BRITISH STANDARD

BS 7074-1:
1989

Application, selection and installation of expansion vessels and ancillary equipment for sealed water systems —

Part 1: Code of practice for domestic heating and hot water supply

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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/7 upon which the following bodies were represented:

Associated Offices Technical Committee
Association of Consulting Engineers
Association of Manufacturers of Domestic Unvented Supply Systems Equipment (MODUSSE)
British Marine Equipment Council
Building Services Research and Information Association
Chartered Institution of Building Services Engineers
Heating and Ventilating Contractors' Association
HEVAC Association
Institute of Domestic Heating Engineers
Sealed Expansion Vessel Association
Waterheater Manufacturers' Association

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Contents

Foreword

This British Standard code of practice has been prepared under the direction of the Refrigeration, Heating and Air Conditioning Standards Policy Committee.

The code complements BS 4814 and gives recommendations in its three Parts for the installation of expansion vessels in domestic heating and supply systems (Part 1); low and medium temperature hot water heating systems (Part 2); chilled water and condenser systems (Part 3) and boosted hot water supply systems[1)].

The code deals with the work involved in the general planning, designing and installation of the various systems when the expansion and contraction of the system water is catered for in a sealed diaphragm type vessel. In all other respects the customary design process should be followed for the appropriate system.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 10, 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.

[1)] Planned.

Section 1. General

1 Scope

This Part of BS 7074 gives recommendations on the application of expansion vessels for use in individual domestic premises. It includes description, design considerations and types of application.

Sections 1 and 2 cover domestic heating systems using expansion vessels complying with BS 4814 and include recommendations on:

a) the application and use of ancillary equipment and

b) testing, commissioning and maintenance.

Section 3 makes reference to domestic hot water supply systems.

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

2 Definitions

For the purposes of this Part of BS 7074 the following definitions apply.

2.1
charging pressure

the initial pressure to which the gas/air side of the vessel is charged which is equal to the initial system design pressure

2.2
design acceptance factor (a)

the ratio of the volume of water due to expansion, to total vessel volume

2.3
diaphragm (or membrane)

the flexible means by which the chamber of an expansion vessel is partitioned to maintain separation between the expanding hot water and the gas or air which in consequence becomes compressed. It may be either a literal diaphragm clamped between two parts (or halves) of the vessel, or a bag located by its mouth which is secured to the point of the water connection to the vessel

2.4
expansion percentage (e)

the expansion percentage increase in volume when water is heated to maximum design system temperature

2.5
expansion volume (V_a)

the increase in volume of water due to expansion when heated to the maximum design system temperature

2.6
final system design pressure (P_f)

the pressure occurring at the mid-height of the expansion vessel at the maximum design system temperature

2.7
initial cold water fill temperature (t_i)

the basic reference temperature is taken to be 4 °C

2.8
initial system design pressure (P_i)

the pressure occurring at the mid-height of the expansion vessel at cold fill. This is equal to the static height pressure plus the pressure margin

2.9
lowest working pressure component (LWPC)

the component having the lowest working pressure in the system

2.10
maximum acceptance factor (A)

the ratio of maximum acceptance volume of the system to total volume

2.11
maximum acceptance volume (V)

the volume of water which the vessel may be allowed to contain

2.12
maximum vessel temperature

the maximum water temperature at which the vessel may be allowed to operate continuously

2.13
maximum vessel working pressure

the maximum pressure that the vessel may be allowed to contain in operation

2.14
pressure depth (P_d)

the vertical distance between the component being considered and the mid-height of the expansion vessel situated above it

2.15
pressure margin (P_s)

the additional pressure imposed on the circuit to prevent water vaporizing or boiling and/or to exclude air from the system at the highest point

2.16
safety valve set pressure (P_{max})

the pressure at which the safety valve is set for operation

2.17
static height pressure (P_h)

the pressure created by the column of water between the uppermost part of the heating circuit and the mid-height of the expansion vessel

2.18
system flow temperature (t_f)

the maximum designed temperature of the water circulating in the system

2.19
total system volume (V_s)

the total volume of water in the complete system

2.20
total vessel volume (V_t)

the volume occupied by gas/air when the vessel is empty of water

3 Symbols, designations and units

The symbols for physical quantities, their designations and units used in this code of practice are given in Table 1.

Table 1 — Symbols, designations and units

Symbol	Designation	Unit
A	Maximum acceptance factor	—
a	Design acceptance factor	—
e	Expansion percentage	—
P_d	Pressure depth	bar gauge
P_f	Final system design pressure	bar gauge
P_h	Static height pressure	bar gauge
P_i	Initial system design pressure	bar gauge
P_{max}	Safety valve, set pressure	bar gauge
P_s	Pressure margin	bar gauge
t_f	System flow temperature	°C
t_i	Initial cold water fill temperature	°C
V	Maximum acceptance volume	L
V_a	Expansion volume	L
V_s	Total system volume	L
V_t	Total vessel volume	L

4 Testing and commissioning

4.1 Testing the system

The completed installation, as well as being checked for leaks, should be rinsed to minimize presence of solid particles and chemical residues which may cause damage within the system. The following procedure should be followed:

a) fill system and vent all high points, pump and radiators;

b) examine for leaks and rectify where necessary.

4.2 Commissioning the system

The boiler and pump should be put into operation and the system allowed to heat up to normal operating temperature for 1 h. After this period the boiler and pump should be turned off and the system allowed to cool. Further checks should be made for any leakages.

Any water loss should be made up thus ensuring the system design pressure is restored.

5 Maintenance and servicing

It is necessary that procedures for maintenance and servicing of the system be explained to the user and confirmed in writing.

6 Workmanship

All work on domestic premises systems as described in this Part of the code of practice should be carried out by competent persons.

Section 2. Heating systems

7 Design considerations

7.1 General

Successful and continuing safe operation of a domestic heating system depends on the use of the correct equipment properly installed to a good design and effectively serviced and maintained.

In addition to the customary design procedures applicable to small-bore or micro-bore systems, the following design considerations should be adhered to when a sealed diaphragm expansion vessel is incorporated.

a) The preferred and the acceptable positions of the expansion vessel are shown in Figure 1.

b) The method of filling should be in accordance with the requirements of the local water authorities.

c) System flow temperature (t_f). Whilst the normal operating temperature is limited to 82 °C, a fault condition may occur with the safety devices enabling system temperature to rise to 110 °C and it is recommended that this figure be used in the calculation of vessel sizes.

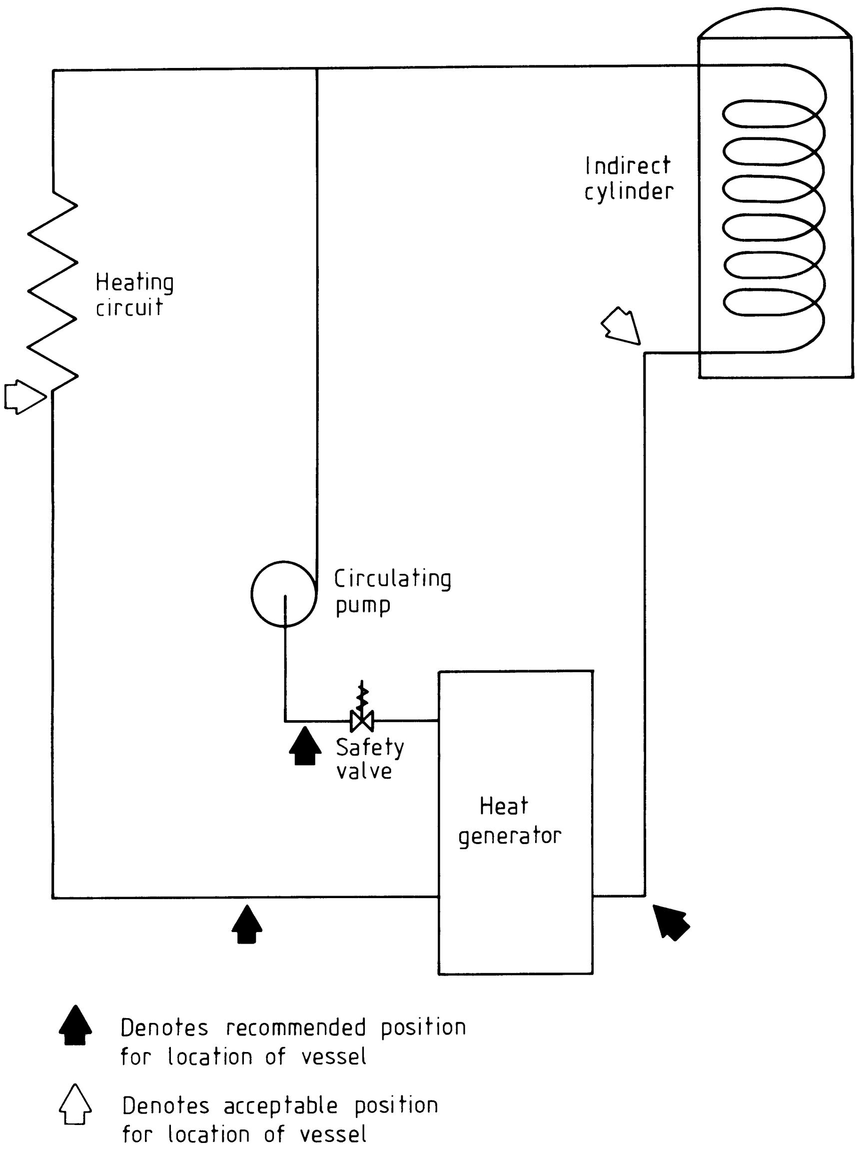


Figure 1 — Location of connection of expansion vessel in a system

d) Static height pressure (P_h).

e) Final system design pressure (P_f).

f) Total water content of system. As an approximation of water content, where it is not feasible to make accurate calculation, a figure of 12 L/kW output of the heat generator could be used.

g) Capacity of expansion vessel. It is recommended that the method given in **7.2** for the accurate selection of the expansion vessel capacity be followed. Where design information is not complete Table 2 can be used for selecting the size of the vessel; it should be noted that the sizes given in Table 2 take account of the fault condition temperature rise referred to in c) and other safety factors.

h) Should it be considered necessary to use a chemical inhibitor to prevent corrosion in the system, care should be taken to ensure compatibility with the diaphragm, and other system components.

i) Connection of the expansion vessel. The point of connection of the expansion pipework is the neutral point of the system and it is recommended that this is in the return pipework close to the heat generator. The fill position should be between the expansion vessel connection point and the inlet of the circulation pump. The point of connection of the expansion vessel into the system having been clearly defined, the physical location of the vessel can be anywhere.

Table 2 — Capacities of expansion vessels

Safety valve setting (bar gauge)	3.0			2.5			2.0	
Vessel charge and initial system pressure (bar gauge)	0.5	1.0	1.5	0.5	1.0	1.5	0.5	1.0
Total water content of system	**Vessel volume**							
L	L	L	L	L	L	L	L	L
25	2.1	2.7	3.9	2.3	3.3	5.9	2.8	5.0
50	4.2	5.4	7.8	4.7	6.7	11.8	5.6	10.0
75	6.3	8.2	11.7	7.0	10.0	17.7	8.4	15.0
100	8.3	10.9	15.6	9.4	13.4	23.7	11.3	20.0
125	10.4	13.6	19.5	11.7	16.7	29.6	14.1	25.0
150	12.5	16.3	23.4	14.1	20.1	35.5	16.9	30.0
175	14.6	19.1	27.3	16.4	23.4	41.4	19.7	35.0
200	16.7	21.8	31.2	18.8	26.8	47.4	22.6	40.0
225	18.7	24.5	35.1	21.1	30.1	53.3	25.4	45.0
250	20.8	27.2	39.0	23.5	33.5	59.2	28.2	50.0
275	22.9	30.0	42.9	25.8	36.8	65.1	31.0	55.0
300	25.0	32.7	46.8	28.2	40.2	71.1	33.9	60.0
325	27.0	35.7	50.7	30.5	43.5	77.0	36.7	65.0
350	29.1	38.1	54.6	32.9	46.9	82.9	39.5	70.0
375	31.2	40.9	58.5	35.2	50.2	88.8	42.3	75.0
400	33.3	43.6	62.4	37.6	53.6	94.8	45.2	80.0
425	35.4	46.3	66.3	39.9	56.9	100.7	48.0	85.0
450	37.5	49.0	70.2	42.3	60.3	106.6	50.8	90.0
475	39.6	51.8	74.1	44.6	63.6	112.5	53.6	95.0
500	41.6	54.5	78.0	47.0	67.0	118.5	56.5	100.0
Multiplying factors for other system volumes	0.0833	0.109	0.156	0.094	0.134	0.237	0.113	0.2

7.2 Expansion vessel size calculation

The accurate size of the expansion vessel is calculated as follows.

a) Establish.

1) The water content of the system in litres (V_s) (this to include circulatory pipework, heat emitters and heat generators).

2) The system flow temperature (t_f) in °C.

3) The expansion percentage (e) (see Table 3).

NOTE The addition of anti-freeze or similar fluid will affect the expansion percentage co-efficient and may also affect the diaphragm material.

4) The static height pressure (P_h) in bar gauge.

NOTE Expansion vessels supplied into the domestic central heating market are filled at factory to pressures of 0.5 bar; 1.0 bar; 1.5 bar equating to the average P_h.

5) The initial system design pressure (P_i) in bar gauge. The margin normally added to the static height pressure is 0.3 bar[2]. This added pressure margin (P_s) is necessary to expel air from the system, also to permit system control pressure differentials.

$$P_i = P_h + P_s$$

The minimum value of P_i should be 0.7 bar.

6) The final system design pressure (P_f) in bar gauge. This pressure has to be less than the set pressure of the safety valve by 0.3 bar.

7) The design acceptance factor (a):

$$a = \frac{(P_f + 1) - (P_i + 1)}{P_f + 1}$$

where $P_f + 1$ and $P_i + 1$ expresses P_f and P_i respectively in absolute units.

b) The total vessel volume (V_t) in L, can now be calculated from:

$$V_t = \frac{V_a}{a}$$

where $V_a = V_s \times e$

To allow for contingencies and operational variances a margin should be added. It is recommended that this should be at least 10 %. The vessel selected needs to have a volume equal to or greater than the final vessel volume (V_t + 10 %).

Table 3 — Expansion percentages (e) for various system flow temperatures. Base temperature 4 °C

$$e = \left(\frac{V_a}{V_s}\right) 100$$

System flow temperature, t_f	Expansion percentage, e
°C	%
60	1.71
70	2.28
80	2.91
82	3.07
90	3.60
100	4.35
110	5.15

8 System filling and make-up

8.1 System initial fill connection

To facilitate the initial filling of the system a temporary hose connection may be made from a water mains supply in accordance with water byelaws. For protection to the installation when filling from a temporary connection to the mains supply, a non-return valve and an air-inlet valve (see Figure 2) should be incorporated at the point of filling. The temporary hose connection has to be removed after the system has been filled. Care should be exercised to ensure that the fill pressure does not exceed the calculated value of P_i.

8.2 Automatic make-up unit

Automatic make-up may be used to ensure the initial system design pressure is maintained. A separate small pump and associated cold water break tank may be required for the purpose of injecting water into the system to make up for leakage losses, etc. (see Figure 3).

8.3 Semi-automatic make-up

Semi-automatic make-up may be used to ensure that any minor loss of system water is replaced thus enabling the system to operate correctly.

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

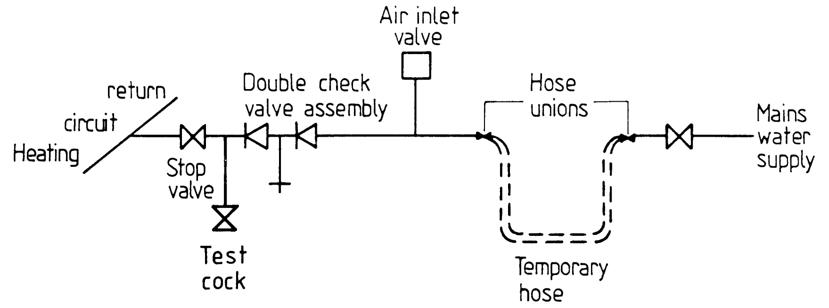
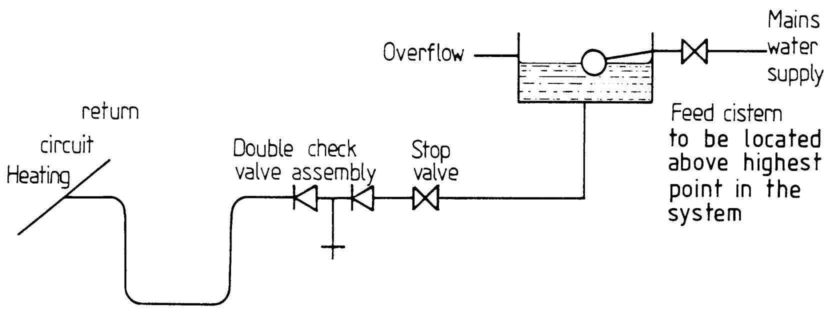
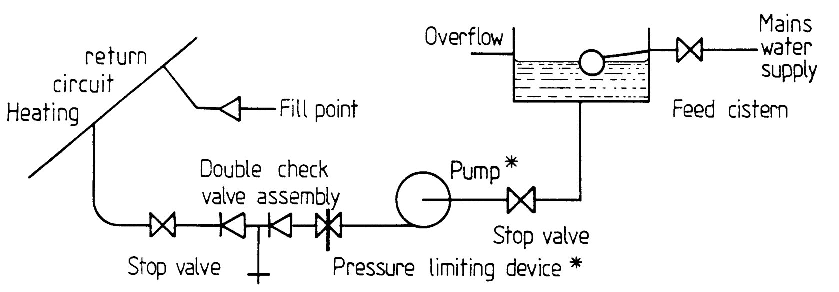


Figure 2 — Non-automatic filling and make-up



(a) Automatic filling and make-up



*For larger installations.

(b) Automatic make-up with pump (for larger installations)

Figure 3 — Automatic filling and make-up

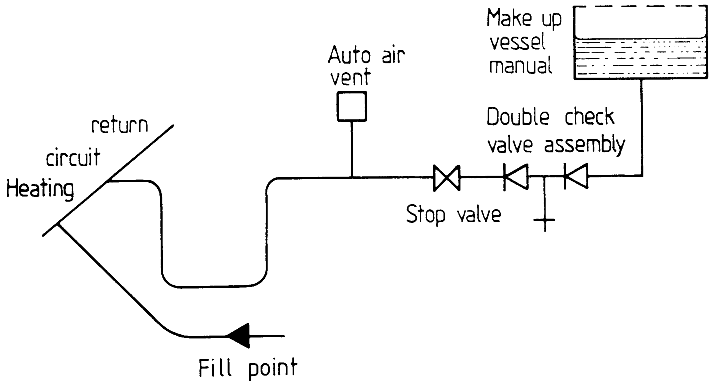


Figure 4 — Semi-automatic make-up

9 Ancillary equipment

9.1 General

For the satisfactory operation of a system containing an expansion vessel certain items of ancillary equipment will need to be incorporated. **9.2** provides a list commentary as appropriate, but does not necessarily comprise a complete control or safety system as may be required for certain projects; neither will every system need to incorporate all the ancillaries listed.

Ancillaries may be combined; when this is done the composite needs to be designed to meet the higher requirements of the individual items included.

All ancillaries should, where practicable, be so constructed that they fail safe.

All ancillaries should comply with any relevant British Standards or water byelaws.

9.2 Components

9.2.1 *Safety valve*. A device to ensure that the pressure in the system does not exceed a predetermined level.

9.2.2 *Pressure gauge*.

9.2.3 *Thermometer*.

9.2.4 *High pressure switch*. A device that causes the boiler or heat source to shut off when a predetermined maximum system pressure is reached. The pressure at which this switch operates should not be less than 0.3 bar below the safety-valve pressure setting. A manual reset may be incorporated.

9.2.5 *Low pressure switch*. A device that causes the boiler or heat source to shut off when a predetermined minimum system pressure is reached.

9.2.6 *Heat generator thermostat*. A device to control the heat generator operating temperature. The thermostat setting should provide a margin below the temperature of saturated steam corresponding to the pressure at the highest point of the circulating system.

9.2.7 *High limit thermostat*. A device with manual reset (not necessarily incorporated in the instrument) that causes the heat generator or heat source to shut off when a predetermined maximum system water-flow temperature is reached. The temperature for this switch should not be less than 6 °C above the setting of the heat generator thermostat.

9.2.8 *Air separator*. A device that separates air and other gases from suspension in the system water.

9.2.9 *Automatic air vent*. A device that automatically allows air to be vented from a part of a system. Hygroscopic devices are not recommended.

9.3 Constructional details

Ancillaries should be selected from those constructed of corrosion-resistant material of adequate strength.

All fastenings should comply with relevant standards.

All electrical wiring and equipment should comply with the detailed requirements of the Regulations for the Electrical Equipment of Buildings (published by the Institution of Electrical Engineers), or be in accordance with appropriate regulations.

Dials or scales, where fitted, should be clearly visible.

9.4 Mounting and positioning

Clear instructions regarding installation and operation should be included with each ancillary.

9.5 Marking

Each ancillary item should carry the following information:

a) manufacturer's or agent's name or symbol;

b) serial number or batch number where practicable;

c) temperature rating or pressure rating where appropriate;

d) electrical rating where appropriate;

e) indication of year of manufacture;

f) the number of the relevant British Standard where applicable.

Section 3. Hot water supply systems

10 General

For the design and installation of unvented domestic hot water supply systems attention is drawn to the British Board of Agrément method of assessment and testing document for this subject. Document "(Method of Assessment and Testing) M.O.A.T. No. 38, 1936".

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Publications referred to

BS 4814, *Specification for expansion vessels using an internal diaphragm, for sealed hot water heating systems.*

HMSO — Model water Byelaws.

Institution of Electrical Engineers — Regulations for the Electrical Equipment of Buildings.

British Board of Agrément — Method of Assessment and Testing.

BSI — British Standards Institution

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