
British Standard

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

Part 2. Code of practice for low and medium temperature hot water heating systems

Utilisation, choix et installation des vases d'expansion et équipements auxiliaires des circuits
d'eau fermés

Partie 2. Systèmes de production d'eau chaude à moyenne température pour le chauffage —
Code de bonne pratique

Anwendung, Auswahl und Einbau von Ausdehnungsgefäßen und Zubehör für Systeme mit
geschlossenem Wasserkreislauf

Teil 2. Leitfaden für Warmwassererzeugungssysteme für niedrige und mittlere Temperaturen

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*.

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.

*Planned.

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Section one. General

1 Scope

This Part of BS 7074 gives recommendations on the application of expansion vessels complying with BS 4814 and having a maximum pressure of 7 bar* for use in hot water heating systems. It includes description, design considerations and application.

Sections one and two cover low temperature systems in which the flow temperature does not exceed 100 °C.

Sections one and three cover medium temperature systems in which the flow temperature does not exceed 120 °C.

Recommendations are also given on:

- (a) the application and use of ancillary equipment and
- (b) testing, commissioning and maintenance.

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 closed valve head. The maximum head developed by a pump under a no-flow condition.

2.3 design acceptance factor (a). The ratio of the volume of water due to expansion, to total vessel volume.

2.4 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.

2.5 expansion percentage (e). The expansion percentage increase in volume when water is heated to maximum design system temperature.

2.6 expansion volume (V_a). The increase in volume of water due to expansion of water when heated to the maximum design system temperature.

2.7 final system design pressure (P_f). The pressure occurring at the mid-height of the expansion vessel at the maximum design system temperature.

2.8 initial cold water fill temperature (t_i). The basic reference temperature is taken to be 4 °C.

2.9 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.

2.10 lowest working pressure component (LWPC). The component having the lowest working pressure in the system.

2.11 maximum acceptance factor (A). The ratio of maximum acceptance volume of the system to total volume.

2.12 maximum acceptance volume (V). The volume of water which the vessel may be allowed to contain.

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

2.14 maximum vessel working pressure. The maximum pressure that the vessel may be allowed to contain in operation.

2.15 pressure depth (P_d). The vertical distance between the component being considered and the mid-height of the expansion vessel situated above it.

2.16 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.

2.17 safety valve set pressure (P_{max}). The pressure at which the safety valve is set for operation.

2.18 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.

2.19 system flow temperature (t_f). The maximum designed temperature of the water circulating in the system.

2.20 total system volume (V_s). The total volume of water in the complete system.

2.21 total vessel volume (V_t). The volume occupied by gas/air when the vessel is empty of water.

2.22 pressure allowance (P_a). The pressure allowance added to the pressure at the highest point in the system to prevent flashing to steam.

*1 bar = 10^5 N/m² = 100 kPa.

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
P_a	Pressure allowance	bar gauge
V_s	Total system volume	L
V_t	Total vessel volume	L

4 Connection of expansion vessel to the system

4.1 General

The neutral point of the system is the point of connection of the pipework to the expansion vessel. It is recommended that the expansion vessel is in the system return pipework close to the heat generator (exchanger). The filling position should be into the expansion pipework.

The point of connection of the expansion vessel(s) into the system having been clearly defined, the physical location of the vessel can be anywhere.

4.2 Location of pump relative to expansion vessel

4.2.1 General. When the pump in the heating system is not operating the only pressure existing varies between P_i and P_f depending upon the water temperature. When the pump is started the pressure within the system will change from its original condition to a completely new set of pressure conditions. This new pressure condition is defined as the pump head and is indicated by the pressure drop between the suction and discharge of the pump. The pressure at the pump discharge will be higher than the system pressure at the pump suction by an amount equal to the

pump head. The pressure drop due to friction within the system will gradually decrease the system pressure from that existing at the pump discharge to the lower pressure existing at the pump suction.

With the pump running, the system pressure will change generally as illustrated in figures 1, 2 and 3. Attention is drawn to the point of no pressure change being relative to the point of connection of the expansion vessel into the system.

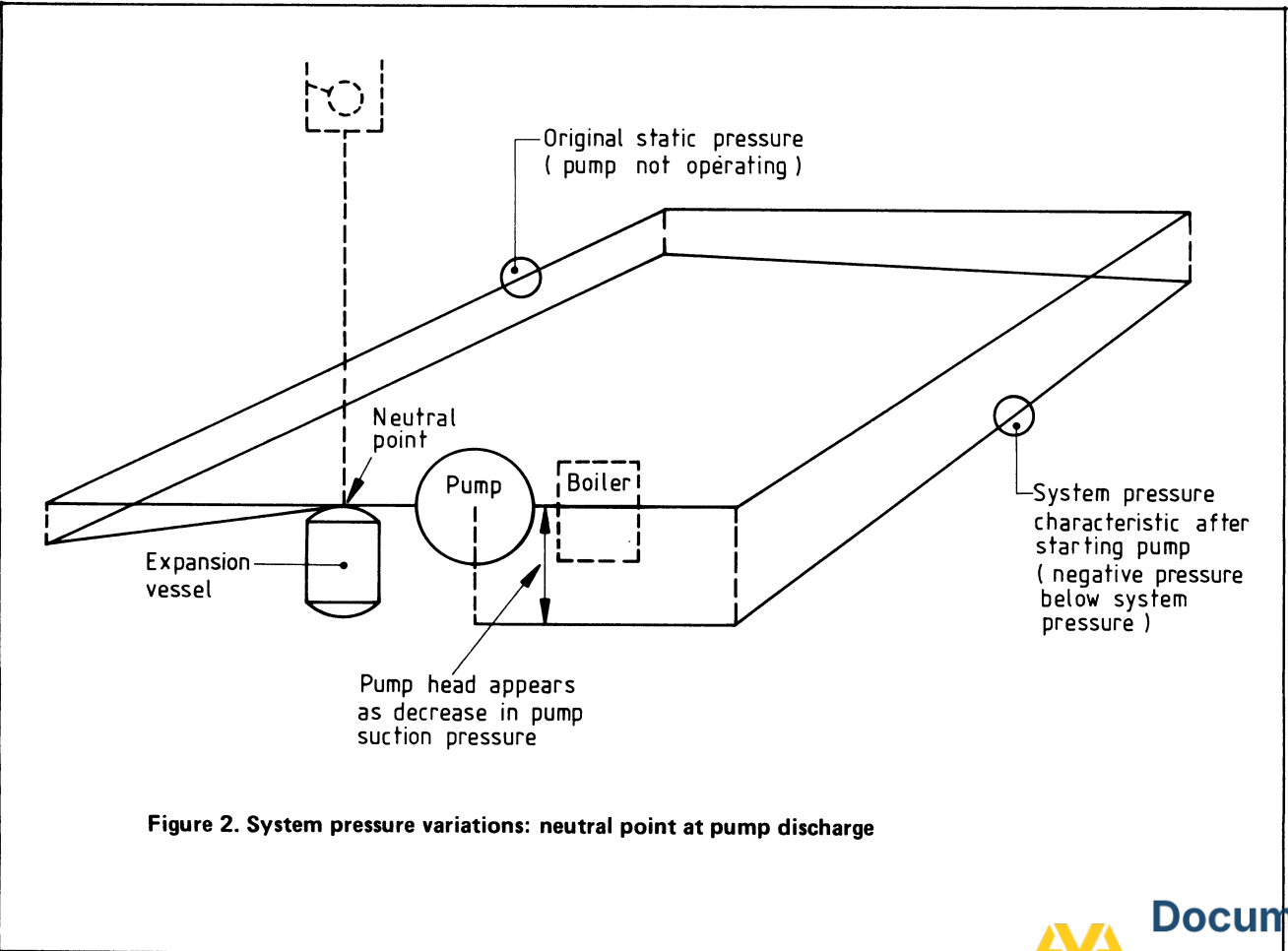
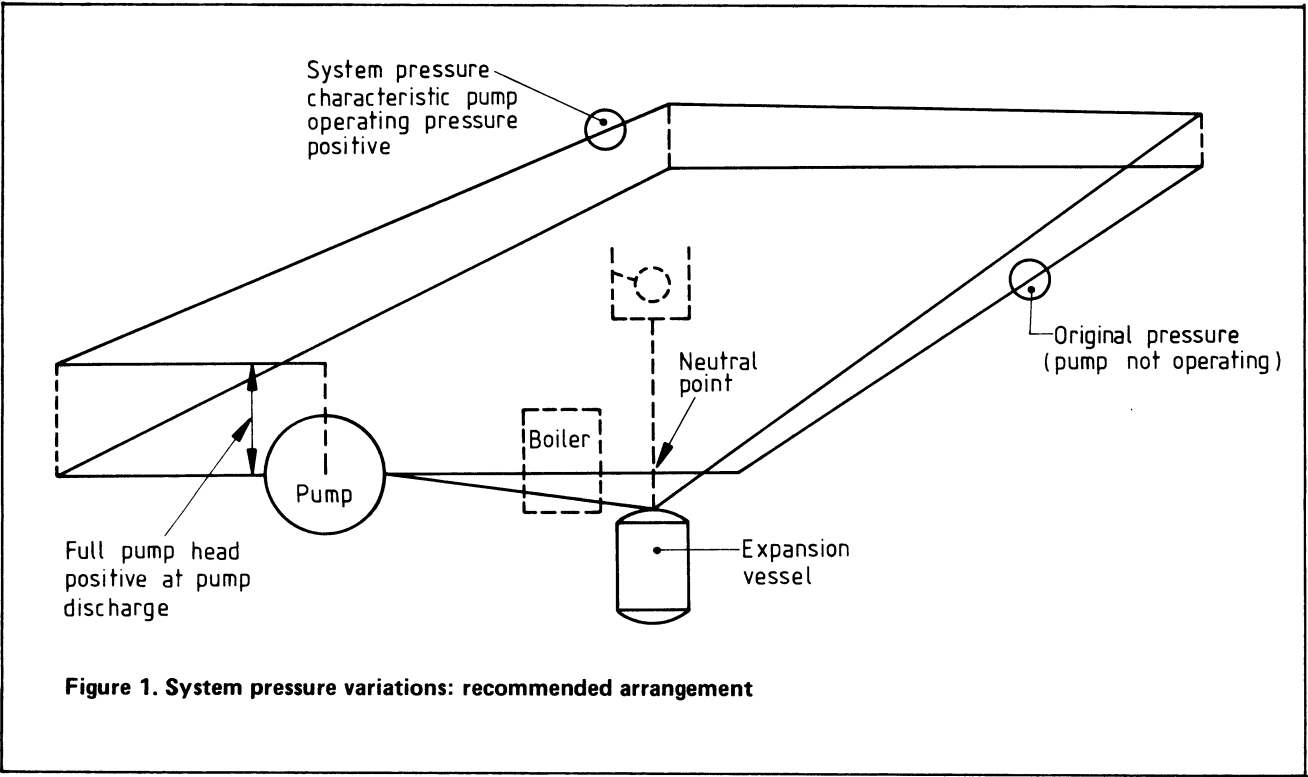
The pump only has the ability to create the pressure difference across itself and therefore there is no reason why the full pump head should not appear on its suction side as shown in figure 2. It will be noted that the position of no pressure change (the neutral point) is different from that shown in figure 1. By dictating the point of no pressure change (the neutral point), system pressure changes by pump operation can be controlled. In figure 3, where the neutral point has been changed once again, a new set of pressure characteristics pertain.

4.2.2 Neutral point. The point of no pressure change, or the neutral point, is that point where the expansion vessel is connected to the system. This is because the air gas cushion in the expansion vessel follows basic gas laws and the change in gas pressure has to be accompanied by a change in gas volume. A change in gas volume in the vessel has to be accompanied by a change of water volume in the vessel.

It follows that a change in water volume in the vessel has to be accompanied by a change of water volume in the system; since water is incompressible, pump operation cannot increase or decrease the system water volume, therefore pump operation cannot change vessel pressure. Since vessel pressure cannot change due to pump operation, the junction of the expansion vessel with the system has to be a point of no pressure change regardless of whether or not the pump operates.

4.2.3 Neutral point at pump suction. Figure 1 illustrates a system in which the neutral point is located at the pump suction. The pressure changes caused by pump operation are therefore added to the original system pressure. Because all system pressure changes are additive and positive, there is no possibility of pump cavitation or air being drawn into the system.

4.2.4 Neutral point at pump discharge. Figure 2 shows a system where the point of no pressure change is located at the pump discharge. All pressure changes caused by pump operation are subtracted from the original pressure and are of a negative type; under certain conditions this can cause unsatisfactory results. If the pressure decrease below the original pressure is great enough, system pressure could drop to the boiling point, circulation will be unstable and pump cavitation can occur with a resultant pump failure. If the pressure drops below atmospheric pressure, air can be sucked in at the vent, air pockets are created and circulation blocked. It is strongly recommended therefore that the neutral point should not be located at the pump discharge.



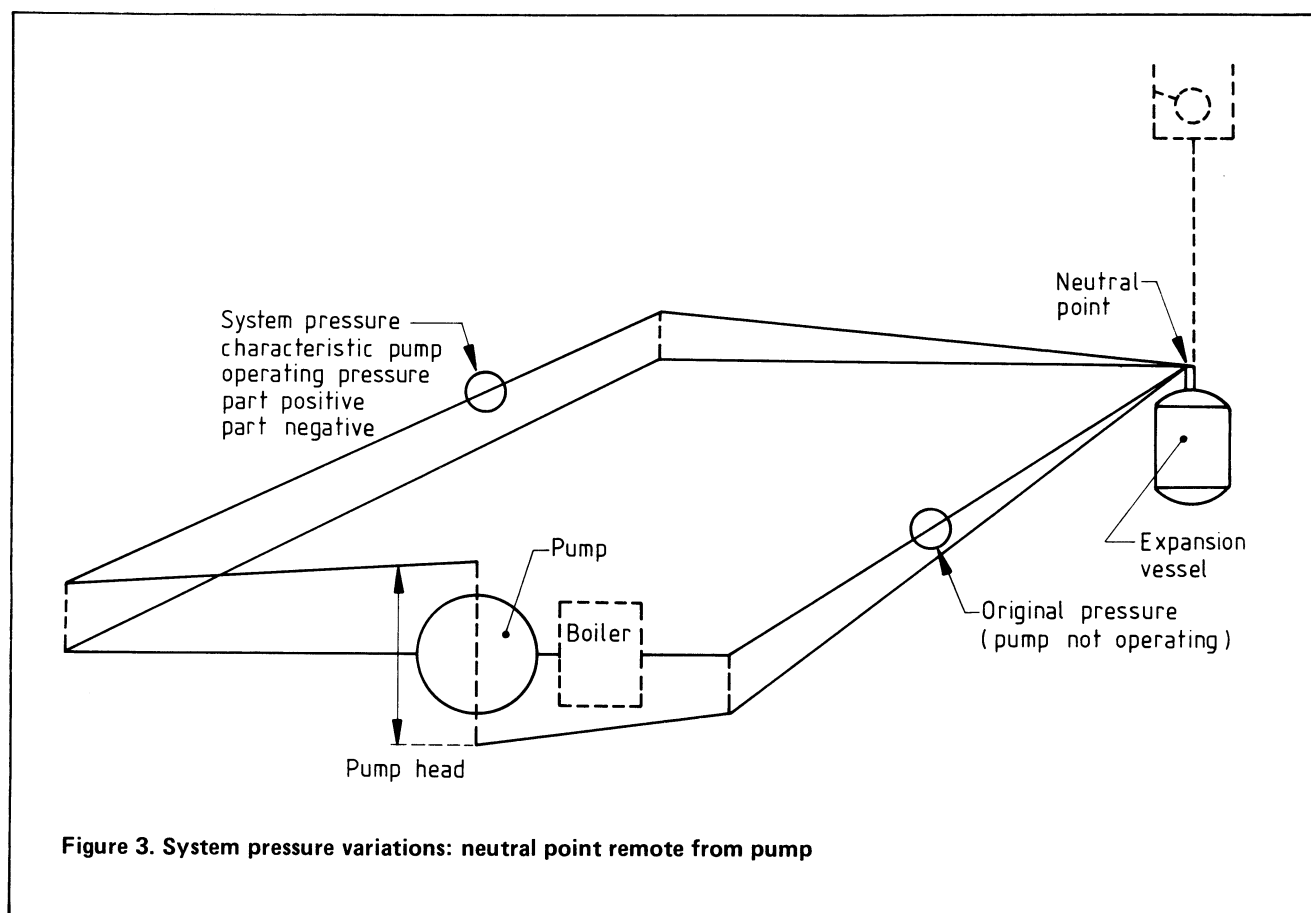


Figure 3. System pressure variations: neutral point remote from pump

4.2.5 Neutral point remote from pump. By locating the expansion vessel at some distance from the pump, the system pressure change due to pump operation would appear as shown in figure 3. The expansion vessel junction would be the neutral point and all pressure system changes would be referred from that point. Pressure gauge readings at the pump suction and discharge would show partially positive and partially negative readings with reference to the original non-operating pressure condition. The pressure changes would be a function of the system pipe friction pressure-drop between the pump and the vessel. When using expansion vessels located at some distance from the pump, perhaps adjacent to the hot water cylinder or in the roof space, it is suggested that the pump should be on the flow from the boiler, providing minimum friction pressure-drop between the vessel and the boiler inlet. It is emphasized that the problems created in systems where the neutral point is such that the pump head is all under suction (figure 2), are more likely to occur in higher head pump systems. Therefore in dealing with micro-bore systems it

is important that the relative position of the neutral point and pump be fully understood in order that the most satisfactory system operation can be effected.

4.2.6 Recommended arrangement. If the expansion vessel is placed at the suction side of the pump, the suction pressure will not change regardless of whether or not the pump is operated; because the pump suction cannot change, the pump discharge pressure has to change. The pump differential head is then manifested as a positive increase in pressure at the pump discharge as shown in figure 1. The pressure increase due to pump head will then decrease around the system, depending upon the various friction losses in the system, until at the pump suction the original pressure is obtained. Because the pump suction pressure is unchanged due to pump operation it is suggested that the boiler be located at the pump suction; this is the recommended relative arrangement of pump, boiler and expansion vessel within a system.

5 Testing and commissioning

5.1 Pressure testing the system

Expansion vessels, pressure switches, safety valve(s) and fill unit have to be isolated prior to hydraulic pressure testing. This is to ensure that these components are not damaged by over pressurization.

5.2 Commissioning

The recommended procedures given in the Chartered Institute of Building Services Engineers (CIBSE) Commissioning Codes should be followed for the system. The operation of the low and high pressure alarm switches should be checked. The system should be allowed to cool and then be partially drained to allow the pressure to drop such that the setting of the low pressure switch can be checked. Then the system should be allowed to return to ambient temperature. The filling unit should be started and pressure raised to check the high pressure switch.

The pressure should then be reduced to a pressure consistent with the ambient temperature. This is best carried out when the expansion vessel has been isolated, which reduces the volume of water necessary to raise the pressure.

6 Maintenance

Maintenance instructions provided by the manufacturers of the equipment installed should be closely followed. These should be handed to the user.

7 Workmanship

Work on sealed systems as described in this Part of this code of practice should be carried out by competent persons.