BRITISH STANDARD

BS 7478:1991

Guide to

Selection and use of thermostatic radiator valves

Confirmed
December 2011

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Refrigeration, Heating and Air Conditioning Standards Policy Committee (RHE/-) to Technical Committee RHE/16, upon which the following bodies were represented:

Association of Manufacturers of Domestic Unvented Supply Systems Equipment (MODUSSE)
BEAMA Ltd. [Association of Control Manufacturers (TACMA)]
British Gas plc
British Plumbing Fittings Manufacturers' Association
British Valve and Actuator Manufacturers' Association
Building Services Research and Information Association
Department of the Environment (Property Services Agency)
Hevac Association
Institute of Domestic Heating Engineers
Institute of Refrigeration
Institution of Gas Engineers
Society of British Gas Industries

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Contents

Foreword

This guide has been prepared under the direction of the Refrigeration, Heating and Air Conditioning Standards Policy Committee to provide guidance to the user and installer of heating systems on thermostatic radiator valves.

These temperature sensing valves are installed in place of manually operated radiator valves, enabling individual rooms to be controlled at different temperatures. Additionally thermostatic radiator valves (TRV) automatically compensate for heat gains from other sources, such as cooking, open fires, solar gain, additional occupancy, etc. Each TRV has its own temperature sensing actuator, which enables the valve to admit more or less hot water to the radiator as the room temperature falls or rises, thereby maintaining comfort conditions and economizing on fuel. Since TRVs are entirely automatic, no manual adjustment is needed once the desired temperatures have been set. To obtain these benefits it is important that the guidelines given in this standard are adhered to.

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Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 12, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

Section 1. General

1 Scope

This British Standard gives guidance on the selection, application and use of thermostatic radiator valves (TRV) manufactured in accordance with BS EN 215-1 for use in domestic and commercial wet central heating systems up to a water temperature of 120 °C.

This standard covers two areas of TRV use, these are domestic installation and commercial installation.

It is assumed that the installations to which the TRV is to be added are installed in accordance with BS 5449, for domestic heating systems and in accordance with BS 6880 and CIBSE Commissioning Code Series W "Water distribution systems" for commercial installations.

NOTE The titles of the publications referred to in this standard are listed on the inside back cover.

2 Definitions and symbols

2.1 Definitions

For the purposes of this British Standard the following definitions apply.

2.1.1
two degree deviation

the temperature change in kelvins which, from the closed position, results in 60 % of maximum flow rate through the TRV

NOTE 1 A TRV generally moves from a closed to a fully open position for a temperature change of 6 K. This magnitude of temperature change would obviously be unsuitable for controlling space temperature. For this reason a smaller deviation is normally chosen, typically 2 K.

NOTE 2 It can be seen from the graph in Figure 1 that more than 60 % of the maximum flow through the valve occurs with a temperature change of 2 K from the closed position. This valve characteristic has been found to give the optimum control.

2.1.2
maximum K_v (K_{vs})

a means of identifying the maximum capacity of a TRV in the fully open position, in terms of flow (m^3/h) at a differential pressure of 1 bar[1)]

NOTE This enables the capacity of one valve to be compared with another. This position is normally reached for a temperature change of 6 K.

2.1.3
differential pressure (Δp)

the difference in pressure between the valve inlet and the valve outlet

2.1.4
static pressure

the pressure existing in a central heating system when no water is flowing

2.1.5
maximum working pressure

the sum of the static and the differential pressures

2.1.6
valve authority (N)

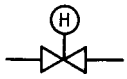
the ratio between the pressure loss across the valve when in the two degree position and the total pressure loss in the circuit

NOTE The ratio is used to determine the suitability of a valve for a particular purpose. Typical ratios for TRVs lie between 0.3 and 0.5.

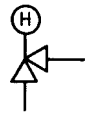
2.2 Symbols

For the purposes of this British Standard the following symbols apply:

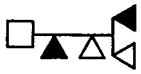
a) two-port thermostatic radiator valve (straight pattern)



b) two-port thermostatic radiator valve (angle pattern)



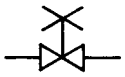
c) four-port thermostatic radiator valve



d) isolation valve

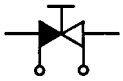
e) lockshield regulating valve (angle pattern)

f) lockshield regulating valve (straight pattern)

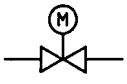


g) double regulation valve (regulation and isolation with adjustable regulation stop)

h) isolation valve with calibrated orifice and pressure tappings for flow measurements



i) two-port motorized valve



j) circulation pump

[1)] 1 bar = 10^5 N/m^2 = 100 kPa.

k) radiator 

l) direction of flow 

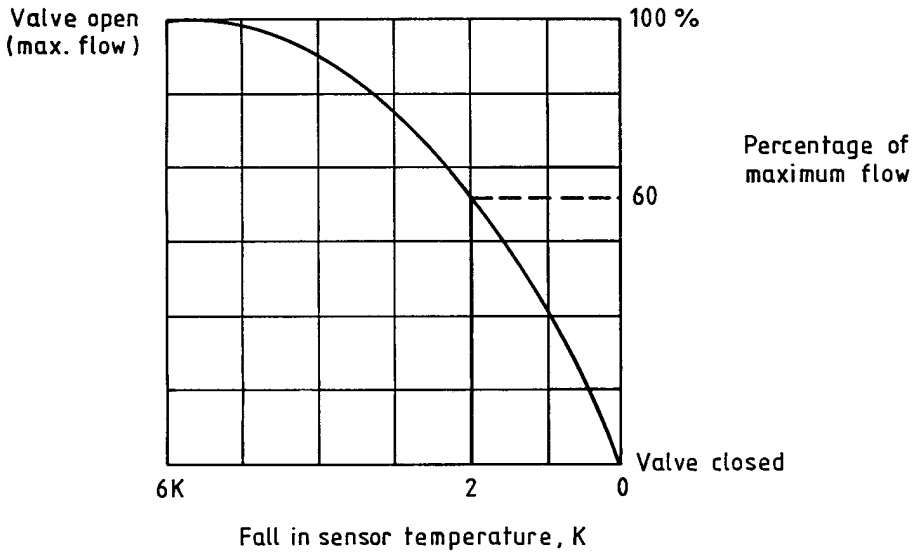


Figure 1 — Typical flow characteristics showing the two degree position

Section 2. Domestic installations

3 General

Figure 2 shows diagrammatically a typical two-pipe system heating installation showing TRVs and omitting all other controls.

4 Features

4.1 Typical thermostatic radiator valve

The arrangement and principal components of a typical thermostatic radiator valve are shown in Figure 3.

4.2 Temperature selector scale

Most TRVs have a graduated temperature selector scale. The relationship between the temperature at the thermostatic head assembly and the temperature at the centre of the room will vary between installations.

NOTE It is important that an appropriate setting should be selected on the temperature selector scale to give comfort conditions in the room. (See clause **8**.)

4.3 Manual shut-off

TRVs designed in accordance with BS EN 215-1 are either capable of positively shutting-off the valve by means of the thermostatic head assembly or a manual cap is provided to obtain a positive shut-off.

4.4 Seal change

TRVs designed in accordance with BS EN 215-1 incorporate a facility which enables the seal to be replaced without draining the system.

4.5 Frost protection

Most TRVs include a frost position signified by a star, snowflake or other symbol. When the system is operating the frost position will give a room temperature of approximately 10 °C which is intended to protect against freezing.

4.6 Range limiting

Range limiting enables the user to restrict the movement of the temperature selector scale to a chosen range.

4.7 Lock setting

The lock setting enables the user to lock the temperature selector scale to a chosen position.

4.8 Vandal guard

Some TRVs can be provided with a protective device to render the valve tamper-proof or vandal-proof.

NOTE In a commercial situation this is an important consideration when ordering a valve.

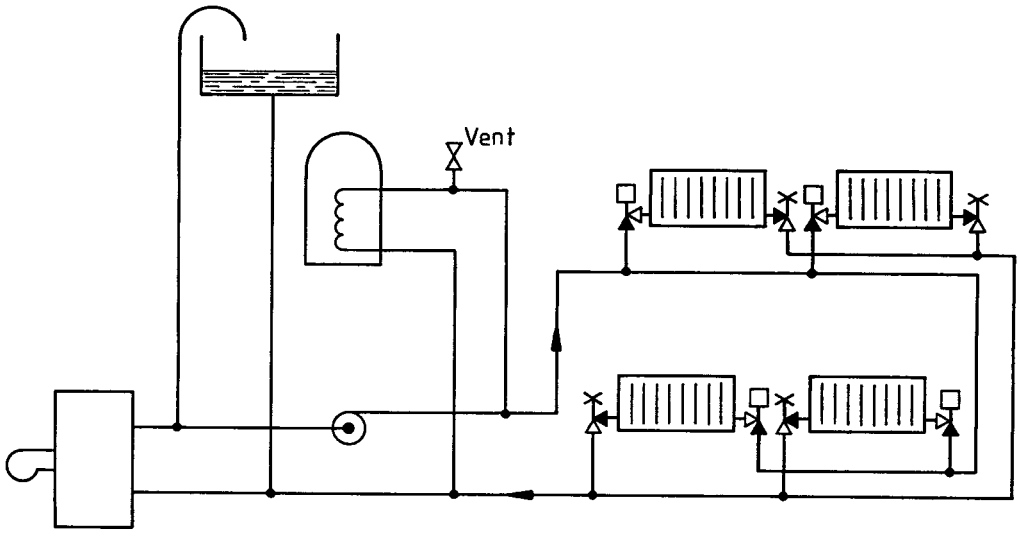


Figure 2 — Typical two-pipe system installation

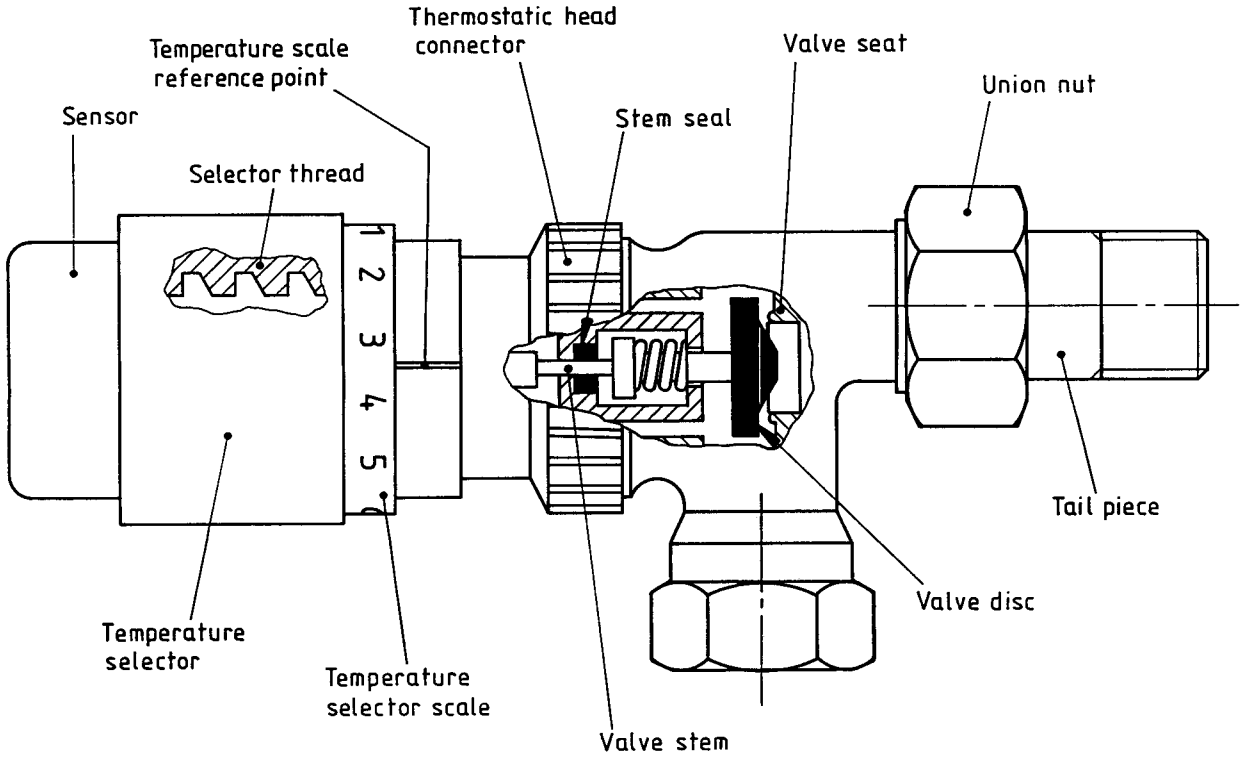


Figure 3 — Principal components of thermostatic radiator valve

5 Valve selection

5.1 Types of valve and pipe connections

Different valve patterns are available to suit installation positions. These are shown in Figure 4.

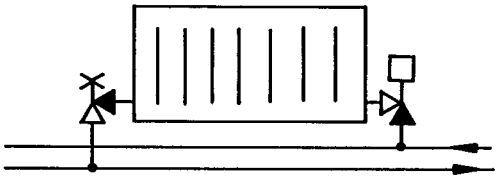
Types of valve connections are shown in Figure 5. They are available in straight or angled patterns.

Typical connections for use in domestic installations where copper pipe is commonly used are shown in Figure 5(b) and Figure 5(d).

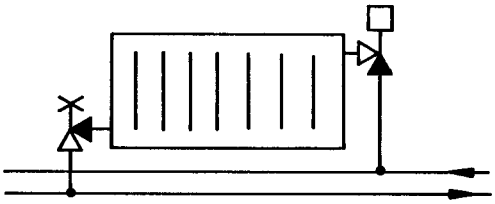
NOTE In retrofit applications it is sometimes possible to replace a manual radiator valve without removing the existing tailpiece and nut.

5.2 Valve sizing

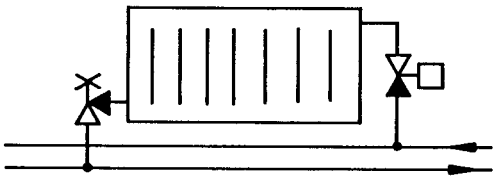
Examples of manufacturer's sizing charts are shown in **11.2**. Valves of 15 mm body diameter give adequate control for most domestic installations up to an output of 4 kW.



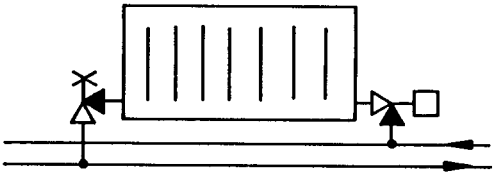
(a) Bottom fixing with a vertical angled body and an integral sensor



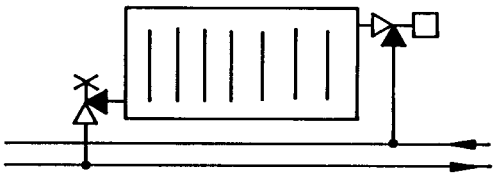
(b) Top fixing with a vertical angled body and an integral sensor



(c) Intermediate fixing with a straight body and an integral sensor



(d) Bottom fixing with a horizontal angled body and an integral sensor



(e) Top fixing with a horizontal angled body and an integral sensor

Figure 4 — Valve position with respect to the radiator

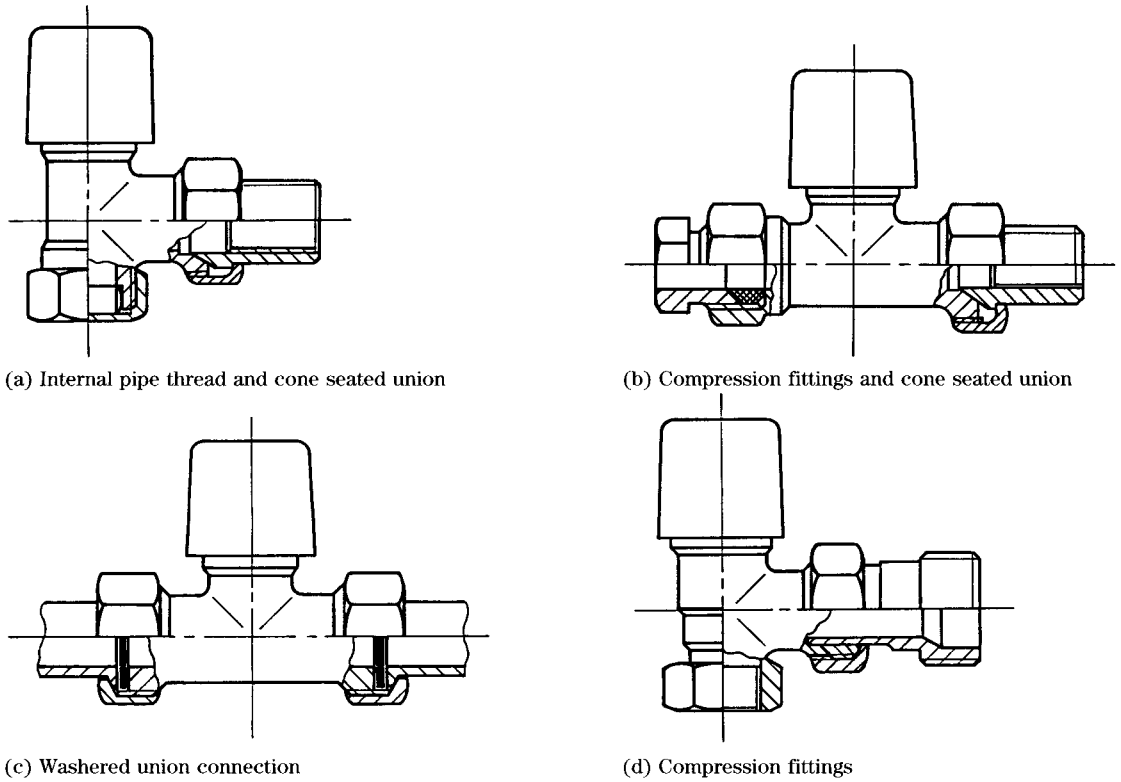


Figure 5 — Examples of radiator valve connections

6 Checklist

The purchaser should ensure that all the design requirements are specified when purchasing TRVs. The following list includes the main points and should be read in conjunction with **7.1**:

a) compliance with BS EN 215-1;

b) body type;

c) size of valve;

d) type and size of pipe connection;

e) range limiting;

f) range setting;

g) lock setting;

h) vandal guard;

i) sensor type;

j) length of capillary, if remote sensor used.

7 Installation

7.1 Siting

To obtain the best performance from a TRV ensure the following.

a) *Integral sensor type*

1) The temperature selector scale and temperature reference point are easily visible.

2) A free flow of convected air, i.e. avoid siting behind curtains, furniture or other obstruction which will prevent free flow of convected air over the sensor.

3) Avoid direct sunlight falling on the sensor.

4) Avoid fitting the valve in draughty locations.

5) Allow space to adjust temperature selector and remove and replace the thermostatic head of the valve body.

b) *Remote sensor type*

If the conditions given in a) 2) to a) 4), cannot be achieved using an integral sensor, a remote sensor should be used (see Figure 6). It is usual to mount the sensor on the wall, but if this is not possible or is undesirable, it is permissible to fit it beneath, but not touching, the radiators, as there is normally a convective flow of air in this position.

When inaccessiblity of the valve to the user is unavoidable, e.g. when the radiator and valve are located behind a decorative grille, valves with combined remote temperature sensors and adjusters should be used.

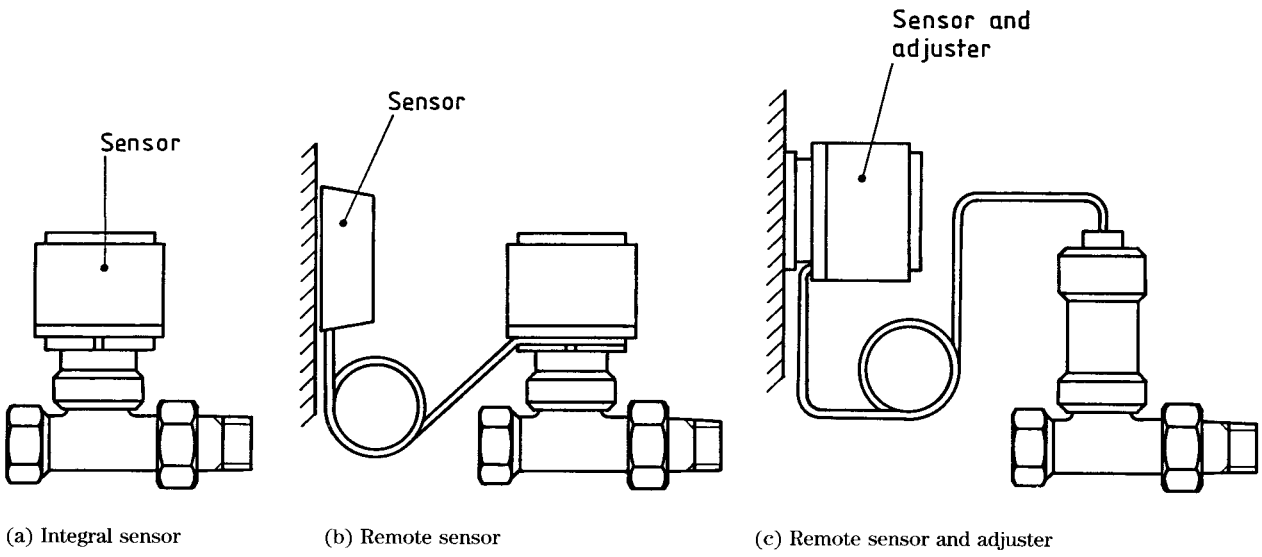


Figure 6 — Integral and remote sensor

7.2 Fitting the valve

It is essential to ensure that the direction of flow through the valve corresponds to the direction of the arrow on the valve body.

The valves should be fitted in accordance with the manufacturers' instructions.

NOTE In retrofit installations where the direction of water flow is not known, it can be determined by first cooling the radiator by closing the valve and then re-opening the valve and identifying which connection to the radiator heats up first. This is the flow connection and water flows from this connection through the radiator and out through the return connection.

7.3 Absence of by-pass

In systems without a by-pass between the flow and return pipes, TRVs should not be fitted to all radiators. A radiator or radiators should be left without a TRV sufficient to provide the necessary minimum flow rate through the boiler and/or pump. This is often done using the smallest radiator or towel rail, in which case it should be fitted with two lockshield valves to prevent it from being manually turned off.

7.4 Room thermostat

When the over-riding space heating control is by a room thermostat, TRVs should not be fitted to radiators in that same room or space.

7.5 Flushing

It is essential that all systems are flushed to remove all debris left after installation and prior to commissioning. This should be done with all TRV sensor heads removed and valves fully open.

8 Commissioning

8.1 Balancing

When hydraulically balancing the system the thermostatic heads should be removed from all the TRVs to prevent changes in room temperature affecting the balancing procedure.

8.2 Temperature setting

Fit all the thermostatic heads and set the temperature selector scales to the mid-position.

Bring the heating system into operation and wait until the room temperatures remain constant.

If the temperatures achieved are not satisfactory the TRV temperature selectors should be adjusted up or down as appropriate. At least 2 h should be allowed after making the adjustments before re-measuring the room temperatures.

When the required temperatures have been achieved the TRV temperature selectors should be left in their final positions.

If lock or range setting devices are provided, these may now be set if desired.

9 User instructions

The end-user should be informed of the following:

a) that when the TRVs are correctly set they should not normally require further adjustment; but turning the temperature selector anti-clockwise increases the temperature and clockwise reduces the temperature;

b) that if the room overheats during the heating season through the effects of sunshine etc., the TRV will automatically turn the radiator off and it will feel cold to the touch;

c) that if the house is left unoccupied for a period during cold weather, when freezing conditions may occur and there is a risk of the system freezing:

1) ensure that the heating system is on, to maintain a temperature of approximately 10 °C; and

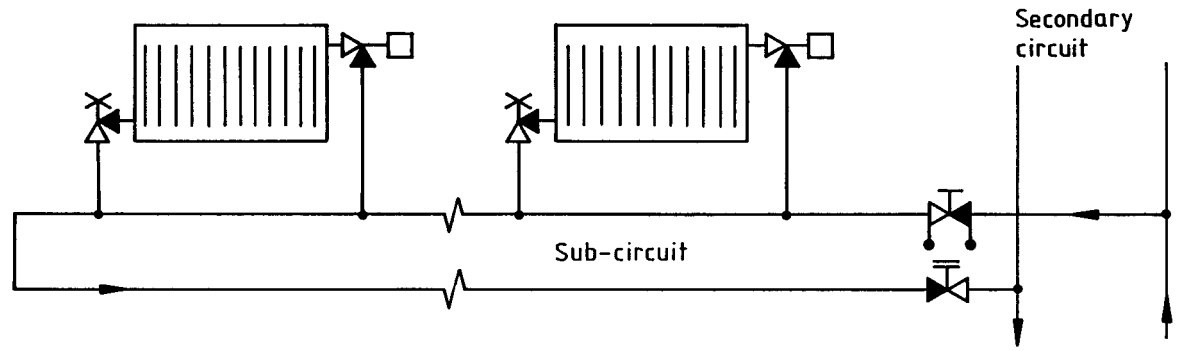
2) the TRV temperature selectors should be set to the frost position, after noting the normal setting.

Section 3. Commercial installations

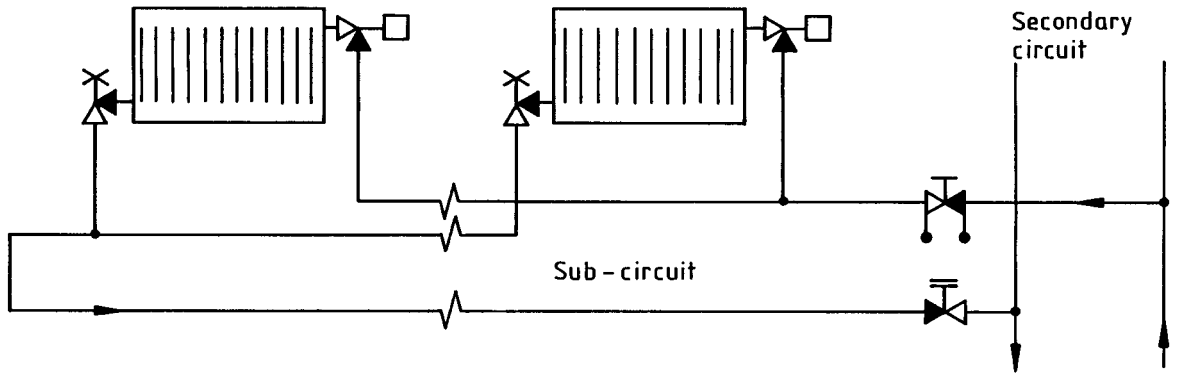
10 General

In the commercial/industrial sector the two principal pipework configurations in common use are shown in Figure 7. A third system is sometimes used as shown in Figure 7(c) and requires a four-port valve.

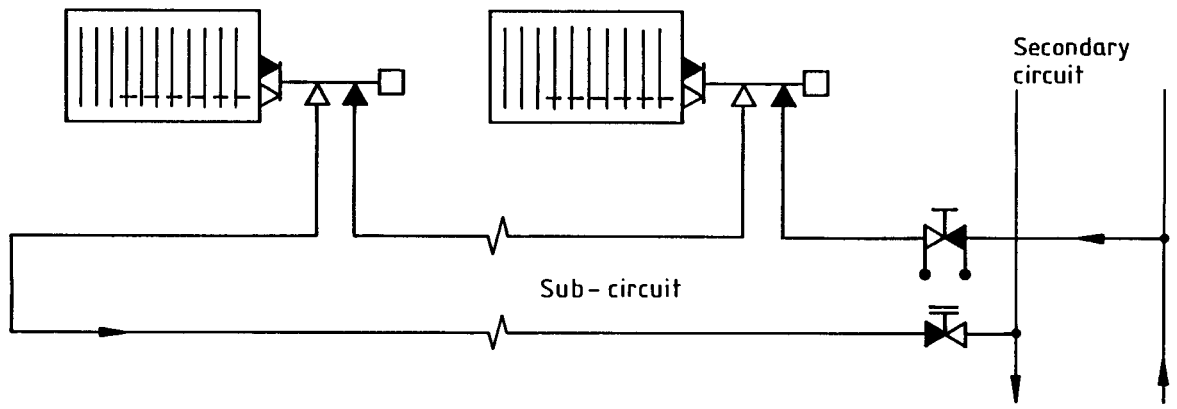
Many factors of commercial/industrial use are identical with those for domestic use and appropriate references are made to the relevant clauses in section 2.



(a) Single pipe



(b) Two pipe



(c) Single pipe, double entry

Figure 7 — Pipework configurations

11 Valve selection

11.1 Types of valve and pipe selection

Types of valve and pipe selection for commercial installations are identical with those for domestic use (see **5.1**).

11.2 Valve sizing

11.2.1 *General*

The most common means of valve sizing is by use of a manufacturer's sizing chart. Examples of sizing charts are shown in Figure 8(a) and Figure 8(b) and explanations on the use of the charts are given in **11.2.2** and **11.2.3**.

11.2.2 *Use of chart (a) in Figure 8*

A horizontal line drawn across the chart indicates the relationship between ΔP (differential pressure) and Q (flow rate) for a given valve body size.

Example: The pressure loss for a 15 mm angle valve body passing a flow rate of 0.05 L/s is approximately 165 mbar.

11.2.3 *Use of chart (b) in Figure 8*

A horizontal line drawn across the chart to intersect with a selected valve body size, is then projected vertically to obtain the relationship between ΔP (differential pressure) and Q (flow rate).

For example the pressure loss for a 15 mm valve body passing a flow rate of 0.05 L/s is approximately 1.4 kPa.

11.3 Matching valves to systems

11.3.1 *Two-pipe system*

To determine whether a two-port TRV will be suitable when fitted to a radiator on a two-pipe circuit, the following procedure can be used.

a) Calculate the radiator flow rate Q.

b) Calculate the emitter circuit pressure losses (P_2 and P_3 in Figure 9) using CIBSE Guide, Volume C, Section C4 to determine the required pipe and fitting sizes.

c) Calculate the required pressure loss P_1 across the TRV in the two degree deviation position to give the necessary valve authority.

NOTE Experience has shown that the calculation should be made using valve authorities of 0.3 (at P_1') and 0.5 (at P_1'') to give a range of pressure losses which the TRV will control correctly. (See Figure 9.)

TRV = P_1

Rest of sub-circuit = $P_2 + P_3$

$$\text{Valve authority} = \frac{P_1}{P_1 + P_2 + P_3} = 0.3 \text{ to } 0.5$$

d) Selection of a suitable size of TRV can thus be made using manufacturer's data as follows.

1) If the manufacturer's flow capacity charts (at the two degree deviation position) are available (see Figure 8), using the flow rate obtained in a), and the pressure losses P_1' where $N = 0.3$, and P_1'' where $N = 0.5$, obtained in c), select a valve from the charts; or

2) If the manufacturer's flow capacity charts (at the two degree deviation position) are not available, using the flow rate Q obtained in a) and the pressure losses P_1' and P_1'' obtained in c), calculate a suitable range for K_v using the formula:

$$K_v = \frac{Q}{\sqrt{P_1}} \text{ using } P_1' \text{ and } P_1''$$

Then using the manufacturer's data, select a valve having a K_v value in the two degree deviation position within the range calculated.

11.3.2 *Single-pipe system*

To determine whether a two-port TRV will be suitable when fitted to a radiator on a single-pipe circuit, follow the same procedure as for a two-pipe circuit but calculate the pressure losses shown in Figure 10.

12 Features

Features of TRVs for commercial use are identical with those for domestic use (see clause **4**).

13 Checklist

The checklist for purchasing TRVs for commercial use is identical with that for domestic use (see clause **6**).

14 Installation

14.1 Siting

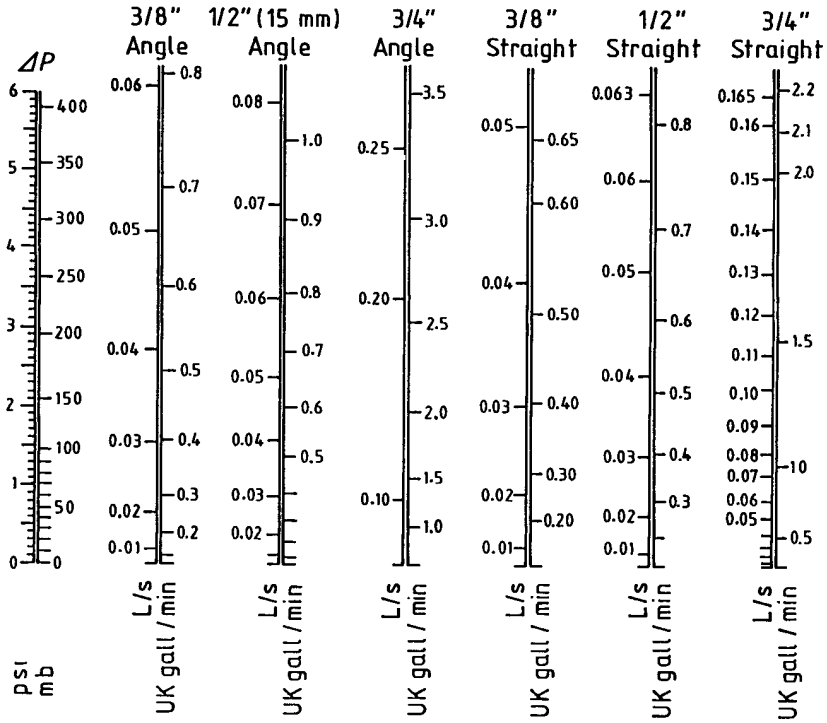
Siting of the valve in commercial/industrial installations should be given the same considerations as those given for domestic installations (see **7.1**).

14.2 Fitting the valve (see **7.2**)

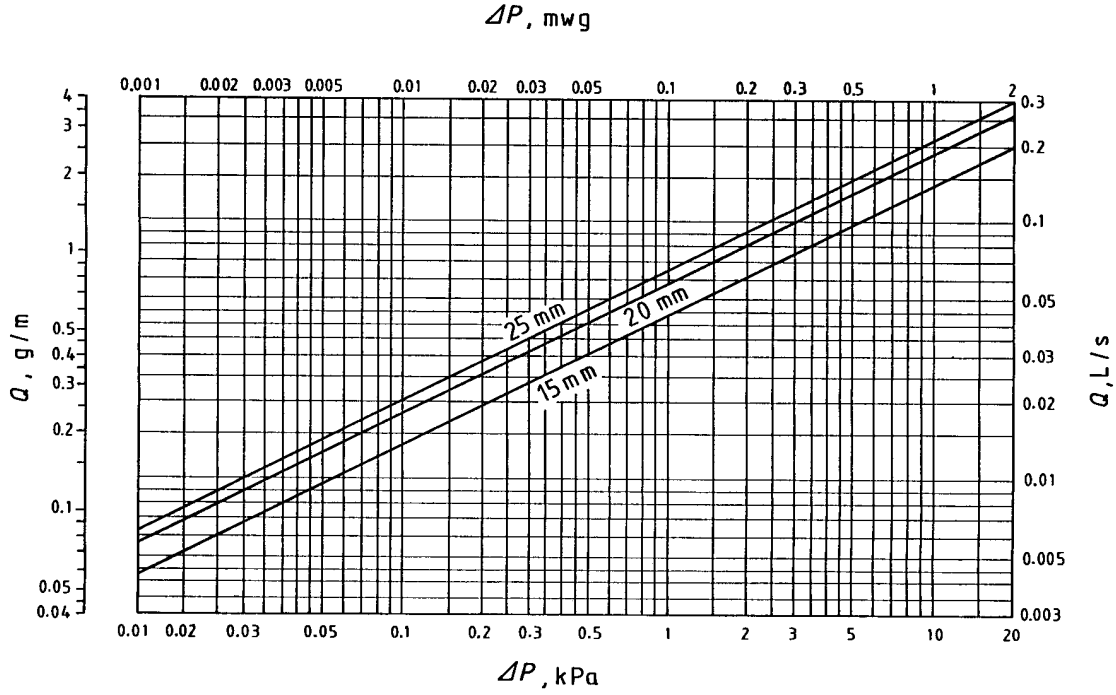
Ensure adequate space is allowed for the installation and maintenance of large TRVs in commercial installations. This is particularly important where screwed iron fittings are employed.

14.3 Room thermostat

The recommendations, in commercial use, for rooms in which thermostats are fitted are identical with those for domestic use (see **7.4**).



(a)



(b)

Figure 8 — Typical manufacturer's flow capacity charts for two degree deviation

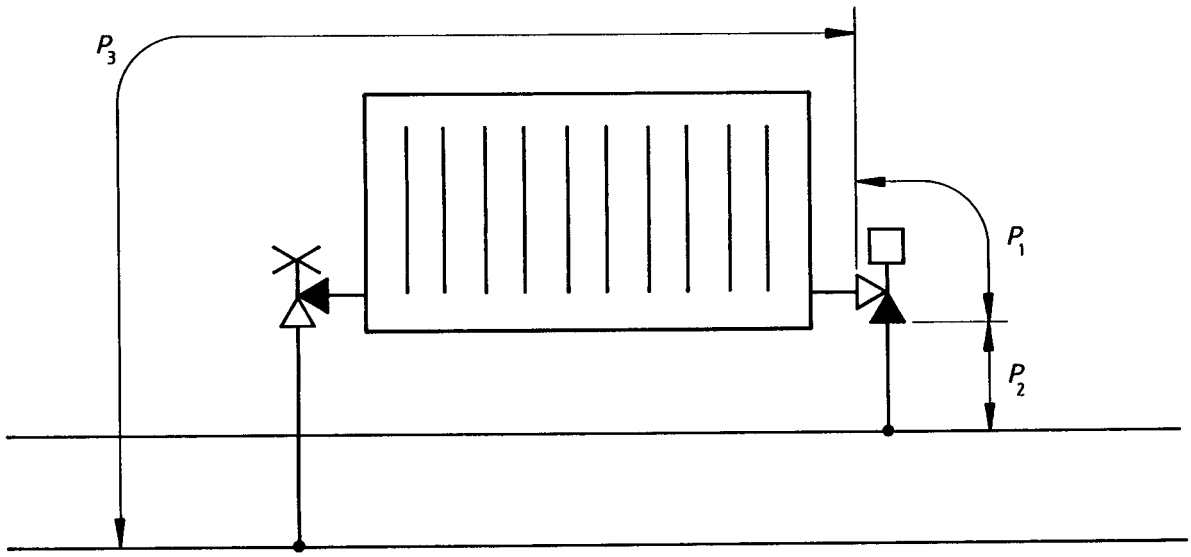


Figure 9 — Sub-circuit pressure losses: two-pipe circuit

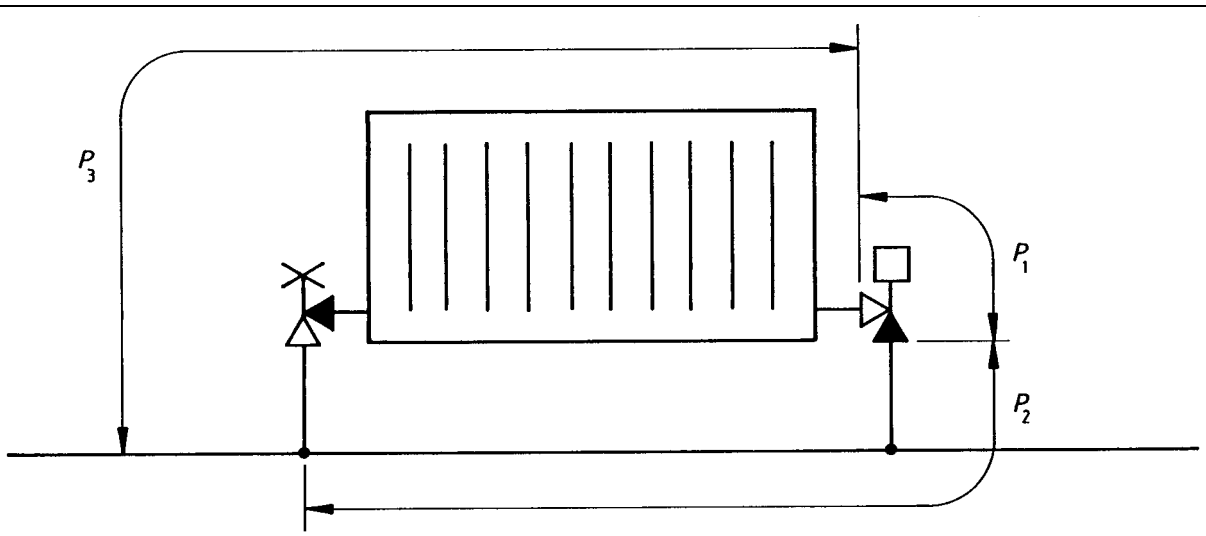


Figure 10 — Sub-circuit pressure losses: single-pipe circuit

14.4 Optimizers and time switches

Where TRVs are installed in heating systems which use optimum start or fixed time start controllers, the heating-up period may be extended and due allowance in setting the controller should be made for this effect.

15 Commissioning

15.1 Balancing

Valves should normally be set in the same position (nominally two degrees) for initial balancing purposes.

15.2 Temperature setting

Bring the heating system into operation and wait until the room temperatures remain constant. If the temperatures achieved are not satisfactory the TRV temperature selectors should be adjusted up or down as appropriate. At least 2 h should be allowed after making the adjustments before re-measuring the room temperatures.

When the required temperatures have been achieved the TRV temperature selectors should be left in their final positions.

If lock or range setting devices are provided, these may now be set if desired.

Publication(s) referred to

BS 5449, *Specification for forced circulation hot water central heating systems for domestic premises.*
BS 6880, *Code of practice for low temperature hot water heating systems of ouput greater than 45 kW.*
BS EN 215-1, *Thermostatic radiator valves — Part 1: Requirements and test methods.*
CIBSE, *Commissioning code series W "Water distribution systems"*[2)].
CIBSE, *Guide, Volume C, Section C4*[2)].

[2)] Obtainable from Chartered Institution of Building Services Engineers (CIBSE) Delta House, 222, Balham High Road, London SW12 9BS.

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