Drinking water supply systems

Pressure boosting and reduction (DVGW Code of practice)

DIN 1988 Part 5

Technische Regeln für Trinkwasser-Installationen (TRWI); Druckerhöhung und Druckminderung (Technische Regel des DVGW)

This standard, together with DIN 1988 Parts 1 to 4, and Parts 6 to 8, December 1988 editions, supersedes DIN 1988, January 1962 edition.

In keeping with current practice in standards published by the International Organization for Standardization (ISO), a comma has been used throughout as the decimal marker.

This standard has been prepared in agreement with *DVGW Deutscher Verein des Gas- und Wasserfaches e.V.* (German Society of Gas and Water Engineers). It has been included in the body of DVGW Codes of practice for water.

Contents

1 Scope and field of application

This standard, in conjunction with DIN 1988 Parts 1 to 4 and Parts 6 to 8, applies to the design, installation, modification, maintenance and operation of drinking water supply systems ('supply systems', for short) inside buildings and their curtilages. It gives criteria for the installation of pressure boosting and reducing appliances and includes specifications for their design and installation, the aim being to ensure safe and economic operation of the supply systems.

2 Quantities, symbols and units

The quantities, symbols and units used are defined in table 1 and in DIN 1988 Part 3, the graphical symbols being taken from DIN 1988 Part 1.

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Table 1. **Quantities, symbols and units**

Term	Symbol	Unit	Definition
Effective volume of break cistern	V_B	m^3	Effective volume of atmospheric cistern upstream of boosting pumps
Total volume of upstream pressure vessel	V_V	m^3	Total volume of pressure vessel upstream of boosting pumps
Total volume of downstream pressure vessel	V_E	m^3	Total volume of pressure vessel downstream of boosting pumps
Maximum flow rate a)	$\dot{V}_{max\ P}$	l/s or m^3/h	Maximum volume of liquid delivered by a pressure booster per unit time
b)	$\dot{V}_{max\ L}$	l/s or m^3/h	Maximum volume of compressed air supplied by a compressor per unit time to generate and maintain the air cushion in the pressure vessel
Maximum supply pressure	$p_{max\ V}$	bar, mbar or Pa	Maximum static pressure at junction of service pipe and public water main (according to information provided by public water supplier)
Minimum supply pressure	$p_{min\ V}$	bar, mbar or Pa	Minimum static pressure at junction of service pipe and public water main (according to information provided by public water supplier)
Minimum flow pressure	$p_{min\ Fl}$	bar, mbar or Pa	Static pressure required to achieve the minimum flow rate at a draw-off fitting that still permits it to fulfil its function
Head loss due to difference in elevation	Δp_{geo}	bar, mbar or Pa	$\Delta p_{geo} = h_{geo} \cdot g \cdot \varrho$
Available inlet pressure	p_{outlet}	bar, mbar or Pa	Minimum static pressure upstream of boosting pumps
Design outlet pressure	p_{inlet}	bar, mbar or Pa	Sum of all design pressure and head loss components downstream of boosting pumps
Pump pressure	Δp_P	bar, mbar or Pa	Difference between downstream (outlet) and upstream (inlet) pressure of boosting pumps at maximum flow rate, $\dot{V}_{max P}$
Switching-on pressure	p_E	bar, mbar or Pa	Static pressure which starts the pump(s) of a pressure-controlled booster
Switching-off pressure	p_A	bar, mbar or Pa	Static pressure which stops the pumps of a pressure-controlled booster
Switching pressure differential	$\Delta p_{(A-E)}$	bar, mbar or Pa	Difference between switching-off and switching-on pressure
Switching frequency	s	1/h	Number of switching cycles (i.e. starts and stops) of a boosting pump per hour

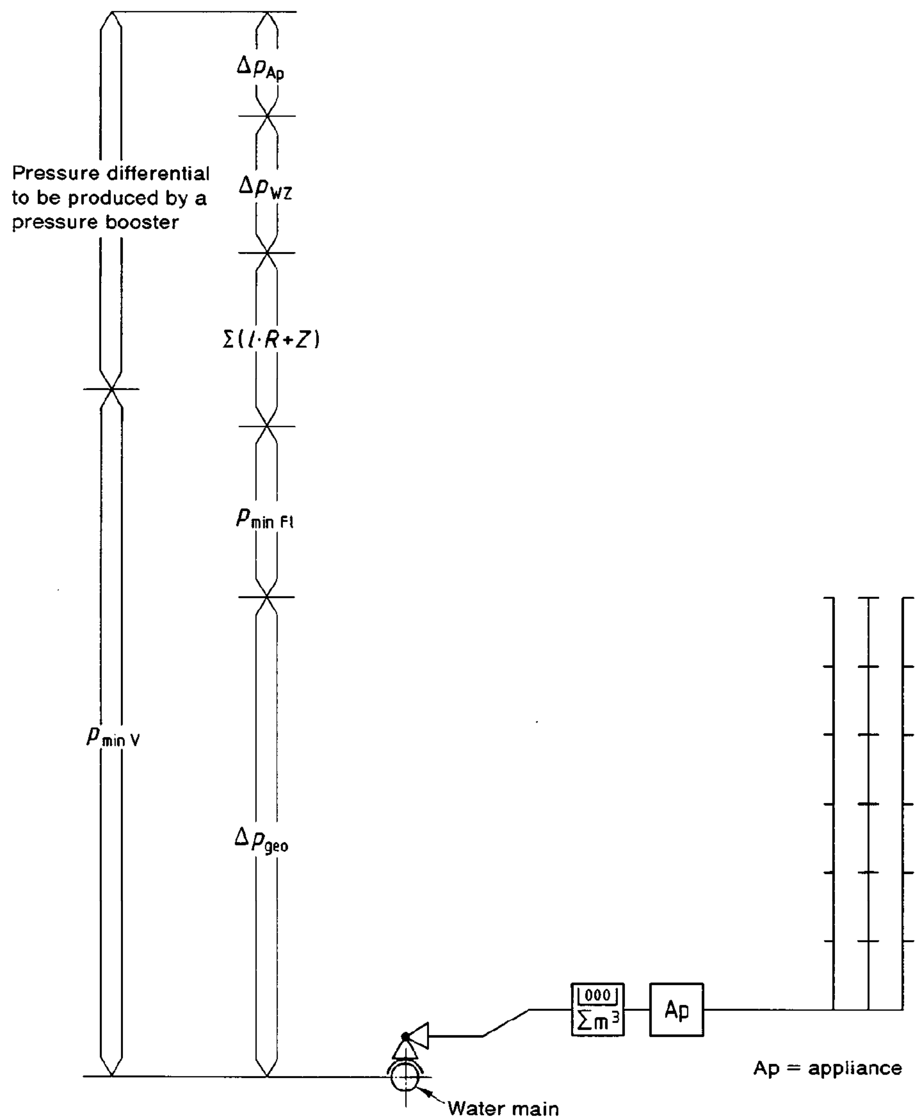

Figure 1. Representation of pressure and head loss components in a supply system

3 Design considerations

3.1 Pressure boosting

Installation of a pressure booster ('booster', for short) is required where the minimum supply pressure, $p_{min\,V}$, in bar, is less than the sum of minimum flow pressure at the worst-case draw-off point, $p_{min\,FL}$, and total head losses from difference in elevation, Δp_{geo}, pipe and fittings resistance $\sum(l \cdot R + Z)$, water meter resistance, Δp_{WZ}, and resistances in appliances (e.g. filters, dosing apparatus), Δp_{Ap}, i.e.

$$p_{min\,V} < \Delta p_{geo} + p_{min\,Fl} + \sum (l \cdot R + Z) + \Delta p_{WZ} + \Delta p_{Ap} \quad (1)$$

An example of the pressure conditions requiring installation of a booster is illustrated in figure 1.

3.2 Pressure reduction

A pressure reducing valve shall be installed where the maximum supply pressure, $p_{max\,V}$, or the outlet pressure, p_{outlet}, is likely to rise above the permissible working pressure of appliances, valves and connected systems (cf. subclause 5.1).

3.3 Combinations

Where there is a considerable difference between minimum and maximum supply pressure to properties or buildings (e.g. more than 1 bar), the installation of both pressure reducing valves and boosters may be necessary.

4 Pressure boosters

Pressure boosters shall be designed, operated and maintained so as to ensure continuous and safe operation of the supply system and not to adversely affect the public water supply or connected systems and the quality of the water.

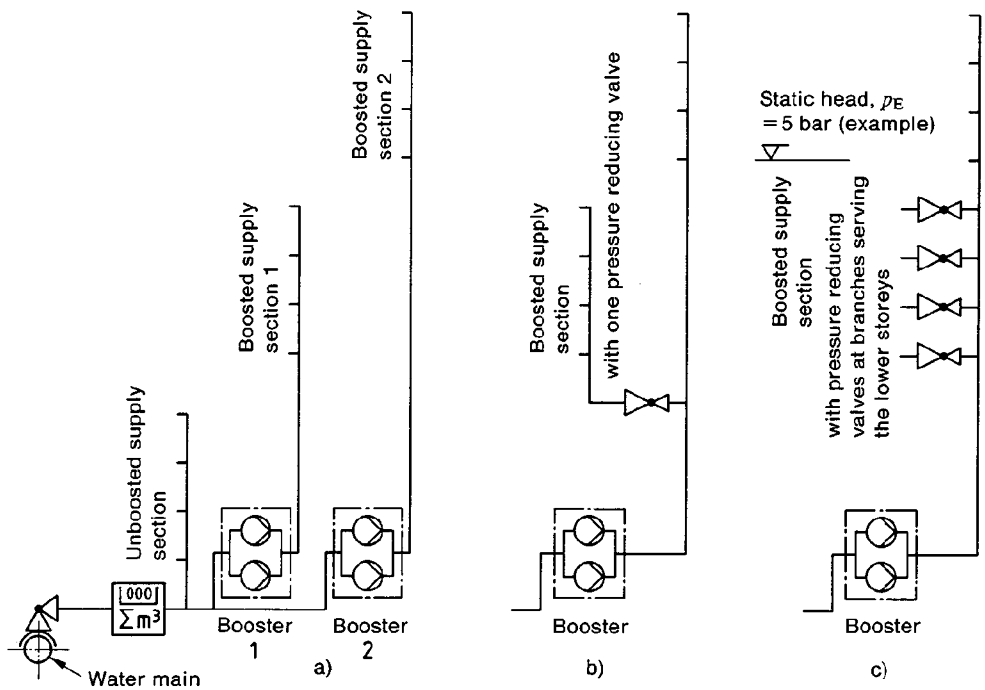

Figure 2. Booster configurations

4.1 Supply sections

It shall be checked whether boosters are required for the whole building or only for those storeys which cannot be constantly supplied with the minimum supply pressure. Where this cannot be clearly established, the need for the provision of a booster is to be checked using the detailed calculation method described in DIN 1988 Part 3.

Where more than one section is to be served with boosted supply, the booster configurations may be as follows:

a) one booster for each section to be served (cf. figure 2 a));

b) one booster serving a number of sections, with one pressure reducing valve per section (cf. figure 2 b));

c) one booster serving a number of sections with one pressure reducing valve per lower storey (cf. figure 2 c)).

4.2 Determination of maximum design flow rate

4.2.1 Drinking water supply systems

The maximum design flow rate, $\dot{V}_{\max P}$ (equal to peak flow rate, $\dot{V}_S$), of boosters of drinking water supply systems shall be calculated as specified in DIN 1988 Part 3. For residential buildings, calculation may be based on a total flow rate per flat of 2,0 l/s (2).

4.2.2 Fire fighting systems

Calculation of the maximum flow rate of booster for fire fighting systems shall be based on the design flow rate of these systems.

4.2.3 Boosters serving both drinking water supply and fire fighting systems

Where boosters are to serve both drinking water supply systems and fire fighting system, their maximum flow rate shall be calculated in accordance with both subclause 4.2.1 and 4.2.2, and be assumed to be equal to the higher value.

4.3 Determination of pump pressure

Assuming that the pipe parameters (e.g. material, nominal size) are known, the pump pressure, Δp_P, in bar, is to be obtained by deducting the minimum supply pressure, $p_{\min V}$, from the sum of minimum flow pressure at the worst-case draw-off point, $p_{\min FL}$, and total head loss from difference in elevation, Δp_{geo}, pipe and fittings resistances, $\sum(l \cdot R + Z)$, water meter resistance, Δp_{WZ}, and resistances in appliances, Δp_{Ap}, i.e.:

$$\Delta p_P = [\Delta p_{geo} + p_{\min Fl} + \sum(l \cdot R + Z) + \Delta p_{WZ} + \Delta p_{Ap}] - p_{\min V} \quad (3)$$

Where booster configuration and design outlet pressure are known, the pipework downstream of the booster shall be sized on the basis of the service pipe parameters (material, nominal size), head loss in the water meter and the minimum supply pressure as stated by the public water supplier.

In these cases, the pump pressure, in bar or mbar, should be calculated from outlet pressure and inlet pressure at peak flow rate, $\dot{V}_S$, using equation (4):

$$\Delta p_P = p_{outlet} - p_{inlet} \quad (4)$$

4.3.1 Design outlet pressure

The design pressure downstream of the boosting pumps, p_{outlet}, in bar or mbar, shall be calculated as the sum of the head loss due to difference in elevation in the pipework between booster and worst-case draw-off point, $\Delta p_{geo, outlet}$, the minimum flow pressure at the worst-case draw-off point, $p_{\min Fl}$, the total head loss due to pipe and fittings resistances (including losses in valves, pipe joint assemblies, tank inlets and outlets), $\sum(l \cdot R + Z)_{outlet}$, and resistances in appliances downstream of the booster, i.e.:

$$p_{outlet} = \Delta p_{geo, outlet} + p_{\min Fl} + \sum(l \cdot R + Z)_{outlet} + \Delta p_{Ap, outlet} \quad (5)$$

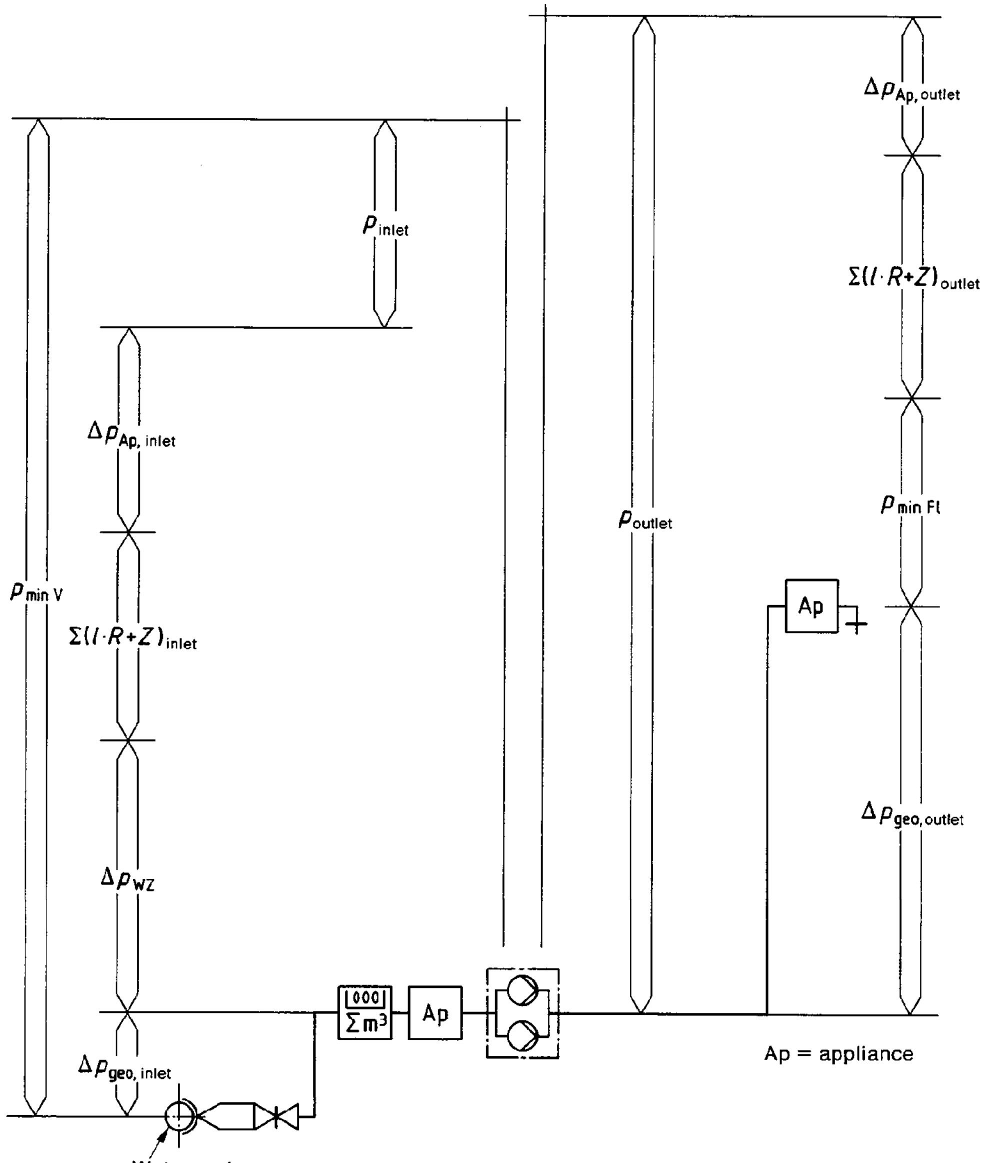

Figure 3. Representation of pressure and head loss components upstream and downstream of booster in a supply system

An estimation of the total head loss due to pipe and fittings resistances, $\sum(l \cdot R+Z)$, in the pipework downstream of the booster may be based on the values given in table 2.

Table 2. **Mean head loss for a given pipe run**

Length of pipe run to worst-case draw-off point, $\sum l_{\text{outlet}}$, in m	Mean head loss in distributing pipes, in mbar/m $\frac{\Delta p}{l} = \frac{(l \cdot R + Z)_{\text{outlet}}}{\sum l_{\text{outlet}}}$
≤ 30	20
$> 30 \leq 80$	15
> 80	10

4.3.2 Available inlet pressure

The minimum static pressure upstream of the pumps of a pressure booster, p_{inlet}, in bar or mbar, is to be obtained by deducting the sum of total head loss due to differences in elevation, $\Delta p_{\text{geo, inlet}}$, pipe and fittings resistances (including losses in valves, pipe joint assemblies, tank inlets and outlets), $\sum(l \cdot R + Z)_{\text{inlet}}$, water meter resistance, Δp_{WZ}, and resistances in appliances upstream of the pressure booster, $\Delta p_{\text{Ap, inlet}}$, from the minimum supply pressure, $p_{\text{min V}}$, i.e.:

$$p_{\text{inlet}} = p_{\text{min V}} - [\Delta p_{\text{geo, inlet}} + \Delta p_{\text{WZ}} + \Sigma(l \cdot R + Z)_{\text{inlet}} + \Delta p_{\text{Ap, inlet}}] \quad (6)$$

4.3.3 Siting of booster

The pump pressure is not a function of the location of a booster in a supply system (cf. figure 4). However, to avoid unacceptable pressures in the system, boosters shall be located at a height where p_{inlet} remains at a level exceeding 0,5 bar and sufficient to ensure that p_{outlet} does not exceed 10 bar.

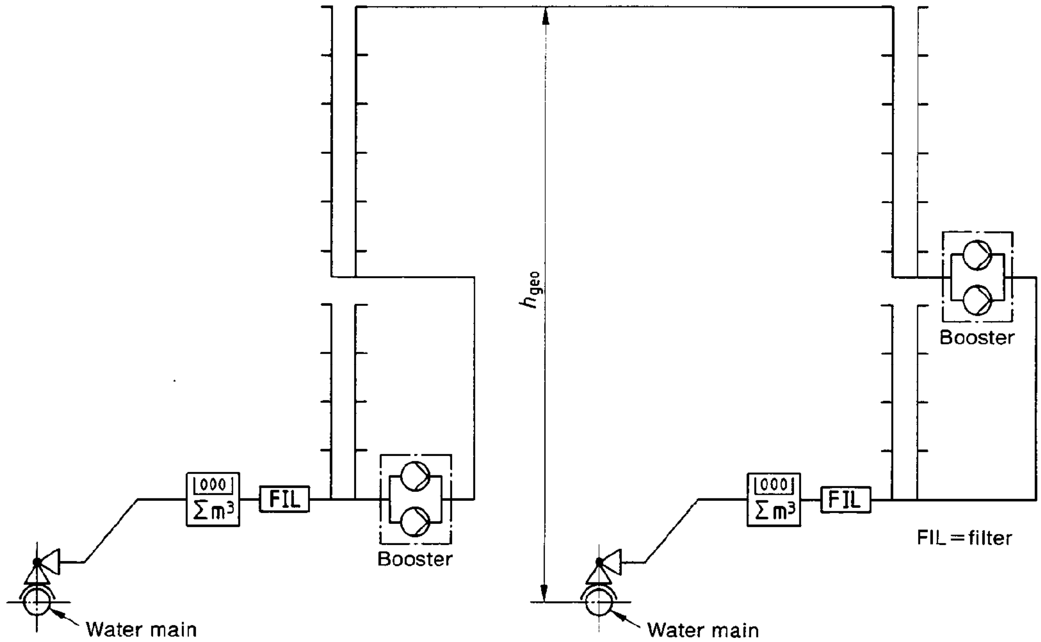

Figure 4. Location of boosters without pressure vessel (examples)

For boosters with downstream pressure vessel, it should be taken into account that the location of the vessel may influence the pressure which starts and stops pumping.

Where pressure vessel and pumps are installed as a packaged set, i.e. at the same level, the switching-on pressure, p_E, is equal to p_{outlet}. Where the vessel is at a higher level than the pumps, p_E is reduced by the head loss due to difference in elevation between pumps and vessel and the total head loss due to pipe and fittings resistances in the pipe runs between pumps and vessel.

Unless particular technical advantages (e.g. pressure reducing valve for pressure vessel may be dispensed with) are offered by installing pressure vessel and boosting pump at different levels, such an installation configuration should be avoided since this would result in servicing and inspection being made more difficult.

4.4 Boosting systems

Pumped systems used to increase the water pressure in a building are classified into direct and indirect boosting systems (cf. figure 5). Depending on the system used, the flow velocities in the service pipe and the distributing pipework serving the booster shall be limited to certain maximum values (cf. table 5 of DIN 1988 Part 3). This is to avoid unacceptable drops in the mains pressure in connected systems as well as pressure surges in service pipes and the distributing pipework of the supply system.

Examples of boosting system arrangements are illustrated in figures 7 to 12.

4.4.1 Direct boosting systems

In direct boosting systems, the booster is directly connected to the service pipe supplied by the water main. Such systems shall be given preference to indirect systems since there is no risk of drinking water contamination owing to the ingress of harmful substances.

Direct boosting without upstream pressure vessel is subject to one of the following conditions being satisfied.

a) The maximum difference in the flow velocities in the service pipe and in the pipe serving the booster, generated by operation of level switches of boosting pumps or of valves is less than 0,15 m/s and does not exceed 0,5 m/s in the event of failure of all pumps, thus avoiding unacceptable pressure surge, even in the case of power failure.

b) The minimum flow pressure does not drop by more than 50% and to a value below 1 bar when the pumps start (cf. figure 6), and the pressure at the downstream end of the service pipe does not exceed the permissible working pressure by more than 1,0 bar when the pumps are switched off (cf. figure 6).

4.4.1.1 Direct boosting without downstream pressure vessel

Direct boosting without downstream pressure vessel is permitted in systems where the pumps are pressure or water flow controlled, without generating pressure surges. The temperature of the water immediately downstream of the pump shall not exceed 25 °C.

Where the conditions specified in item a) or b) of subclause 4.4.1 are not satisfied, a pressure vessel shall be installed upstream of the booster. Otherwise, this may be dispensed with.

The total volume of the pressure vessel shall be determined as described in subclause 4.5.2.2.

4.4.1.2 Direct boosting with downstream pressure vessel

Where the conditions specified in item a) or b) of subclause 4.4.1 are not satisfied, a pressure vessel shall be installed upstream of the booster. Otherwise, this may be dispensed with.

The total volume of the pressure vessel shall be determined as described in subclause 4.5.2.2.

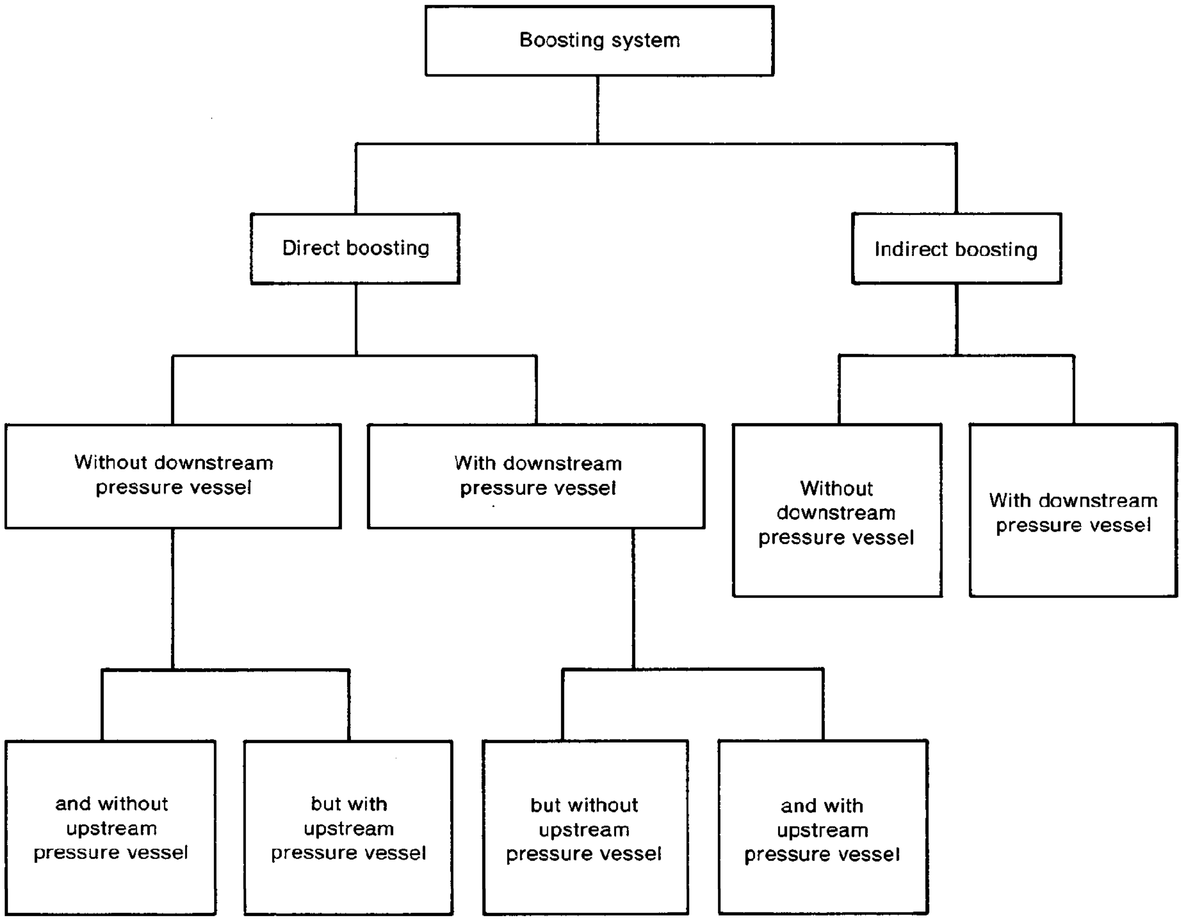

Figure 5. Boosting system arrangements

4.4.2 Indirect boosting systems

In indirect boosting systems, an atmospheric storage cistern (break cistern) to which water is fed via one or more water level controlled valves is installed between the pumping unit and the service pipe. Such systems may be operated with a downstream pressure vessel (cf. figure 12) and are subject to compliance with the requirements specified in subclause 4.4.1.

Indirect boosting systems shall be installed where

a) the minimum flow pressure required at the worst-case draw-off point of connected systems is not achieved owing to the booster operating at the maximum flow rate (taking into account the draw-off in these connected systems);

b) it is intended to connect public and private systems via pipes (cf. DIN 1988 Part 4);

c) the drinking water may come into contact with contaminants (cf. DIN 1988 Part 4).

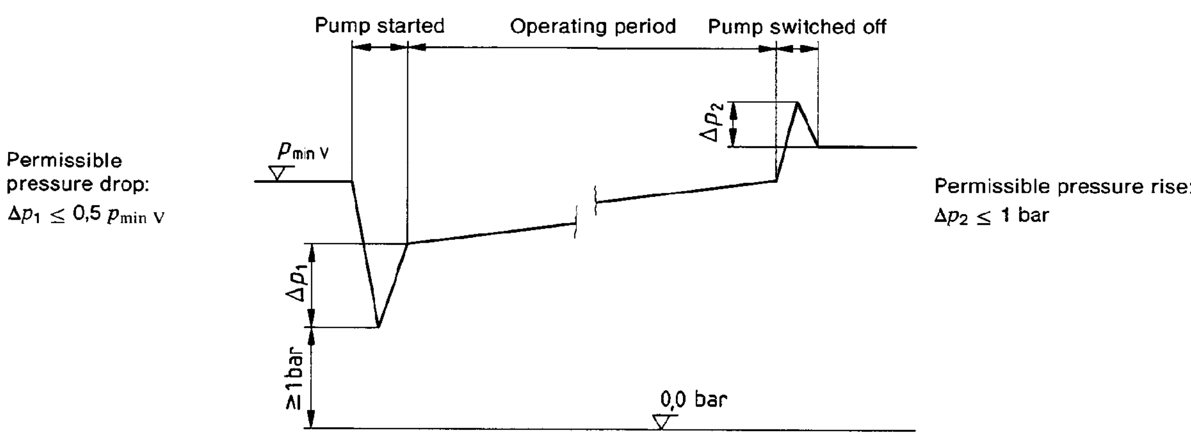

Figure 6. Pressure characteristic at the downstream end of the service pipe when the pumps are started and are switched off

4.5 System components

All system components subjected to pressure shall be rated for an allowable working pressure of 10 bar, unless higher pressures are to be allowed for.

4.5.1 Break cistern

The effective volume of the break cistern, in m^3, is a function of the maximum flow rate and the minimum supply pressure in the water main (i.e. the available pressure upstream of the cistern) and of the peak flow rate, $\dot{V}_S$ ($= \dot{V}_{max\,P}$), in the pipework downstream of the booster.

Where the peak flow rate required for the building cannot be produced from the supply pressure in the water main, determination of the effective volume of the cistern shall be based on the total flow rate. Otherwise, the approximate effective volume may be taken as being equal to 0,03 $\dot{V}_{max\,P}$ (7).

The booster components and the cistern may be located in the same room.

4.5.2 Pressure vessels

Pressure vessels are subject to the stipulations of the *Druckbehälterverordnung* (German Pressure Vessels Regulation).

They shall be made from corrosion-resistant materials or adequately protected against corrosive attack (cf. DIN 50 930 Part 1) and permit the volume of compressed air to be checked (e.g. by providing a level indicator).

4.5.2.1 Total volume of upstream pressure vessel

The approximate total volume of upstream pressure vessel may be determined on the basis of table 3.

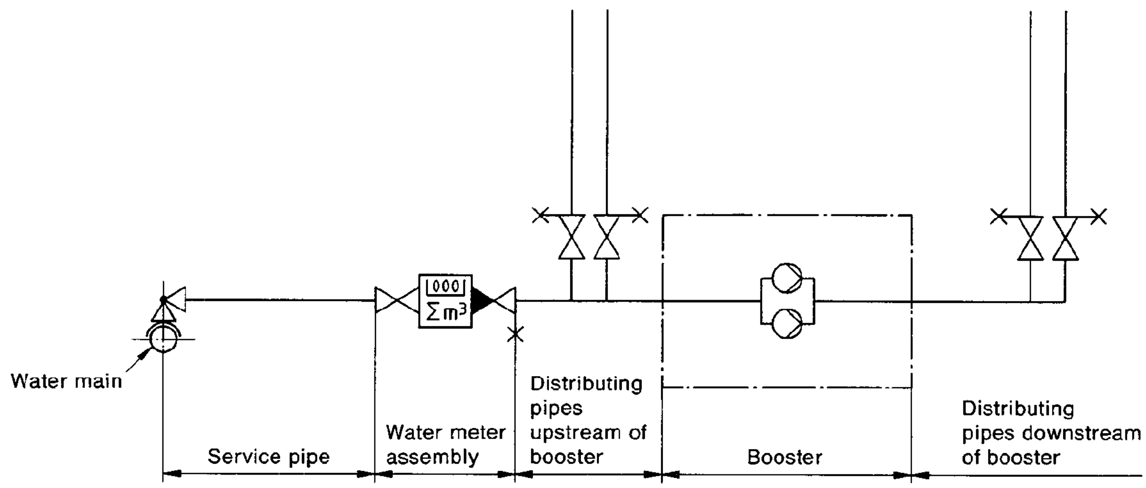

Figure 7. Direct boosting without upstream or downstream pressure vessel

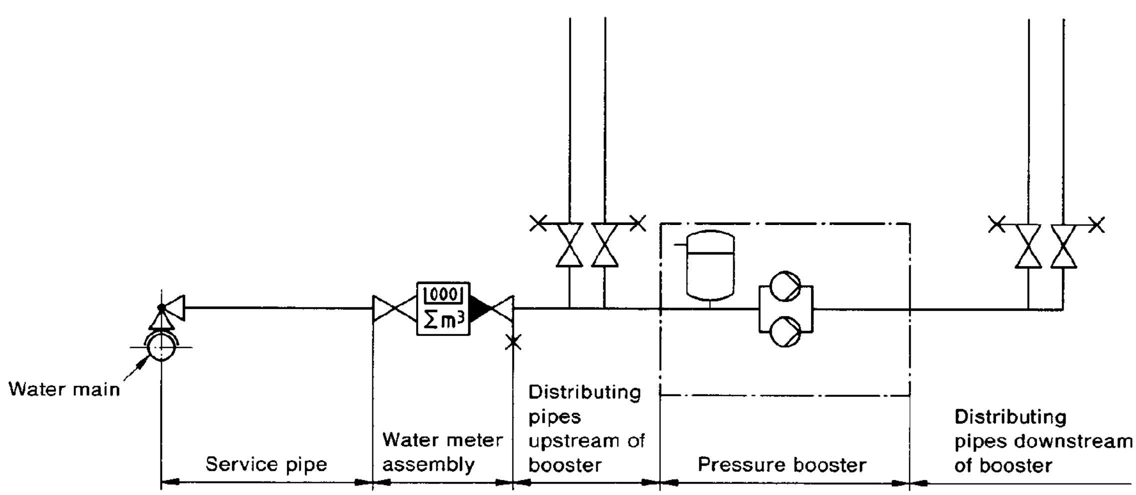

Figure 8. Direct boosting with upstream pressure vessel

Table 3. **Total volume of upstream pressure vessel as a function of maximum flow rate of booster**

Maximum flow rate of pressure booster, $\dot{V}_{max\,P}$, in m^3/h	Total volume of upstream pressure vessel, V_V, in m^3
≤ 7	0,3
$> 7 \leq 15$	0,5
> 15	0,75

The minimum volume shall be 0,3 m^3. For pressure vessels in which the compressed air is separated from water (e.g. by means of a flexible membrane), the total volume may be less than 0,3 m^3 subject to the conditions specified in item b) of subclause 4.4.1 being satisfied.

4.5.2.2 Total volume of downstream pressure vessel

The maximum effective volume of the downstream pressure vessel is utilized by filling it with air so that the water level in the vessel is at least 50 mm above the upper edge of the water outlet when the last pump is started.

The approximate total volume of the pressure vessel, in m^3, may be obtained from equation (8) assuming that 75% of the vessel is filled with air when the pumps are started.

$$V_E = 0{,}33 \cdot \dot{V}_{max\,P} \frac{(p_A + 1)}{\Delta p_{(A\text{-}E)} \cdot s} \qquad (8)$$

where s is less than 20 1/h.

4.5.3 Equipment for generating and maintaining compressed air cushion

The equipment used (e.g. air compressors) shall be such that the pressure vessel is automatically charged with the volume of compressed air necessary for continuous operation of the boosting system [1].

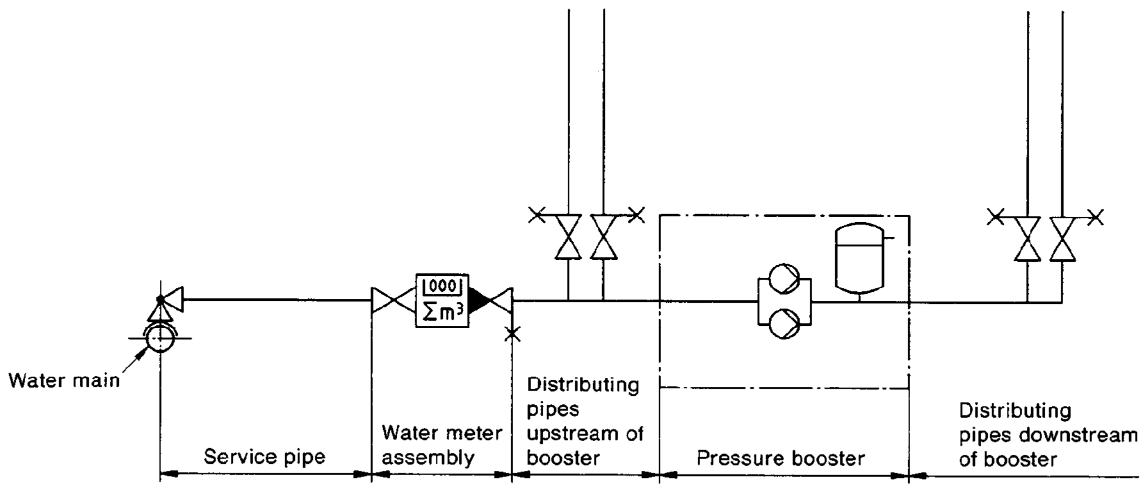

Figure 9. Direct boosting with downstream pressure vessel

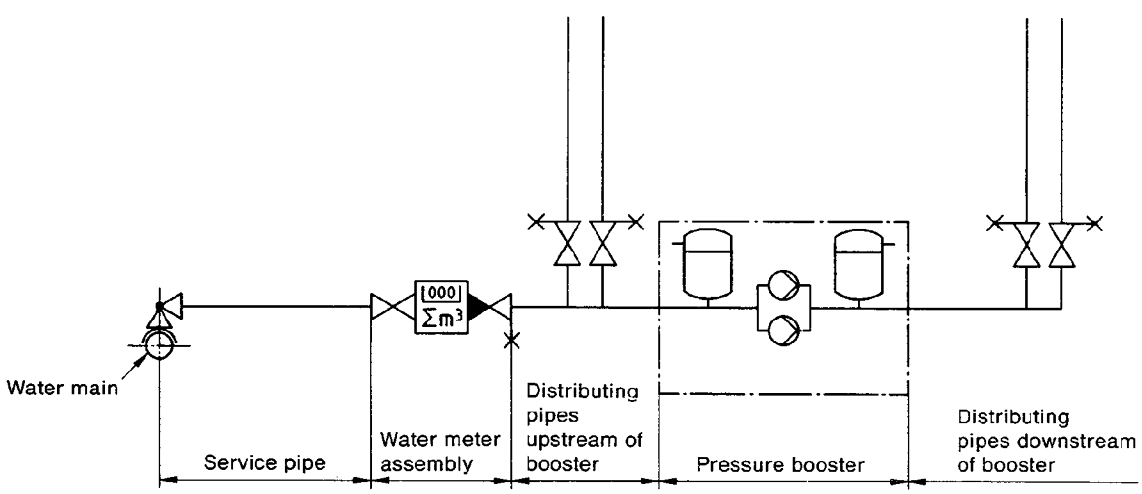

Figure 10. Direct boosting with upstream and downstream pressure vessels

Suitable means shall be provided to ensure that the required air cushion is maintained, use of compressed air cylinders for this purpose not being permitted. At maximum inlet pressure, the water level in both upstream and downstream pressure vessels shall not rise above two-thirds of the vessel height.

Measures shall be taken to prevent the ingress of oil into the air in the vessel.

The approximate maximum flow rate of compressed air, in m^3/h, supplied to generate and maintain the air cushion in the pressure vessel may be obtained from equation (9), assuming that 75 % of the vessel is filled with air when the pumps are started and that it takes three hours to fill the vessel.

$$\dot{V}_{\max L} = 0{,}25 \cdot V_E \cdot (p_E + 1) \quad (9)$$

4.5.4 Pumps

Centrifugal pumps with a stable characteristic (head-capacity curve) shall be used. Self-priming pumps may only be used in indirect boosting systems (cf. subclause 4.4.2).

4.5.4.1 Flow rate, pump pressure and number of pumps

The maximum flow rate, $\dot{V}_{\max P}$, shall be determined as described in subclause 4.2, the pump pressure required, Δp_P, being determined in accordance with subclause 4.3. Pressure boosters shall be provided with at least two pumps of equal size, taking care to ensure that the conditions specified in subclauses 4.4.1 and 4.4.2 are satisfied. Unless otherwise specified, this shall not apply to boosters used only for fire fighting purposes.

Pumps shall be selected so that, in the event of failure of one of the pumps, the maximum design flow rate of the booster is maintained.

In boosting systems with two pumps, each pump shall be capable of maintaining the maximum flow rate required.

4.5.4.2 Speed

Pumps of any speed may be used provided that they do not generate an unacceptable noise level.

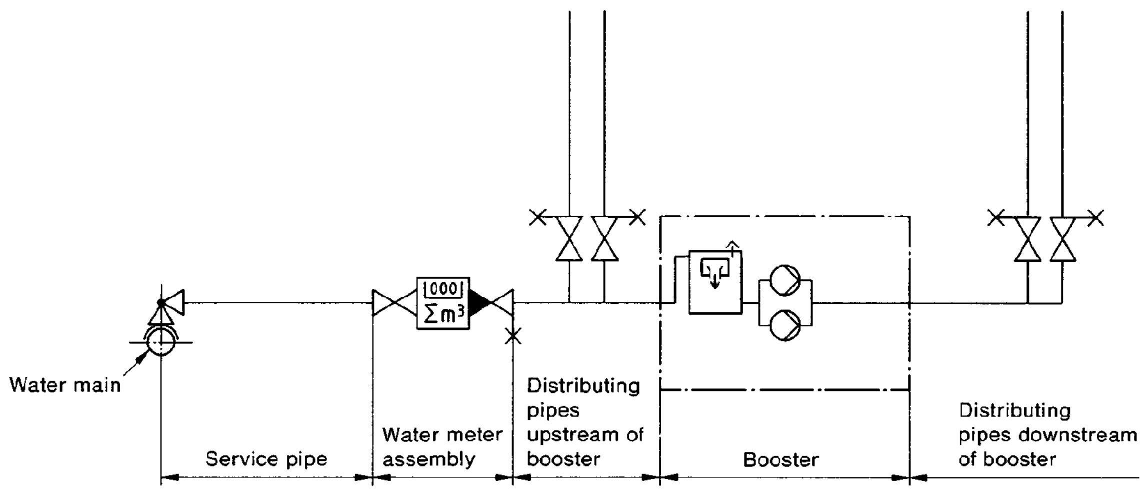

Figure 11. Indirect boosting with break cistern, without downstream pressure vessel

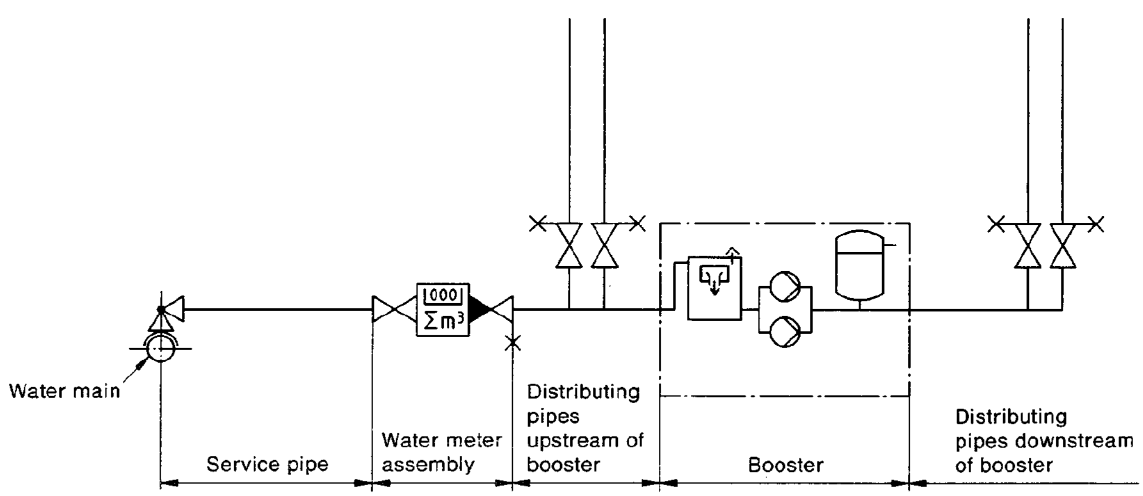

Figure 12. Indirect boosting with break cistern, with downstream pressure vessel

4.5.4.3 Control systems

The pumping equipment shall be controlled so that, in the event of failure of one of the pumps, another pump is started and the breakdown indicated.

Pumps of identical performance (including the back-up pumps) shall be controlled via selector switches or similar devices so that they operate alternately.

In boosting systems without pressure reducing valves, the switching pressure differential, $\Delta p_{(A-E)}$ should not exceed 2,5 bar.

In direct boosting systems, level switches shall be arranged so that the pumps are switched off and remain in the off-state in the following cases:

a) the inlet pressure falls below the minimum (in exceptional cases, below 1,0 bar[1]);
b) the inlet pressure rises above the required minimum operating pressure downstream of the booster.

In indirect boosting systems, the pumps must not run dry.

Provisions shall be made to prevent the pumps from switching on and off unnecessarily often.

4.5.5 Motors

Electric motors shall comply with the relevant VDE Specifications. The responsible electricity supplier shall be consulted to determine the permissible mode of connecting motors, frequency transformers and similar equipment.

4.5.6 Valves

4.5.6.1 Stopvalves

Stopvalves shall be installed upstream and downstream of each pump so that one pump can be removed without the water supply being interrupted.

4.5.6.2 Pressure-relief valves

A pressure-relief valve complying with *AD-Merkblatt* (Instruction sheet) A2 shall be fitted to the pressure vessel of a booster if the sum of maximum inlet pressure and maximum outlet pressure of the pump exceeds the allowable working pressure of the vessel. The valve shall be capable of opening at a pressure equal to 1,1 times the allowable working pressure, adequate discharge of the water escaping from the valve being ensured.

The allowable working pressure in the system shall be maintained by other suitable means (e.g. pressure reducing valves), as shall the air pressure used to generate and maintain the compressed air cushion.

4.5.6.3 Check valves

Check valves shall comply with *DVGW-Arbeitsblatt* (DVGW Worksheet) W 376.

4.5.6.4 Water level controlled valves

Only valves that take longer than 0,5 s to open or close and that are water level controlled shall be used.

In the case of break cisterns, a servicing valve shall be installed upstream of such valves, and a pressure reducing valve provided if required.

The nominal size of float-operated valves shall not exceed DN 50. For systems with a high flow rate, as and when required, several valves shall be installed in parallel, their floats being adjusted for different water levels, or a diaphragm valve with a nominal size greater than DN 50 shall be used.

[1]) Making allowance for local conditions.

4.5.6.5 Pressure switch

The settings of the pressure switch shall be stated on the booster.

4.5.6.6 Pressure reducing valves

Only pressure reducing valves complying with clause 5 shall be installed.

4.6 Pipework connections

Examples of boosting system arrangements are illustrated in figures 7 to 12.

Pressure vessels may be arranged in line with the booster or connected to a branch. The distributing pipes shall be connected to the vessels in such a way that no compressed air can enter the service pipes or the pipework downstream of the booster. This can be achieved, for example, by the provision of suitable stopvalves.

Suitable provisions shall be made to prevent water entering the compressed air system.

For indirect boosting systems, use of bypass pipes is not permitted.

4.7 Installation

Boosters shall be located in the basement of a building or in a room that can be locked and satisfies hygienic and technical requirements such as adequate ventilation, adequate insulation against frost and tightness to harmful gases. An adequately sized drainage connection shall be provided. The room shall not be used otherwise.

Pressure vessels shall be installed so as to permit inspection of their inside and so that their nameplate is easy to read.

The room shall not be in the immediate vicinity of bedrooms or living rooms, provision of adequate sound insulation being recommended. Any vibration isolators used shall be of adequate strength and easy to replace.

4.8 Commissioning

The building owner or his representative shall notify the responsible body (public water supplier or trade inspectorate) that the system is ready for operation. Prior to commissioning, the system installer shall provide proof that the boosting system complies with the specifications of this standard.

5 Pressure reducing valves

5.1 Application

Pressure reducing valves shall be installed where

a) the static pressure at the draw-off points determined in accordance with DIN 4109 exceeds 5 bar;
b) the working pressure in the distributing pipes must be limited (e.g. where the maximum static pressure at any point in the supply system is to be prevented from reaching or exceeding the allowable working pressure, or where low-pressure appliances and equipment are connected);
c) the static pressure upstream of a pressure-relief valve exceeds 80% of its set pressure (i.e. in the case of a set pressure of 10 bar, the static pressure exceeds 8 bar);
d) one booster serves several supply sections in a multistorey building (cf. subclause 4.1).

Pressure reducing valves should not be installed in fire fighting water supply pipes. If this cannot be avoided, the local fire protection regulations shall be observed.

Table 4. **Nominal sizes of pressure reducing valves for systems subject to compliance with the noise control requirements specified in DIN 4109** (e.g. systems in residential buildings)

Nominal size DN	Peak flow rate, $\dot{V}_S$,	
	in l/s	in m³/h
15	0,5	1,8
20	0,8	2,9
25	1,3	4,7
32	2	7,2
40 *)	2,3	8,3
50 *)	3,6	13
65 *)	6,5	23
80 *)	9	32
100 *)	12,5	45
125 *)	17,5	63
150 *)	25	90
200 *)	40	144
250 *)	75	270

*) Type approval not yet granted as regards noise emission.

Table 5. **Nominal sizes of pressure reducing valves for systems not subject to compliance with the noise control requirements specified in DIN 4109** (e.g. systems on commercial and trade premises)

Nominal size DN	Peak flow rate, $\dot{V}_S$,	
	in l/s	in m³/h
15	0,5 (0,35 *))	1,8 (1,3 *))
20	0,9	3,3
25	1,5	5,4
32	2,4	8,6
40	3,8	13,7
50	5,9	21,2
65	9,7	35
80	15,3	55
100	23,3	83
125	34,7	125
150	52,8	190
200	92	330
250	139	500

*) For valve combinations.

5.2 Sizing

The nominal size of pressure reducing valves is a function of the peak flow rate, $\dot{V}_S$, at the draw-off point or point of connection of an appliance. This rate shall be calculated as specified in DIN 1988 Part 3. The nominal size shall be selected from table 4 or 5 so that the actual maximum flow rate at the valve approaches, but does not exceed, the relevant value given. Sizing of pressure reducing valves shall not be based on the nominal size of the pipes to which they are fitted.

5.3 Marking

Pressure reducing valves shall be marked as specified in *DVGW Arbeitsblatt* W 375.

5.4 Installation

It is recommended that pressure reducing valves be installed in the cold water pipe downstream of the water meter assembly.

Pressure reducing valves installed in a hot water pipe in which the temperature of the water exceeds 70 °C shall be additionally marked with '95 °C'.

Where pressure reduction is necessary in domestic applications provided with mixing valves, a central pressure reducing valve shall be installed.

Pressure reducing valves shall be installed so as to prevent their being subjected to mechanical stresses, preferably with their axis arranged vertically, any instructions of the manufacturer being observed.

Stopvalves and a pressure gauge or a pressure tapping shall be provided upstream and downstream of pressure reducing valves so as to permit their adjustment and servicing. A pipe run with a minimum length equal to five times its internal diameter shall be installed at the outlet side of the pressure gauge to prevent backpressure effects.

Where parts of the system located downstream of a pressure reducing valve are subjected to unacceptably high pressure in the event of incomplete closure of the valve, a pressure-relief valve shall be installed, the suitability of which has been verified by type testing as specified in *AD-Merkblatt* A2. In such cases, the outlet pressure of the valve shall be adjusted to at least 20% below the set pressure of the pressure-relief valve.

Where a bypass pipe is required for operational reasons, it shall also be provided with a pressure reducing valve.

All pressure reducing valves in the system shall be selected to suit the actual operating conditions and set so that water flows through all valves.

Standards and other documents referred to

DIN 1988 Part 1	Drinking water supply systems; general (DVGW Code of practice)
DIN 1988 Part 2	Drinking water supply systems; materials, components, appliances, design and installation (DVGW Code of practice)
Supplement 1 to DIN 1988 Part 2	Drinking water supply systems; summary of standards and other technical rules relating to materials, components and appliances (DVGW Code of practice)
DIN 1988 Part 3	Drinking water supply systems; pipe sizing (DVGW Code of practice)
Supplement 1 to DIN 1988 Part 3	Drinking water supply systems; examples of calculation (DVGW Code of practice)
DIN 1988 Part 4	Drinking water supply systems; drinking water protection and drinking water quality control (DVGW Code of practice)
DIN 1988 Part 6	Drinking water supply systems; fire fighting installations (DVGW Code of practice)
DIN 1988 Part 7	Drinking water supply systems; measures to prevent corrosion and scale formation (DVGW Code of practice)
DIN 1988 Part 8	Drinking water supply systems; operation (DVGW Code of practice)
DIN 4109	Sound insulation in buildings; requirements and testing
DIN 50 930 Part 1	Corrosion behaviour of metallic materials in contact with water; general

AD-Merkblatt A2 *Sicherheitseinrichtungen gegen Drucküberschreitung; Sicherheitsventile* (Pressure-relief devices; safety valves)

DVGW-Arbeitsblatt W 314 *Druckerhöhungsanlagen* (Pressure boosters)

DVGW-Arbeitsblatt W 375 *Bau und Prüfung von Druckminderern bis NW 50* (Installation and testing of pressure reducing valves up to DN 50)

DVGW-Arbeitsblatt W 376 *Bau und Prüfung von Rückflußverhinderern bis NW 50* (Installation and testing of check valves up to DN 50)

DVGW-Merkblatt W 382 Druckminderer (Pressure reducing valves)

Druckbehälterverordnung, BGBl. (German Federal Law Gazette) I, p. 184, obtainable from *Deutsches Informationszentrum für Technische Regeln (DITR) im DIN*, Burggrafenstraße 6, D-1000 Berlin 30.

[1] *Unfallverhütungsvorschrift Verdichter* (Accident prevention regulation on compressors) (VBG 16)

Other relevant standards

DIN 2000	Central drinking water supply; basic requirements for drinking water; design, construction and operation of systems
DIN 2001	Private and individual drinking water supply systems; basic requirements for drinking water; design, construction and operation of systems (DVGW Code of practice)
DIN 4046	Water supply; terminology (DVGW Code of practice)

Previous editions

DIN 1988: 08.30, 09.40, 03.55, 01.62.

Amendments

In comparison with the January 1962 edition of DIN 1988, the contents of the standard has been supplemented, completely revised and is now dealt with in eight separate Parts.

Explanatory notes

This standard has been prepared jointly by Technical Committee IV 7 of the *Normenausschuß Wasserwesen* (Water Practice Standards Committee) and the *DVGW Deutscher Verein des Gas- und Wasserfaches e.V.* It is based on *DVGW-Arbeitsblatt* W 314 and *DVGW-Merkblatt* W 382.

International Patent Classification

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