be completed while the digit of the next lower value is changing from 9 to 0. The lowest-value decade may have a continuous movement, the aperture being large enough to permit a digit to be unambiguously read. The visible height of the digits shall be at least 4 mm.

A.1.2.3 Type Ⅲ combination of analog and digital devices: The volume is given by a combination of types Ⅰ and Ⅱ indicating devices, and the respective requirements of each shall apply. The lowest-value decade of the digital indicator may have a continuous movement.

A.1.3 Supplementary devices: In addition to the indicating device already described, the water meter may include supplementary devices which may be permanently incorporated or temporarily added. The device may be used to detect movement of the measuring device before this is clearly visible on the indicating device. The device may be used as a control for testing and initial verification of the water meter, provided that other means guarantee the satisfactory operation of the indicating device in accordance with the requirements of additional verification elements.

Additional verification elements: Additional verification elements may be used, provided that their verification scale interval is small enough for the measurement uncertainty caused by reading the meter not to exceed 0.5% of the volume flow.

The presence of supplementary devices, if temporarily added, and their general manner of use shall not change the metrological characteristics of the water meter.

A.2 Marking: All water meters shall be clearly and indelibly marked with the following information, either grouped or distributed on the casing, the indicating device dial, an identification plate, or the water meter cover if not detachable.

A.2.1 Name or trade mark of the manufacturer,

A.2.2 Metrological class, meter designation and pressure loss, in MPa; where the numerical value of the permanent flow-rate q_p is not equal to the numerical value of the meter designation N, the value of q_p shall be in addition to the meter designation N.

For example:

A N 0.1MPa

A N1.5/ q_p 2.5 0.1MPa

A.2.3 Year of manufacture and serial number.

A2.4 One or two arrows indicating the direction of flow, the indication of flow shall not be made on the lid but on the body of the meter.

A.2.5 Mark of type approval.

A.2.6 Nominal pressure (PN) in MPas, if exceed 1 MPa.

A.2.7 The letter V or H if the meter can only be operated in the vertical or horizontal position.

A.2.8 Meter size or nominal size (DN), if different from the value are shown in A 2 and A3.

A.3 The diameter and overall size of water meters: Meter designation and permanent flow-rate.

A.3.1 Diameter and overall dimension: The diameter of water meter is characterized by the thread size of the end connections or by the nominal size of the flange. For each meter size there is a corresponding fixed set of overall dimensions (see Figure A.1). The dimensions are giving in table A.2 and A.3. For thread and connections, two minimum dimensions, *a* and *b*, are specified (see A.3.4).

H1+H2, L1, L2+L3 define the height, length and width respectively of a cuboid within which the water meter can be contained (the cover being at right angles to its closed position).

H1, H2, L1, L2, L3 are maximum dimensions.

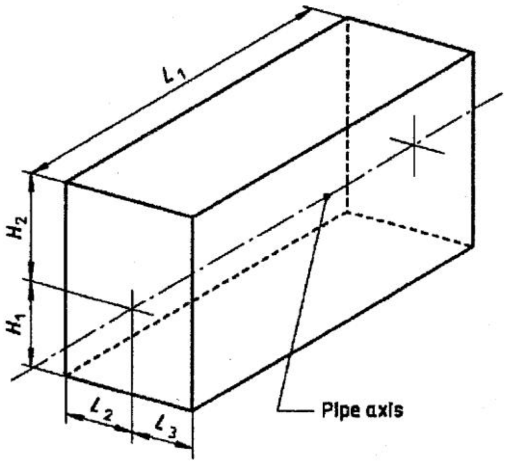


Figure A.1 – Meter size and overall dimension

A.3.2 Relationship between meter designation and permanent flow-rate: The numerical value of the permanent flow-rate, q_p, expressed in cubic meters per hour (m^3/h), shall be at least equal to the meter designation. Where the value is greater than the meter designation, it shall be equal to one of the values given in tables A.2 and A.3 for meter designation provided that the relationship between meter diameter and meter designation according to A.3.3 is maintained.

A3.3Relationship between meter diameter and meter designation: Meter diameter and hence overall dimensions are in principle linked to the designation of the water meter as specified in Tables A.2 and A.3. For a given meter diameter, it nevertheless is permitted to adopt the immediately adjacent larger or smaller meter diameter, provided that the metrological requirements are met. In such a case the meter shall be designated not only by its N value but also by its DN. End connections shall be the same at the water meter inlet and outlet.

Table A.2 Water meters with threaded end connections-Meter sizes and dimensions

Dimensions in millimeters

Meter size			Meter dimensions					
Meter designation N	Nominal Diameter DN	Meter diameter (nominal size of threaded end connection	a_{min}	b_{min}	L_{1max}	L_{2max} and L_{3max}	H_{1max}	H_{2max}
N 1.5	15(13)	G 3/4 B([3])	10	12	165	50	40	100
N 2.5	20	G 1 B([3])	12	14	190	65	40	100
N 3.5	25	G 1-1/4 B([3])	12	16	210	85	45	110
N 10	40	G 2 B([3])	13	20	245	85	50	140
N 15	50	G 2-1/2 B([3])	13	20	270	115	60	180
([3]) thread size of the next larger value is accepted as an alternative.								

Table A.3 – Water meters with flanged end connection – Meter designations, meter sizes and dimension

Meter size				Meter dimension (unit: millimeters)										
Meter designation N			Size	L_{1max}			L_{2max} and L_{3max}			H_{1max}			H_{2max}	
Volumetric, single-jet and multi-jet	Woltmann		DN ([1])	Volumetric, single-jet and multi-jet	Woltmann		Volumetric, single-jet and multi-jet	Woltmann		Volumetric, single-jet and multi-jet	Woltmann		Volumetric, single-jet and multi-jet	Woltmann
	Vertical axis	Horizon axis			Vertical axis	Horizon axis		Vertical axis	Horizon axis		Vertical axis	Horizon axis		
N15	N15	N15	50	350	560	200	135	135	135	115	140	100	300	390
N20	-	N25	65	450	-	300	150	-	135	130	-	110	320	39
N25	N30	N35	75	480	630	200	170	135	135	140	170	120	320	410
N50	N45	N60	100	650	750	250	225	135	135	215	180	140	320	440
	-	N100	125	-	-	250	-	-	135	-	-	140	-	440
	N100	N150	150	-	1000	300		180	175		220	180		500
	N150	N250	200		1160	350		225	190		255	200		500
	N250	N400	250		1240	450		250	210		270	220		500
	N400	N600	300		1600	500		290	240		2850	250		500

Note; ([1]) Nominal size of flange end connections.

A3.4Threaded connection: Values are given in table A.2. Threads shall comply with CNS 494. Figure A.2 defines dimensions *a* and *b*. When there is installation problem for replacing new water meter, the threads specified in table A. 11 may be adopted.

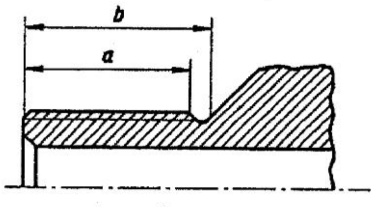


Figure A.2 - Thread

A.3.5 Flanged connection: Either one of the following specification of flange shall be adopted.

A3.5.1 Flanged end connections shall comply with table A.2 for working pressure 0.735 MPa of CNS 12795 or CNS 13272. The manufacturer shall provide a reasonable clearance behind the rear face of the flange to allow access for installation and removal.

A.3.5.2 The flange rate class may adopt other than the class specified in 3.5.1. However, the applicant shall provide the connection adaptor for type approval testing. The manufacturer shall provide a reasonable clearance behind the rear face of the flange to allow access for installation and removal.

A.4 Material

A.4.1 Water temperature variations, within the working temperature range, shall not adversely affect the materials used in the construction of the water meter. All materials of water meter which are in contact with the water flowing through the water meter shall be non-toxic and non-tainting. The materials shall comply with operative national standards.

A.4.2 The water meter shall be constructed throughout of materials which are resistant to normal internal and external corrosion or which are protected by some suitable surface treatment. The water meter shall be made of materials of strength adequate for purpose for which it is to be used.

A.4.3 The indicating device of the water meter shall be protected by a transparent window (glass or other material). Further protection may be provided by a suitable cover.

A.4.4 The water meter shall be provided with means for the removal of condensation, if the latter can occur on the underside of the window of the indicating device of the water meter.

A.5 Pressure test: The meter under test is required to withstand, without leakage or seepage through the walls, and without damage, a pressure as specified as below:

A.5.1 1.6 MPa or 1.6 times the nominal pressure when the nominal pressure is higher than 1 MPa for 15 minutes; and

A.5.2 2.0 MPA or 2 times the nominal pressure for 1 minute.

A.6 Indicating error tests

A.6.1 The method described in this specification to determine the indicating errors is the so-called "collection" method, in which the quantity of water passed the water meter is collected in one or more collecting vessels and the quantity determined volumetrically or by weighing. Other methods may be used, provided the accuracy levels stated in this specification are attained. The checking of the indicating error consists in comparing the indications given by the meter under test against a calibrated device.

A.6.2 Description of the test rig: the test rig consist of:

A.6.2.1 A water supply (mains, non-pressurized tank, pressurized tank, pump, etc.):

A.6.2.2 Pipe-work;

A.6.2.3 A calibrated reference device (calibrated tank, reference meter, etc);

A.6.2.4 Means for measuring time of the test.

A.6.3 Pipe-work:

A.6.3.1 Description: Pie-work shall include:

(a) A test section in which the meter(s) is (are) placed:

(b) Means to establish the desired flow-rate;

(c) One or more isolating devices;

(d) Means for determining the flow-rate;

And if necessary:

(e) One or more air bleeds;

(f) A non-return device;

(g) An air separator;

(h) A filter.

During the test, flow leakage, flow input and flow drainage shall be permitted neither between the meter(s) and the reference device nor from the reference device. The pipe-work shall be such that in the upper part of the meter a positive pressure exists of at least 0.005MPa, even at zero flow-rate.

A.6.3.2 The test section: The test section shall include, in addition to the meter(s):

(a) One or more pressure tappings for the measurement of pressure, of which one pressure tapping is situated upstream of , and close to, the (first) meter;

(b) If necessary, means for measuring the temperature of the water at the entry to the (first) meter.

The different devices placed in the measuring section shall not cause cavitation or flow disturbances capable of altering the performance of the meters or causing measurement errors.

A.6.3.3 Precautions to be taken during tests: The operation of the test rig shall be such that the quantity of water which has flowed through the meter(s) equals that measurement by the reference device. It shall be checked that pipes (for example, the swan-neck in the outlet pipe) are filled to the same extent at the begging and at the end of the test. Air shall be bled from the interconnecting pipe-work and the meter(s). All precaution shall be taken to avoid the effects of vibration and shock.

A.6.3.4 Special arrangements for installation of certain types of meter:

A.6.3.4.1 Principle: The following reminder of the most frequent causes of error and the necessary precautions for the installation of water meters on the test bench is prompted by the recommendation of OIML D 4, which aims to help achieve a test installation in which:

(a) The hydrodynamic flow characteristics cause no discernible difference to the meter functioning when compared with hydrodynamic flow characteristics which are undisturbed;

(b) The overall error of the method employed does not exceed the stipulated value (see A.6.4.1).

A.6.3.4.2 Need for the straight lengths of pipe or a flow straightener: The accuracy of the water meter can be affected by upstream disturbance caused, for example, by the pressure of bend, tees, valves or pumps. In order to countertact these effects, the meter shall be installed for test in a straight length. The connecting pipe-work shall have the same internal diameter as the hole in the connection of the meter. It may, moreover, be necessary to put a low straightener upstream of the straight length.

A.6.3.4.3 Common causes of flow disturbance: A flow can subject to two types of disturbance: velocity-profile distortion and swirl, both of which affect the accuracy of the water meter. Velocity-profile distortion is typical caused by an obstruction partially blocking the pipe, for instance the presence of a partly closed valve or a misaligned flange joint. This can easily be eliminated. Swirl is caused mainly by two or more bends in different planes. This effect can be controlled either by ensuring an adequate length of straight pipe upstream of water meter, or by installing a straightening device, or by a combination of the two.

A.6.3.4.4 Volumetric water meters: Volumetric water meters (that is, involving chambers with mobile walls), such as oscillating meters, are considered insensitive to upstream installation conditions: hence no special conditions are required.

A.6.3.4.5 Velocity-type water meters: Certain velocity-type water meters are sensitive to flow disturbance, which can result in significant errors, but the way installation affect their accuracy has not yet been clearly determined. It is simply recommended to avoid, as far as possible, the pressure of bends, pumps, taper pieces and changed in the diameter of pipe-work immediately upstream, and to position the meter to afford the maximum possible straight length of pipe upstream and downstream.

A.6.3.5 Errors test commencement termination

A.6.3.5.1 Principle: Adequate precaution shall be taken to reduce the uncertainties resulting from operation of test rig components during the test. Details of the precaution to be taken are given in A.6.3.5.2 and A.6.3.5.3 for two cases encountered in the “collection” method.

A.6.3.5.2 Tests with reading taken with the meter at rest: Flow is established by opening a valve, preferably situated downstream of the meter, and it is stopped by closure of this valve. The meter is read whilst completely stationary. Time is measured between begging and of the movement of valve at the opening and at the begging of closure. Whilst flow is begging and during the period of running at the specified constant flow-rate, the indicating error of the meter varies as a function of the change in flow-rate(indicating error curve).Whilst the flow is being stopped, the combination of inertia of the moving parts of the meter and the rotational movement of the water inside the meter may casue an appreciable error to be introduced in certain types of meter and for certain test flow-rate. It has not been possible, in this case, to determine a simple empirical rule which lays down conditions so that this error may always be negligible. Certain types of meter are particularly sensitive to such error. In case of doubt, it is advisable:

(a) To increase the volume and duration of the test;

(b) To compare the results with those obtained by one or more other methods, and in particular the method described in A.6.3.5.3, which eliminates the causes of uncertainty given above.

A.6.3.5.3 Tests with reading taken under flow conditions and diversion of flow: The measurement is carried out when flow conditions have stabilized. A switch diverts the flow into a calibrated vessel at the begging of the measurement and diverts it away at the end. The meter is read while in motion. The reading of the meter is synchronized with the movement of the flow switch. The volume collected in the vessel is the volume passed. The uncertainty introduced into the volume may be considered negligible if the times of motion of the flow switch in each direction are identical within 5 % and if this is less than 1/50 of the total time of the test.

A6.4 Calibrated reference device (tank):

A.6.4.1 Overall error of the method employed: For type approval and initial verification, the total error in the method used for the determination of the volume of water meter passed through the water meter shall not exceed 1/10 of the relevant maximum permissible error.

A.6.4.2 Minimum volume (volume of the calibrated vessel is used in this method): The minimum volume permitted depends on requirements determined by the test start and end effects, and the design of the indicating device (verification of the scale division).

A.6.5 Meter reading: It is accepted that the maximum interpolation error for the scale does not exceed half a scale division per observation. Thus, in the measurement of a volume of flow delivered by the water meter (consisting of two observations of the water meter), the total interpolation error can reach one scale division. In the absence of other requirements, the maximum error in the reading of the volume indicated by the meter shall not exceed 0.5 %. The effects of a possible cyclic distortion on the reading of the meter (visual or automatic) shall be negligible.

A6.6 Major factors affecting indicating error checks:

A.6.6.1 General: Variations in the pressure, flow-rate and temperature in the test rig, and uncertainties in the precision of measurement of these physical quantities, are the principal factors affecting the indicating-error test results.

A.6.6.2 Pressure: The pressure shall be maintained at a constant value throughout the test at the chosen flow-rate. For testing meters which are designation $N \leqq 10$, at least flow-rate $\leqq 0.1q_p$, constancy of pressure at the inlet of the meter (or at the inlet of the first meter of a series being tested) is achieved if the test rig is supplied through a pipe from a constant head tank. This ensures an undisturbed flow. Any other method of supply shown not to cause pressure pulsation exceeding those of a constant head tank may be used. For all other tests, the pressure upstream of meter shall not vary by more than 10 %. The maximum uncertainty in the measurement of pressure shall be 5 % of the measured value. Pressure at the entrance to the meter shall not exceed the nominal pressure for the meter.

A.6.6.3 Flow-rate: The flow0rate shall be maintained constant throughout the test at the chosen value. The relative variation in the flow-rate during each test (not including starting and stopping) shall not exceed:

± 2.5 % from q_{min} to q_p (not inclusive);

± 5 % from q_t (inclusive) to q_s.

The flow-rate value is the volume passed during the test divided by the time. This flow-rate variation condition is acceptable if the relative pressure variation (in flow to free air) or the relative variation of pressure loss (in closed circuits) does not exceed:

± 5 % from q_{min} to q_p (not inclusive);

± 10 % from q_t (inclusive) to q_s.

A.6.6.4 Temperature: During a test, the temperature of the water shall not change by more 5 ℃. The maximum uncertainty in the measurement of temperature shall not exceed 1 ℃.

A.7 Anti-static test: The water meter under test shall be demonstrated that it is not affected by a static magnetic field with 1500 gauss.

A.8 Metrological characteristics:

A.8.1 The maximum permissible error in the lower zone from q_{min} inclusive up to but excluding q_t is ± 5 %. The maximum permissible error in the upper zone from q_t inclusive up to and including q_s is ± 2 %.

A.8.2 Water meters are divided into four metrological classes according to the values of q_{min} and q_t (see table A.4).

Table A.4 – Classification of water meters according to values of q_{min} and q_t in cubis meters per hours

Class	Numerical value of meter designation N	
	N<15	N≧15
Class A		
q_{min}	0.04N	0.08N
q_t	0.10N	0.30N
Class B		
q_{min}	0.02N	0.03N
q_t	0.08N	0.20N
Class C		
q_{min}	0.01N	0.006N
q_t	0.015N	0.015N
Class D		
q_{min}	0.0075N	-
q_t	0.0115N	-

A.9 Pressure-loss tests: Test methods and equipments for the measurement of press-loss tests are described in A.9.3.

A.9.1 From the results of tests, water meters are divided into four groups on the basis that the pressure loss corresponds to one of the following maximum values: 0.1 MPa, 0.06 MPa, 0.03 MPa and 0.01 MPa over the entire flow-rate range (see A.9.2).

A.9.2 The value of the pressure loss is determined at the flow-rate between q_p and q_s. If necessary, a calculation is made to obtain the pressure loss at q_s based on the formula:

$$\text{Pressure loss at } q_s = \frac{(q_s)^2}{(\text{test flowrate})^2} \text{ x measured pressure loss}$$

The value of the pressure loss at q_s is required to conform to the pressure loss group of the approved model. The check is normally carried out by sampling.

A.9.3 Test methods and equipments for the measurement of press-loss tests

A.9.3.1 Principle: The method of pressure-loss testing is a reference method. Other methods may be used on condition that the values of the pressure loss obtained are equal to those obtained by the reference method. The pressure loss of the water meter may be determined from measurements of the static differential pressure across the water meter at the stipulated flow-rate. Pressure tapping situated in the walls of the pipe fitted up- and downstream of the water meter are used for the measurement of the differential pressure. The pressure-loss tests shall take into account any pressure recovery downstream of the meter by suitably locating the downstream pressure tapping (see A.9.3.2.2.2). The results of the tests shall take account of the pressure recovery, and shall also compensate as necessary for the lengths of the pipe between the pressure tappings (see A.9.3.3).

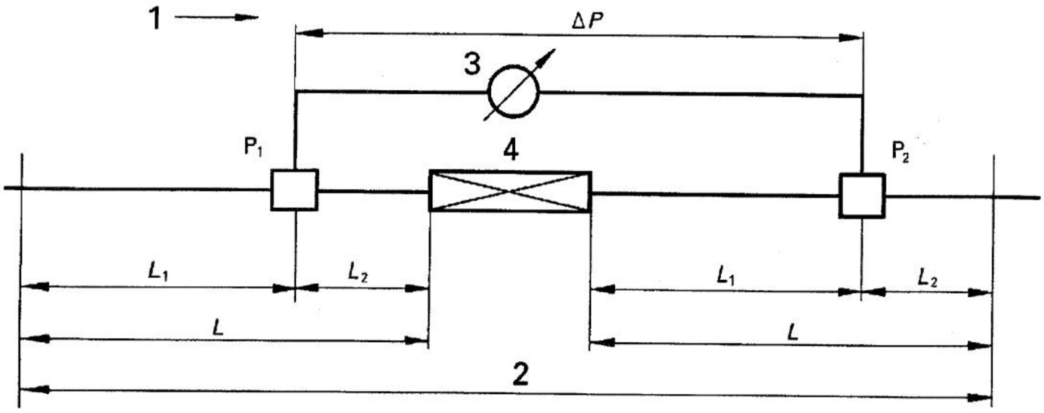
A.9.3.2 Test equipments for the measurement of press-loss tests:

A.9.3.2.1 General: The equipment needed to carry out pressure-loss tests consists of a measuring section of pipe-work containing the water meter under test and means for producing the stipulated constant flow-rate through the meter. The same constant flow-rate means as that employed for the measurement-error tests described in clause A.6 is generally used for pressure-loss tests.

A.9.3.2.2 Measuring section: The up- and downstream pipe lengths, with their end connections and pressure tappings, plus the water meter on test, constitute the measuring section.

A.9.3.2.2.1 Internal diameter of measuring section: The up- and downstream pipe lengths in contact with the water meter shall have the same internal diameter as the meter connection, so as to avoid hydraulic discontinuities. The pipe internal diameters shall be specified by the meter manufacturer. A difference in the diameter of the connecting pipe-work and that of the meter may result in a measurement uncertainty incompatible with the precision desired.

A.9.3.2.2.2 Measuring-section straight lengths: Up- and downstream of the meter, and up- and downstream of the pressure tappings, straight lengths of pipe shall be provided in accordance with Figure A.3 where D is the internal diameter of the pipe-work of the measuring section.



Key

1 Flow direction

2 Measuring section

3 Differential manometer

4 Water meter

Note P_1 and P_2 are the planes of pressure tapping

$L \geqq 15D$;

$L_1 \geqq 10D$;

$L_2 \geqq 5D$.

Figure A.3 – Layout of the measuring section

A.9.3.2.2.3 Design of measuring-section pressure tappings: Pressure tappings of similar design and dimension shall be fitted to the inlet and outlet pipes of the measuring section. Pressure tappings may consist of holes drilled through the wall of pipe or be in the form of an annular slit in the pipe wall, in either case perpendicular to the pipe axis. There should be at least four such pressure-tapping holes, equally spaced in one plane around the pipe circumference. Examples of both types of pressure tapping are described in A.9.3.2.2.4 (see Figure A.4, A.5 and A.6). Four or more pressure-tapping holes may be interconnected by means of tee-shaped connectors which connect up the pressure tappings, forming an annulus to give a true mean static pressure at the pipe cross-section. Other means, such as a ring or balance chamber, may also be used.

A.9.3.2..2.4 Pressure tappings, hole and slit details: Holes drilled through the wall of the pipe (see Figure A.4 and A.6) shall be perpendicular to the pipe axis, and the diameter *d* of the holes shall not exceed 0.08 *D* and shall preferably be less than 4 mm. The diameter of the holes shall remain constant for a distance of not less than two diameters before breaking into the pipe. The holes drilled through the pipe wall shall be free from burrs at the edges where they break through into the inlet and outlet pipe bores. Edges shall be sharp, that is, neither radiussed nor chamfered. Slits shall be perpendicular to the pipe axis and shall have dimensions as follows (see Figure A.3).

- width *i* equal to or less than 0.08 *D* and less than 4 mm;
- depth *k* greater than 2 *i*.

A.9.3.2.2.5 Measurement of static difference pressure: Each group of pressure tapping in the same plane shall be connected by a leak-free tube to one limb of a differential-pressure measuring device, for example, a manometer. Provision shall be made for clearing air from the installation.

A.9.3.3 Test procedure:

A.9.3.3.1 Principle: The method consists in measuring the static differential pressure (ΔP_2) between pressure tappings of the measuring section with the meter present, and deducting from it the pressure loss (ΔP_1) of the up- and downstream pipe lengths measured at the same flow-rate in the absence of the meter.

A.9.3.3.2 The pressure loss of up- and downstream pipe (ΔP_1) may be determined prior to the tests proper, and checked periodically. This is done by joining the up- and downstream pipe faces together in the absence of the meter (carefully avoiding joint protrusion into the pipe bore or misalignment of the two faces), and measuring the pressure loss of the pipe measuring section for each test flow-rate. The absence of water meter will shorten the measuring section. If telescopic sections are not fitted on the test rig, the gap may be filled by inserting, at the downstream end of the measuring section, either a temporary pipe of the same length and internal diameter as the pipe lengths, or the water meter itself.

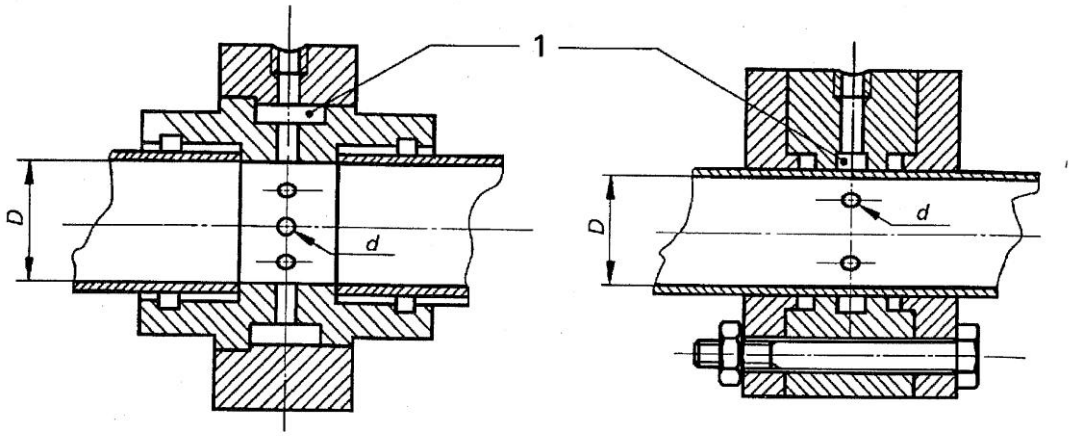
A.9.3.3.3 Measurement and calculation of the actual ΔP of the water meter (measurement 2): At the same test flow-rate used to determine the pipe pressure losses, in the same installation, which the same pressure tappings and the same manometer but with the water meter in position, the differential pressure (ΔP_2) across the metering section shall be measured.

The actual pressure loss (ΔP) of the water meter at given flow-rate is calculated by making the subtraction $\Delta P = \Delta P_2 - \Delta P_1$.

The value arrived at may be converted to the pressure loss corresponding to the q_s of the water meter by reference to the formula given in A.8.2.

Note if the flow-rates with and without the meter present differ, they may be adjusted to the same value by the square law formula.

A.9.3.4 Maximum uncertainty: The maximum uncertainty in the results of the measurement of pressure loss shall be ± 5 %. The uncertainty is established to lie at the 95 % probability level.

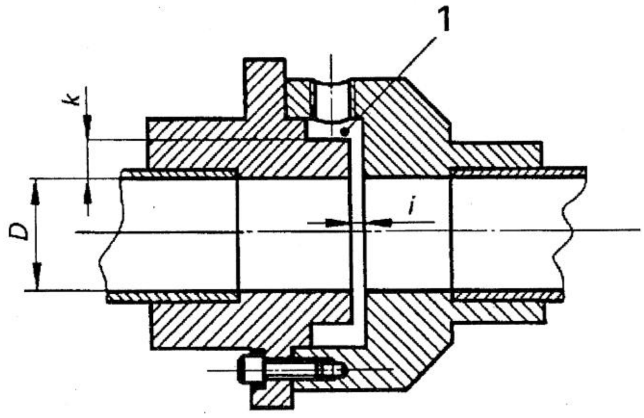


Key

1 Ring chamber

Figure A.4 Example of drilled-hole type of pressure tapping with ring chamber,

Suitable for small/medium diameter test section

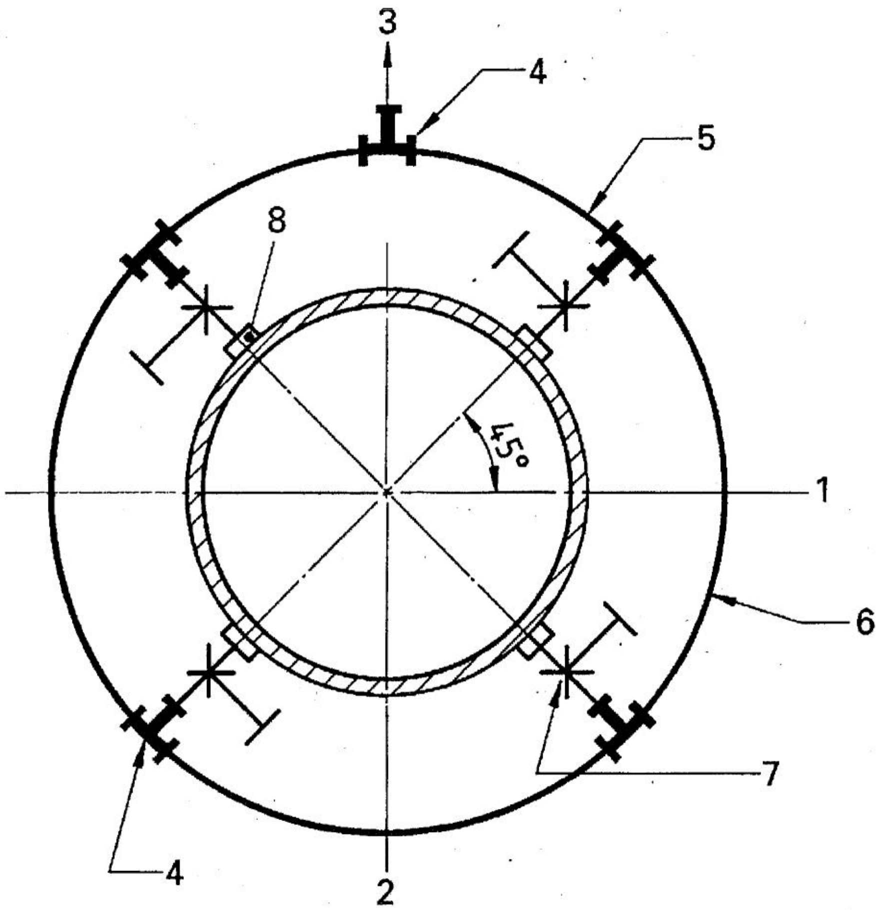


Key

1 Ring chamber

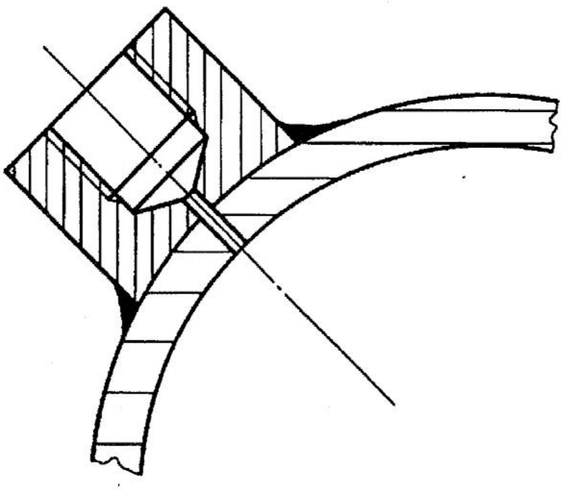
Figure A.5 Example of slit type of pressure tapping with ring chamber,

Suitable for small/medium diameter test section



Key

1 Horizontal axis | 5 Flexible hose or copper pipe



2 Vertical axis | 6 Loop giving mean static pressure

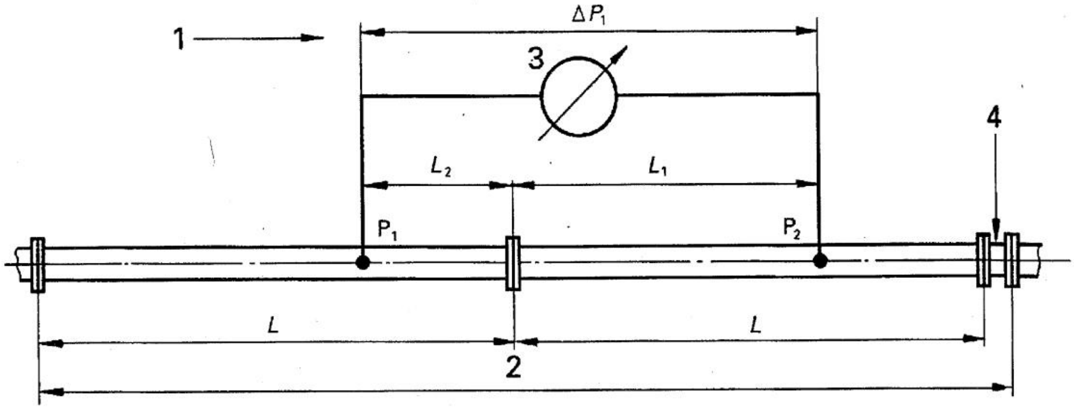
3 To manometer | 7 Isolating cock

4 Tee | 8 Pressure tapping (see detail)

(a) Cross-section through pipe and pressure tapping

(b) Detail of pressure tapping and boss

Figure A.6 Example of drilled – hole type of pressure tapping with loop with mean static pressure



interconnections, suitable for medium/ large diameter test sections

Key

1 Flow direction

2 Measuring section

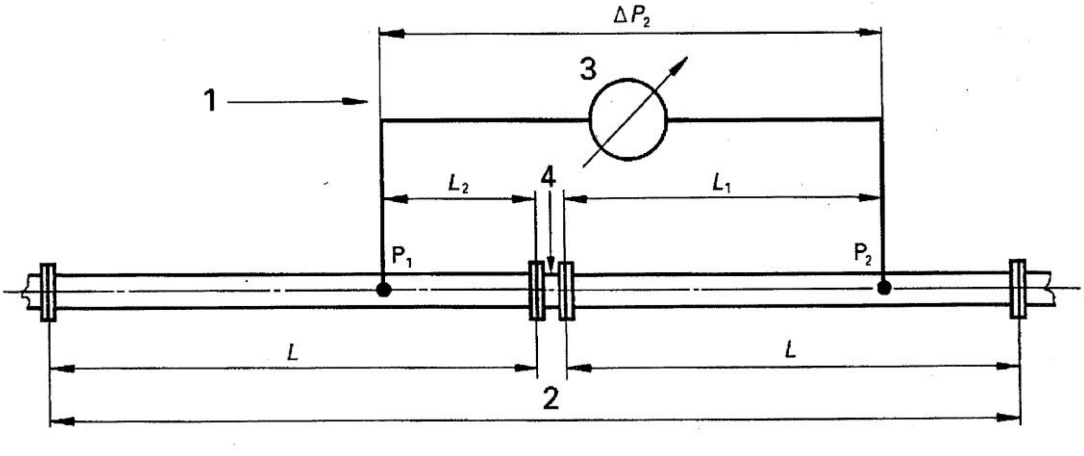
3 Differential manometer

4 Water meter in downstream position or temporary pipes

ΔP_1 Is the pressure loss of up- and downstream pipe lengths not including water meter

$\Delta P_2 = (\Delta PL_2 + \Delta PL_1)$

(a) Measurement 1 (see A.9.3.3.2)



Key

1 Flow direction

2 Measuring section

3 Differential manometer

4 Water meter in downstream position or temporary pipes

ΔP_2 is the pressure loss of up- and downstream pipe lengths not including water meter

$\Delta P_2 = (\Delta PL_2 + \Delta PL_1 + \Delta P_{\text{meter}})$

$\Delta P_2 - \Delta P_1 = (\Delta PL_2 + \Delta PL_1 + \Delta P_{\text{meter}}) - (\Delta PL_2 + \Delta PL_1) = \Delta P_{\text{meter}}$

(b) Measurement 2 (see A.9.3.3.3)

Figure A.7 – Procedure for pressure-loss measurement

A.10 Accelerated wear tests

A.10.1 Continuous flow test

A.10.1.1 Principle: The tests consist of subjecting the meter to constant flow-rate. For the convenience of laboratories, the test can be divided up to periods of at 6 h.

A.10.1.2 Description of the installation:

(a) a water supply (mains, non-pressurized tank, pressurized tank, pump, etc.);

(b) pipe-work.

A.10.1.3 Pipe-work:

A.10.1.3.1 Description: In addition to the meter or meters to be tested, the pipe-work comprises:

(a) A flow-regulating devices;

(b) One or two isolating devices;

(c) A device for measuring the water temperature at the meter inlet;

(d) Means for checking the flow-rate and duration of the test.

If the pipe-work ends in the open air, that end shall be located at a higher level than the upper part of the meter.

The different devices shall not cause cavitations phenomena.

A.10.1.3.2 Precautions to flow-rate: The meter and connecting pipes shall be suitably bled of air.

A.10.1.4 Tolerance on flow-rate: The flow-rate shall be kept constant throughout the test at a predetermined level. The relative variation of the flow-rate values during each test shall not exceed ± 10 % (except when starting and stopping).

A.10.1.5 Tolerance on test timing: The specified duration of the test is a minimum value.

A.10.1.6 Tolerance on discharged volume: The volume indicated at the test shall not be less than that determined from the product of the theoretical flow-rate of the test and the theoretical duration. To satisfy this condition, sufficiently frequent corrections to the flow-rate shall be made.

A.10.2 Continuous flow tests

A.10.2.1 Principle: The test consists of the meter to a large number of starting and stopping cycles of short duration, the constant test flow0rate phase of each cycle being kept at the same flow-rate throughout the duration of the test (see A.10.2.4).

A.10.2.2 Description of the installation: the installation consists of:

(a) a water supply (mains, non-pressurized tank, pressurized tank, pump, etc.);

(b) pipe-work.

A.10.2.3 Pipe-work:

A.10.2.3.1 Description: the meters can be arranged in series or in parallel, or the two systems can be combined. In addition to the meter(s), the piping system consists of:

(a) One flow-regulating device (per line of meters in series, if necessary);

(b) One or more isolating devices;

(c) A device for measuring the temperature of the water upstream of the meters;

(d) Devices for checking: flow-rate, the duration of cycles and the number of cycles;

(e) One or more flow-interrupting devices (one per line of meters in series).

If the pipe-work ends in the open air, that end shall be located at a higher level than the upper part of the meter. The various devices shall not cause cavitations phenomena or other causes of parasitic wear of the meter(s).

A.10.2.3.2 Precaution to be taken: The meter connecting pipes shall be suitably bled of air. The flow variation during the repeated opening and closing operations shall be progressive, so as to prevent water hammer.

A.10.2.4 Flow: The relative variation of the flow value shall not exceed ± 10 % closing and stoppage periods.

A.10.2.5 Cycles

A.10.2.5.1 Phases: A complete cycle comprises the following four phases:

(a) A period from zero to test flow-rate;

(b) A period at constant test flow-rate;

(c) A period from the test flow-rate to zero;

(d) A period ay zero flow-rate.

The test program shall specify the number of cycles, the duration of the four phases of a cycle, and the total volume to be charged.

A.10.2.5.2 Tolerance on test timing: The tolerance on the specified duration of each phase shall not exceed ± 10 %. The tolerance on the total duration shall not exceed ± 5 %.

A.10.2.5.3 Tolerance on the number of cycles: The number of cycles shall not be less than that stipulated, but shall not exceed this number by more than ± 1 %.

A.10.2.6 Tolerance on discharged volume: the volume discharged throughout the test shall be equal to half the product of the theoretical test flow times the total theoretical duration of the test (operating periods plus transient and stoppage with a tolerance of ± 5 %). This precision can be obtained by sufficiently frequent corrections of the instantaneous flows and operating periods.

A.10.3 The water meter is subjected to an endurance test simulating service conditions. In addition to periods extend running at specified flow-rate, water meters which are designated N ≦ 10 are subjected to intermittent tests in which the water meter is operated for a short period at a flow-rate given in the test program, followed by a period of rest. An example of an accelerated wear test is given in Table A.5.

Table A.5- Example of accelerated wear test

Meter Designated N	Test Flow-rate	Type of Test	Number of interruptions	Duration Of pauses s	Period of Operation at Test flow-rate	Duration of Start-up and Rundown
N ≦ 10	q_p	Discontinuous	100 000	15	15 s	0.15(N)[a] (minimum 1 s)
	2 q_p	Continuous			800 h	
N > 10	q_p	Continuous			800 h	
	2 q_p	Continuous			200 h	

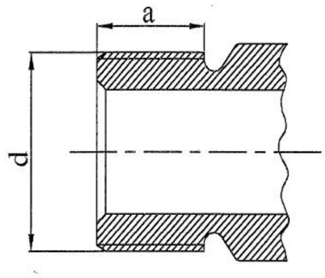
[a] (N) is the number equal to the value of N.

A.11 The thread specification of threaded connecting of water meters

A.11.1 Type: the thread type of threaded connecting of water meters are divided into two types, male pipe thread and female pipe thread.

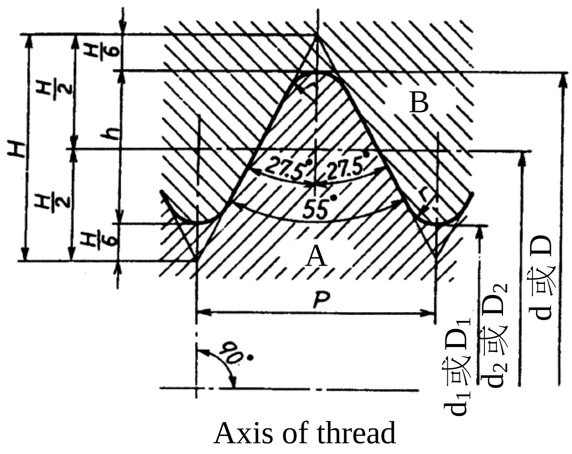
A.11.2 Dimension: The dimension of thread is described in Table A.6, the basic profile of and basic dimension is described A.7 and the tolerance of dimension is described in Table A.8.

Table A.6- Dimension of thread of water meters



Nominal Diameter (unit: mm)	Outside diameter of water meter d (unit: mm)	Number of Threads per 25.4 mm	a (minimum)(unit: mm)
15(13)	25.8	14	14
20	33.0	14	14
25	39.0	14	14
4.	56.0	11	18
50	67.6	11	18

Table A.7 Thread profile



Solid-line indicates the profile of thread

$$P = \frac{25.4}{n}$$

$H=0.960491P$

$h=0.640327P$

$r=0.137329P$

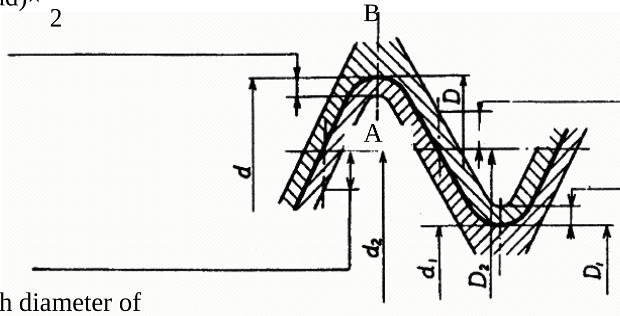
$d_2=d-h \quad D_2=d_2$

$d_1=d-2h \quad D_1=d_1$

Nominal Diameter (unit: mm)	Number of Threads per 25.4 mm	Pitch (unit: mm)	Height of thread	Radius of rounded crests and roots	Diameters of external thread (unit: mm)		
					Major d	Pitch d_2	Minor d_1
					Diameters of internal thread (unit: mm)		
					Major D	Pitch D_2	Minor D_1
15(13)	14	1.8143	1.162	0.25	25.8	24.64	23.48
20	14	1.8143	1.162	0.25	33.0	31.81	30.68
25	14	1.8143	1.162	0.25	39.0	37.84	36.67
40	11	2.3091	1.479	0.32	56.0	54.52	53.04
50	11	2.3091	1.479	0.32	67.6	66.12	64.64

The basic profile of threads in this table is according to CNS 494.

Table A.8 Deviation of dimension



A: external thread

B: internal thread

Nominal Diameter (unit: mm)	Number of Threads per 25.4 mm	Tolerance on the pitch of external thread (unit: μm)						Tolerance on the pitch of internal thread (unit: μm)					
		Major d		Pitch ([1]) d_2		Minor d_1		Major D		Pitch ([1]) D_2		Minor D_1	
		Upper deviation	Lower deviation (-)	Upper deviation	Lower deviation (-)	Lower deviation	Upper deviation	Lower deviation	Upper deviation	Lower deviation	Upper deviation (+)	Lower deviation	Upper deviation (+)
15(13)	14	0	284	0	284	0	No specified	0	No specified	0	142	0	541
20	14	0	360	0	360	0		0		0	180	0	640
25	14	0	360	0	360	0		0		0	180	0	640
40	11	0	360	0	360	0		0		0	180	0	640
50	11	0	434	0	434	0		0		0	217	0	640

Note: ([1]) For thin-walled parts, the tolerances apply to the mean pitch diameter, which is the arithmetical mean of two diameters measured at right angles to each other.

1. The deviations specified in this table are according to B Class of CNS 494.

2. The deviations of half angle of thread and the pitch dimension that not specified in this table have been converted into diametral pitch and included in the tolerance of pitch.

Appendix B Vortex Water Meter

Contents

B.1 Indicator

B.1.1 General requirements:

B.1.1.1 Function: The indicating devices shall provide an easily read, reliable and unambiguous visual indication of the volume flow. The device shall include means for verification and calibration. The device may include additional elements for verification and calibration by other methods, e.g. automatic.

B1.1.2 Unit of measurement, symbol and its location: the volume of water measured shall be expressed in cubic mete. The unit symbol (m^3) shall appear on the dial or immediately adjacent to the numbered display.

B.1.1.3 Indicator range: The indicating device shall be able to record, without passing zero, the volume expressed min cubic meters. The indicator range is described in Table B.1.

Table B.1-Indicator range

Nominal diameter (mm)	Indicator range (minimum)	Verification scale Interval (maximum)	Unit of measurement
50 75 100	999 999	0.001	m^3

B.1.1.4 Electronic digital indicator: The incremental change in electronic digital indication shall be instantaneous equipped a signal of water flowing and . The digits shall be black when the electronic indicator is liquid crystal. The digits for integral shall be larger than the digits for the decimal of cubic meter.

B.1.2 Type of indicators: The volume is given by a line of adjacent digits appearing in one or more apertures. The advance of any given digital unit shall be completed while the digit of the next lower value is changing from 9 to 0. The lowest-value decade may have a continuous movement, the aperture being large enough to permit a digit to be unambiguously read. The visible height of the digits shall be at least 4 mm.

B.2 Technical characteristics

B.2.1 Diameter and overall size of meters: The structure of meters are described as Figure B.1, the overall size and flow-rates are described as Table 2. Unspecified structure and dimension mat be decided by manufacturers.

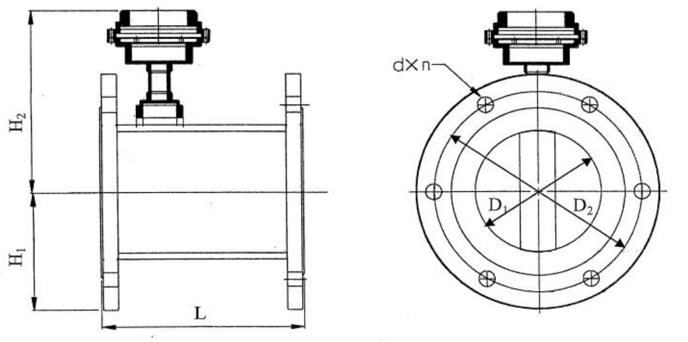


Figure B.1 The flange dimension of Vortex water meters

Table B.2 – The flow-rate and dimension of vortex meters

Specification / Nominal Diameter (DN) (unit: mm)	Vortex water meters				
	Maximum flow-rate (m^3/h) ≧	Minimum flow-rate (m^3/h) ≦	L (unit: mm) ≦	Button to Center of Bore(H_1) (unit: mm) ≦	Top to Center of Bore(H_2) (unit: mm) ≦
50	60	6	170	100	390
75	160	16	190	120	410
100	250	25	210	140	440

Note 1. The flow-rates listed in the table are based on the working medium (water) with dynamic viscosity 1 x 10^{-6} m^2/s.

2. The dimension D_2 and d x n of the flanges are specified in CNS 12795 or CNS 13727.

B.3 Materials

B.3.1 Water temperature variations, within the working temperature range, shall not adversely affect the materials used in the construction of the water meter. All materials of water meter which are in contact with the water flowing through the water meter shall be non-toxic and non-tainting. The materials shall comply with operative national standards.

B.3.2 The water meter shall be constructed throughout of materials which are resistant to normal internal and external corrosion or which are protected by some suitable surface treatment. The water meter shall be made of materials of strength adequate for purpose for which it is to be used.

B.3.3 The indicating device of the water meter shall be protected by a transparent window (glass or other material). Further protection may be provided by a suitable cover.

B.3.4 The water meter shall be provided with means for the removal of condensation, if the latter can occur on the underside of the window of the indicating device of the water meter.

B.4 Pressure test

B.4.1 Principle: he meter under test is required to withstand, without leakage or seepage through the walls, and without damage, a pressure as specified as below.

B.4.2 Precautions to be taken during the tests: The test rig and the meter shall be suitably bled of air and leak-proof. Pressurizing shall be carried out gradually without pressure surges.

B.4.3The water shall withstand a specified hydraulic test pressure for a specified time without leakage or damage.

B.4.3.1 1.6 MPa or 1.6 times the nominal pressure when the nominal pressure is higher than 1 MPa for 15 minutes; and

B.4.3.2 2.0 MPA or 2 times the nominal pressure for 1 minute.

B.5 Indicating test

B.5.1 The method described in this specification to determine indicating error is the so-called "collection" method, in which the quantity of water passed through the water meter is collected in one or more collecting vessels and the quantity determined volumetrically or by weighing. Other methods may be used, provided the accuracy levels stated in this specification are attained. The checking of the indicating error consists in comparing the indications given by the meter under test against a calibrated reference device.

B.5.2 Description of the test rig: The rig consists of:

B.5.2.1 A water supply (mains, non-pressurized tank, pressurized tank, pump, etc.);

B.5.2.2 Pipe-work;

B.5.2.3 A calibrated reference device (calibrated tank, reference meter, etc.);

B.5.2.4 Means for measuring the time of the test.

Devices for automating the testing of water meters are permissible.

B.5.3 Pipe-work

B.5.3.1Description: pipe-work shall include:

(a) A test section in which the meter(s) is(are) placed;

(b) Means to establish the desire flow-rate;

(c) One or more isolating devices;

(d) Means for determine the flow-rate;

and if necessary,

(e) One or more air bleeds;

(f) A non-return device;

(g) An air separator;

(h) A filter.

During the test, flow leakage, flow input and flow drainage shall be permitted neither between the meter(s) and the reference device nor from reference device. The pipe-work shall be such that in the upper part of the meter a positive pressure exists of at least 0.005 MPa, even at zero flow-rate.

B.5.3.2 The test section: The test section shall include, in addition to the meter(s):

(a) One or more pressure tappings for the measurement of pressure, of which one pressure tapping is situated upstream of , and close to, the (first) meter;

(b) If necessary, means for measuring the temperature of the water at the entry to the (first) meter.

The different devices placed in the measuring section shall not cause cavitation or flow disturbances capable of altering the performance of the meters or causing measurement errors.

B.5.3.3 Precautions to be taken during tests: The operation of the test rig shall be such that the quantity of water which has flowed through the meter(s) equals that measurement by the reference device. It shall be checked that pipes (for example, the swan-neck in the outlet pipe) are filled to the same extent at the begging and at the end of the test. Air shall be bled from the interconnecting pipe-work and the meter(s). All precaution shall be taken to avoid the effects of vibration and shock.

B.5.3.4 Special arrangements for installation of certain types of meter:

B.5.3.4.1 Principle: The following reminder of the most frequent causes of error and the necessary precautions for the installation of water meters on the test bench, which aims to help achieve a test installation in which:

(a) The hydrodynamic flow characteristics cause no discernible difference to the meter functioning when compared with hydrodynamic flow characteristics which are undisturbed;

(b) The overall error of the method employed does not exceed the stipulated value (see B.5.4.1).

B.5.3.4.2 Need for the straight lengths of pipe or a flow straightener: The accuracy of the water meter can be affected by upstream disturbance caused, for example, by the pressure of bend, tees, valves or pumps. In order to countertact these effects, the meter shall be installed for test in a straight length. The connecting pipe-work shall have the same internal diameter as the hole in the connection of the meter. It may, moreover, be necessary to put a low straightener upstream of the straight length.

B.5.3.4.3 Common causes of flow disturbance: A flow can subject to two types of disturbance: velocity-profile distortion and swirl, both of which affect the accuracy of the water meter. Velocity-profile distortion is typical caused by an obstruction partially blocking the pipe, for instance the presence of a partly closed valve or a misaligned flange joint. This can easily be eliminated. Swirl is caused mainly by two or more bends in different planes. This effect can be controlled either by ensuring an adequate length of straight pipe upstream of water meter, or by installing a straightening device, or by a combination of the two.

B.5.3.5 Errors test commencement termination

B.5.3.5.1 Principle: Adequate precaution shall be taken to reduce the uncertainties resulting from operation of test rig components during the test. Details of the precaution to be taken are given in B.5.3.5.2 and B.5.3.5.3 for two cases encountered in the “collection” method.

B.5.3.5.2 Tests with reading taken with the meter at rest: Flow is established by opening a valve, preferably situated downstream of the meter, and it is stopped by closure of this valve. The meter is read whilst completely stationary. Time is measured between begging and of the movement of valve at the opening and at the begging of closure. Whilst flow is begging and during the period of running at the specified constant flow-rate, the indicating error of the meter varies as a function of the change in flow-rate(indicating error curve).Whilst the flow is being stopped, the combination of inertia of the moving parts of the meter and the rotational movement of the water inside the meter may casue an appreciable error to be introduced in certain types of meter and for certain test flow-rate. It has not been possible, in this case, to determine a simple empirical rule which lays down conditions so that this error may always be negligible. Certain types of meter are particularly sensitive to such error. In case of doubt, it is advisable:

(a) To increase the volume and duration of the test;

(b) To compare the results with those obtained by one or more other methods, and in particular the method described in B.5.3.5.3, which eliminates the causes of uncertainty given above.

B.5.3.5.3 Tests with reading taken under flow conditions and diversion of flow: The measurement is carried out when flow conditions have stabilized. A switch diverts the flow into a calibrated vessel at the begging of the measurement and diverts it away at the end. The meter is read while in motion. The reading of the meter is synchronized with the movement of the flow switch. The volume collected in the vessel is the volume passed. The uncertainty introduced into the volume may be considered negligible if the times of motion of the flow switch in each direction are identical within 5 % and if this is less than 1/50 of the total time of the test.

B.5.4 Calibrated reference device (tank):

B.5.4.1 Overall error of the method employed: For type approval and initial verification, the total error in the method used for the determination of the volume of water meter passed through the water meter shall not exceed 1/10 of the relevant maximum permissible error.

B.5.4.2 Minimum volume (volume of the calibrated vessel is used in this method): The minimum volume permitted depends on requirements determined by the test start and end effects, and the design of the indicating device (verification of the scale division).

B.5.5 Meter reading: It is accepted that the maximum interpolation error for the scale does not exceed half a scale division per observation. Thus, in the measurement of a volume of flow delivered by the water meter (consisting of two observations of the water meter), the total interpolation error can reach one scale division. In the absence of other requirements, the maximum error in the reading of the volume indicated by the meter shall not exceed 0.5 %. The effects of a possible cyclic distortion on the reading of the meter (visual or automatic) shall be negligible.

B.5.6 Major factors affecting indicating error checks:

B.5.6.1 General: Variations in the pressure, flow-rate and temperature in the test rig, and uncertainties in the precision of measurement of these physical quantities, are the principal factors affecting the indicating-error test results.

B.5.6.2 Pressure: The pressure shall be maintained at a constant value throughout the test at the chosen flow-rate. For testing meters which are designation N $\leqq$ 10, at least flow-rate $\leqq$ $0.1q_p$, constancy of pressure at the inlet of the meter (or at the inlet of the first meter of a series being tested) is achieved if the test rig is supplied through a pipe from a constant head tank. This ensures an undisturbed flow. Any other method of supply shown not to cause pressure pulsation exceeding those of a constant head tank may be used. For all other tests, the pressure upstream of meter shall not vary by more than 10 %. The maximum uncertainty in the measurement of pressure shall be 5 % of the measured value. Pressure at the entrance to the meter shall not exceed the nominal pressure for the meter.

B.5.6.3 Flow-rate: The flow-rate shall be maintained constant throughout the test at the chosen value. The relative variation in the flow-rate during each test (not including starting and stopping) shall not exceed± 2.5 % . The flow-rate value is the volume passed during the test divided by the time. This flow-rate variation condition is acceptable if the relative pressure variation (in flow to free air) or the relative variation of pressure loss (in closed circuits) does not exceed± 5 %.

B.5.6.4 Temperature: During a test, the temperature of the water shall not change by more 5 ℃. The maximum uncertainty in the measurement of temperature shall not exceed 1 ℃.