

Thermostatic radiator valves — Requirements and test methods

The European Standard EN 215:2004 has the status of a British Standard

ICS 91.140.10

National foreword

This British Standard is the official English language version of EN 215:2004. It supersedes BS EN 215-1:1991 and BS 7556:1992 which are withdrawn.

The UK participation in its preparation was entrusted to Technical Committee RHE/16, Performance requirements for control systems, which has the responsibility to:

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This British Standard was published under the authority of the Standards Policy and Strategy Committee on 25 June 2004

Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 38, an inside back cover and a back cover.

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Amendments issued since publication

Amd. No.	Date	Comments

© BSI 25 June 2004

ISBN 0 580 43981 X

English version

Thermostatic radiator valves - Requirements and test methods

Robinets thermostatiques d'équipement du corps de
chauffe - Exigences et méthodes d'essai

Thermostatische Heizkörperventile - Anforderungen und
Prüfung

This European Standard was approved by CEN on 8 April 2004.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.



EUROPEAN COMMITTEE FOR STANDARDIZATION
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Foreword

This document (EN 215:2004) has been prepared by CMC

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by December 2004, and conflicting national standards shall be withdrawn at the latest by December 2004.

This document will supersede EN 215-1:1987 and HD 1215-2:1988.

This European Standard constitutes the merging of EN 215-1:1987 and HD 1215-2:1988, according to Resolution BT 80/1998. The merging has been provided such that HD 1215:1988 has been included into prEN 215 mainly as a normative annex.

The work on radiator valves started in September 1982 in CEN/TC 105 with the aim of drafting a standard for requirements and a test procedure to form the basis of a possible certification scheme for radiator valves. EN 215-1:1987 was first accepted by CEN on 1986-10-28, published in July 1987, and a Corrigendum EN 215:1987/AC 1:1987 was published in November 1987.

This European Standard incorporates the corrigendum, and it will thus supersede EN 215-1:1987 and EN 215-1:1987/ AC 1:1987.

This European Standard further includes HD 1215-2:1988, which was first accepted by CEN on 1987-08-13, published in September 1988, and a Corrigendum HD 1215-2:1988/AC1:1989 was published in March 1989.

This European Standard incorporates the corrigendum, and will supersede HD 1215-2:1988 and HD 1215-2:1988/AC1:1989.

This European Standard can be used as a reference for a CEN/CENELEC Certification Mark System on radiator valves.

Annex A is normative. Annex B is informative.

This document includes a Bibliography.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

1 Scope

This European Standard specifies definitions, requirements and test methods for thermostatic radiator valves (referred to hereafter as thermostatic valves).

This standard applies to two port thermostatic valves with or without pre-setting facility for fitting to radiators in wet central heating installations up to a water temperature of 120 °C and a nominal pressure of PN 10.

This standard further specifies the dimensions, the materials and the connection details of four series of straight and angle pattern thermostatic radiator valves of nominal pressure $\leq$ PN 10.

This standard can be used as reference in a CEN/CENELEC Certification Mark System on thermostatic radiator valves.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text, and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

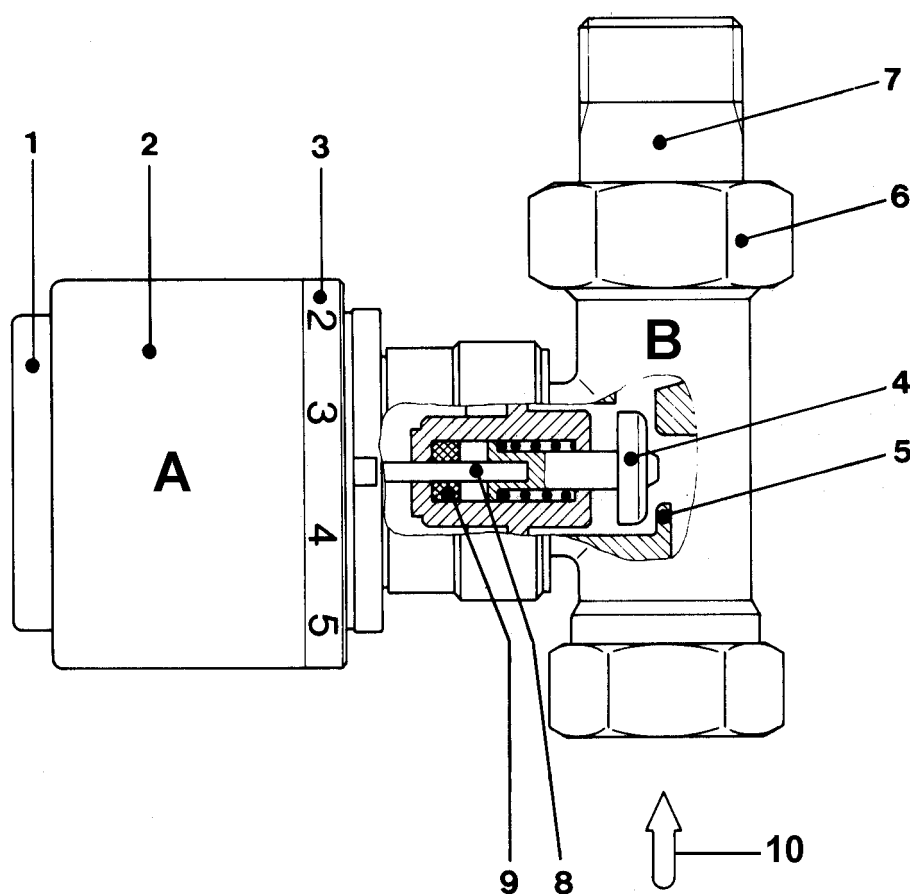
EN 1982	<i>Copper and copper alloys - Ingots and castings.</i>
EN 12164	<i>Copper and copper alloys - Rod for free machining purposes.</i>
EN 12168	<i>Copper and copper alloys - Hollow rod for free machining purposes.</i>
EN 12420	<i>Copper and copper alloys – Forgings.</i>
EN 12449	<i>Copper and copper alloys - Seamless, round tubes for general purposes.</i>
EN ISO 228-1	<i>Pipe threads where pressure-tight joints are not made on the threads - Part 1: Dimensions, tolerances and designation (ISO 228-1:2000).</i>
ISO 7-1	<i>Pipe threads where pressure-tight joints are made on the threads - Part 1: Dimensions, tolerances and designation.</i>
ISO 965-1	<i>ISO general purpose metric screw threads -Tolerances - Part 1: Principles and basic data.</i>
ISO 7268	<i>Pipe components – Definition of nominal pressure.</i>

3 Terms and definitions

For the purposes of this European Standard, the following terms and definitions apply.

3.1

thermostatic radiator valve - components (see Figure 1)

**Key**

A Thermostatic head assembly

1 Sensor

2 Temperature selector

3 Temperature selector scale

B Valve body assembly

4 Valve disc

5 Valve seat

6 Union nut

7 Tailpiece

8 Valve stem

9 Stem seal

10 Flow direction arrow

Figure 1 - Schematic drawing of the assembly of a thermostatic valve with integral sensor

3.1.1

sensor

part of the thermostatic valve that senses the temperature (controlled value) (Figure 2)

3.1.2

transmission unit

part of the thermostatic valve that converts a change of temperature or pressure of the sensor into a linear movement of the valve stem (Figure 2)

3.1.3

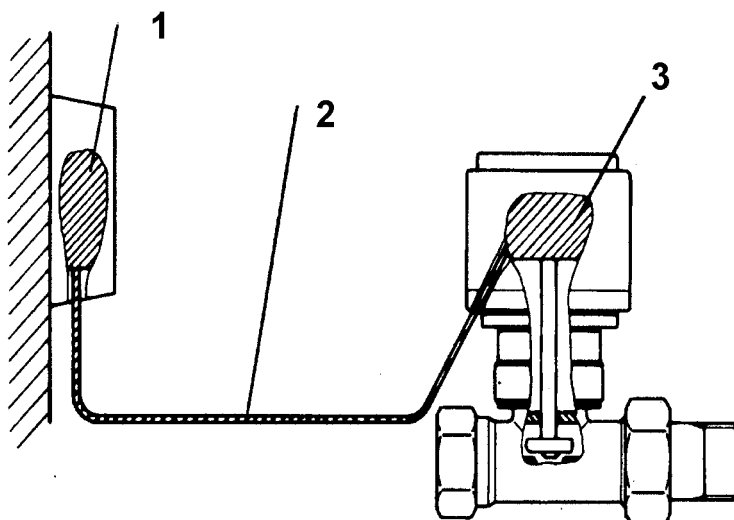
transmission element

part of the thermostatic valve (e.g. capillary) that transmits the volume or pressure changes from the sensor or temperature selector to the transmission unit (Figure 2)

3.1.4

thermostatic element

section containing all parts that are filled with the expansion medium (e.g. sensor, transmission element and transmission unit, shown as cross hatched parts in Figure 2)



Key

- 1 Sensor
- 2 Transmission element
- 3 Transmission unit

Figure 2 - Thermostatic element

3.1.5

protection cap

device that protects the valve stem and thread before the initial fitting of the thermostatic head assembly. It can be used to adjust the different flow rates as specified in 5.2.4 and 6.4.1.6.

3.2

types of thermostatic valves (see Figure 3)

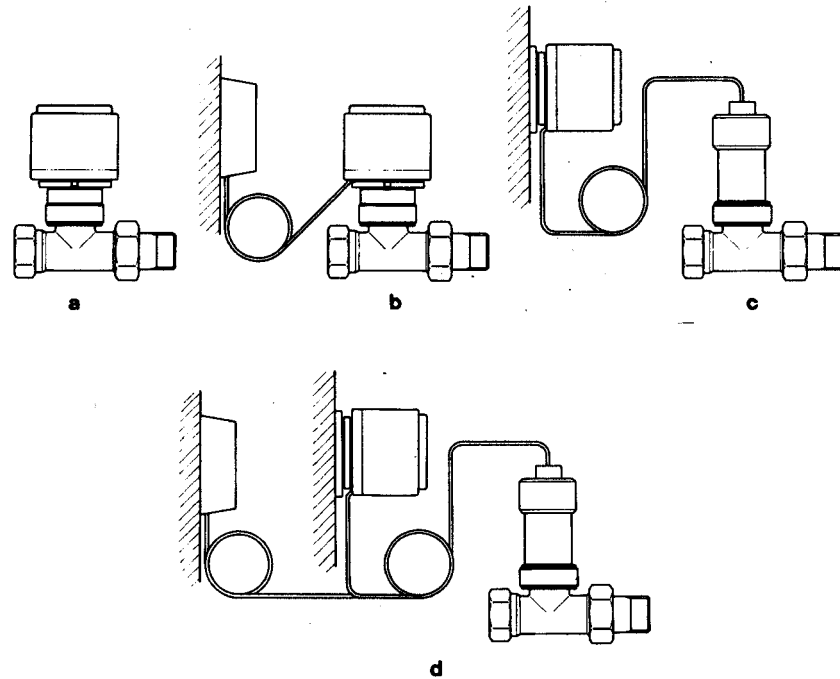


Figure 3a - Thermostatic valve with integral sensor

Figure 3b - Thermostatic valve with integral temperature selector with remote sensor

Figure 3c - Thermostatic valve with the remote sensor incorporating the selector

Figure 3d - Thermostatic valve with remote sensor and remote selector

Figure 3 - Types of thermostatic valves

3.2.1

thermostatic valve with integral sensor

valve where the sensor, transmission unit and temperature selector constitute an assembly which is incorporated with the valve body assembly (Figure 3a)

3.2.2

thermostatic valve with integral temperature selector and with remote sensor

valve where the temperature selector is incorporated within the valve. The sensor is separated from the transmission unit, and there is a transmission element between the sensor and the transmission unit (Figure 3b)

3.2.3

thermostatic valve with the remote sensor incorporating the selector

valve where the sensor and temperature selector assembly is mounted remotely from the valve body assembly and from the transmission unit. There is a transmission element between the sensor and the transmission unit (Figure 3c)

3.2.4

thermostatic valve with remote sensor and remote selector

valve where both the sensor and the temperature selector are separate from each other and from the valve body assembly with transmission unit. There is a transmission element between the sensor and the transmission unit and between the temperature selector and the transmission unit (Figure 3d).

3.2.5

thermostatic valve with pre-setting

valve where a reduced flow rate can be obtained by means of mechanical pre-adjustment incorporated in the valve body assembly

3.3

types of connections

examples of connections used to fit the valve to the radiator and to the pipe work are shown in Figure 4

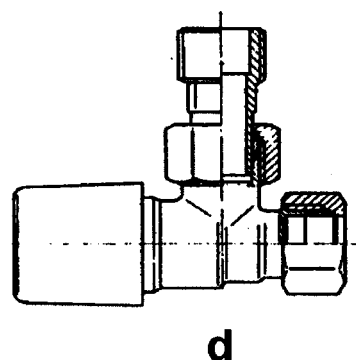
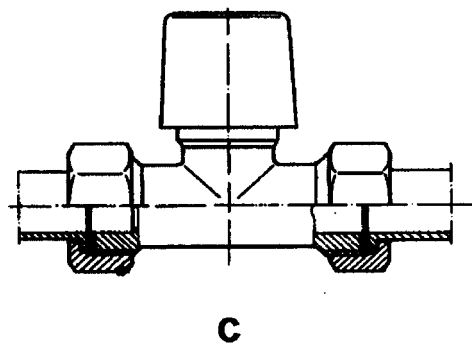
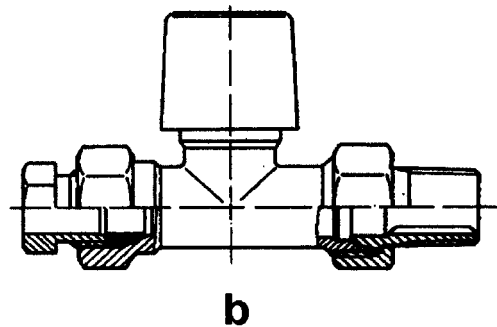
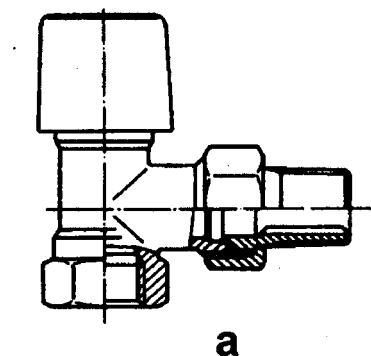


Figure 4a - Internal pipe thread and cone seated union
Figure 4c - Washered union connections

Figure 4b - Compression fitting and cone seated union
Figure 4d - Compression fittings

Figure 4 - Types of radiator valve connections

3.4 operating characteristics

3.4.1 characteristic flow rate ($q_{m\ s}$)

water flow rate that is obtained at a temperature of point S-2K, and at a differential pressure of 10 kPa (0,1 bar), at any desired setting

3.4.2 nominal flow rate ($q_{m\ N}$)

characteristic flow rate for an intermediate setting of the temperature selector according to 6.2.1.2.

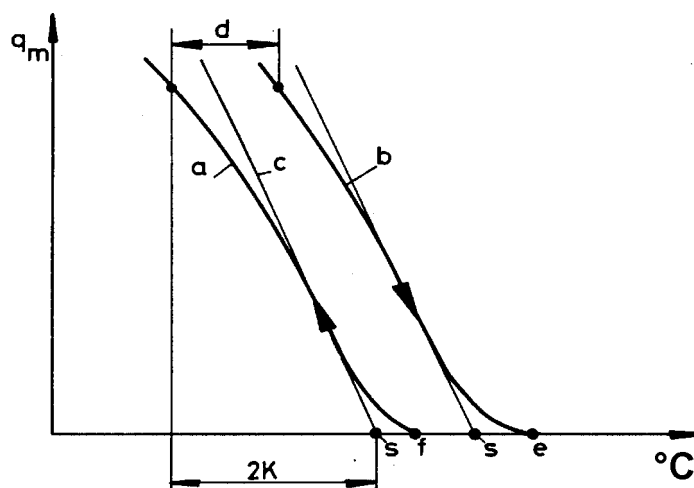
The nominal flow rate for thermostatic valves having a pre-setting facility is that obtained when the pre-setting facility is inoperative.

3.4.3 maximum flow rate ($q_{m\ max}$)

maximum water flow rate that can be obtained at a differential pressure of 10 kPa (0,1 bar)

3.4.4 hysteresis

temperature difference between the opening and closing curves obtained at the same flow rate (Figure 5)



Key

q_m Flow rate
 $^{\circ}\text{C}$ Water bath temperature

a) Opening curve
 b) Closing curve
 c) Theoretical curve
 d) Hysteresis
 e) Closing temperature
 f) Opening temperature
 s) Temperature point S

Figure 5 - Explanatory graph of characteristic curves

3.4.5

differential pressure influence

difference between the temperature points S on the theoretical closing curves obtained at different differential pressures

3.4.6

influence of static pressure

temperature difference between two closing curves plotted at different static pressures at the same flow rate

3.4.7

water temperature effect

difference in sensor temperatures which is equivalent to the flow rate deviation caused by a change of temperature of the water flowing through the valve

3.4.8

influence of ambient temperature on thermostatic valves with transmission elements

temperature difference obtained at the same flow rate between two opening curves, one recorded with and one without temperature difference between sensor and transmission unit (valves according to 3.2.2 to 3.2.4)

3.4.9

response time

time taken for a change of flow rate after a step-change of air temperature.

This change of flow rate corresponds to a pre-determined temperature difference in accordance with 6.4.1.13.

3.5

technical definitions

3.5.1

sensor temperature

measured temperature of the sensor. In the test it is the same as the temperature of the water bath

3.5.2

differential pressure (Δp)

difference of pressure between valve inlet and valve outlet

3.5.3

closing curve and opening curve

curves showing the functions of the water flow versus sensor temperature at constant differential pressure when the valve is closing and opening respectively and at the same temperature selector setting (Figure 5)

3.5.4

closing temperature and opening temperature

sensor temperatures obtained from the closing and opening curves respectively for zero flow (Figure 5)

3.5.5

theoretical curve

straight line which passes through the points $0,5 q_{m\ s}$ and $0,25 q_{m\ s}$ on the characteristic curve and which is constructed according to 6.2.2 (Figure 5)

3.5.6

temperature point S

point of intersection of the theoretical curve with the abscissa $q_m = 0$ according to 6.2.2 (Figure 5).

4 Symbols and abbreviations

Table 1 - Symbols and abbreviations

Symbol	Explanation	Unit
q_m	Flow rate	kg/h
$q_{m\ N}$	Nominal flow rate	kg/h
$q_{m\ s}$	Characteristic flow rate	kg/h
$q_{m\ max}$	Maximum flow rate	kg/h
$q_{m\ s\ max}$	$q_{m\ s}$ at maximum setting of the temperature selector	kg/h
$q_{m\ s\ min}$	$q_{m\ s}$ at minimum setting of the temperature selector	kg/h
$q_{m\ x1},$ $q_{m\ x2}$	Auxiliary flow rates for measuring the response time	kg/h
t_s	Sensor temperature which corresponds to the characteristic flow rate	°C
$t_{s\ max}$	t_s at maximum setting of the temperature selector	°C
$t_{s\ min}$	t_s at minimum setting of the temperature selector	°C
S	Temperature point	°C
Δp	Differential pressure	Pa
K	Temperature difference	Kelvin

5 Requirements

5.1 Dimensions

Dimensions and connection details for different types of radiator valves are given in annex A.

5.2 Mechanical properties

5.2.1 Resistance to pressure, leak-tightness of the valve body assembly

During the test according to 6.3.1 there shall be no leak from the connections nor through the wall of the body.

5.2.2 Leak-tightness of the stem seal

The stem seal shall show no leakage of air during the test according to 6.3.3.

5.2.3 Resistance of the valve body assembly to a bending moment

The valve shall withstand the load according to 6.3.4 without permanent functional impairment, and shall fulfil the requirements of the subsequent tests.

Permanent deformation shall not be taken into account.

5.2.4 Resistance of the temperature selector to a torque

No damage or permanent deformation shall be visible after the test according to 6.3.5.

5.2.5 Resistance of the temperature selector to a bending moment

No damage or permanent deformation shall be visible after the test according to 6.3.6.

5.2.6 Exchange of the stem seal

It shall be possible to exchange the stem seal without draining the heating installation in which the valve is mounted.

5.3 Operating characteristics

5.3.1 Nominal flow rate and flow rate at S-1 K

The nominal flow rate declared by the manufacturer shall not vary by more than 10 % for flow rates > 33 kg/h and by more than 3 kg/h for flow rates = 33 kg/h from the value determined in the test specified in 6.4.1.1.

The plotted flow rate S -1 K shall not be more than 70 % of the nominal flow rate.

5.3.2 Characteristic flow rate at the minimum and maximum setting of the temperature selector

This flow rate $q_{m\ s}$ determined according to 6.4.1.4 shall be within the following ranges:

- at maximum setting: $q_{m\ s\ max} \geq 0,8q_{m\ N}$
- at minimum setting: $1,2q_{m\ N} \geq q_{m\ s\ min} \geq 0,5q_{m\ N}$

5.3.3 Characteristic flow rate for thermostatic valves having a pre-setting facility

For thermostatic valves having a pre-setting facility the characteristic flow rate declared by the manufacturer for an intermediate setting of the temperature selector according to 6.2.1.2 and for each specified pre-setting position, shall not vary by more than the tolerance declared by the manufacturer from the values determined in the test specified in 6.4.1.2.

5.3.4 Change of the flow rate by means of the protection cap

The manufacturer shall indicate how to change a flow rate by means of the protection cap (e.g. setting marks or similar).

The difference in temperature determined according to 6.4.1.6 shall be between 0,8 K and 1,2 K.

5.3.5 Sensor temperature at the minimum and maximum setting of the temperature selector

This sensor temperature t_s determined according to 6.4.1.5 shall be within the following ranges:

- at maximum setting: $t_{s\ max} \leq 32\ ^\circ\text{C}$;
- at minimum setting: $5\ ^\circ\text{C} \leq t_{s\ min} \leq 12\ ^\circ\text{C}$.

5.3.6 Hysteresis at the nominal flow rate

The hysteresis determined according to 6.4.1.7 shall not be greater than 1 K.

5.3.7 Differential pressure influence

The differential pressure influence determined according to 6.4.1.8 shall not be greater than 1 K.

5.3.8 Influence of the static pressure

The influence of the static pressure determined according to 6.4.1.9 shall not be greater than 1 K.

5.3.9 Temperature difference between temperature point S and the closing and opening temperature respectively

The temperature difference between temperature point S and the closing and opening temperature respectively determined according to 6.4.1.10 shall not be greater than 0,8 K.

5.3.10 Influence of ambient temperature on thermostatic valves with transmission elements

The influence of the ambient temperature determined according to 6.4.1.11 shall not be greater than 1,5 K.

5.3.11 Water temperature effect

The effect that is caused by a change of the temperature of the water flowing through the valve of 30 K and which is determined according to 6.4.1.12 shall not be greater than:

- 1,5 K for thermostatic valves with the sensor incorporated according to 3.2.1;
- 0,75 K for thermostatic valves with the transmission elements according to 3.2.2 to 3.2.4.

5.3.12 Response time

The response time determined according to 6.4.1.13 shall not exceed 40 min.

5.4 Endurance and temperature resistance

5.4.1 Mechanical endurance

The values of the sensor temperatures at the nominal flow rate before and after the mechanical endurance test according to 6.4.2.1 shall not vary by more than 2 K.

The nominal flow rate determined after the mechanical endurance test shall not vary by more than ± 20 % from that determined before the endurance test.

5.4.2 Thermal endurance

The values of the sensor temperatures at nominal flow rate before and after the thermal endurance test according to 6.4.2.2 shall not vary by more than 2 K.

The nominal flow rate determined after the thermal endurance test shall not vary by more than ± 20 % from that determined before the endurance test.

5.4.3 Temperature resistance

The values of the sensor temperatures at nominal flow rate before and after the temperature resistance test according to 6.4.2.3 shall not vary by more than 1,5 K.

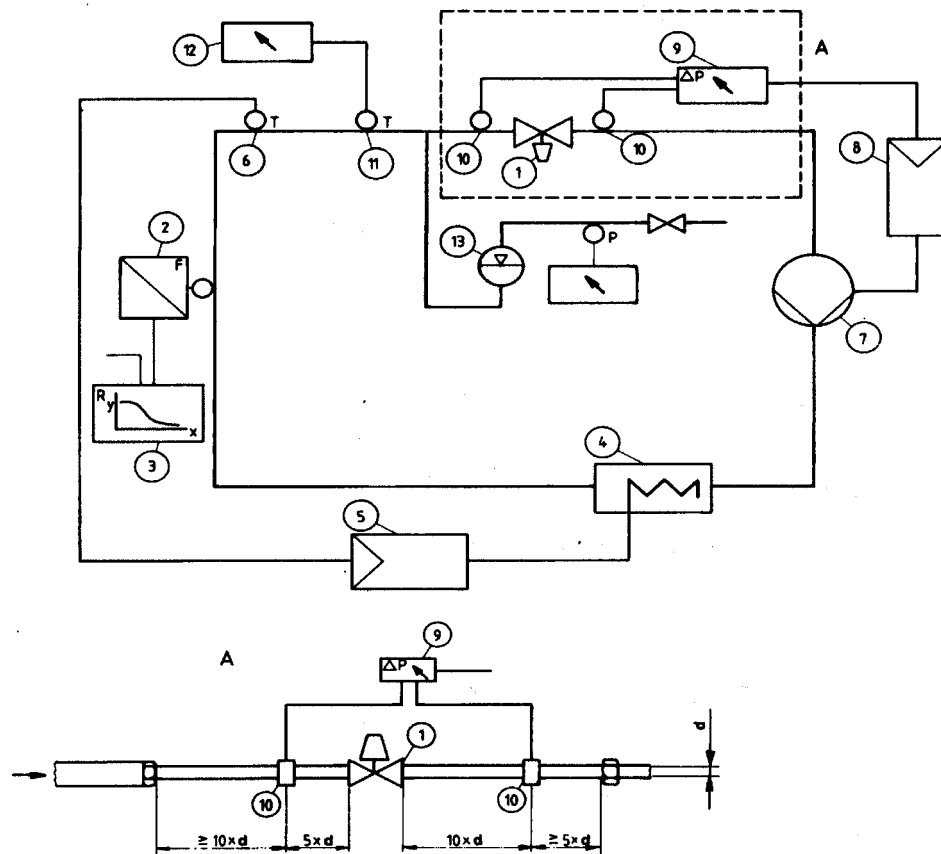
The nominal flow rate determined after the temperature resistance test shall not vary by more than ± 20 % from that determined before the temperature resistance test.

6 Test apparatus and methods

6.1 Test apparatus

6.1.1 Apparatus to obtain the hydraulic data

Use a test circuit with the functions shown in Figure 6 to obtain the hydraulic data of the valve.



Key

- | | |
|----------------------------------|--|
| 1 Test sample | 7 Circulating pump |
| 2 Flow meter F | 8 Differential pressure controller |
| 3 xy recorder R | 9 Differential pressure meter |
| (x = temperature, y = flow rate) | 10 Measuring points for differential pressure |
| 4 Heater | 11 Temperature sensor |
| 5 Temperature controller | 12 Temperature meter |
| 6 Temperature sensor | 13 Device for maintaining the pressure in the system by means of an expansion vessel |

Figure 6 - Schematic layout of the test circuit to obtain the hydraulic data of the thermostatic valve

Table 2 - Dimensional pipe characteristics

Nominal size DN ^a	Pipe thread	Internal diameter <i>d</i> mm
8	1/4	10
10	3/8	10
15	1/2	13
20	3/4	20
25	1	25
^a See EN ISO 6708		

The flow measurement accuracy shall be at least:

- $\pm 3\%$ of the measured value for flow rates > 33 kg/h;
- ± 1 kg/h for flow rates ≤ 33 kg/h.

The pressure differential measurement accuracy shall be at least:

- $\pm 1\%$ of the measured value.

By means of a controller it shall be possible to maintain a differential pressure, when measured across the inlet and outlet pressure tapplings of the test sample, at a value between 10 and 60 kPa (0,1 and 0,6 bar) and constant within $\pm 2\%$. Furthermore, it shall be possible to apply a constant inlet pressure of 100 kPa (1 bar) $\pm 2\%$ or of 1 000 kPa (10 bar) $\pm 2\%$ at the inlet pressure tapping of the sample.

At the inlet of the test circuit there is a water temperature measuring point.

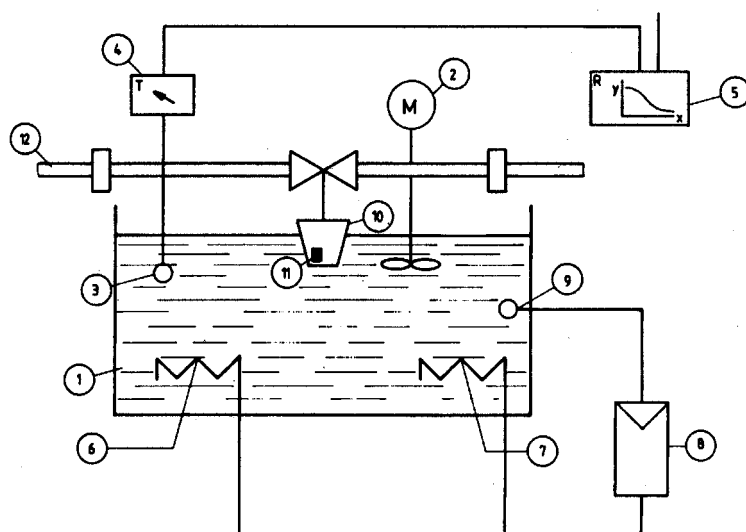
It shall be possible to keep the water temperature constant within $\pm 0,2$ K at a chosen temperature between 50 °C and 80 °C.

6.1.2 Apparatus for testing the thermostatic valve in the water bath

Use a circuit functionally as shown in Figure 7 for testing the thermostatic valve in the water bath. Totally immerse the thermostatic element in the water bath, ensuring that the water is continuously mixed and circulated around the thermostatic element.

It shall be possible to change the temperature smoothly by means of a control device. The rate of change shall be 3 K/h. The temperature of the water bath shall be measured and recorded with an accuracy of $\pm 0,2$ K and the temperature change in the bath with an accuracy of $\pm 0,03$ K.

For the test according to 6.2.1.4, two water baths shall be used.



Key

- | | |
|----------------------------------|---------------------------------------|
| 1 Water bath | 7 Water bath cooler |
| 2 Stirrer | 8 Temperature controller |
| 3 Temperature sensor | 9 Temperature sensor |
| 4 Temperature meter | 10 Thermostatic head assembly |
| 5 xy recorder | 11 Thermostatic element |
| (x = temperature, y = flow rate) | 12 Test circuit according to Figure 6 |
| 6 Water bath heater | |

Figure 7 - Schematic layout of the test apparatus for the water bath

6.1.3 Apparatus for testing the thermostatic valve in the air stream

Use a testing equipment consisting of two air ducts, each having a symmetrical cross sectional area of at least 0,36 m² (Figure 8). The thermostatic valve shall be placed in the centre of one duct with the axis of the thermostatic head with integral sensor mounted in a horizontal position, unless otherwise specified by the manufacturer. Thermostatic valves with transmission elements in accordance with 3.2.2 to 3.2.4 shall be mounted in a position as declared by the manufacturer.

Air shall pass across the thermostatic valve in an upward direction. A device shall effect rapid transfer of the thermostatic valve from one duct to the other.

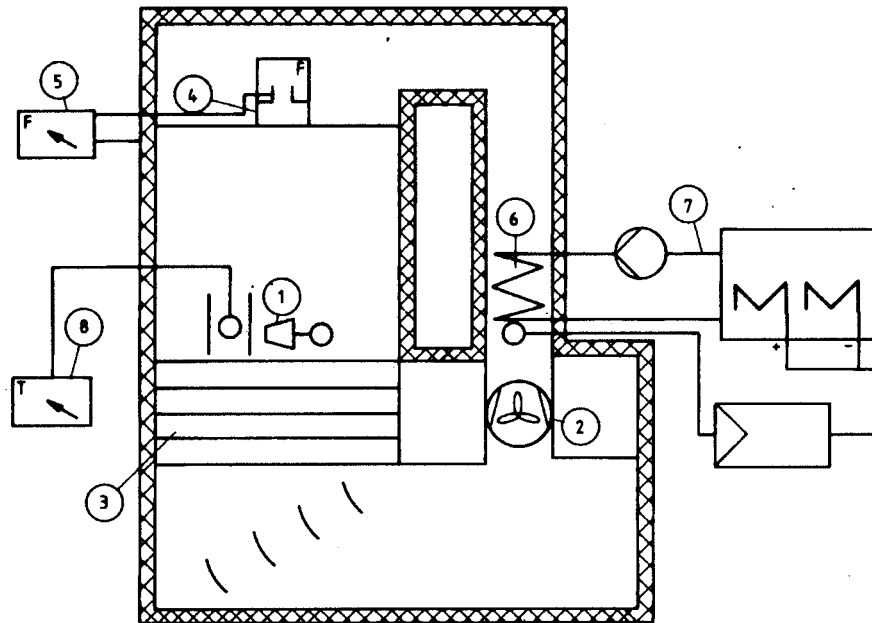
The inside wall of the measuring duct shall be protected against radiated heat. The temperature and velocity profiles in the duct at test level shall be uniform over at least 80 % of the cross section. During the test, the air stream shall be controlled by a measuring device having an adequate measuring accuracy. The air temperature shall be maintained constant to $\pm 0,1$ K.

The connection pipes shall not be in the air stream in front of the test sample. They shall be thermally insulated.

The air temperature change shall be measured with a maximum uncertainty of measurement of $\pm 0,03$ K. The temperature sensor shall be insulated against radiation.

The airflow shall be turbulent. The air velocity, shall be adjusted to obtain a mean velocity of $0,1 \text{ m/s}^{+0,05}_0 \text{ m/s}$.

The standard deviation, calculated from velocity variations, by statistical methods and compared to the mean value, or the degree of turbulence, shall be within 30 % to 50 % (see annex B).



Key

- 1 Test sample
- 2 Fan
- 3 Duct installations for obtaining a smooth flow profile and for generating turbulence
- 4 Calibrated venturi
- 5 Differential pressure gauge F
- 6 Heat exchanger
- 7 Temperature controlled water circuit
- 8 Temperature meter

Figure 8 - Schematic layout of the air test apparatus

6.2 Characteristic curves of thermostatic valves

6.2.1 Determination of the characteristic curves

Use the curves 1 to 7 according to Figure 9 for the assessment of the performance of thermostatic valves.

These curves are plotted using the test apparatus as described in 6.1.1 and 6.1.2.

Unless specified differently in the following clauses, the measurements shall be carried out with a static pressure at the inlet of the valve of $100 \text{ kPa (1 bar)} \pm 10 \%$ and with a differential pressure of $10 \text{ kPa (0,1 bar)} \pm 2 \%$. The temperature of the water flowing through the thermostatic valve shall be maintained at $50 \text{ }^\circ\text{C} \pm 2 \text{ }^\circ\text{C}$. The water bath temperature shall not vary by more than 3 K/h .

For all the characteristic curves which are measured at an intermediate setting of the temperature selector, this intermediate setting shall be obtained in the closing direction.

6.2.1.1 Opening curve at minimum setting of the temperature selector (curve no. 1) and at maximum setting (curve no. 2)

Adjust to the minimum setting. Starting with a temperature of at least 2 K above the opening temperature, decrease the sensor temperature to 3 K below the opening temperature and plot the opening curve. Now adjust to the maximum setting and repeat the procedure given for the minimum setting above.

6.2.1.2 Opening curve at an intermediate setting of the temperature selector (curve no. 3)

Choose a mean setting of the temperature selector for which the opening temperature on the opening curve is between 20 °C and 24 °C. Start with a temperature of at least 2 K above the opening temperature. Decrease the sensor temperature to 6 K below the opening temperature and plot the opening curve.

6.2.1.3 Closing curve at an intermediate setting of the temperature selector (curve no. 4)

The setting of the temperature selector remaining unchanged, start from a temperature of at least 4 K below the opening temperature. Increase the sensor temperature up to 1 K above the closing temperature and plot the closing curve.

6.2.1.4 Opening curve for thermostatic valves with transmission elements in accordance with 3.2.2 to 3.2.4 at an intermediate setting of the temperature selector (curve no. 5).

The setting of the temperature selector remaining unchanged, immerse the transmission unit with 1 m of its transmission element in a second water bath. This shall be at a constant temperature of $10\text{ K} \pm 0,1\text{ K}$ above that sensor temperature, at which the nominal flow rate is obtained. The remainder of the transmission element, the sensor, and for thermostatic valves according to 3.2.4 the remote temperature selector as well shall be immersed in the first water bath.

Starting with the temperature of at least 2 K above the opening temperature, decrease the sensor temperature to 3 K below the opening temperature and plot the opening curve.

6.2.1.5 Closing curve at an intermediate setting of the temperature selector and at a differential pressure greater than 10 kPa (0,1 bar) (curve no. 6)

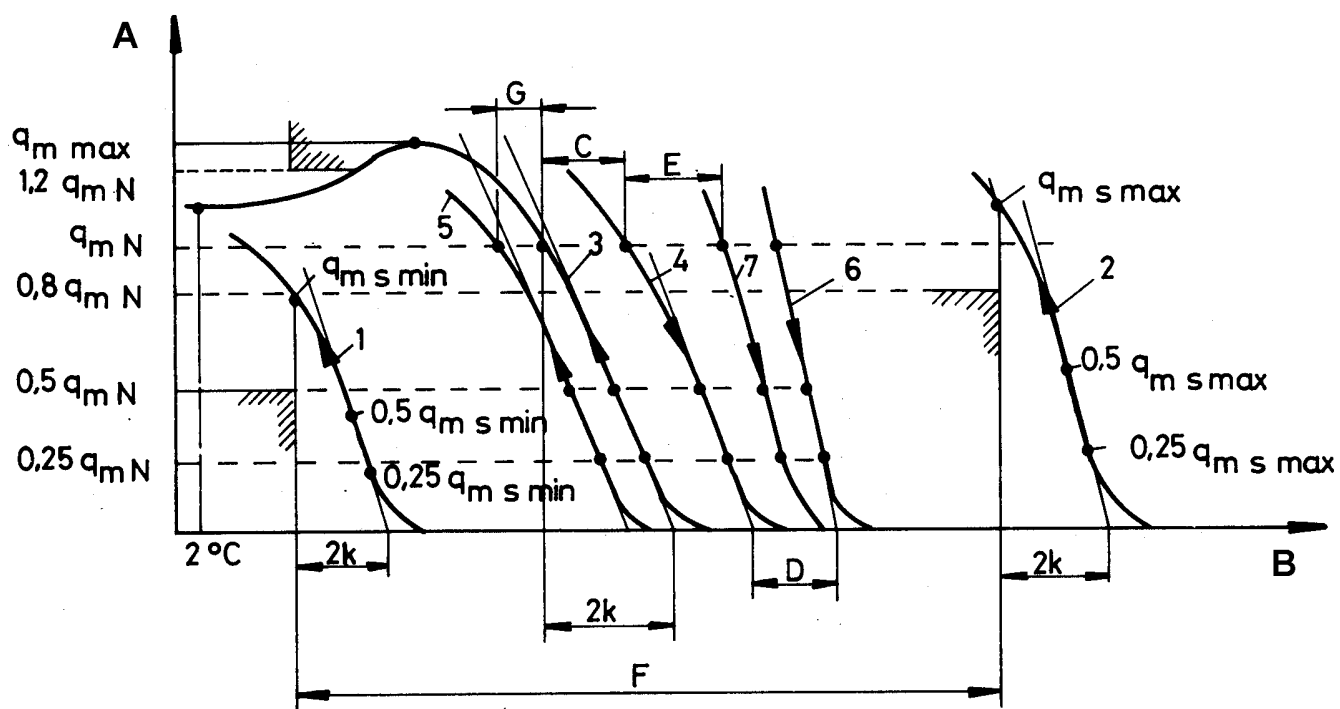
For thermostatic valves with integral sensor, plot the closing curve at a differential pressure of 60 kPa (0,6 bar) $\pm 2\%$ immediately after the measurement as described in 6.2.1.3 and in the same way.

For thermostatic valves with transmission elements according to 3.2.2 to 3.2.4, plot the same curve after the measurement as described in 6.2.1.4.

If the maximum permissible differential pressure declared by the manufacturer is less than 60 kPa (0,6 bar), the test shall be carried out at that differential pressure.

6.2.1.6 Closing curve at an intermediate setting of the temperature selector and at a static pressure of 1000 kPa (10 bar) (curve no. 7)

In the same way as described in 6.2.1.3 and immediately after the measurement described in 6.2.1.5, plot the closing curve at a static pressure of 1000 kPa (10 bar) $\pm 2\%$.



Key

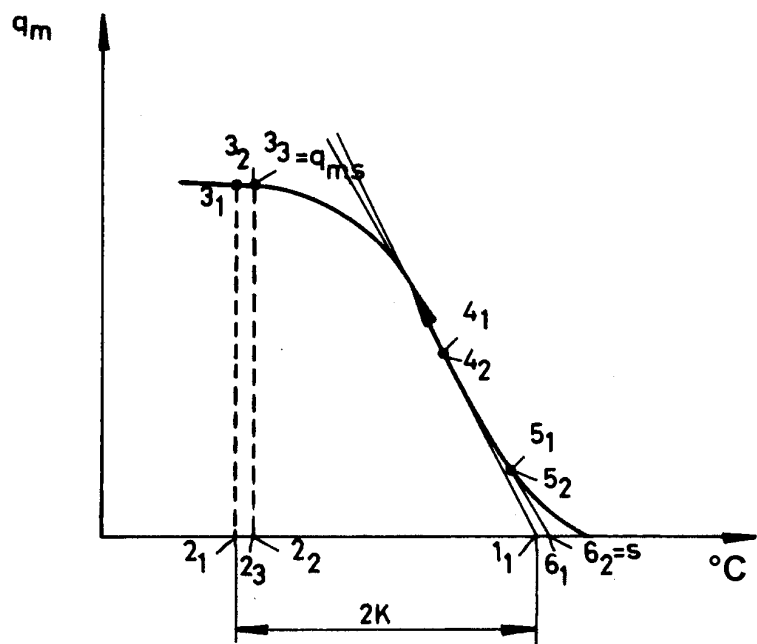
- A Flow rate, q_m
- B Water bath temperature, °C
- C Hysteresis
- D Differential pressure effect
- E Effect of the static pressure
- F Difference of sensor temperatures at minimum and maximum setting
- G Influence of ambient temperature on thermostatic valves with transmission elements

Figure 9 - Characteristic curves of thermostatic valves

6.2.2 Plotting of the theoretical curve

This procedure is used for any plotted opening and closing curve. It is effected by the following iterative steps (see Figure 10):

- 1) The linear part of the curve is extended to meet the abscissa $q_m = 0$ (point 1_1) or the tangent is drawn through the point of inflexion;
- 2) At a temperature of 2 K below the intersection (point 1_1) point 2_1 is obtained and the corresponding water flow rate (point 3_1) is determined;
- 3) Point 4_1 is obtained at 50 % and point 5_1 at 25 % of the water flow rate at point 3_1 ;
- 4) Join point 4_1 and 5_1 and continue to cut the abscissa ($q_m = 0$) at point 6_1 ;
- 5) Repeat the process starting from point 6_1 until further repetition does not result in a shift in point 6; this final point is designated by S;
- 6) The water flow rate at a temperature 2 K lower is $q_{m s}$;
- 7) The line through the final points of 50 % and of 25 % of $q_{m s}$ on the characteristic curve and S on the abscissa is the theoretical curve.



Key

- q_m Flow rate
- $^{\circ}\text{C}$ Water bath temperature

Figure 10 - Plotting of the theoretical curve and of point S

6.3 Testing of mechanical properties

6.3.1 Resistance to pressure, leak-tightness of the valve body assembly

The test shall be carried out as shown in Figure 11.

Tighten the union nut of the tailpiece piece for the connection to the radiator (cone seated union shown in Figure 4) with a torque given in Table 3 and shut the valve on the radiator side. The tightening torque for other connections shall be according to the manufacturer's instructions.

Subject the valve in the open position, to a static water pressure of the next higher nominal pressure (see ISO 7268), compared to the nominal pressure of the valve body assembly. The temperature of the water shall be $20\text{ }^{\circ}\text{C} \pm 10\text{ }^{\circ}\text{C}$. Check after 1 min whether water leaks from the connections or through the wall of the body.

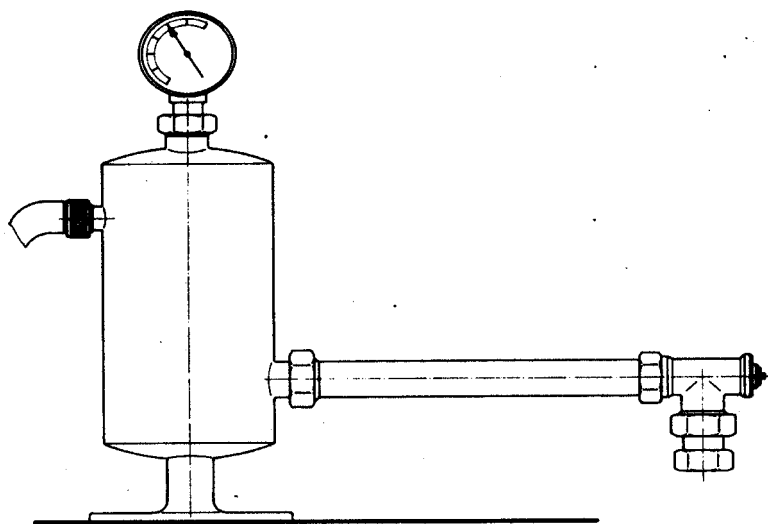


Figure 11 - Testing of pressure resistance of the valve body

Table 3 - Tightening torques for the tailpiece nut

Nominal size ^a	Size of thread	Tightening torque in Nm
15 mm copper tube fitting		40
DN 8	1/4	40
DN 10	3/8	40
DN 15	1/2	60
DN 20	3/4	80
DN 25	1	100
^a See EN ISO 6708.		

6.3.2 Leak-tightness of the valve closed mechanically by means of the protection cap.

This test shall be carried out only if the manufacturer declares that the valve can be shut-off by means of the protection cap against a pressure, which he declares.

Mount the valve body assembly in the test apparatus shown in Figure 11 so that it remains open on the radiator side. Shut the valve by means of the protection cap. Apply a static water pressure equal to the pressure declared by the manufacturer. The temperature of the water shall be $20\text{ °C} \pm 10\text{ °C}$. Check after 1 min whether water has escaped past the valve disc.

6.3.3 Leak-tightness of the stem seal

The test shall be carried out as shown in Figure 12. The valve shall be blanked off on the radiator side and immersed in water. Apply an air pressure of $20\text{ kPa (0,2 bar)} \pm 10\%$. After 1 min operate the stem 5 times. Check the leak-tightness of the stem seal.

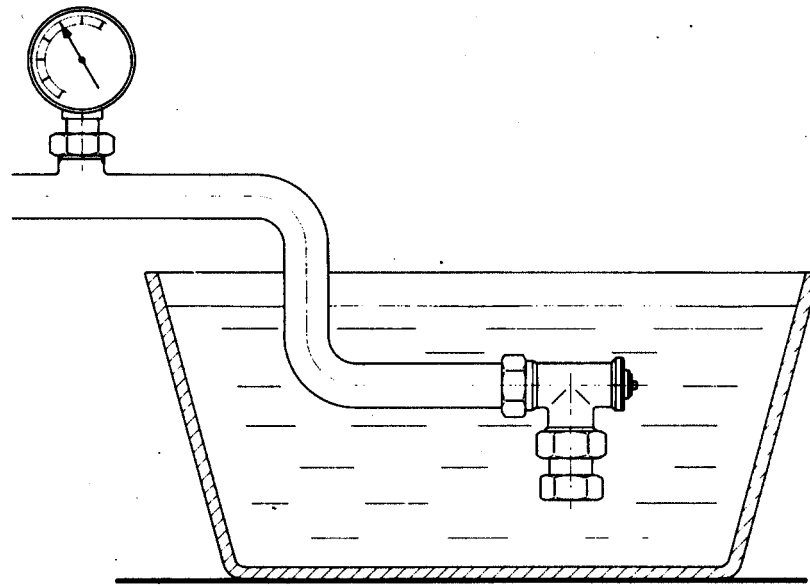


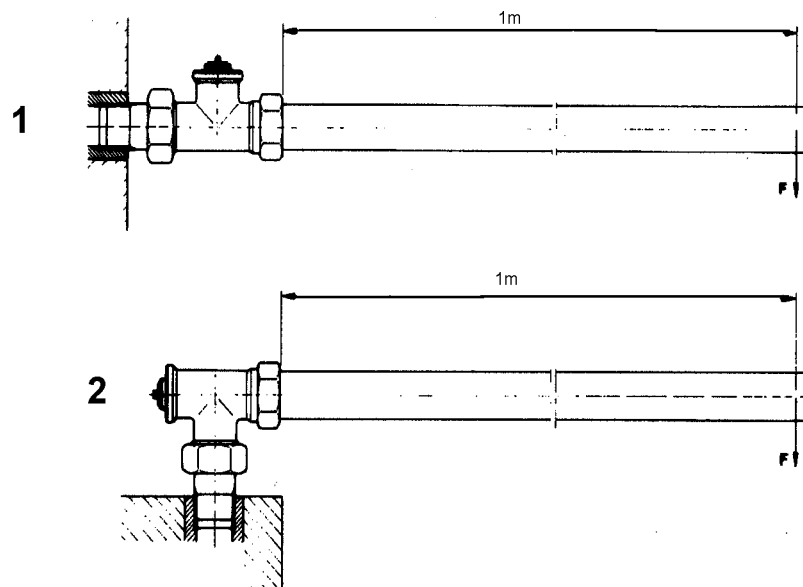
Figure 12 - Testing of leak-tightness of the stem seal

6.3.4 Resistance of the valve body assembly to a bending moment

The test shall be carried out as shown in Figure 13. Tighten the union nut of the tailpiece piece according to Table 3. Apply a force F at the end of the pipe and perpendicular to its axis for 30 s. F shall result in a bending moment as specified in Table 4.

After this test, check the leak tightness by the method specified in 6.3.1.

Permanent deformation shall not be taken into account.



Key

- 1 Straight-through valves
- 2 Right-angle valves

Figure 13 - Testing of bending strength of the valve body assembly

Table 4 - Bending moments for testing thermostatic valves

Nominal size ^a	Size of thread	Bending moment in Nm
15 mm copper tube fitting		20
DN 8	1/4	80
DN 10	3/8	100
DN 15	1/2	120
DN 20	3/4	180
DN 25	1	220
^a See EN ISO 6708.		

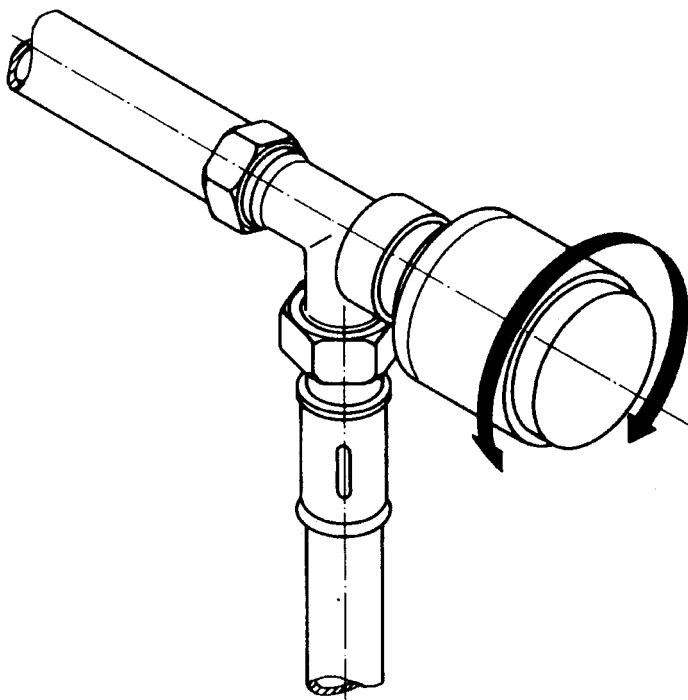
6.3.5 Resistance of the temperature selector to a torque

The test shall be carried out as shown in Figure 14 with water at a temperature of $90\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ and a static pressure of 100 kPa (1 bar) flowing through the valve body assembly. After a period of at least 20 min for thermal equilibrium to be reached, set the temperature selector at the minimum stop position. Apply for 30 s a force that results in a torque of 8 Nm without any transverse force in the direction of the stop.

Finally, the temperature selector is set to the maximum stop position and the test is carried out accordingly.

Remote selectors according to 3.2.3 and 3.2.4 shall be set following the manufacturer's instructions. The water temperature is not important.

After the test, check whether a damage occurred (breakage, cracking, permanent deformation).

**Figure 14 - Testing of resistance of the temperature selector to a torque**

6.3.6 Resistance of the temperature selector to a bending moment

The test shall be carried out as shown in Figure 15 with water at a temperature of $90\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ and a static pressure of 100 kPa (1 bar) flowing through the valve body assembly. A period of at least 20 min is necessary to reach thermal equilibrium. After this apply a force $F = 250\text{ N}$ for 30 s on the temperature selector perpendicularly to its axis. Apply the force at a distance of 10 mm from the most remote edge of the temperature selector by means of a strap of 20 mm width.

Remote selectors complying with 3.2.3 and 3.2.4 shall be fixed according to the manufacturer's instructions. The water temperature is not important.

After the test, check whether any damage occurred (breakage, cracking, permanent deformation).

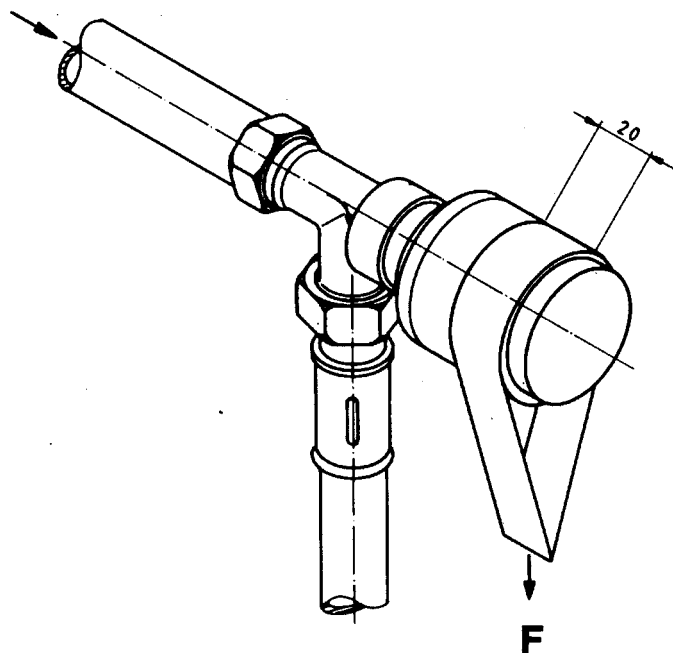


Figure 15 - Testing of resistance of the temperature selector to a bending moment

6.4 Testing of operating characteristics

6.4.1 Characteristic data

Use the characteristic curves plotted as described in 6.2 for the determination of the characteristic data.

6.4.1.1 Nominal flow rate and flow rate at S-1 K

Plot point S according to the method described in 6.2.2. The flow rates at S-2 K and S-1 K, are obtained on curve no. 3 (Figure 9). The flow rate at S-2 K corresponds to the nominal flow rate.

6.4.1.2 Characteristic flow rate for thermostatic valves with pre-setting

For thermostatic valves with pre-setting, plot curve no. 3 (Figure 9) for each specified pre-setting position. If there are more than 3 specified pre-setting positions, the test shall be carried out only at the lowest, highest and one pre-setting position selected by the test laboratory.

The flow rate at S-2 K is obtained. This flow rate represents the characteristic flow rate.

6.4.1.3 Maximum flow rate

Measure the flow rate at an intermediate setting of the temperature selector with the sensor held at $2^{\circ}\text{C} \pm 1^{\circ}\text{C}$ and with a differential pressure of 10 kPa (0,1 bar) $\pm 2\%$.

Afterwards compare the largest flow rate obtained on curve no. 3 (Figure 9) with that as determined above.

The larger of the two is the maximum flow rate.

6.4.1.4 Characteristic flow rate at the minimum and maximum setting

Use the method described in 6.2.2. The flow rate at S-2 K ($q_{m\ s\ min}$ and $q_{m\ s\ max}$) is obtained from curves 1 and 2 (Figure 9).

6.4.1.5 Sensor temperature at minimum and maximum setting of the temperature selector

The sensor temperatures referring to the flow rates $q_{m\ s\ min}$ and $q_{m\ s\ max}$ shall be obtained from curves 1 and 2 (Figure 9).

6.4.1.6 Change of the flow rate by means of the protection cap

Replace the thermostatic head assembly by the protection cap. Adjust the flow rate between 0,9 and 1,2 times the nominal flow rate at 10 kPa (0,1 bar) differential pressure. The flow rate shall always be adjusted in the closing direction. Mark the corresponding setting. Then make an adjustment equivalent to decreasing the temperature 1 K in accordance with the manufacturer's instructions and measure the resulting flow rate. Determine the values of temperatures of the sensor for these 2 flow rates from curve no. 4 (Figure 9).

Determine the difference in temperatures in Kelvin.

6.4.1.7 Hysteresis at nominal flow rate

The hysteresis is represented as the difference of the temperatures in Kelvin at a nominal flow rate between the opening and closing curves (3 and 4 in Figure 9) obtained immediately one after the other.

6.4.1.8 Differential pressure influence

The differential pressure influence is represented as the distance between the temperature points S in Kelvin of the theoretical closing curves 4 and 6 in Figure 9.

6.4.1.9 Influence of the static pressure

The influence of the static pressure is represented as the temperature difference in Kelvin between the closing curves 4 and 7 in Figure 9 for the nominal flow rate.

6.4.1.10 Temperature difference between temperature point S and the closing and opening temperature respectively

Record the difference in Kelvin between the respective temperature points S and the temperature for valve closing (e) and for valve opening (f) from the characteristic curves as shown in Figure 5.

6.4.1.11 Influence of ambient temperature on thermostatic valves with transmission elements

The influence of the ambient temperature is represented as the temperature difference in Kelvin between the opening curves 3 and 5 in Figure 9 for the nominal flow rate.

6.4.1.12 Water temperature influence

The test shall be carried out in an apparatus as described in 6.1.1 and 6.1.3 without any change of the temperature selector setting.

The air temperature shall be decreased by at least 6 K below the closing temperature. Then, the air temperature shall be increased until the water flow rate through the valve has reached 0,9 to 1,2 times of the nominal flow rate in equilibrium condition. The water flow rate is then measured and recorded on closing curve no. 4.

Increase the water temperature to at least 70°C and wait for equilibrium condition. During that time the air temperature shall not drop but may increase by 0,2 K maximum. The water flow rate shall be measured and recorded on closing curve no. 4 as well (Figure 16).

It shall be at least 0,1 times of the nominal flow rate, otherwise the measurement shall be repeated with smaller water temperature increase.

With the temperature difference between points $t_2 - t_1$, which can be obtained from the closing curve, and with the air temperature increase Δt_L , the effect of the water temperature is obtained according to the following formula:

Water temperature effect in Kelvin: $30 \text{ K} \cdot \frac{t_2 - t_1 - \Delta t_L}{\Delta t_W}$

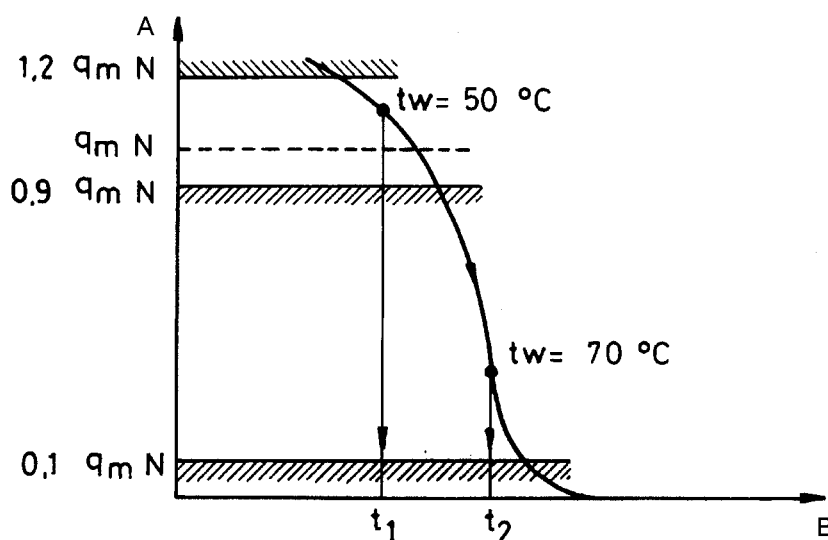
where:

t_1 is the temperature read on the closing curve at low water temperature

t_2 is the temperature read on the closing curve at increased water temperature

Δt_L is the increase of the air temperature

Δt_W is the increase of the water temperature.



Key

A Flow rate q_m

B Water bath temperature

$t_w = 50\text{ °C}$ is an example

Figure 16 - Plotting of the water temperature effect on closing curve no. 4

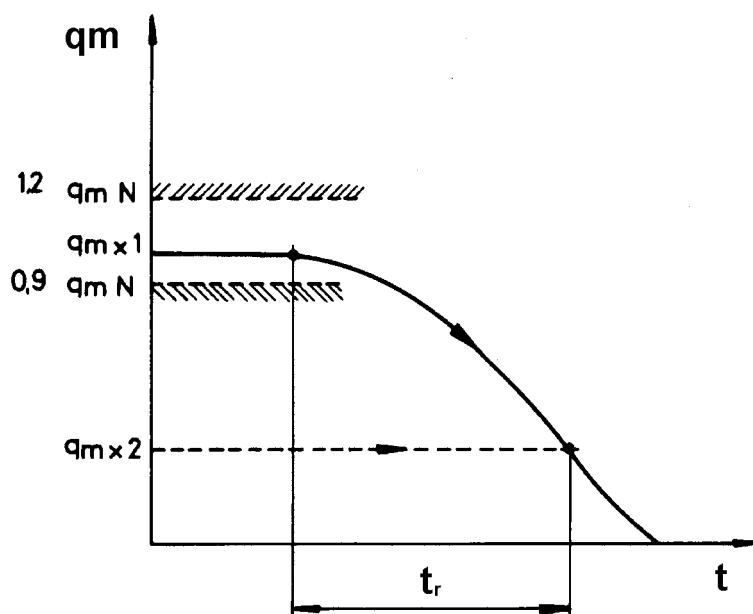
6.4.1.13 Response time

The test shall be carried out in an apparatus according to 6.1.1 and 6.1.3 without any change of the temperature selector setting.

Starting with a temperature of 6 K below the closing temperature, increase the air temperature until a flow rate $q_{m\ x1}$ (Figure 17) is reached. This should be between 0,9 to 1,2 times of the nominal flow rate. Wait for the equilibrium condition.

Insert the point $q_{m\ x1}$ in the closing curve no. 4 (Figure 9) and add 1,5 K to the temperature which corresponds to this point. Read the corresponding new flow rate $q_{m\ x2}$ on the closing curve no. 4 (Figure 9).

Then, increase the air temperature with a step change of $3\text{ K}^{+0,2}_0$ K and measure the time taken for the water flow rate $q_{m\ x2}$ to be obtained (Figure 17).



Key

q_m Flow rate
 t Time
 t_r Response time

Figure 17 - Plotting of response time

6.4.2 Endurance tests and temperature resistance test

6.4.2.1 Mechanical endurance test

Before this test, plot the curve no. 3 (Figure 9) and mark the temperature selector setting. Then, mount the valve in a device supplied with water at $90\text{ °C} \pm 2\text{ °C}$ and with a static pressure of 100 kPa (1 bar). The differential pressure shall be adjusted to 60 kPa (0,6 bar) $\pm 2\%$ at the closed position of the valve. Operate the temperature selector for 5 000 cycles. The time taken for one turn shall be approximately 10 s, and the temperature selector shall not quite touch the mechanical stop. There shall be a waiting period of 5 s at each reversal of rotation. The temperature at the sensor shall be such that complete opening and closing can be achieved.

After the mechanical endurance test the thermostatic valve shall be stored at least 24 h in the open position, at ambient temperature.

After this test, readjust the temperature selector to the marked setting and plot the characteristic curve no. 3 (Figure 9) again. Establish the nominal flow rate and the sensor temperature at nominal flow rate obtained both before and after the endurance test.

6.4.2.2 Thermal endurance test

Before this test, plot the curve no. 3 (Figure 9). Do not change the setting of the temperature selector throughout the whole test. Then, mount the valve in a device that permits immersion of the thermostatic head assembly 5 000 times alternately in 2 water baths at temperatures of $15\text{ °C} \pm 1\text{ °C}$ and $25\text{ °C} \pm 1\text{ °C}$ respectively. The water of the baths shall contain no additives not expressively permitted by the manufacturer. No water shall flow through the valve. The thermostatic head assembly shall remain in each bath for at least 30 s.

Make sure that the thermostatic valve closes completely during its immersion in the water bath at 25 °C and opens at least as far as to obtain the nominal flow rate in the water bath at 15 °C . Otherwise, the time shall be prolonged.

After the thermal endurance test the thermostatic valve shall be stored for at least 24 h in the open position at ambient temperature.

After the test, plot the characteristic curve no. 3 (Figure 9) once more. Establish the nominal flow rate and sensor temperature at nominal flow rate obtained before and after the endurance test.

6.4.2.3 Temperature resistance test

Before this test, plot the curve no. 3 (Figure 9) and mark the temperature selector setting. Afterwards, reset the temperature selector to the dispatch-position, and repack the thermostatic valve either as a complete valve or separately according to the manufacturer's method of packing. The packaged valve shall then be held in still air at a temperature of -20 °C for 6 h and then at 50 °C for 6 h. Afterwards, assemble the complete thermostatic valve and expose it to a temperature of 40 °C for 6 h at the minimum setting.

After the test the thermostatic valve shall be stored at least 24 h in the open position at ambient temperature.

Hence, adjust the selector to the marked setting of the temperature selector and plot the characteristic curve no. 3 (Figure 9) once more. Establish the nominal flow rate and the sensor temperature at nominal flow rate obtained before and after the temperature resistance test.

6.5 Test schedule

Table 5 specifies the sequence of the different tests to be followed and the required numbers of test samples for a complete test of a thermostatic valve as described in 6.3 and 6.4.

Use the same test samples throughout each test series.

Test series A.1 to A.4 relate to thermostatic angle valves DN 15 with an integral sensor.

Test series B relates to thermostatic valves with flow rates, form and nominal size different from the series A.

Test series C relates to thermostatic right-angle valves DN 15 with remote sensor or remote selector as specified in 3.2.2 to 3.2.4. This applies if the nominal flow rates determined do not vary by more than $\pm 15\%$ from the manufacturer's declaration for thermostatic valves with integral sensor. Otherwise the complete test series A.1 to A.4 shall be carried out for such valves.

Table 5 - Test schedule

Clause number	Test sequence	Number of test samples for test series no.					
		A.1	A.2	A.3	A.4	B	C
6.3.4	Resistance of the valve body assembly to a bending moment				1	1	
6.3.1	Resistance to pressure, leak-tightness of the valve body assembly				1	1	
6.3.5	Resistance of the temperature selector to a torque	3					1
6.3.6	Resistance of the temperature selector to a bending moment	3					1
6.4.1.3	Maximum flow rate	3				1	1
6.2.1.1	Opening curve at minimum setting of the temperature selector (curve no. 1)	3					1
6.2.1.1	Opening curve at maximum setting of the temperature selector (curve no. 2)	3					1
6.2.1.2	Opening curve at an intermediate setting of the temperature selector (curve no. 3)	3 ^a	1	1	1	1 ^a	1 ^a
6.2.1.3	Closing curve at an intermediate setting of the temperature selector (curve no. 4)	3				1	2
6.2.1.4	Opening curve for thermostatic valves with transmission elements in accordance with 3.2.2 to 3.2.4 at an intermediate setting of the temperature selector (curve no. 5)	3					1
6.2.1.5	Closing curve at an intermediate setting of the temperature selector and at a differential pressure greater than 10 kPa (curve no. 6)	3				1	1
6.2.1.6	Closing curve at an intermediate setting of the temperature selector and at a static pressure of 1 000 kPa (curve no. 7)	3					1
6.4.1.6	Change of the flow rate by means of the protection cap	3				1	1
6.4.1.12	Water temperature effect	2					2
6.4.1.13	Response time	2					2
6.4.2.3	Temperature resistance test		1				
6.4.2.1	Mechanical endurance test			1			
6.4.2.2	Thermal endurance test				1		
6.2.1.2	Opening curve at an intermediate setting of the temperature selector (curve no. 3)		1	1	1		
6.3.3	Leak-tightness of the stem seal			1			
6.3.2	Leak-tightness of the valve closed mechanically by means of the protection cap ^b				1	1	
^a For thermostatic valves having a pre-setting facility test at those pre-setting positions specified in 6.4.1.2.							
^b Only if declared by the manufacturer.							

7 Technical information to be published in the manufacturer's instruction for installation and operation

At least the following information shall be made available by the manufacturer:

- minimum setting of the temperature selector and its mark;
- maximum admissible static pressure;
- maximum admissible differential pressure;
- nominal flow rate q_m N;
- for thermostatic valves with pre-setting facilities;
 - a) indication of pre-setting positions and of the adjoined characteristic flow rates according to 5.3.3;
 - b) tolerances for the characteristic flow rates at the defined pre-setting positions;
- maximum admissible heating water temperature if less than 120°C
- a diagram of the differential pressure Δp as a function of the flow rate q_m ($\Delta p = f(q_m)$) with at least 2 curves for flow rates at S-1 K and S-2 K, as a function of different differential pressures at an intermediate setting of the temperature selector (Figure 18). For thermostatic valves with pre-setting facilities these curves shall be given for every specified pre-setting position.

In addition the curve $\Delta p = f(q_m)$ shall be indicated which shows the differential pressure as a function of the flow rate without the pressure drop across the valve seat. Normally this can be determined by the measurement of the maximum flow rate (except for valves having a limited lift or similar valves or valves with a shaped valve disc).

- seat authority a at nominal flow rate or at characteristic flow rate for valves with pre-setting, where

$$a = \frac{\Delta p_1 - \Delta p_2}{\Delta p_1}$$

$$\Delta p_1 = 10 \text{ kPa (0,1 bar)}$$

Δp_2 is the differential pressure at nominal flow rate without pressure drop across the valve seat.

Authority a shall also be indicated for each specified pre-setting position in case of valves having a pre-setting facility;

- use of the protection cap.

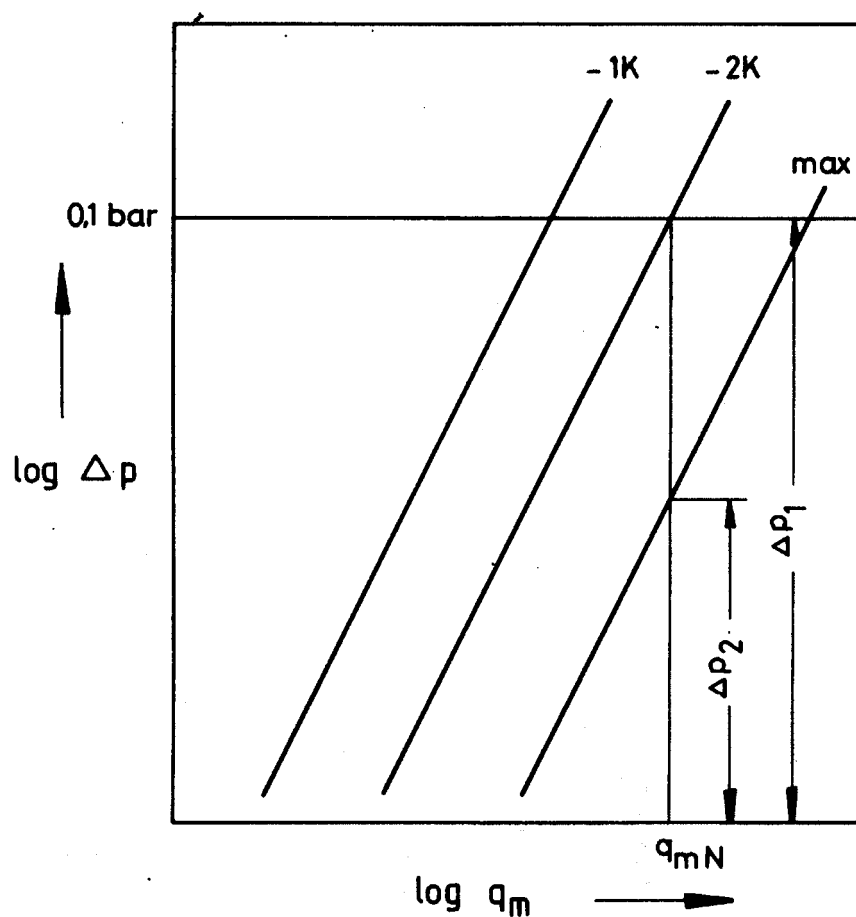


Figure 18 - Differential pressure Δp as a function of the flow rate q_m

Annex A (normative)

Thermostatic Radiator Valves Dimensions and details on connection

A.1 General

This annex A specifies the dimensions, the materials and the connection details of four series of straight and angle pattern thermostatic radiator valves of nominal pressure $\leq$ PN 10.

A.2 Dimensions

See Tables A.1 to A.4

All dimensions in millimetres.

Figures are for reference of dimensions only and do not indicate design details.

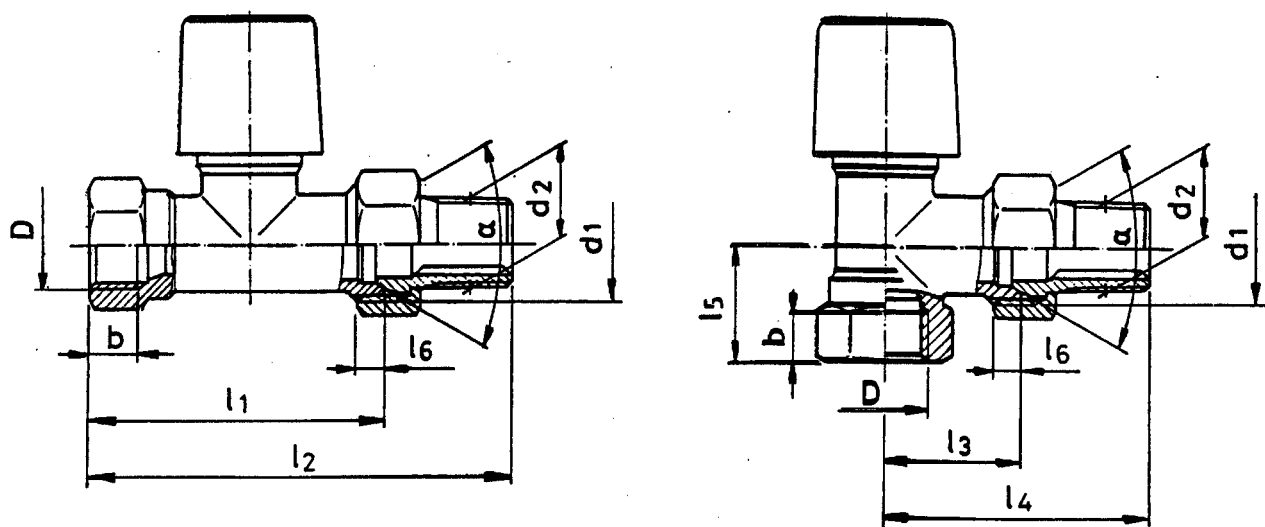


Figure A.1 - Straight and angle valves, series D and F

Table A.1 - Series D

DN	D	b min.	d ₁	d ₂	l ₁ ± 2	l ₂ ± 2	l ₃ ± 1	l ₄ ± 1,5	l ₅ ± 1,5	l ₆ min.	α ± 10°
10	Rp3/8	10,1	G 5/8	R 3/8	59	85	26	52	22	6	
15	Rp1/2	13,2	G 3/4	R 1/2	66	95	29	58	26	7	70°
20	Rp3/4	14,5	G 1	R 3/4	74	106	34	66	29	8	

Table A.3 - Series S

Technical drawings of two types of valves:

- a) Valve with a handle:** Shows side and front views. Dimensions include: U (height of handle), b (width of handle base), l_1 (distance from handle base to valve body), l_2 (total length), l_6 (length of valve body), f (width of valve body), e (height of valve body), d_1 (outer diameter), d_2 (inner diameter), and α (angle of valve body).
- b) Valve with a knob:** Shows side and front views. Dimensions include: l_5 (height of knob), b (width of knob base), l_3 (distance from knob base to valve body), l_4 (total length), l_6 (length of valve body), d_3 (height of valve body), f (width of valve body), e (height of valve body), d_1 (outer diameter), d_2 (inner diameter), and α (angle of valve body).

Table A.3 - Series S

DN	D	b	d ₁	d ₂	e		f	l ₁	l ₂	l ₃	l ₄	l ₅	l ₆	l ₇	d ₃	α
		min.			min.	max.	min.	±1	±2	±1	±2	±1	+2 -0,5	min.	±0.2	
10	Rp/G 3/8	8,5	M22x1,5	R 3/8	4,5	6,5	2,5	50	75	23	48	20	6	3,5	17	1:1,5 (37°)
15	Rp/G 1/2	10,5	M26x1,5	R 1/2	5,5	8,5	3,0	58	88	26	56	24	7	3,5	21	
20	Rp/G 3/4	12,0	M34x1,5	R 3/4	6,5	9,5	3,0	68	102	31	65	28	8	4,0	27	

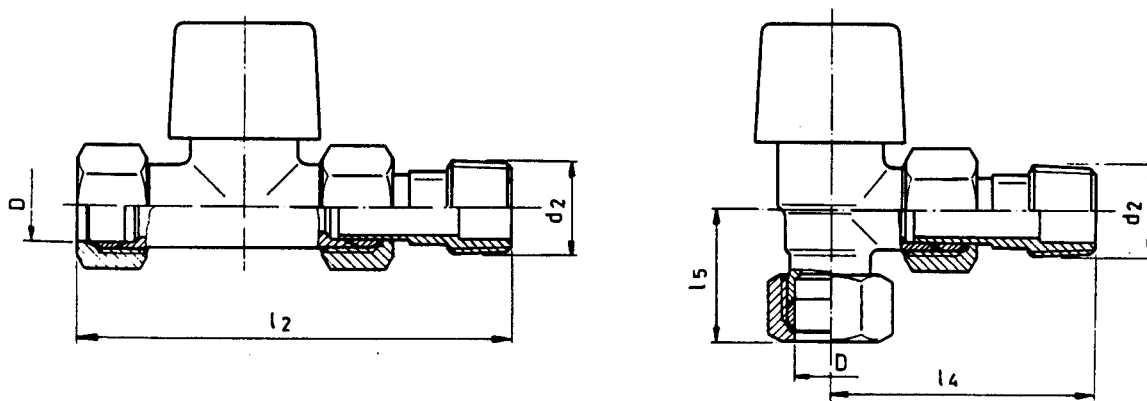


Figure A.3 - Straight and angle valves, series GB

Table A.4 - Series GB. With Olive-type compression fitting

DN	d_2	l_2	l_4	l_5
		± 2	± 2	± 2
15	R 1/2	105	60	30

A.3 Connection details

Sealing between valve body and tailpiece (series D, F and S) is obtained by use of cone/ball joint, where female body part end is tapered and male tailpiece end is spherical.

For series D, F and GB:

Threads: D and d_2 according to ISO 7-1

Threads: d_1 according to EN ISO 228-1

For series S:

Threads: D according to ISO 7-1 or EN ISO 228-1

Threads: d_1 according to ISO 965-1

Threads: d_2 according to ISO 7-1

A.4 Materials for body, tailpiece and nut

At the option of the manufacturer:

CuZn39Pb3 (CW614N) in accordance with EN 12449, EN 12164, EN 12168 and EN 12420

CuZn40Pb2 (CW617N) in accordance with EN 12449, EN 12164, EN 12168 and EN 12420

CuZn39Pb1A1-C (CC754S) in accordance with EN 1982

CuSn5Zn5Pb5-C (CC491K) in accordance with EN 1982

NOTE Materials CW 614N and CW617N are also available in the form of wire (EN 12166), profiles/rectangular bar (EN 12167) and forging stock (EN 12165).

EN 215:2004 (E)

At his option the manufacturer can use other materials provided that he is able to demonstrate that their suitability for purpose is at least equal to that of the materials listed above.

A.5 Designation

A thermostatic radiator valve in accordance with this standard is designated by reference to the standard, series, body form and nominal size.

Example: EN 215, series D, angle pattern, DN 15

A.6 Marking (This marking does not cover possible certification marking)

The valves shall be marked on the body as follows:

- a) manufacturer's trade mark
- b) series letter
- c) flow direction arrows (where applicable)

If the valve is subject to the CEN/CENELEC Certification Mark System, it shall also be marked according to the certification rules.

Annex B (informative)

Degree of turbulence of the air current in a room

An air current should be generated that corresponds largely to the real conditions at the radiator in the room.

Regarding the air current in the room, it is a turbulent air current, i.e., the movement in the main flow direction, characterized by the mean current velocity $\bar{v}'$, is subject to velocity fluctuations in the three co-ordinate directions (designated by v_x' , v_y' and v_z').

The mean value of the deviation movements is obtained by the relationship:

$$\bar{v}' = \sqrt{\frac{1}{3} (v_x'^2 + v_y'^2 + v_z'^2)}$$

For space air movements, it can be considered that no direction is preferred for the deviation movements, so that it is sufficient to consider a two-dimensional current. At one measurement, the value v' is then directly obtained. As the turbulent movement can only be obtained according to statistical evaluations of time based data, it needs time dependent information to be considered. In case of space air movements, the deviations occur with frequencies of about 1 Hertz, which requires measuring times of about 1 to 3 min to obtain reproducible data.

The dimension of the turbulence is characterized by the so called degree of turbulence τ which results as relation of the mean value of deviation to the mean value of the velocity:

$$\tau = \frac{\bar{v}'}{\bar{v}} \cdot 100 \%$$

For the statistical evaluation of measurements, for which e.g. a number of n samples of the instantaneous value of the velocity v_i is established, it is possible to determine $\bar{v}$ as mean value of all measured values:

$$\bar{v} = \frac{1}{n} \sum_{i=1}^n v_i$$

and $\bar{v}'$ as standard deviation:

$$\bar{v}' = \sqrt{\frac{1}{n-1} \sum_{i=1}^n (v_i - \bar{v})^2}$$

If a statistical evaluation is used for which a distribution of the velocity values is assumed according to the standard gaussian distribution curve, the standard deviation then is conform to the difference between the so called 84 % value and the mean value.

For the adjustment of the air velocity in the test duct, only measurements with a thermal anemometer are suitable.

Bibliography

EN 12165	<i>Copper and copper alloys - Wrought and unwrought forging stock.</i>
EN 12166	<i>Copper and copper alloys - Wire for general purposes.</i>
EN 12167	<i>Copper and copper alloys - Profiles and rectangular bar for general purposes.</i>
EN ISO 6708	<i>Pipework components - Definition and selection of DN (nominal size) (ISO 6708:1995).</i>

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