

Pressure boosting technology

Planning guide



2008

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Foreword

As the structures in Europe change, standards are being revised with international validity (for all EU member countries). Country-specific standards are being reworked to create internationally applicable EN standards.

Country-specific standards or supplementary standards can continue to exist as well, as long as they do not contradict or restrict the applicable EN standards (e.g. Germany's DIN 1988).

In Germany the Trinkwasserverordnung 2001 (Drinking water regulations) and the rules of the DVGW (German Technical and Scientific Association for Gas and Water) also apply.

The standards are an official guideline for areas of application, usage, installations, safety measures and maintenance. They are not laws which must be obeyed, but they are used for purposes of clarification in the event of legal ambiguities.

This guide is a practice-oriented aid for planning and configuring pressure boosting systems in the water supply system.

Note:

On the following pages you will find a status report on the new European and German standards.

New European and German standards

Status report on the status of the new technical regulations for potable water installations (TRWI), (Part 1)

MR. WOLFGANG PRÜFROCK*

About 85% of the standardisation work of the DIN (German Industrial Standard) has been determined by European topics for many years. This is obvious to every standard user as he encounters nearly exclusively DIN EN standards nowadays. This is also the case for the area of potable water installation, where European standardisation has increasingly found its way, without, however, allowing national sets of standards to be completely done away with yet. The reasons for this are manifold. The most important ones will be named in the following.

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1. Introduction

The realisation of the European domestic market requires a unified European set of standards, which has been worked on for about the past 20 years and which meanwhile exists to a very large proportion. The processing of so-called functional standards, which also includes the standards for potable water installation, has proven itself to be more difficult than product standardisation. The first attempt at European harmonisation in this area has proven to be very difficult and tedious, since the national practices of doing things had an inertia which was greatly over-estimated at the beginning of work. Thus, the result of the European standard work, presented here in the form of standard series EN 806, is to be understood as the 1st step of harmonisation, of which none yet achieve the standardisation depth comparable with DIN 1988-1 to -8. This requires a supplemental national set of regulations parallel to the European EN standards, here, in the form of revisions of the standard series DIN 1988. Both processes are being worked on right now at the same time. The individual standardisation projects will be briefly discussed with regard to content and processing status. It is planned to create another self-contained, consistent complete standard work from all the available DIN EN and DIN standards, the "New TRWI" ("Technische Regeln für Trinkwasser-Installationen" or "Technical Regulations for Potable Water Installations"). This concept will be explained with regard to content, as well as a time frame introduced for the realisation of the project.

2. On the way to European Technical Regulations for Potable Water Installations (TRWI)

2.1. General

The standards for potable water installations are so-called functional standards,

which, as opposed to product standards, are much more difficult to harmonise in Europe. This has been clearly proven to be the case in the last nearly 20 years of past European standardisation processes. The first attempt from the German side to present the German standard series DIN 1988 as a suggestion for the European standard series EN 806 was unfortunately a complete failure, and after many years of work on CEN/TC 164/WG 2, a new approach had to be attempted after several years of thinking, before one finally had to return the standardisation application to the applicant with the comment "not possible at this time".

The reasons for the first failure were basically the following:

- The German standardisation suggestions derived from DIN 1988 could not find a majority in the European expert debate, since the differences in the technical/craftsman traditions, as well as the national sets of regulations, were much greater than supposed.
- The first European standard drafts for EN 806-1 "General", -2 "Planning" and -3 "Calculation" were all rejected, and it was necessary to find a new solution approach.

In the course of this new approach, after analysing the reasons for rejection, new drafts were created, which were reduced to the specifications on which consensus might be reached. For partial areas for which no consensus could be expected, only references were made to national regulations, whether it be governmental provisions, standards or other specifications.

These reduced European standards, which henceforth are to be assessed as being the 1st step toward a European consensus, then found a majority in the European vote, and the standards were published and implemented on a national level. Due to the numerous omissions and references to national sets of regulations, it became necessary,

Table 1: Status of the European and German standardisation for potable water installations

German standard			European standard		
DIN No.	Issue	Title	EN No.	Issue	Title
1988-1	12.88	General	806-1	12.01	General
1988-2	12.88	Design and installation	806-2	06.05 draft 04-07	Planning and installation
1988-3	12.88	Pipe sizing	806-3	07.06	Calculation of the pipe diameter
1988-4	12.88	Drinking water protection	1717	05.01	Drinking water protection
1988-5	12.88	Pressure boosting and reduction	-		
1988-6	05.02	Fire fighting and fire protection installations	-		
1988-7	12.04	Prevention of corrosion and scaling	-		
1988-8	12.88	Operation	806-5	In process.	Operation and maintenance

Table 2: National options for pressure and temperature in potable water installations in accordance with EN 806-2

Class for maximum operating pressure	Pressure	Design temperatures for plastic pipe systems	
		Class	Temperature
PMA1.0	10 bar	1	60 °C
PMA0.6	6 bar		
PMA 0,25	2.5 bar	2	70 °C

in addition to the European standards, to check the corresponding DIN set of standards and to revise them, in order to provide German users again with a comprehensive and detailed set of regulations for potable water installation. The work on the remaining European standards and the supplementary DIN standards is in full swing, and in the following, a progress report as well as a perspective for the goal being strived for, the "New TRWI", will be given.

2.2. The still available standard series DIN 1988-1 to -8 and the already existing European standards EN Fundamentally, the European EN standards have to be implemented nationally. In Germany, they are available as DIN-EN standards. Conflicting national standards on the same topic/subject-matter are to be withdrawn. For larger standard series which consist of several parts, such as with DIN 1988-1 to -8,

this regulation would lead to great difficulties when successive individual parts from this series are withdrawn and replaced by the corresponding parts from the EN standard series. The individual parts of the DIN 1988 contain numerous references to other parts, and the successive EN standards only incompletely correspond to the parts from the DIN 1988 series with regard to content. For these cases, CEN has defined a so-called standard package, which means that the national standard series only has to be withdrawn once the corresponding European standard series is completely available. Thus, for a certain transition time, the already created European standards will exist in parallel to the still completely existing standard series DIN 1988-1 to -8. For this reason, when composing tenders, offers, contracts, etc., an exact designation is always required with regard to according to what standards the demanded services

are to be performed. For German affairs, it is still recommended to use DIN 1988 as a reference, since this introduced set of standards completely describes the technical issues in detail. The present status of the European and national sets of standards for potable water installation can be seen in Table 1.

2.3. Structure and composition of the European set of standards for potable water installations

2.3.1.General The European standards from the area of water supply are being compiled in CENAC164, which is being directed by the French standardisation organisation AFNOR. The TC 164 is divided up into 13 work groups (WG). CENAC 164/WG 2 "Systems inside buildings", which is directed by DIN, is responsible for the standards on potable water installations. The subsequent explanations will provide information about the structure and content of the European work results which existed before.

2.3.2. DIN EN 806-1 "General" This standard makes definitions about the terminology and the graphical symbols as they are used in the planning and design drawings. Furthermore, the fundamental objectives of a proper potable water installation, as well as the responsible parties for planning, building and operation of the systems, are named. This standard is oriented to a great degree toward DIN 1988-1, so that there are no contradictions when using either standard.

2.3.3. DIN EN 806-2 "Planning" In this part, extensive and in some parts also considerable deviations from DIN 1988-2 are registered. This central part from the EN 806 series has demanded the longest debates and has had the most difficult consensus building, and even in one of the early versions, did not get any agreement in the European final voting, so that the entire process had to be repeated with the publication of a 2nd standard draft. In the second attempt, the paper was completely revised and references were made to the valid national regulations for many of the specifications which cannot be harmonised at this time. This is a kind of confirmation from the European standardisation committee that national supplementary standards are still necessary. These options for national

Table 3: Conditions for the applicability of the calculation in accordance with EN 806-3			
Parameter	Value		
Maximum flow velocity	in rising and floor supply pipes:		2 m/s
	In individual pipes:		4 m/s
Pressure conditions	Static pressure:	max	5 bar
	Flow pressure:	min	1 bar
Flow time	No constant consumption	>	15 min

deviations refer, for example, to the dimensioning of the system in accordance with the operating pressure and the operating temperatures. The corresponding data can be seen in Table 2. This option was necessary, although standardisation actually has the goal of reducing the variants, so that the important partner countries, such as France, England and Italy, could also agree to the standard. In England, for example, the unpressurised tank supply is widespread (low-pressure system 2.5 bar). In France, the medium-pressure system with 6 bar is used, and Germany uses the high-pressure system with 10 bar. With regard to the two temperature classes for plastic pipe systems, an urgent request from Italy was followed, where systems with a design temperature of 60 °C are obviously widespread. Further examples for opening national options are specifications for fire protection, noise control and for potable water hygiene, for which special national ordinances are to be observed in Germany. With regard to materials for pipes, fittings and pipe connection types, all relevant products described in the European standards are listed with reference to these standards. Thus, all materials made of metals, plastics and composite materials which are used in the member countries are included in EN 806-2. The demand for European approval for materials and components in contact with potable water could not yet be established in EN 806-2, since this is being delayed by the EU-planned EAS (European Acceptance Scheme). Further chapters of the EN 806-2 have to do with the installation of pipes, protection from temperature influences, arrangement of check valves and extraction valves, protection from pressure surges in hot water systems, the installation of water meters and the treatment of potable water (for example, for the purpose of water softening or corrosion protection). The systems for pressure boosting are treated in

somewhat more detail. For this, the German suggestions from DIN 1988-5 were accepted to a large extent. The further statements with regard to pressure reduction, fire extinguishing systems and corrosion protection are very short and kept general, and therefore also call for a national supplementary standard. The detailed main section 19 discusses special demands for open supplied systems (via a roof tank). This was a concession to the conditions in the United Kingdom, where these systems are still widespread. For most other countries, these specifications only have a very subordinate meaning, or no meaning at all. In discussions with the British colleagues, we found out that in England, too, they are planning to switch to high-pressure water supplies long-term, but the large majority of existing buildings are still supplied via a roof tank and this system must therefore be included in the European standard. The conclusion for EN 806-2 can be summarised as follows from the German point of view: The standard is the result of a first attempt at European harmonisation in the area of planning systems for potable water installation. It is the lowest common European denominator and therefore only achieves a relatively shallow depth of . Important parts are not treated at all, or only unsatisfactorily, and in many places, references are made to national standardisation regulations. The necessity for a national supplementary standard is derived from this, which has also been acted on by the countries which have corresponding national sets of regulations available.

2.3.4. EN 806-3 "Calculation of the inner pipe diameter"

In this European project, too, a similarly tedious path was trodden as with EN 806-2, and there was only success in the second attempt. The 1st standard draft from October 1996 was about 80 pages long and discussed the simplified

method of calculation as well as four differentiated calculation methods, one each from France, Great Britain, Holland and Germany. This was supposed to open up selection options and make agreement easier for the most important CEN member countries. After carrying out the CEN survey (draft process) and processing numerous comments/opinions, the final voting, the so-called formal vote, was carried out, and the result was a majority for rejection. There was an adjournment on this issue as well for several years to determine whether the project should be dropped completely, or whether a second attempt should be started on Part 2. As a kind of redemption, a suggestion came from our Swiss colleague, presented by Mr. Bruno Stadelmann, to take over the simplified method, practiced to a large extent in Switzerland, as a model for a European standard. CEN/TC 164/WG 2 followed this suggestion, especially in recognition of the fact that it can only be initially considered to be a first step toward harmonisation when one realistically assesses the situation in the member countries, which means standardisation at a low level. This second approach then easily jumped over the voting hurdles, and the EN 806-3 could be presented in April 2006. EN 806-3 defines two types of installations: the so-called normal installation and the special installation. The simplified calculation method can only be applied for the normal installation. For calculating the special installations, references are made to the nationally differentiated calculation methods which are listed in the informative Appendix C. For Germany, reference is made there to DIN 1988-3. The normal installation especially covers the area of residential buildings, which means single- and multi-family houses with up to 5 floors and the usual furnishings with kitchens and bathrooms. A few important constraints for using the calculation method can be found in Table 3. The intended extraction fixtures are allocated load units (LU), whereby 1 LU is equivalent to a fitting flow of 0.1 l/s. Starting from the most distant extraction point, the LU values for the individual sections are added up, and the nominal pipe diameters allocated to the LU values for the various types of pipes are gotten directly from the tables. The probability of same-time use and the peak flow derived from this are considered in the table values. The practical execution of the calculation is explained

using the example of a normal installation in a multi-family house with 5 apartments. In Switzerland, and also in Germany, comparative calculations have been carried out in the meantime, which have shown that for purely residential buildings, the same nominal pipe diameters are determined for the most part using the method according to EN 806-3 as with a differentiated calculation. This means that after determining the hydraulically required inner pipe diameter, the next higher nominal pipe diameter is to be chosen respectively, which partially compensates for the inaccuracies of the simplified method. For larger buildings and especially for the commercial area, however, the differentiated calculation method is still required in any case, which will be made available again in the form of a revised DIN 1988-3.

2.3.5. EN 806-4 (draft) "Installation"
EN 806-4 has to do with the installation of systems on the building premises and buildings, and thus also corresponds with DIN 1988-2 "Planning and construction". Various methods for connecting pipes with each other, as well as with tanks and fittings, are described.

All metal and plastic pipes commonly used in potable water installation, as well as multi-layer pipe systems are taken into account. Pipe installation is treated in detail, such as the position of the pipes in the floor and walls (distances, free space), wall and ceiling feed-throughs, pipe insulation, selection and arrangement of the extraction and line fittings, as well as the labelling of pipes and fittings. Another chapter discusses the combination of components made of different metals with regard to lowering the risk of corrosion. The measures for professionally commissioning the finished installation are described in detail. The methods for filling and checking pressure are specified according to the different material groups, as well as flushing the pipes, firstly for pure water flushing, and secondly for flushing with a water/air mixture. Furthermore, various methods and means for disinfecting the systems are named, as far as this is required by national or local regulations. The disinfection of water tanks is especially discussed, which, in turn, is a concession and demand for the common unpurified systems in Great Britain. In English residential construction,

one has one single potable water extraction point, which is fed directly from the low-pressure mains supply line, the so-called "drinking water tap" in the kitchen. The bathrooms are supplied with water treated with disinfectants from the tank in the attic. EN 806-4 contains 3 appendices: the "Normative Appendix A", which contains additional specifications about pipe joints and connection methods, as well as the "Informative Appendix B", with a method for calculating and compensating for the effects of heat on plastic pipes. The results of these calculations are to be observed when planning the pipe supports. The also "Informative Appendix C" provides guide values in a table for the maximum distances for pipe supports for pipes made of metal. The objection deadline for standard draft DIN EN 806-4 was May 31, 2007. It remains to be seen what degree of acceptance the paper will achieve in the European survey. The German installation trade has already reported clear criticism, which may make a national supplementary standard necessary for this part of EN 806 as well.

(to be continued)

New European and German standards

Status report on the status of the new technical regulations for potable water installations (TRWI), (Part 2)

MR. WOLFGANG PRÜFROCK*

About 85% of the standardisation work of the DIN (German Industrial Standard) has been determined by European topics for many years. This is obvious to every standard user as he encounters nearly exclusively DIN EN standards nowadays. This is also the case for the area of potable water installation, where European standardisation has increasingly found its way, without, however, allowing national sets of standards to be completely done away with yet. The reasons for this are manifold. The most important ones will be named in the following.

2.3.6. ENw "Drinking water protection"
This standard also belongs to the whole complex of potable water installations. It was created by another workgroup of the CENAC 164 and unfortunately was not numbered as part of the standard series EN 806.
The standard contents correspond well with the content of DIN 1988-4. For example, the 5 hazard classes for the harmful effects on potable water as a result of backflow or back-suctioning can be found here, designated as categories 1 to 5. Graded according to the hazard potential of the five fluid categories, the respectively suitable protective equipment is allocated by means of a protection matrix. The protection equipment systematics consider all constructions introduced in the member countries, each labelled with two capital letters. For example, the constructions AA, AB, AC and AD stand for four different constructions for the free outlet. In an extensive "Normative Appendix A", in the form of data sheets, all safety equipment is listed with an abbreviation, graphical symbol, definition, functional requirement, product specifications as well as requirements for installation. These data sheets are also the basis for developing the European product standards for the various safety valves, which meanwhile exist to a large extent. The "Informative Appendix B" provides a few examples for the allocation of different fluids for categories 1 to 5, e.g. heated water in the sanitary area category 2 (fluid without health hazard) or water from washing machines and dishwashers, category 5 (health hazard due to pathogens). This allocation was unfortunately not very successful, since for

the multitude of cases which occur in practice, especially in the commercial area, an exact allocation to one of the categories is not possible, which leads to uncertainties when applying the standard. The very detailed application matrix contained in the standard draft was discarded without substitution in the course of the objection deliberation. To help the German user, an application matrix made up of 63 items was added to DIN EN 1717 in the form of a "National Appendix". The individual extraction points and fittings are listed in the columns of this matrix, and in the rows, the suitable safety valves. The fields with safety valves not commonly used in Germany were specially marked by a grid pattern. With this and a few other supplements in the "National Appendix", with DIN 1988-4, a nearly comparable regulation level was reached. Finally, the "Informative Appendix C" of EN 1717 should be mentioned, in which a potable water installation analysis is described with regard to potential backflow and contamination hazards.

2.3.7. EN 806-5
"Operation and maintenance"
For this part, there is only a preliminary consultancy document, which, for the most part, is derived from the English translation of DIN 1988-8. For this part, too, the German experts in CEN/TC 164/WG 2 require that as many of the regulations introduced in Germany be established in EN 806-5. To what degree this actually happens will be shown in the further deliberations and the results of the European surveys and voting, which will take place in 2007/2008.

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Con- secu- tive no.	DIN No	Short title	Replace- ment for DIN	Areas to be integrated	National supplements for	Processing status
1	EN 806-	General	1988-1	-	-	Standard 2001-12
2	1988-20	Planning	1988-2 (partial)	DVGW W551, VDI 6023	EN 806-2	Standard model
3	1988-30	Pipe sizing	1988-3	DVGW W553	EN 806-3	-
4	1988-40	Installation	1988-2 (par- tial)	ZVSHK MB Flushing MB Leak-tightness	EN 806-4	-
5	EN 1717	Drinking water protection	1988-4 (partial)	-	-	Standard 2001-05
6	1988- 400	Drinking water protection	1988-4 (partial)	-	EN 1717	Standard draft manuscript
7	1988-500	Pressure boosting and reduction	1988-5	-	EN 806-2	-
8	1988-50	Operation and maintenance	1988-8	EN 15161	EN 806-5	-
9	1988-60	Fire fighting and fire protection installations	1988-6	-	-	Standard model
10	1988-70	Prevention of corrosion and scaling	1988-7	-	-	-

3. The concept for a "New TRWI"

3.1. Reasons for a transitional regulation

The introduced European standards as well as the national supplementary standards in the form of revisions of individual parts of the standard series DIN 1988-1 to -8 form the building blocks for a "New TRWI". The goal is to provide the standard users with another complete and self-contained, contradictory-free set of standards for potable water installation. As explained, the existing European work results right now do not meet this demand. On the other hand, they are integrated in the DIN set of standards as DIN-EN standards, and therefore have the same status as the purely national DIN standards. The European standards also are subject to a 5-year review session, and the final objective, of course, is to reach a state which makes the national supplementary standards on the same topic unnecessary.

After several discussions, the responsible expert panel on the standard committee for water issues has developed a concept for the development of the

national supplementary standards, and the goal is to present a common set of standards from DIN and the DVGW.

3.2. The system, European standards and supplementary German standards

The individual building blocks of the "New TRWI" are shown in Table 4. The two-digit and three-digit part numbers were selected in order to establish a relationship with both the previous standard series DIN 1988 as well as the European standard series EN 806. In a revision of the European standards, it was thought to include the German supplementary standards as suggestions in order to reduce the number of necessary German supplementary standards in this second step, or to make them completely unnecessary. Working committees were assigned to work on the national supplementary standards, and preliminary work results in the form of standard guidelines and manuscripts for standard drafts are already available.

In the selection of the TRWI building block selection, it is decisive what quality and to what degree of standard depth the European work results have

Table 4:
Building
blocks of the
"New TRWI"

reached or will still reach and what supplementary standard requirement is still derived. For the two parts EN 806-4 and -5, which are still being worked on, this question can only be answered at a later time. For the available European standards, the situation is as follows:

- EN 806-1 "General": Can completely replace DIN 1988-1.
 - EN 806-2 "Planning": Requires extensive supplementary standards, such as DIN 1988-20 for planning, DIN 1988-500 for pressure boosting and reduction and DIN 1988-60 for fire extinguishing and fire protection systems.
 - EN 806-3 "Calculation, simplified method": Requires a national supplementary standard DIN 1988-30, in which a differentiated calculation method is described.
 - EN 806-4 "Installation": Since this standard only exists as a draft, the supplementary standard DIN 1988-40 is noted, the requirement of which, however, will only be decided after EN 806-4 is completed.
 - EN 806-5 "Operation and maintenance": The necessity of a supplementary standard DIN 1988-50 can only be decided at a later time.
 - EN 1717 "Drinking water protection": Requires a national supplementary standard DIN 1988-400, in which the informative national appendix from the currently available DIN EN 1717 is specifically defined as the normative part.
- For the areas of "Fire extinguishing and fire protection systems" as well as "Prevention of corrosion and scaling", only a few general statements are made in the EN 806 series, and otherwise, references are made to the national sets of regulations. This resulted in the necessity for completing the TRWI, to revise parts 6 and 7 as DIN 1988-60 and -70.

3.3. The time estimate for the availability of the standards for the "New TRWI"

The present revision status of the individual 10 standard parts for the TRWI can be seen in Table 4. Already available are the two parts DIN EN 806-1 and DIN EN 1717. In 2007, the standard

drafts for DIN 1988-20, -60 and -400 will appear, and possibly also the draft for DIN 1988-30. In 2008, the finished standards from these standard drafts will appear, and the corresponding parts of the now still valid DIN 1988 can be withdrawn. In 2008, the still outstanding European standards EN 806-4 and -5 will become available and, parallel to this, also the possibly required supplementary standards DIN 1988-40 and -50. The parts DIN 1988-60 and -70, which aren't affected by the European standard, should also become available in 2008. This schedule for the availability of all standards for the "New TRWI" by 2008 is a very optimistic estimation. If the national and European objection processes should take up more time than hoped, the target date could be pushed back to 2009.

4. Final consideration and outlook

In many discussions, representatives of the DVGW and DIN have both expressed their desire to have the "New TRWI" presented as a joint set of regulations of both institutions. In addition, the individual standards as well as the standard series DIN 1988-1 to -8 will be integrated in the DVGW set of regulations. On the title pages, they will get the additional text "Technical regulations of the DVGW". To make life easier for the standard user, it is planned to create a complete set of TRWI regulations from the basic material of the individual standards, ordered according to the main chapters Planning, Construction as well as Operation and Maintenance, and to supplement the newly compiled standard texts according to these specifications with binding and explanatory texts, as far as

necessary. This work should also be the result of cooperation between the responsible expert committees of the DVGW and DIN, and not the work of individual authors, as is familiarly commented about DIN 1988-1 to -8. The processing should proceed in parallel to the standardisation work, so that the publication can be done at about the same time as the completion of the European standards and German supplementary standards, i.e. presumably around 2009. The common objective of the DVGW and DIN is to again make a complete, modern, easily understandable technical set of regulations available to the German standard user for potable water installation, including the European standardisation results, which achieves the acceptance of the expert groups, and thus also can claim the status of "generally recognised rules of technology".

Real-world example:
Skyper tower, Frankfurt-on-Main.

153 metres in height, with a total of thirty-eight above-ground storeys, the Skyper is one of the most impressive skyscrapers in “Mainhattan”. The ultramodern building is connected by a nine-metre high glass hall to a neoclassical villa from the year 1915 and houses offices, restaurants and medical practices in the most prestigious location of the heart of Frankfurt: the banking quarter.

Ensuring a reliable supply of drinking water up to such dizzying heights requires pump technology which can maintain a constant high pressure. With the pressure boosting system specially designed for pressure level PN 25 and a flow capacity of $Q = 22 \text{ m}^3/\text{h}$ at height $H = 165 \text{ m}$, the Wilo Comfort-Vario maintains the required pressure. In addition the VR System electronic controller endows the system with control capacity that is second to none, thus enabling a demand-responsive and energy-efficient water supply.

The skyscrapers of Frankfurt's skyline are subject to heightened fire protection requirements, exceeding the national average. The fire extinguishing water supply is safely maintained by a pressure boosting system from the Wilo Comfort series. With a flow capacity of $Q = 36 \text{ m}^3/\text{h}$ at height $H = 218 \text{ m}$, it is guaranteed to meet the sustained demands of the Frankfurt fire brigade.



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General basic principles

Potable water is an essential nutrient for which there is no substitute. For the consumer to be able to extract the water, it must be available at the extraction point in sufficient quality and at a certain flow pressure. If, for example, the minimum flow pressure cannot be guaranteed at the extraction points with the highest static head, use is made of pressure boosting systems in the water supply or fire protection system.

An explanation of the term “pressure boosting system”

Flow pressures in water supply networks, generally supplied by the supply company with a stated minimum flow pressure p_{minFI} , are often not adequate at high extraction points in buildings. The required minimum flow pressure for conventional taps and fittings for planning purposes is found in Table 12 of DIN 1988 Part 3.

If the required supply pressure is not met due to the excessive static height of the extraction point or too much head loss in the pipe system, pressure boosting systems must be used.

The installation and operation of pressure boosting systems interfere with the existing municipal supply network, with potentially negative consequences for the existing distribution and supply. Connections must be discussed with and approved by the local water supply company. In addition, the applicable regulations, standards and guidelines must be taken into consideration during planning and execution.

Applicable guidelines include the following:

- DIN 1988
Drinking water supply systems (TRWI)
- DIN EN 1717
Protection against pollution of potable water in water installations
- DIN 2000
Central drinking water supply – Guidelines for drawing up requirements for the design, construction, operation and maintenance of supply systems
- DIN EN 806
Specifications for installations inside buildings conveying water for human consumption

The information in the following on planning, calculation methods and implementation is also based on the guidelines in DIN 1988.

DIN 1988, Part 5 contains rules specifically concerning pressure boosting and reduction. Part 6, furthermore, is specifically concerned with fire extinguishing and fire protection systems. Both parts are classified as codes of practice of the DVGW.

For pressure boosting systems for fire extinguishing purposes, there are unfortunately no uniform regulations for the whole of Germany. The individual states (Länder) or rather the fire protection authorities in the states have the power to apply special regulations in their areas. Therefore, for pressure boosting systems (PBS) for fire extinguishing purposes, the local fire protection authority must be contacted regarding the specific requirements in the state before planning a fire extinguishing system (FES) (see also the chapter entitled *Basic principles of fire protection systems*).

*Note:
See also the status report in the foreword.*

*Note:
State building laws are of primary importance. Fire prevention measures must be taken.*

Flow and static pressure

Important:
Pressure surges and variations in flow velocities are not caused by the pressure boosting system, but rather by the consumers, taps, fittings and storage tanks beyond it.

The flow pressure is the gauge pressure existing at a measuring point in the water supply system while water is flowing, in other words when water is being extracted from at least one extraction point.

The static pressure is the gauge pressure existing at a measuring point in the water supply system when water is not flowing.

As a basic requirement, the minimum flow pressure p_{minFI} required by the fittings must be available at the least hydraulically favourable extraction point, while the maximum static pressure p_{maxS} at the most hydraulically favourable extraction point must not exceed 5 bar. Compliance with these limits is the basis for the required division of a building into pressure zones, also in cases where a pressure boosting system is required.

Important:
Depending on the region you are in, these may be stated as static or flow pressures.

The water supply company must be contacted to find out the minimum and maximum supply pressures.

Fluid being pumped

Potable water is a nutrient

For the consumer to be able to extract the potable water, it must be available at the extraction point in sufficient amounts, in the quality defined by law and at the required minimum flow pressure.

The quality requirements for potable water (PW) in Germany are set out in the TrinkwV 2001 (Drinking Water Ordinance) and in the DIN standards listed in the chapter *General basic principles; An explanation of the term “pressure boosting system”*. All water which does not meet the aforementioned requirements is considered to be non-potable water (NPW).

Potable water production, treatment, transport, storage and distribution to end users is normally the task of the public water supply company.

The planning, construction, modification, maintenance and operation of potable water installations on properties and in buildings with connection to the public mains is subject to the provisions of regulations such as DIN 1988 – Drinking water supply systems on properties.

Important:
Self-sufficient water supply installations must never be connected directly to the public potable water supply network. In Germany, these installations must be registered with the local health authority 14 days before commissioning.

If there is no public water supply, such as in the case of rural buildings or in commercial and industrial facilities, water requirements can be met by private water supplies using a self-sufficient supply system.

Flow rates

To prevent possible unacceptable effects from the operation of a pressure boosting system, both on the supplying distributor pipe system on the suction side and on the distribution system on the discharge side, the following criteria must be observed:

On the suction side

Generally speaking, depending on the type of connection, the flow velocity or the maximum difference in flow velocity in the building connection line and the consumption line to the pressure boosting system caused by switching pumps on and off must not exceed certain upper limits, so that:

- The supply to neighbouring buildings is not disrupted unacceptably by excessive falls in pressure
- Unacceptable pressure surges are prevented in the connection line and in the pipelines of the public potable water supply

The total flow velocity in the connection line to the pressure boosting system and to consumption lines without a pressure boosting system must not exceed 2 m/s.

On the discharge side

There must not be any disruptive pressure surges in the distributor pipe system connected to the pressure boosting system on the discharge side.

Compliance with these specifications determines the type of connection (indirect or direct) and the choice of buffering elements (pressure vessel on the suction and/or discharge side) for the pressure boosting system.

Real-world example: Dortmund airport

The sanitary facilities of the airport are in operation day in, day out, round the clock. This is where the Wilo pressure boosting system Comfort-N with MVIS pumps using glandless technology proves its worth with its high reliability. Operating alternately, the four pumps each deliver a constant supply output of 14,000 litres per hour at a pressure of 4 bar. The cascade arrangement ensures regular switchover between the four units, which automatically compensates for the failure of any pump.

That means that enough potable water is available at all times to meet the supply requirements of the great flow of passengers.

The sturdy, high-quality construction of the stainless steel pressure boosting systems is designed for long pump life. In addition, stainless steel also satisfies the most stringent hygienic requirements.



Since its expansion in 1997, Dortmund airport has grown from a regional airport into the third biggest passenger airport in North Rhine-Westphalia, with more than two million passengers in 2006.





Basic principles of pump technology

Pump types

For pressure boosting systems centrifugal pumps with a stable pump curve should be used. Self-priming pumps can only be used with an indirect connection.

Pressure boosting systems for public potable water supply must be equipped with at least two pumps of equal output capacity, i.e. one duty pump and one standby pump, where the maximum volume flow capacity V_{maxP} must be 100 % covered by each of the two pumps.

The required pump output capacity is to be calculated in accordance with DIN 1988:

- Maximum volume flow V_{maxP} in accordance with DIN 1988, Part 5, Section 4.2
- Delivery pressure Δp_p in accordance with DIN 1988, Part 5, Section 4.3

Requirements for components, fittings and materials

In Germany, all system parts designed to come in contact with the potable water, pumps included, should be planned, installed, started and maintained in accordance with the TrinkwV 2001 ordinance, the DVGW codes of practice and the KTW regulations.

Electrical drive motors for the pumps must comply with the relevant VDE regulations.

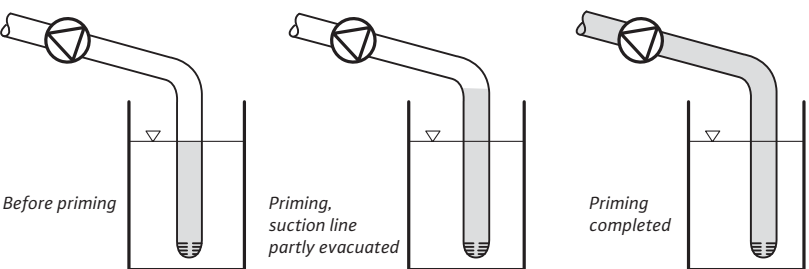
Pumps of any speed can be used as long as they are guaranteed not to produce disruptive noise (DIN 4109, Part 5).

Self-priming

“Self-priming” refers to pumps which evacuate their suction line without an external priming device, which means that they can also pump air through if the pump is filled with water beforehand.

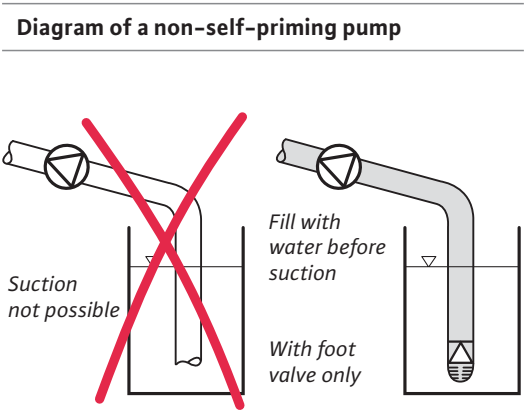
The amount of water remaining in the pump when it cuts out is enough to restart a self-priming pump at any time without need for a foot valve in the suction line. Installing a foot valve is nonetheless recommended so that the suction line does not need to be re-evacuated every time the pump is started.

Diagram of a self-priming pump



Important:
Self-priming pumps must not be connected directly to the public supply network.

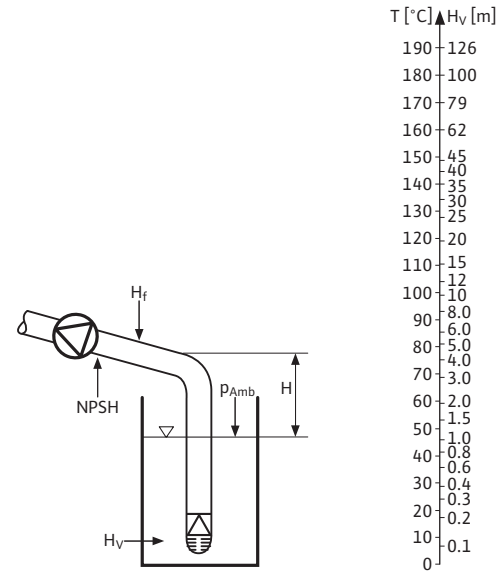
Non-self-priming



- Important:**
- Always observe the NPSH.
 - Possible danger of dry running.
 - If a foot valve is used, non-return valves normally should not be installed on the suction and discharge sides of the pump.

With “non self-priming” pumps in suction mode, the pumping process can only be started when both the pump and its suction line are filled with water. A foot valve in the suction line enables external filling and prevents the draining of the suction line when the pump is shut down.

With non-self-priming pumps, a foot valve must always be installed in the suction line and the NPSH value of the pump must be observed.



- Important:**
- Cavitation can lead to destruction of the pump.

NPSH (Net Positive Suction Head)

The NPSH of the pump is specified by the pump manufacturer.

The NPSH of the system is influenced by the fluid temperature, the height of the water level above the suction pipe and the atmospheric pressure.

Compliance with the NPSH of the system (under poor inflow conditions) is always necessary in suction mode.

- Factors influencing the NPSH are:
- High fluid temperature
 - Volume flow capacity considerably higher than the rated volume flow capacity
 - Very long suction lines
 - Poor inflow conditions

To prevent cavitation, the pumped fluid must be supplied to a centrifugal pump at a certain suction head. The size of this minimum suction head varies depending on the temperature and pressure of the fluid. The maximum suction head H [m] can be calculated according to the following formula:

$$H = p_{Amb} \times 10.2 - NPSH - H_f - H_v - H_s$$

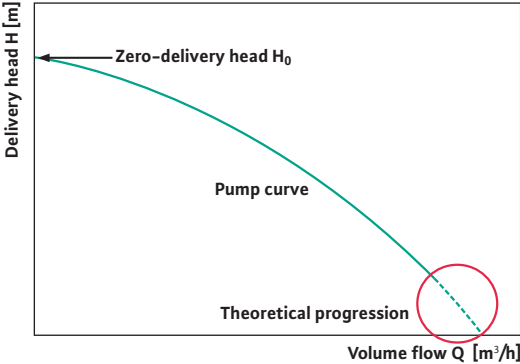
Abbreviation	Meaning
H	Suction intake pressure required at the pump for cavitation-free operation H = positive: max. suction head of the pump in [m] H = negative: min. supply pressure at the pump in [m]
p _{Amb}	Absolute ambient air pressure in [bar] or the system pressure in the case of closed systems
NPSH	Net Positive Suction Head of the pump's duty point in [m] (see pump curve)
H _f	Head loss in [m] in the suction line
H _v	Vapour pressure of the fluid at the relevant temperature
H _s	Margin of safety of 0.5 m

Curves (steep, flat, stable, unstable)

Pump curve

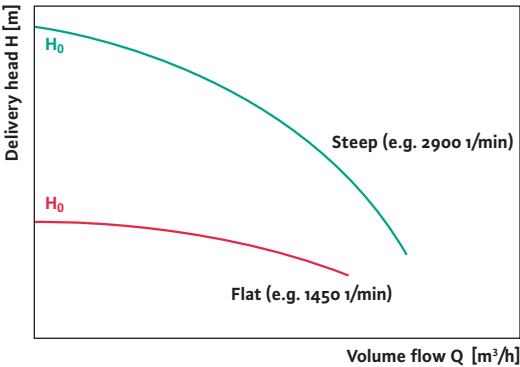
The pump curve – also called the pump performance curve – indicates how the delivery head of a centrifugal pump changes in relation to the volume flow. Generally speaking, the delivery head rises as the flow falls.

- Maximum delivery head (zero-delivery head) H_{\max} means minimum volume flow \dot{V}_0 (zero flow)
- Maximum volume flow \dot{V}_{\max} means minimum delivery head H_{\min}



Steep and flat pump curves

The different gradients of the pump curves is related to the motor speed n, among other factors.

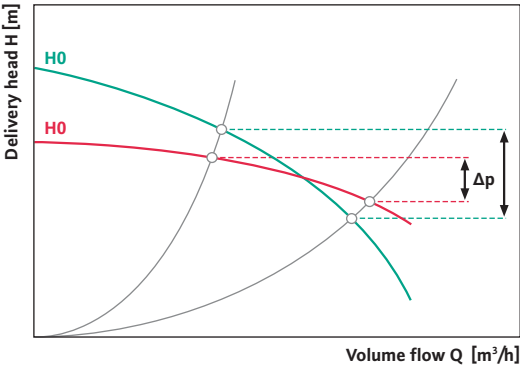


Delivery head ratio = $\frac{H_0 - H_{opt}}{H_{opt}}$

(also called “gradient”)

Relationship between change in head and volume flow for steep or flat pump curves:

- Flat curve = large change in flow, small change in head
- Steep curve = small change in flow, large change in head

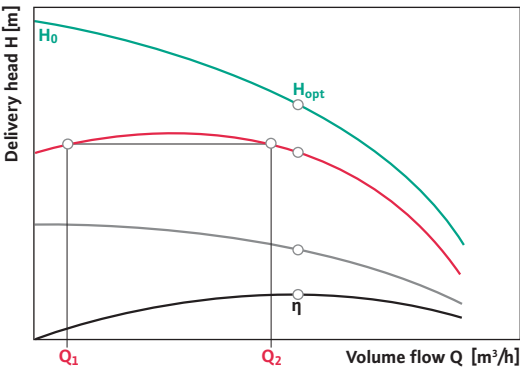


Note:
Volume flow capacity
 \dot{V} = standardized symbol
 Q = conventional symbol

Stable and unstable pump curves

Pump curves where the delivery head rises as the flow falls are said to be stable. With such curves there is only one volume flow capacity for each delivery head. With unstable pump curves, on the other hand, two or more volume flow capacities can be assigned to a particular delivery head.

Note:
Only pumps with a stable pump curve are used in pressure boosting systems.



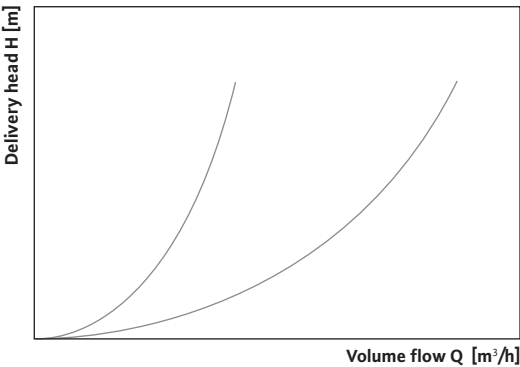
Stable, steep
Stable, flat
Unstable

System curve / system head curve

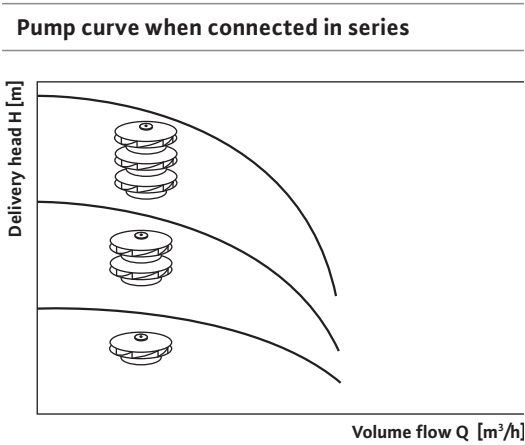
Given by $H_{st} + p_{FI} + \Delta p + \Sigma(l \cdot R + Z)$

Abbreviation	Meaning
H_{st}	Static or geodesic delivery head
p_{FI}	Flow pressure of the pressure boosting system
Δp	Pressure difference
$(l \cdot R + Z)$	Sum of losses
NPSHR	Net positive suction head required

- Flat curve = low friction losses in pipe system
- Steep curve = high friction losses in pipe system



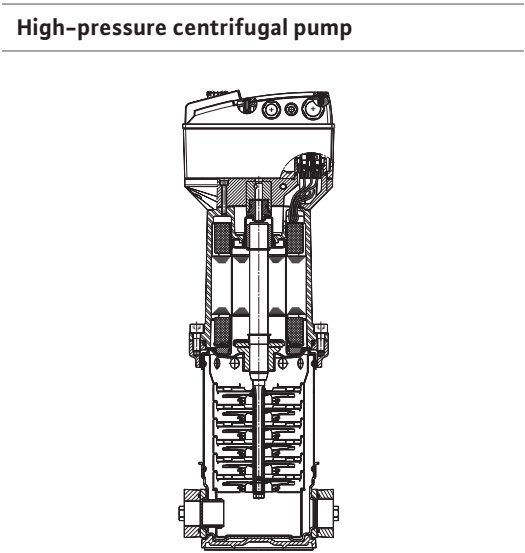
Parallel and series connection



Connection in series

The general rule is:
When multiple impellers are connected in series in a pump housing, as in the case of multistage high-pressure centrifugal pumps, the delivery heads are added together.

Delivery heads are added for the points where the flow capacity is identical.

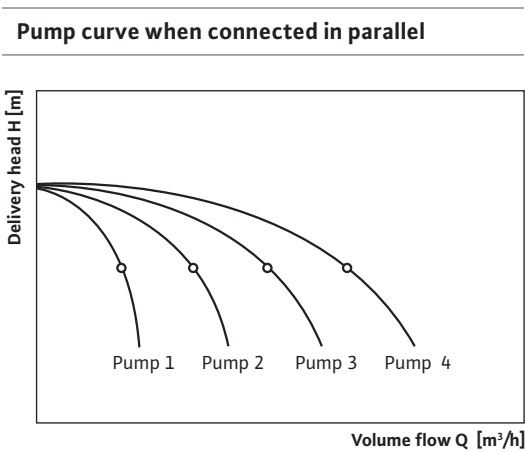


Multistage high-pressure centrifugal pumps connected in series

The general rule is:
When pumps are connected in series, the delivery heads are added together.



Stainless steel construction:
impeller, diffuser, housing



Pumps connected in parallel

Flow capacities are added for the points where the delivery head is identical.



Parallel connection of 2 to
6 pumps of the same capacity

Control variables

Pressure boosting systems are normally controlled by the control variable *constant pressure*. This means that the differential pressure of the system is kept constant; this is referred to as control mode pc, for *pressure constant*.

The output pressure of the pressure boosting system is recorded using suitable pressure sensors with digital or analogue output signals.

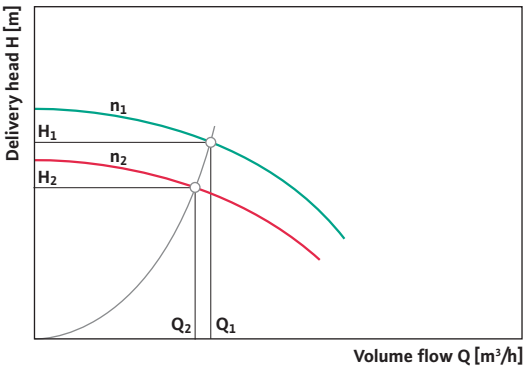
Speed control

Speed control of high-pressure centrifugal pumps today is performed using external or built-in frequency converters. The output frequency of the frequency converter is modified between f_{\min} and f_{\max} to send a corresponding line frequency to the motor which changes the motor speed. This is referred to as infinitely variable speed control.

Speed-controlled pressure boosting systems have a frequency converter in the system assembly which controls the speed of the base-load pump. There are also pressure boosting systems where each pump has its own built-in frequency converter, and where the speed control is transferred to whichever pump is cutting in.

Frequency ranges between 20 and about 60 Hz can be realised, depending on the motor.

Varying the speed



$$\frac{Q_1}{Q_2} = \frac{n_1}{n_2}$$

$$\frac{H_1}{H_2} = \left(\frac{n_1}{n_2} \right)^2$$

$$\frac{P_1}{P_2} \approx \left(\frac{n_1}{n_2} \right)^3$$

Note:
For more information see the guide entitled "Pump technology basics".



Basic principles of system technology

Determining flow data

Determining the maximum volume flow ($V_{\max P}$) of a pressure boosting system in [m³/h]

The pressure boosting system should be designed so that the volume flow $V_{\max P}$ required to supply all connected extraction points can be provided, taking into account simultaneous use (simultaneous extraction by consumer fittings and devices).



Pressure boosting system for potable water supply systems

The required volume flow must correspond to the peak flow V_S . The peak flow should be calculated in accordance with the specifications of DIN 1988, Part 3 / EN 806-3. In the case of residential buildings, a rough calculation can be made if necessary based on a specific consumption of 2.0 l/s per residence. In the interests of cost efficiency, however, this global-estimate calculation method should not be used widely.



Pressure boosting system for fire extinguishing systems/combined systems*

These are discussed separately in the chapter *Basic principles of fire protection systems*.

To determine the required volume flow, refer to the configuration of the fire extinguishing system. Be mindful of the rules for design flows and simultaneous use from the applicable standards and guidelines; e.g. DIN 14461, Part 1 for fire hose reels.



* Systems meeting demand for potable water (PW) and for fire water.

Can only be used without meeting special requirements if the potable water demand is higher than the fire water demand. Otherwise the system must be separated between potable water supply and fire water supply. (See also *Basic principles of fire protection systems* chapter).

Important:
Potable water systems and fire water systems must be kept strictly separate.

Determining the delivery pressure Δp_p

The delivery pressure is calculated as follows:

Important:
With indirect (break tank) connection, the minimum supply pressure on the suction side of the pump is usually 0 bar.

Required delivery pressure

=

Sum of all static head differences, required min. flow pressure $p_{\text{min FI}}$ and pressure losses

-

Available minimum supply pressure $p_{\text{min V}}$

In accordance with DIN 1988 Part 5, it is recommended to calculate the delivery pressure of the pressure boosting system Δp_p using formula 1 (see below).

Formula (1) $\Delta p_p = p_{\text{after}} - p_{\text{before}}$ in (bar)

Abbreviation	Meaning
p_{after}	Operating pressure required at peak flow after the pressure boosting system
p_{before}	Available supply pressure before the pressure boosting system

In detail: formula 2 for the required delivery pressure after the pressure boosting system [bar]

Formula (2) $p_{\text{after}} = \Delta p_{\text{st after}} + p_{\text{min FI}} + \Sigma(I \cdot R + Z)_{\text{after}} + \Delta p_{\text{fitt after}}$ in [bar]

Abbreviation	Meaning
p_{after}	Required delivery pressure after the pressure boosting system [bar]
$\Delta p_{\text{st after}}$	Pressure loss (head loss) due to static head difference after the pressure boosting system [bar]
$p_{\text{min FI}}$	Minimum flow pressure at the least hydraulically favourable extraction point
$\Sigma(I \cdot R + Z)_{\text{after}}$	Pressure loss due to pipe friction and isolated points of resistance after the pressure boosting system [bar]
$\Delta p_{\text{fitt after}}$	Pressure loss in the fittings, e.g. flushing valves, mixers, flood shower etc., after the pressure boosting system [bar]

and formula 3 for the operating pressure available at peak flow before the pressure boosting system [bar].

Formula (3) $p_{\text{before}} = p_{\text{min before}} - [\Delta p_{\text{st before}} + \Sigma(I \cdot R + Z)_{\text{before}} + \Delta p_{\text{WM}} + \Delta p_{\text{fitt before}}]$ in [bar]

Abbreviation	Meaning
p_{before}	Available supply pressure before the pressure boosting system [bar]
$p_{\text{min before}}$	Minimum supply pressure from the water supply company before the pressure boosting system [bar]
$\Delta p_{\text{st before}}$	Pressure loss (head loss) due to static head difference after the pressure boosting system [bar]
$\Sigma(I \cdot R + Z)_{\text{before}}$	Pressure loss due to pipe friction and isolated points of resistance before the pressure boosting system [bar]
Δp_{WM}	Pressure loss due to the water meter [bar]
$\Delta p_{\text{fitt before}}$	Pressure loss in the fittings, e.g. filters, dosing/dispensing devices, before the pressure boosting system [bar]

Calculating $\Sigma(l \cdot R + Z)_{\text{before}}$ and $\Sigma(l \cdot R + Z)_{\text{after}}$ with the aid of the table for the mean pressure drop $\Delta p/l$ for the pipe system before and after the pressure boosting system

Example:
Where: the length of pipeline before the pressure boosting system is 8.50 m, and 48 m after the pressure boosting system

Calculation:

$$\begin{aligned}\Sigma(l \cdot R + Z)_{\text{before}} &= \Sigma l_{\text{before}} \cdot \Delta p/l \\ &= 8.50 \text{ m} \cdot 20 \text{ mbar} \\ &= 170 \text{ mbar} \\ &= 0.17 \text{ bar}\end{aligned}$$

$$\begin{aligned}\Sigma(l \cdot R + Z)_{\text{after}} &= \Sigma l_{\text{after}} \cdot \Delta p/l \\ &= 48 \text{ m} \cdot 15 \text{ mbar} \\ &= 720 \text{ mbar} \\ &= 0.72 \text{ bar}\end{aligned}$$

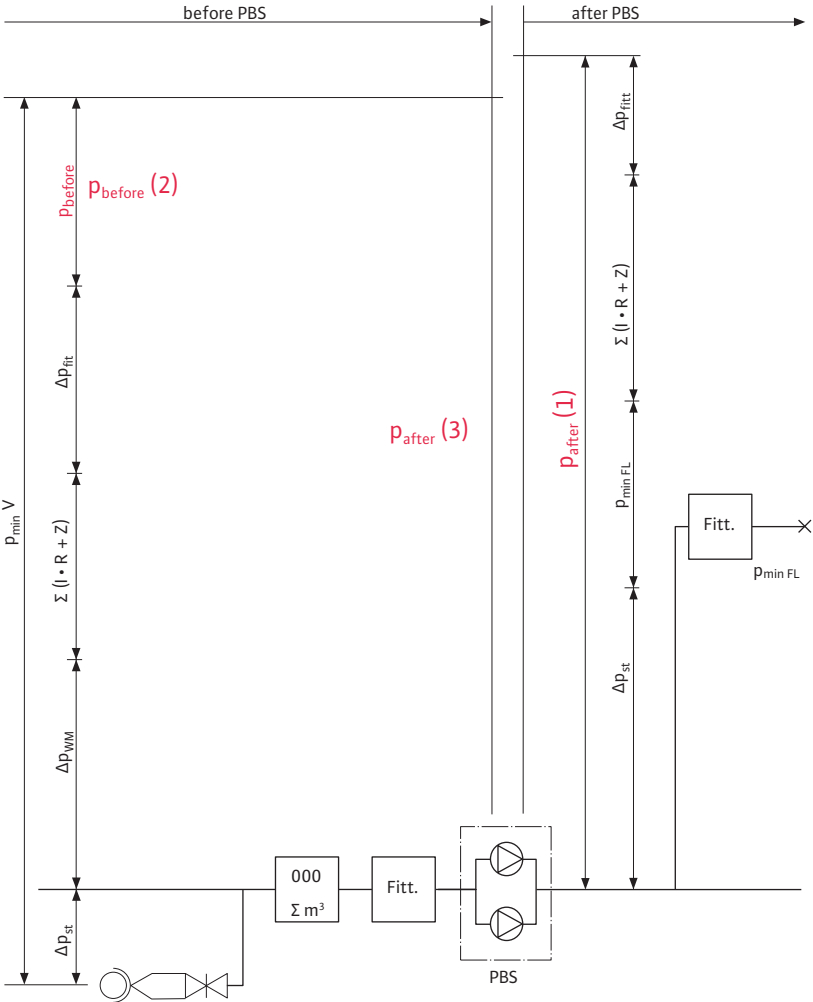
Note: For rough calculations, the form of the building should be considered.

Rule of thumb:
For narrow buildings (e.g. tower-type construction) $H_{\text{st}} + 10\%$ allowance and for buildings covering a wide area (e.g. convention centre) $H_{\text{st}} + 20\%$ to account for pipe system pressure losses $\Sigma(l \cdot R + Z)$.

Table for the mean pressure drop $\Delta p/l$ for the pipe system before and after the pressure boosting system

Total pipeline length from building connection to pressure boosting system or from pressure boosting system to least hydraulically favourable extraction point Σl	Mean pressure drop for the pipe system before and after the pressure boosting system (PBS) $\Delta p/l = \Sigma(l \cdot R + Z) / \Sigma l$
m	mbar/m
≤ 30	20
$> 30 < 80$	15
> 80	10

Diagram of pressures before and after the pressure boosting system (PBS)



Suction supply line /intake pressure

Important:
Pressure surges and variations in flow velocities are not caused by the pressure boosting system, but rather by the consumers, taps, fittings and storage tanks beyond it.

- Maximum flow velocity in the connection line (according to DIN 1988, Part 5, Section 4.4.1)
- I: The total flow velocity to the pressure boosting system and to consumption lines without a pressure boosting system must not exceed 2.0 m/s.
- To enable direct connection without a pressure vessel on the suction side of the pressure boosting system, the differences in the flow velocity in the connection line caused by pressure boosting system pumps switching on and off must not exceed the following values:
- II a: $\Delta v < 0.15$ m/s due to one single pump (the largest)
II b: $\Delta v < 0.5$ m/s due to simultaneous cutting out of all duty pumps in a pressure boosting system.

The table shows, for given nominal diameters of connection lines, the respective flow capacity criteria in relation to each of the following:

- The maximum flow velocities (II a)
- Change in those flow velocities due to pumps cutting in and out (II b)
- The total flow (I)

Table of maximum permissible volume flows in terms of the nominal diameter of the building connection line

Nominal diameters of building connection lines	Maximum total flow to the pressure boosting system (PBS) and to consumption lines without PBS	Maximum volume flows with direct connection of a pressure boosting system (PBS) without pressure vessel on the suction side	
	I	II a	II b
	Q_{\max} at $v < 2$ m/s	Q_{\max} at $\Delta v < 0.15$ m/s	$Q_{\max \text{ PBS}}$ at $\Delta v < 0.5$ m/s
DN 25/1"	3.5 m³/h	0.26 m³/h	0.88 m³/hz
DN 32/1 1/4"	5.8 m³/h	0.43 m³/h	1.45 m³/h
DN 40/1 1/2"	9 m³/h	0.68 m³/h	2.3 m³/h
DN 50/2"	14 m³/h	1.06 m³/h	3.5 m³/h
DN 65	24 m³/h	1.8 m³/h	6 m³/h
DN 80	36 m³/h	2.7 m³/h	9 m³/h
DN 100	57 m³/h	4.2 m³/h	14 m³/h
DN 125	88 m³/h	6.6 m³/h	22 m³/h
DN 150	127 m³/h	9.5 m³/h	32 m³/h
DN 200	226 m³/h	17 m³/h	57 m³/h
DN 250	353 m³/h	26.5 m³/h	88 m³/h
DN 300	509 m³/h	38 m³/h	127 m³/h

Important:
In some regions, values issued by the local water supply company may conflict with the values in this table. In this example: the nominal diameter must be the same from the building connection up to the pressure boosting system. No reduction in pipe size is permitted, except for the water meter.

This table states the maximum volume capacities for the total flow for a direct-connected pressure boosting system (PBS), the given nominal diameter of the building's water connection and the maximum permissible flow velocities.

Example:
The water supply company's connection line: DN 80
Wilo PBS type: CO 4 – MVI 207/CC
 $Q_{\max \text{ PBS}} = 6$ m³/h
 $Q_{\max \text{ P}} = 2$ m³/h

Compared with the critical flow capacities for the DN 80 connection line in the table, it is evident that the Wilo pressure boosting system (PBS) type CO 4 – MVI 207/CC is definitely within the permitted limits and can therefore be connected directly to the public network without a pressure vessel on the suction side, subject to approval from the water supply company.

Practical experience demonstrates that the changes in flow velocity are caused not by the pumps, but by extraction points (II a, II b).

Intake pressure

When registering a potable water system with your local water supply company, find out the $p_{min\ V}$.

The way the value is stated can vary from region to region, e.g. flow pressure or static pressure, or elevation above MSL.

Note: Find out the diameter of the building connection line from your water supply company. Be mindful of static pressure and flow pressure.

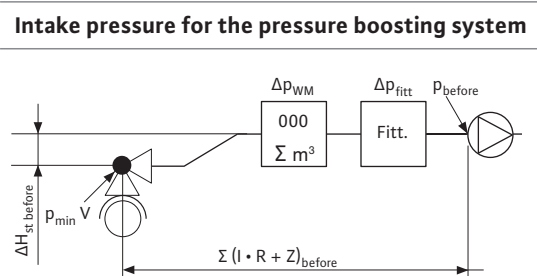
Note: For fittings on the suction side, be mindful of the connection diameter and pressure losses (head losses) of the fittings used (e.g. filter, water meter, pressure reducer, non-return valve).

The available pressure before the pressure boosting system p_{before} is calculated as the difference between the minimum supply pressure $p_{min\ V}$ and the sum of the pressure losses before the system.

The intake pressure for the pressure boosting system is calculated according to the following formula:

$$p_{before} = p_{min\ V} - [\Delta p_{WM} + \Delta p_{fitt\ before} + \Sigma(l \cdot R + Z)_{before} + \Delta p_{st\ before}]$$

in [bar] or [mbar]



Abbreviation	Meaning
p_{before}	Gauge pressure before the pressure boosting system
$p_{min\ V}$	Minimum supply pressure
Δp_{WM}	Pressure loss due to the water meter
$\Delta p_{fitt\ before}$	Pressure loss from fittings before the pressure boosting system
$\Sigma(l \cdot R + Z)_{before}$	Sum of losses before the pressure boosting system
$\Delta p_{st\ before}$	Static head loss before the pressure boosting system

Standard values for pressure loss in water meters

Δp_{WM} : pressure loss (head loss) in the water meter

Table from DIN 1988, Part 3, page 9, Table 3

Meter type	Rated flow $v_n [Q_n]$	Pressure loss Δp at $v_{max} (Q_{max})$ acc. to DIN ISO 4064, Part 1
Impeller meter	< 15 m³/h	1000 mbar (max.)
Vertical turbine meter	≥ 15 m³/h	600 mbar (max.)
Parallel turbine meter	≥ 15 m³/h	300 mbar (max.)

Standard values for pressure loss in fittings, e.g. potable water filters

Δp_{fitt} : pressure loss (head loss) in fittings

Component	Head loss [m]
Gas instantaneous water heater as defined by DIN 3368, Part 2+4	8
Gas combination boiler as defined by DIN3368, Part 2+4	8
Electric cylinder water heater (up to 80 l)	2
Gas cylinder water heater (up to 80 l)	2
Thermally regulated electric instantaneous water heater hydraulically controlled	10
Thermally regulated electric instantaneous water heater thermally controlled	5
Filter (rated volume flow capacity = peak flow)	2

Table from DIN 1988, Part 5,
page 5, Table 2

Mean pressure drop in pipelines

$\Sigma (l \cdot R + Z)_{\text{before}}$: pressure loss in pipes before the pressure boosting system

Length of pipeline from pressure boosting system to least hydraulically favourable extraction point Σl_{after}

Mean pressure drop in consumption lines to fittings $\frac{\Delta p}{l} = \frac{(l \cdot R + Z)_{\text{after}}}{l_{\text{after}}}$

≤ 30 m	20 mbar/m
$> 30 \leq 80$ m	15 mbar/m
> 80 m	10 mbar/m

Mean pressure drop in pipelines

Calculation example:

- l: Length of pipe up to pressure boosting system = 10 m
- R: Pipe friction losses = 20 mbar/m
- Z: Resistance from vertical turbine meter = 600 mbar

$\Sigma [l (10) \cdot R (20) \cdot Z (600)] \text{ mbar} = 200 + 600 \text{ mbar} = 800 \text{ mbar}$

Loss: 800 mbar total

Pressure zone division

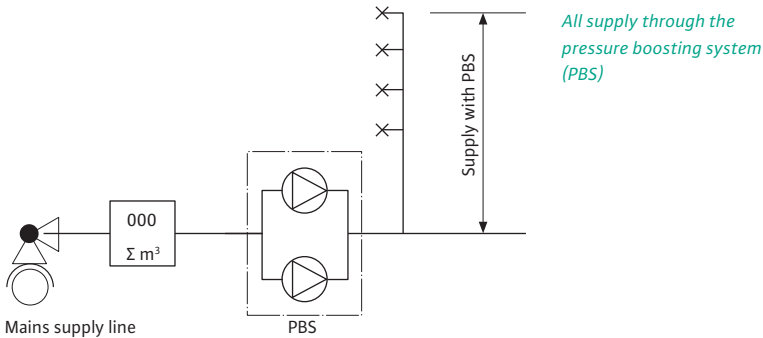
Determining the pressure zones

You need to assess whether the pressure boosting system is required for an entire building or should only be considered for some building areas which cannot be supplied continually with the minimum supply pressure. In borderline cases, the need for a pressure boosting system should be proven using a differentiated calculation procedure as set out in DIN 1988, Part 3.

As a basic requirement, the minimum flow pressure required by the fittings must be available at the least hydraulically favourable extraction point, while the maximum static pressure at the most hydraulically favourable extraction point must not exceed 5 bar. Compliance with these limit values forms the basis for the required pressure zone division of potable water systems.

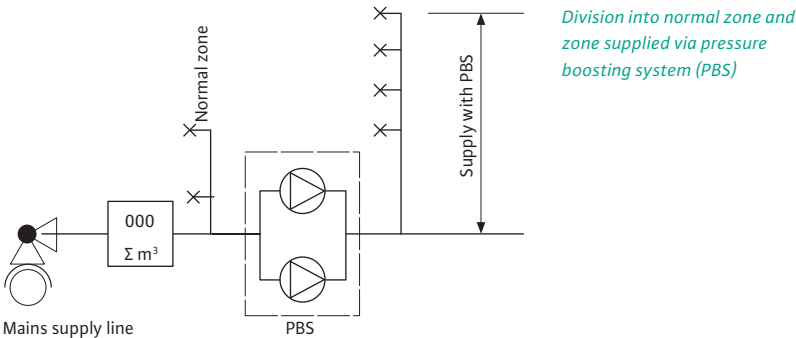
Pressure zones fall into two basic categories:

1. The pressure boosting system (PBS) supplies the entire building

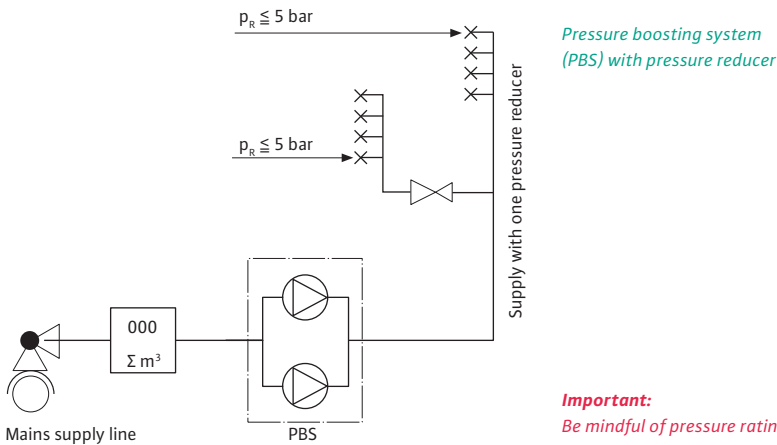


2. The pressure conditions mean that pressure zone division is necessary

The following configurations are possible: the normal zone is supplied by the available supply pressure, and the other parts of the building (the pressure zone) are supplied by a pressure boosting system (PBS).



The pressure boosting system (PBS) supplies the entire building, but the lower lines are connected via a pressure reducing valve.

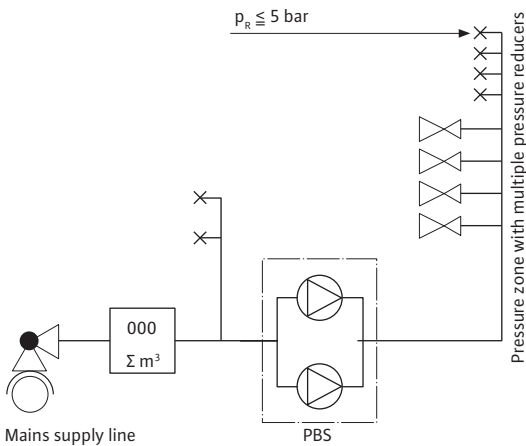


Important:
Be mindful of pressure ratings of pipes and other system components.

2. The pressure conditions mean that pressure zone division is necessary (continued)

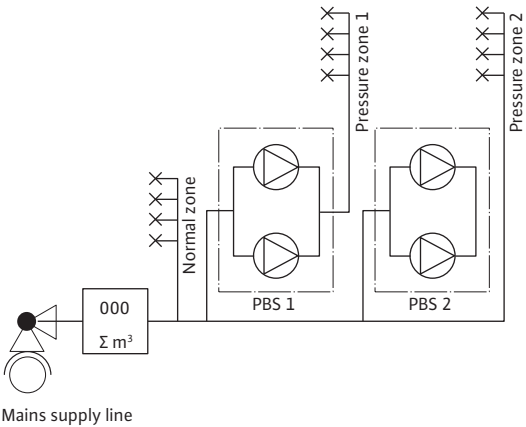
Pressure boosting system (PBS) with multiple pressure reducers

Important:
Be mindful of pressure ratings of pipes and other system components.



The lower floors are supplied with the available supply pressure. The higher parts of the building, which are supplied via the pressure boosting system (PBS), are divided into pressure zones using pressure reducers. The topmost parts of the building in the pressure zone are supplied from the pressure boosting system directly.

Pressure boosting system (PBS), division into pressure zones



The lower parts of the building are supplied with the available supply pressure. The various pressure zones are then supplied by two pressure boosting systems (PBS), and pressure zones can be grouped together so that each resulting pressure zone is supplied by one pressure boosting system. Those zones can then be subdivided if necessary by means of pressure reducers.

Pressure ratings of system components

To ensure safety of the pressurised system, all components in the pressure boosting system must be rated for at least PN 10, except where higher permitted operating pressures make higher pressure ratings necessary.

The general rule according to DIN 1988 is that pressure boosting systems must be designed for a pressure rating of at least PN 10 (see page 46).

Types of connection

The type of connection is determined in accordance with DIN 1988, Part 5

Note:
Regardless of the criteria provided here, you must consult with your local water supply company regarding the type of connection.

The following flowchart is an overview of the possible types of connection in the various possible combinations with pressure surge absorption devices.

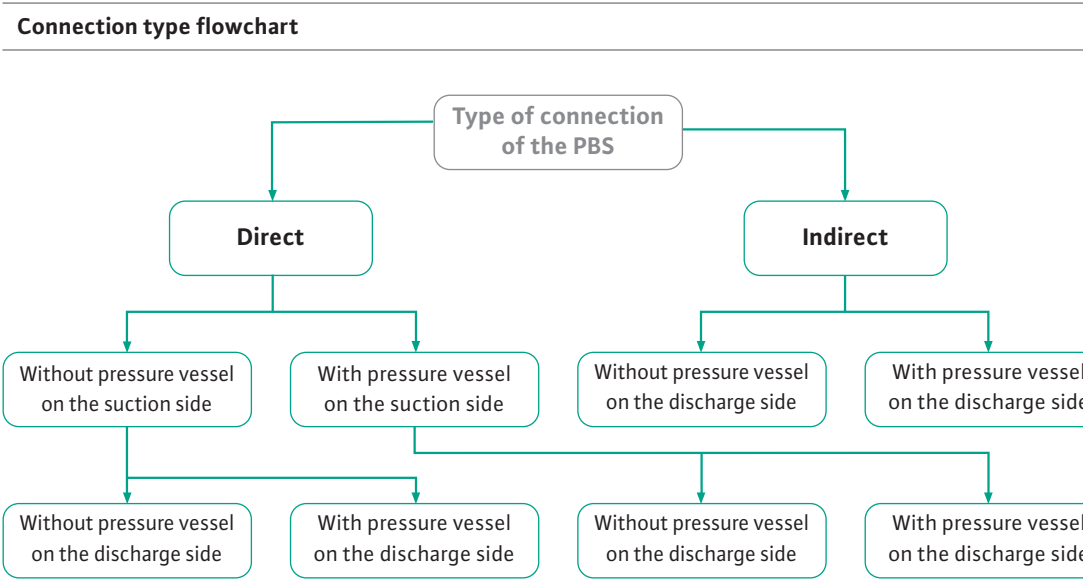
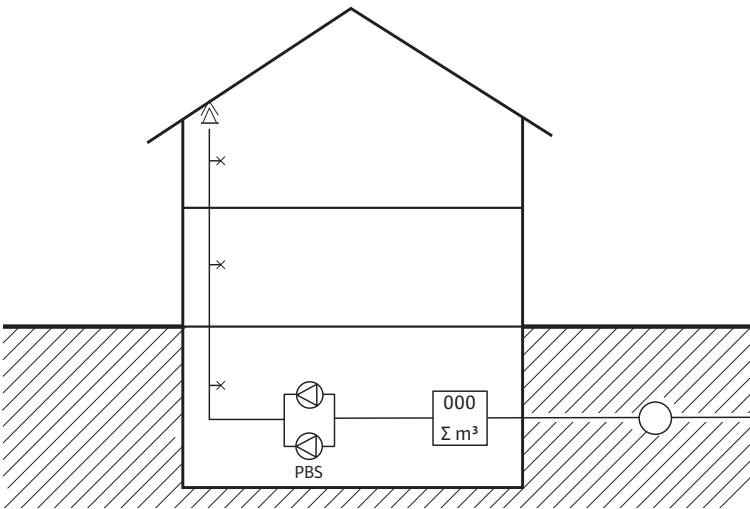


Chart from DIN 1988, Part 5, page 7

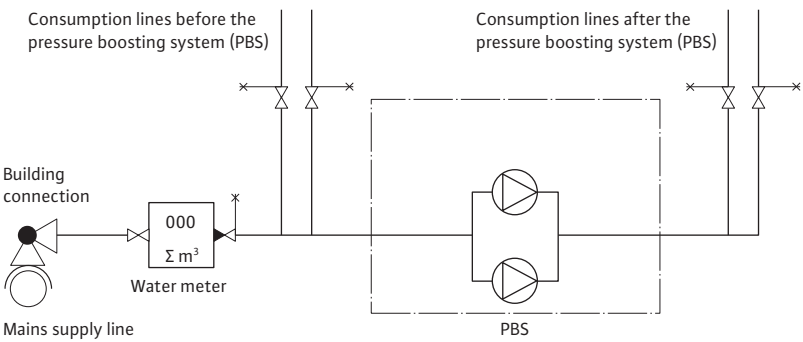
Direct connection

A direct connection links the pressure boosting system (PBS) with the mains supply line directly. This type of connection is generally preferred due to the lower cost of installation. With this type of connection there is no risk of unhygienic contamination of the potable water and the supply pressure available to the pressure boosting system (PBS) is taken on without modification.

Direct connection (schematic drawing in DIN 1988 Part 5, page 8, Figure 7)



Direct connection without pressure vessel on the suction or discharge side

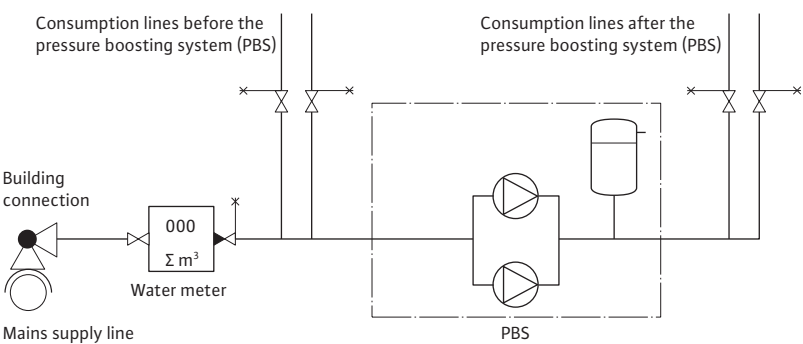


This type of connection can be used as the following prerequisites are met on the suction side:

- a) If the maximum difference in flow velocity in the connection line and in the consumption line to the pressure boosting system (PBS) caused by switching pumps on and off is less than 0.15 m/s.

Unacceptable pressure surges must not occur in the event of failure of all duty pumps, and the resulting difference in flow velocity in the connection line and in the consumption line to the pressure boosting system must not exceed 0.5 m/s, or

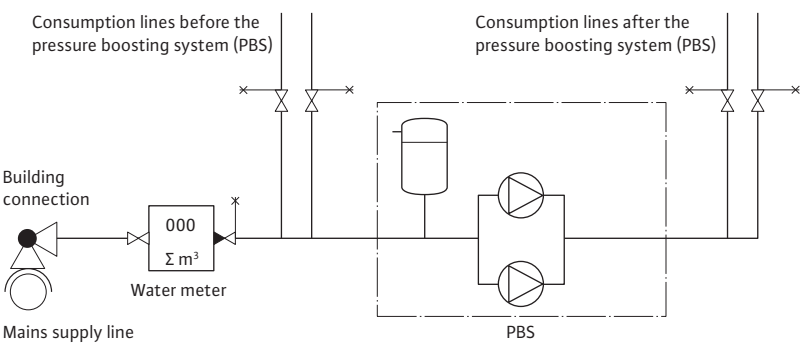
Direct connection without suction pressure vessel, with pressure vessel on the discharge side



- b) If the following can be guaranteed:
 - That the minimum supply pressure will stay ≥ 1 bar when the pumps start up and will not be reduced by more than 50 %;
 - That the rise in pressure Δp when the pumps cut out (including power failures) will not come to more than 1 bar over the permitted operating pressure on the consumer side after shut-down of the pressure boosting system.

To meet the requirements in items a) and b) suction-side pressure vessels can be added to the pressure boosting system as buffering elements (see also *Basic principles of system technology*, section *Diaphragm pressure vessels (DPV) before the pressure boosting system*, page 37).

Direct connection with pressure vessel on the suction side, without discharge pressure vessel

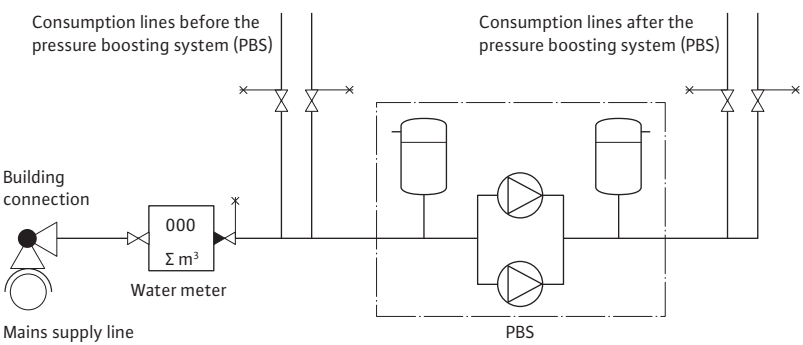


Indirect connection
An indirect connection links the pressure boosting system (PBS) to the connection line branching off from the mains supply line indirectly via a break tank (also called a “preliminary tank”). This tank, which is permanently in connection with the outside air, is supplied with the water via one or more valves controlled by water level. The suction-side prerequisites listed in the section *Direct connection* must also be met here.

An indirect connection is only required if the following apply:

- a) If, as a result of the maximum extraction by the pressure boosting system (PBS) – taking neighbouring water extractors into account – the required minimum flow pressure is not met at the least favourable extraction point (usually the highest);

Direct connection with pressure vessels on the suction and discharge side



- b) If potable water lines from the public water supply and pipes from an installation for self-sufficient water supply are to be merged into shared pipelines (see also DIN 1988, Part 4);
- c) If the potable water could come into contact with other substances (see also DIN 1988, Part 4);
- d) And there is a health risk to consumers connected upstream.

In addition to the higher costs of installing the additional break tank (preliminary tank), another major disadvantage is the loss of the water pressure from the mains network. To compensate that, the pressure boosting system (PBS) normally needs to have a higher pump capacity.

Whether an indirect connection is needed or not can ultimately only be clarified by consulting your water supply company.

Connection options

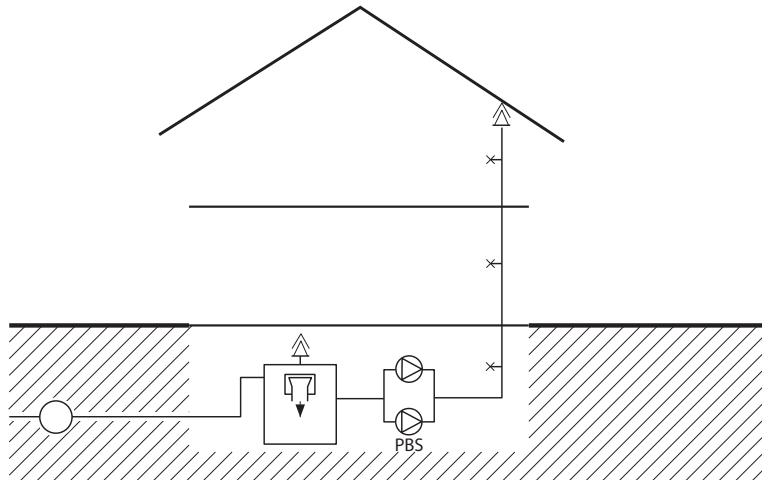
Whereas the decision regarding indirect and direct types of connection and the possible installation of a pressure vessel on the suction side is determined solely by suction-side criteria, whether a pressure vessel needs to be installed on the discharge side depends entirely on the design of the pressure boosting system.

Criteria to consider are as follows:

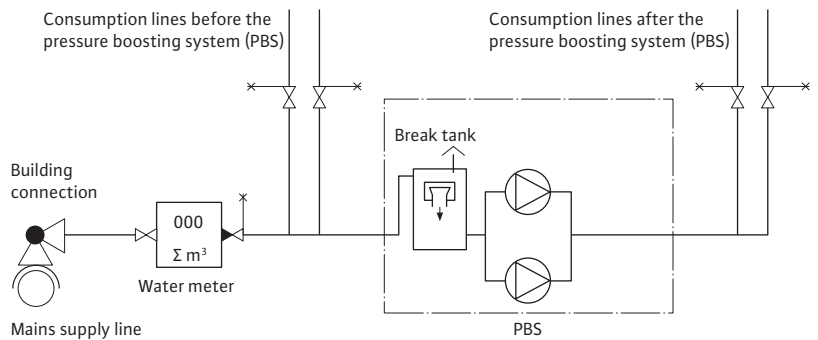
- a) Disruptive pressure surges caused by pressure-dependent or flow-dependent pump control
- b) Excessive cutting in and out
- c) Storage and dispensing of potable water in the idle phase between switch-off and switch-on pulses.

These requisites are normally met by installing multi-pump systems, in which the required maximum volume flow capacity is divided between several pumps each with a relatively low flow capacity ("capacity splitting").

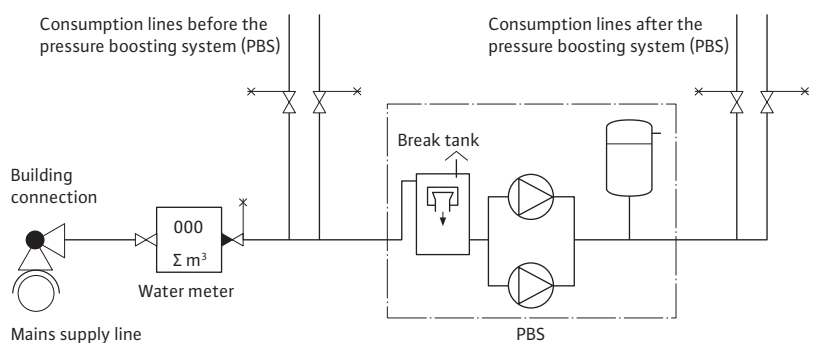
Indirect connection (schematic drawing in DIN 1988 Part 5, page 10, Figure 11)



Indirect connection with open, atmospherically ventilated break tank, without pressure vessel on the discharge side



Indirect connection with open, atmospherically ventilated break tank, with pressure vessel on the discharge side



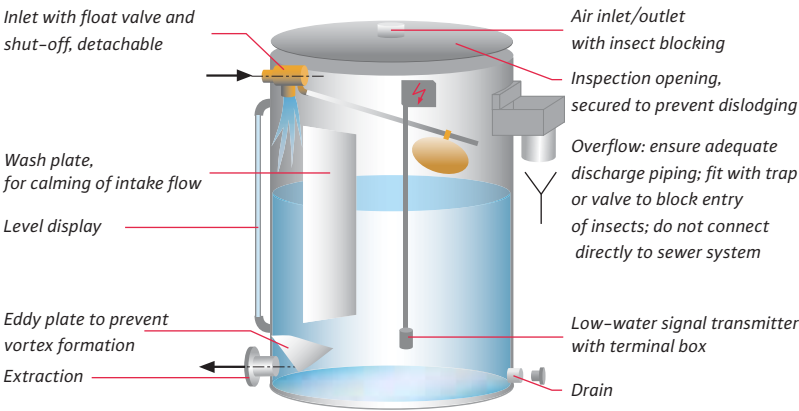
Important:

Pressure vessels only for use with pumps without speed control.

Atmospherically ventilated break tank (BT)

To meet the requirements specified by EN 1717 and DIN 1988 (Parts 2, 5 and 6) for suction-side and discharge-side criteria, it may be necessary to install an atmospherically ventilated break tank (BT) and other additional fittings for your pressure boosting system. The following guidelines apply when choosing the size of the break tank.

Example configuration of an atmospherically ventilated break tank (BT)



When determining the required useable capacity of the break tank required for indirect connection, the following factors must be considered:

- The volume flow V and minimum supply pressure p_{minV} in the connection line from the public water supply, and
- The calculated peak volume flow V_S to be met

If the peak volume flow V_S required for the building cannot be extracted from the mains supply line, the tank volume V_B must be determined by means of volume control (with flow curve and cumulative curve). If volume control does not need to be considered, the useable volume can be calculated approximately using the following formula:

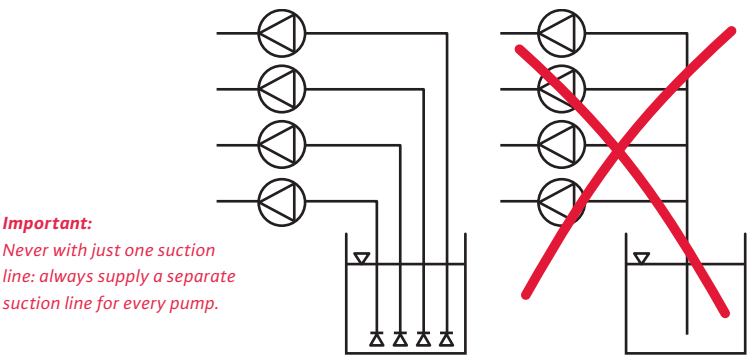
$$V_B = 0.03 \times V_{maxP} [m^3]$$

The break tank and pressure boosting system or parts thereof can be installed in the same room.

Abbreviation	Meaning
V_B	Maximum tank volume
V_{maxP}	Maximum volume flow of the pressure boosting system

Pressure boosting system in suction mode

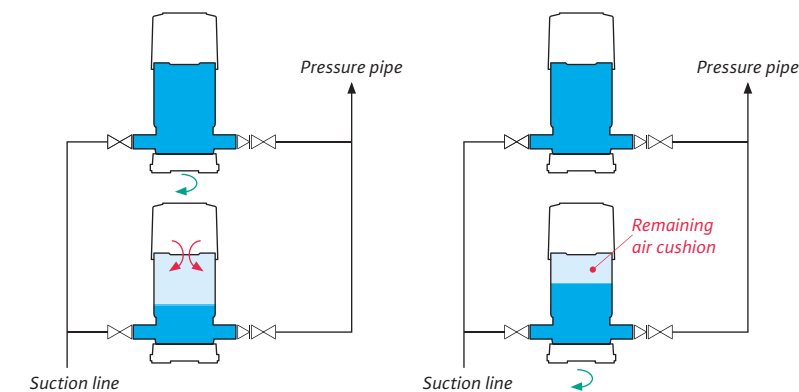
Diagram of a pressure boosting system with non-self-priming pumps



It is recommended to equip every pump with its own suction line with foot valve. In that case the non-return valve on the discharge side is not needed. Systems with a shared suction line are not recommended.

When non-self-priming pumps are operating in suction mode via a shared suction line, there is the possibility that the pump currently running will lower the water level of the switched-off pump and at the same time will suck air into the pump through the mechanical seal. When changing from one pump to another the remaining cushion of air can cause dry running of the mechanical seal and considerable reduction in the delivery head capacity of the pump.

Diagram of the problem caused in a pressure boosting system in suction mode with a shared suction line



Diaphragm pressure vessels (DPV) before the pressure boosting system (PBS)

Diaphragm pressure vessels (DPV) are used in potable water systems for the following reasons:

- To absorb pressure surges especially in large systems
- As buffer and control vessels in conjunction with pressure boosting systems (PBS)

The main requirements for diaphragm pressure vessels (DPV) in potable water applications are:

- Adequate circulation (no stagnation of the water in the diaphragm pressure vessel),
- Corrosion protection for all components coming in contact with the fluid, and
- Hygienically safe, non-metallic construction materials; no reactive modification of the water and no biofilm (KTW C; DVGW W 270).

According to DIN 1988, Part 5, the capacity of the pressure vessel can be estimated and determined without any further evidence using the following table.

Note:
Follow the regulations of your local water supply company.

Total volume of diaphragm pressure vessels (DPV) on the suction side in relation to the volume flow of the pumps

Volume flow of the pressure boosting system (PBS) V_{maxP}	Total volume of the pressure vessel on the suction side of the pumps V_{maxP}
$\leq 7 \text{ m}^3/\text{h}$	0.3 m^3
$> 7 < 15 \text{ m}^3/\text{h}$	0.5 m^3
$> 15 \text{ m}^3/\text{h}$	0.75 m^3

The minimum capacity should not be less than 0.3 m^3 . This figure can be lower in the case of pressure vessels with separate air and water areas (e.g. diaphragm pressure vessels) if the requirements in DIN 1988 (Part 5, section 4.4.1 b) are met.

Example:
Using the table (see above), a system capacity of $V_{\text{maxP}} = 10.8 \text{ m}^3/\text{h}$ gives a vessel size of:

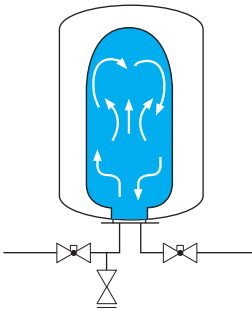
$V_V = 0.5 \text{ m}^3$

The supply pressure on the gas side of the diaphragm pressure vessel (DPV) p_0 must be checked during commissioning and adjusted if necessary to 0.2 to 1 bar below the test pressure p_a of the pressure reducer.

$p_0 = p_a - 0.2 \dots 1.0^* \text{ bar}$

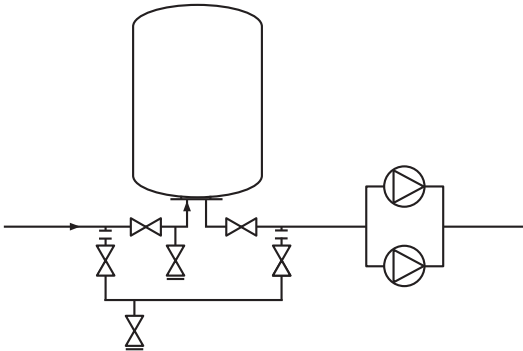
* 1.0 bar if there is a large distance between the pressure reducer and the DPV

Circulation through diaphragm pressure vessel (DPV) (dual connection)



Important:
In Germany, pressure vessels are subject to the Pressure Vessel Code (DruckbehV 4807 Part 5)

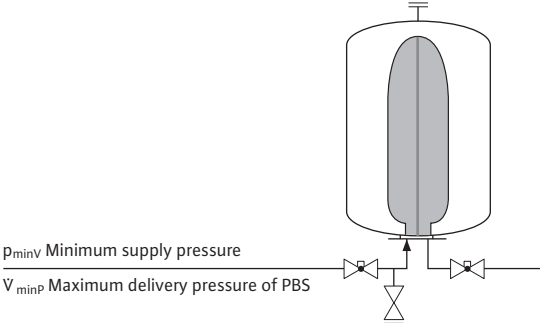
Diaphragm pressure vessel (DPV) on the suction side



Important:
Normally only detachable bypass lines are permitted.

Table from DIN 1988, Part 5, page 11, Table 3

Supply pressure on the gas side of the diaphragm pressure vessel (DPV)



Operating mode: pressure boosting systems controlled with and without speed control



Pressure controlled pressure boosting system without speed control, Wilo-Economy series



Pressure-controlled pressure boosting system with speed control, Wilo-Comfort series



Pressure-controlled pressure boosting system with speed control, Wilo-Comfort-Vario

Pressure-controlled pressure boosting system without speed control

The pumps in a pressure-controlled pressure boosting system without speed control are switched on and off as needed by means of one or more pressure switches to maintain a pre-set pressure range p_{min} and p_{max} or pressure set-point. The base-load pump and the peak-load pumps are activated and deactivated at maximum speed. With systems without speed control, pressure profiles between 1 and 2.5 bar (depending on the control strategy) are realistic.

Pressure-controlled pressure boosting system with speed control

A pressure-controlled pressure boosting system with speed control is adjusted to a pre-set pressure setpoint as needed by means of a pressure sensor. Here, the speed of at least the base-load pump in the pressure boosting system is variably controlled by a frequency converter. The peak-load pumps then cut in and out at maximum speed as needed. In systems where the base load is speed-controlled, pressure profiles between 0.4 and 1.0 bar (depending on the control strategy) are realistic.

In the latest pressure boosting systems, all pumps are now equipped with their own frequency converter, with the pressure control function being passed on from pump to pump. In these “Vario” systems, pressure stability of ± 0.1 bar is realistic.

Pump control

Pressure boosting systems must be fitted with a standby pump.

If a duty pump fails, it must be guaranteed that the peak flow Q_D is 100 % covered.

For smaller buildings such as detached and semi-detached houses, a standby pump is not necessary.

With multi-pump systems, automatic cyclical interchange of the pumps is necessary (including the standby pump) to prevent water stagnation. Furthermore each pump must take over operation at least once every 24 hours (for proper operation).

It must be guaranteed that another pump will take over supply operations if a pump fails, and that the fault will be displayed or signalled.

It is recommended that the switching pressure differential Δp_{ON-OFF} of a system should not exceed 150 kPa.

With a direct connection, a pressure indicating device must be installed directly after the water meter (preferably with a maximum indicator). Make sure that the delivery pressure is above the set switch-off pressure during the run-on time of the pumps at volume flow $Q = 0 \text{ m}^3/\text{h}$.

For this reason, systems which use a speed control unit (usually frequency-controlled systems) to generate a constant flow pressure p_{FI} are preferred, whereby the flow pressure p_{FI} , minimum flow pressure $p_{min FI}$ and static pressure p_s are all on one pressure curve (regardless of variations in intake pressure).

Connections and control should be configured so that in the case of direct connection, the system shuts down when the supply pressure falls below 100 kPa (low-water cutout to protect consumers upstream).

Chatter or “hunting” is to be avoided.

With indirect connection, the system and pumps must be protected against dry running (low water) and must indicate or signal low water – ideally the system should be equipped with a low water indication device.

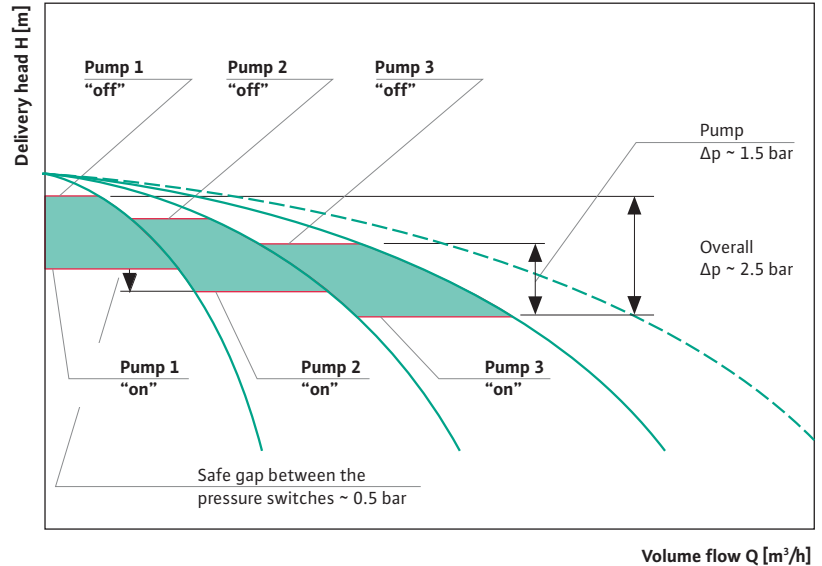
When the water level is restored the system can switch back on automatically.

Pressure boosting system designs and their hydraulic functions

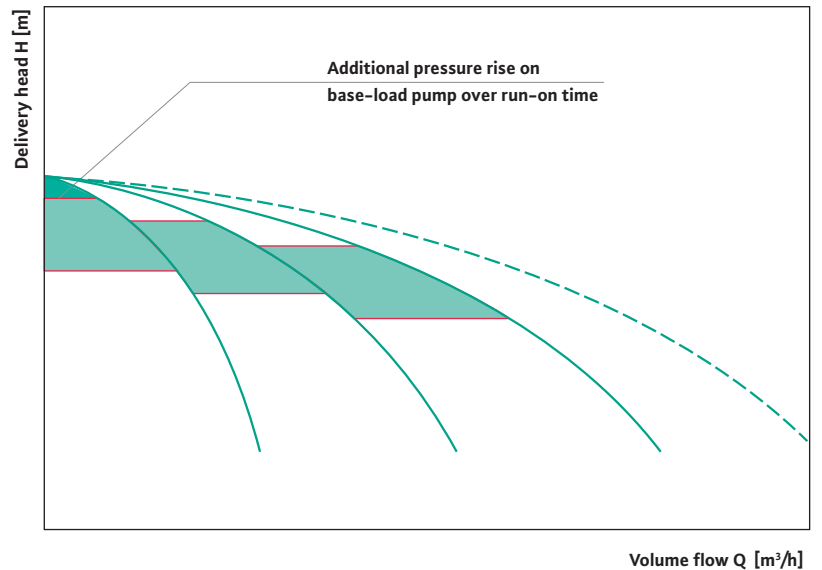
System controlled without speed control

Cascade activation via pressure switches without delay elements, e.g. 4-pump system, where every pump has its own pressure switch.

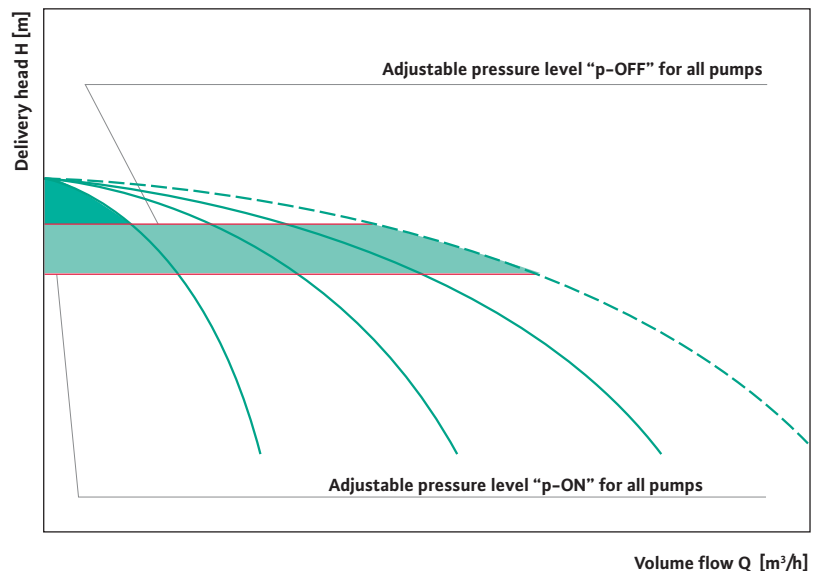
The cascade activation does not allow for precise control; a Δp range of about 2.5 bar (with e.g. three duty pumps) is possible at best.

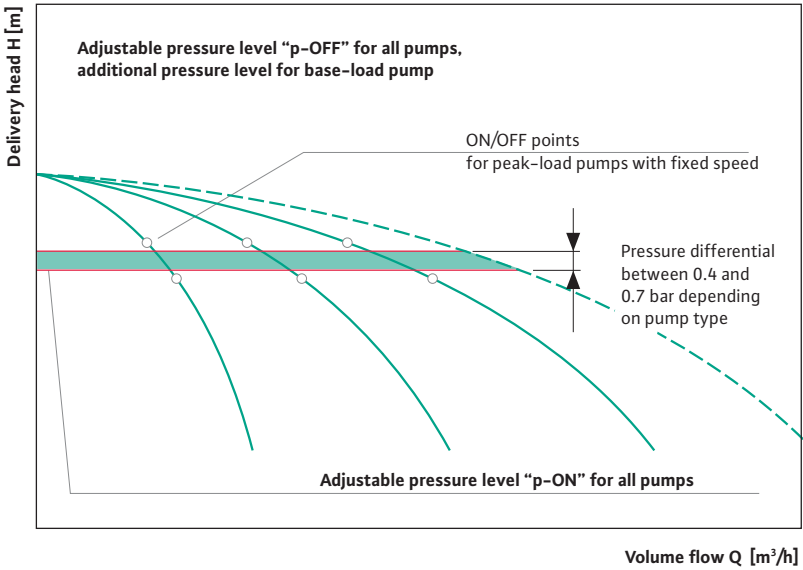


Cascade activation as before but with a delay element for the base-load pump to prevent chatter. Cut-off pressure of the base-load pump = zero-delivery head of the pump.



Cascade activation as before but controlled via pressure sensor or contact manometer. System without speed control, with run-on time for the base-load pump. Reliable system with transfer of base- and peak-load function, but with a broad Δp range. Due to the run-on times, cut-off pressure of the base-load pump is always the same as the zero-delivery head of the pump (H_{\max} of the pump at $Q = 0$).

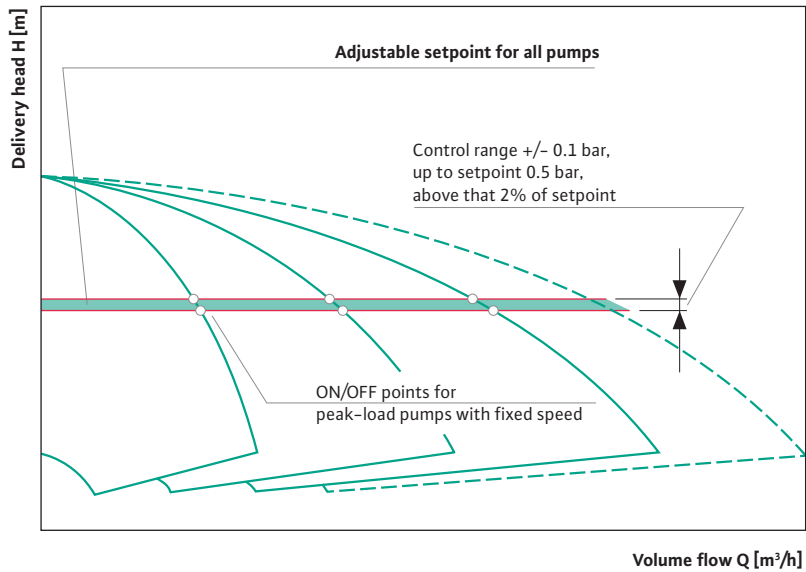




Speed-controlled systems – only base-load pump controlled via frequency converter

Reliable and precise system with transfer of base- and peak-load function, allowing a narrower Δp range to be realised.

Elimination of pressure rise in the weak-load range or when volume flow capacity $Q = 0$. Pressure fluctuations when the uncontrolled peak-load pumps cut in and out.



Speed-controlled systems – all pumps are speed-controlled

Reliable and precise system with efficiency-optimised transfer of control to the peak-load pumps, allowing a very narrow Δp range to be realised. Elimination of pressure rise in the weak-load range or when volume flow capacity $Q = 0$ and when peak-load pumps cut in and out.

Special features of speed-controlled pressure boosting systems

Fluctuations in intake pressure are compensated by the speed control built into every single pump.

This remains true as long as the pressure fluctuation is not greater than the difference between the setpoint pressure and the zero-delivery head H_0 of the pump at minimum speed n_{min} .

If the pressure fluctuation is greater, a pressure reducer must be provided and installed in the suction pipe.

Example 1:

Use of an MVISE 805 with the following data:
 H_0 at n_{min} = 1.7 bar, setpoint = 5 bar,
 p_{vmin} = 1.5 bar, p_{vmax} = 3.0 bar

Calculation:

ΔH_{diff} = setpoint – H_0 at n_{min}
= 5 bar – 1.7 bar
= 3.3 bar

Δp_v = p_{vmax} – p_{vmin}
= 3.0 bar – 1.5 bar
= 1.5 bar

Conclusion:

$pH_{diff} > \Delta p_v$ (3.3 bar > 1.5 bar): the maximum pressure fluctuation can be compensated by speed control of the pump.

Example 2:

Use of an MVIE 402 with the following data:
 H_0 at n_{min} = 0.6 bar, setpoint = 2 bar,
 p_{vmin} = 1.5 bar, p_{vmax} = 3.0 bar

Calculation:

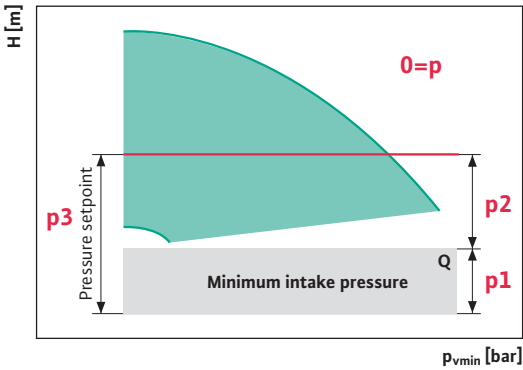
pH_{diff} = setpoint – H_0 at n_{min}
= 2 bar – 0.6 bar
= 1.4 bar

Δp_v = p_{vmax} – p_{vmin}
= 3.0 bar – 1.5 bar
= 1.5 bar

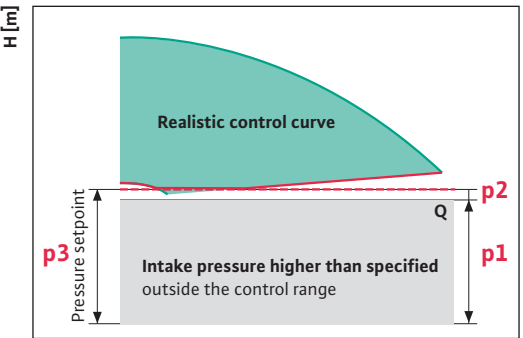
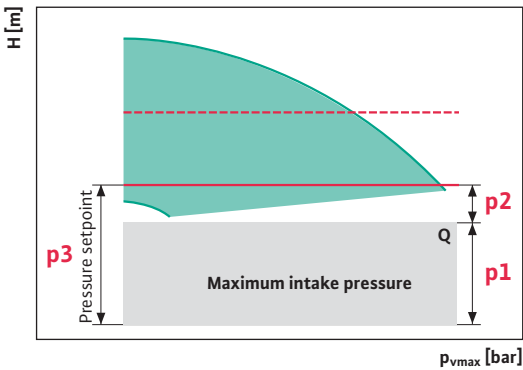
Conclusion:

$pH_{diff} < \Delta p_v$ (1.4 bar < 1.5 bar): the maximum pressure fluctuation cannot be compensated by speed control of the pump.

Pressure fluctuation curve



Compensation of intake pressure fluctuations



A pressure reducer must be used to keep the intake pressure constant

Abbreviation Meaning

n_{min}	Minimum speed
p_{vmin}	Minimum volume flow capacity of pump
p_{vmax}	Maximum volume flow capacity of pump
pH_{diff}	Delivery head differential of pump
p_v	Volume flow of pump
Δp_v	Volume flow differential of pump
ΔH_{diff}	Delivery head differential

Diaphragm pressure vessels used with speed-controlled systems

Diaphragm pressure vessels on the suction side
Local regulations must always be followed.

Diaphragm pressure vessels on the discharge side
Diaphragm pressure vessels on the discharge side are not normally needed in speed-controlled pressure boosting systems, as they no longer perform their intended function (due to low useable volume).

Note:
Space savings due to elimination of the diaphragm pressure vessel(s) and saving on maintenance costs.

The following rule applies: the smaller the p range, the smaller the useable volume of the diaphragm pressure vessel.

In the event of fast changes in consumption (e.g. quick closing valves) they can perform a buffering function.

Important:
A separate diaphragm pressure vessel calculation must be performed for each type of system.

Specific example: system without speed control
Where:
 $V_{\max P} = 11.4 \text{ m}^3/\text{h}$
 $p_{\text{OFF}} = 5.5 \text{ bar (6.5 bar absolute)}$
 $p_{\text{ON}} = 3.8 \text{ bar; } s = 20 \text{ (1/h)}$

Calculation:

$$V_E = 0.33 \cdot V_{\max P} \cdot \frac{(p_A + 1)}{\Delta p_{(\text{OFF-ON})} \cdot s}$$
$$= 0.33 \cdot 11.4 \text{ m}^3 \cdot \frac{6.5 \text{ bar}}{(5.5-3.8) \text{ bar} \cdot 20} = 0.719 \text{ m}^3$$

The selected tank has a total volume of 800 litres. The useable proportion V_{EN} of the total tank volume, which can be used to meet the water demand, is calculated as follows:

$$V_{\text{EN}} = V_E \cdot (\Delta p_{(\text{OFF-ON})} / p_{\text{abs OFF}}) [\text{m}^3]$$
$$= 0.800 \cdot (1.7 \text{ bar} / 6.5 \text{ bar})$$
$$= 0.209 \text{ m}^3$$
$$= 209 \text{ l}$$

Abbreviation	Meaning
$V_{\max P}$	Maximum volume flow capacity of the pressure boosting system
p_{OFF}	Switch-off pressure of the pressure boosting system
p_{ON}	Switch-on pressure of the pressure boosting system
V_E	Total volume of the diaphragm pressure vessel on the discharge side of a pressure boosting system
$\Delta p_{(\text{OFF-ON})}$	Switching pressure differential: difference between the switch-off and switch-on pressure of a pressure boosting system
V_{EN}	Useable proportion of the diaphragm pressure vessel volume
$p_{\text{abs OFF}}$	Absolute switch-off pressure of a pressure boosting system

Specific example: system with speed control
Where:
 $V_{\max P} = 11.4 \text{ m}^3/\text{h}$
 $p_{\text{OFF}} = 4 \text{ bar (5 bar absolute)}$
 $p_{\text{ON}} = 3.8 \text{ bar; } s = 20 \text{ (1/h)}$

Calculation:

$$V_E = 0.33 \cdot 11.4 \text{ m}^3 \cdot \frac{5 \text{ bar}}{(4-3.8) \text{ bar} \cdot 20} = 4.7 \text{ m}^3$$

The selected tank has a total volume of 800 litres. The useable proportion V_{EN} of the total tank volume, which can be used to meet the water demand, is calculated as follows:

$$V_{\text{EN}} = 0.800 \cdot (0.2 \text{ bar} / 5 \text{ bar})$$
$$= 0.032 \text{ m}^3$$
$$= 32 \text{ l}$$

Conclusion:
Only 26 % and 3 % respectively of the total volume of the diaphragm pressure vessel is available as useable water capacity from the time when the pressure boosting system switches off to when it switches back on. When you also take into account that the traditional function of a diaphragm pressure vessel on the discharge side is to keep the number of switch-on cycles per hour within tolerable limits, and that function is taken over by the built-in fully electronic switching and control systems, a diaphragm pressure vessel on the discharge side can usually be dispensed with in the interests of cost reduction.

Material selection

All materials, components and fittings used in potable water installations must comply with the European product standards or the European approvals for construction products. If neither exists, the national standards or local regulations apply.

When planning and selecting materials, the operating conditions and water quality must be considered.

The standards EN 12502-1 to EN 12502-5 list all specifications and criteria for proper selection of metal materials in terms of likelihood of corrosion.

The following must be considered when selecting materials:

- Interaction with the potable water quality
- Vibrations, stresses or settling
- Internal pressure from the potable water
- Internal and external temperatures
- Internal or external corrosion
- Compatibility of different materials
- Aging, fatigue, creep rupture strength and other mechanical factors
- Diffusion characteristics

Pipe joints

All pipe joints in the potable water installation must comply with the relevant standards and must remain watertight under the changing stresses that they are subjected to during operation.

Pipe joints can be divided into two basic categories:

- End-load-bearing pipe joints (can absorb axial forces)
- Non-end-load-bearing pipe joints (requiring additional securing to be able to absorb the hydraulic thrust on the joints)

When selecting materials for pipe joints, use only solder and filler metal which is free of lead, antimony and cadmium, unless otherwise allowed by national and local regulations.

Important:
Pipes and accessories made of lead must not be used.

Diaphragm pressure vessel (DPV) after the pressure boosting system (PBS)

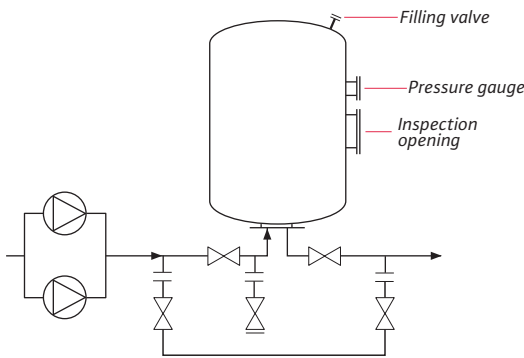
Pressure boosting system accumulator



Pressure boosting system accumulator

The accumulator in the system assembly functions as minimal water storage in the event of small amounts of leakage and to prevent chatter when pumps are switched on and off. These accumulators must be connected in a way which prevents stagnation. They are now included as standard in any pressure boosting system.

Diaphragm pressure vessel (DPV) on the discharge side



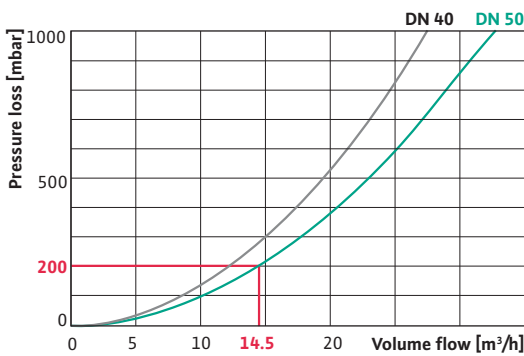
Important:
Must be able to be removed.

Diaphragm pressure vessels (DPV) on the discharge side

The evaluation equation specified as a guideline in DIN 1988, Part 5 refers to air-controlled pressure vessels in accordance with DIN 4810 with a shared air-/water space.

This type of vessel design is now outdated and therefore it is not discussed further here. Please refer to the calculations of the vessel manufacturer.

Characteristic curve



Flow limitation,
e.g. with Wilo types
D 80–180 = 14.5 m³/h

Pressure loss diaphragm vessel

At the volume flow specified by the manufacturer, the pressure loss upon commissioning must not be greater than 0.2 bar. Testing to be done in accordance with DIN 4807, Part 5, section 4.1.6.

The pressure vessel must have forced circulation as described in DIN 4807 Part 5.

In Germany pressure vessels are subject to the Pressure Vessel Code. They must be made from materials with sufficient corrosion resistance or the materials must be sufficiently protected against corrosion. For applicable tests and acceptance procedures, see the overview in the appendix.

Number of pumps

When the public water supply is used, pressure boosting systems (PBS) must be equipped with at least two pumps of identical capacity (a duty pump and a standby pump). The maximum volume flow $V_{\max P}$ must be able to be 100 % covered by each of the two pumps.

The requirement for at least two pumps of identical size does not apply to pressure boosting systems (PBS) which are solely intended for fire extinguishing purposes, unless required by other regulations or the requirements of the local fire protection authority (fire prevention).

To meet the requirement of preventing unacceptable effects on pipe systems on the suction side and discharge side, pressure boosting systems can also be installed as multi-pump systems (3-, 4-, 5- and 6-pump systems). The basic requirement that maximum volume flow $V_{\max P}$ must be able to be 100 % covered if a duty pump fails still applies.

The required system capacity is to be calculated in accordance with DIN 1988.

Protection against low water level/safety features/pressure reducers

Protection against low water level

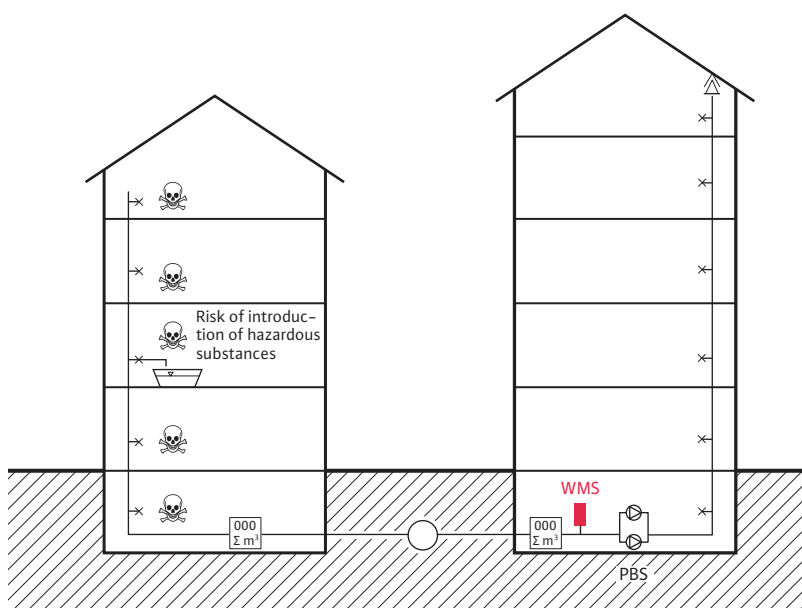
With an indirect connection, make sure that the pumps are protected against low water (dry-running protection system).

With a direct connection, the system must be configured so that pumps switch off or remain switched off when the minimum supply pressure drops to 1.0 bar (taking local conditions into account).

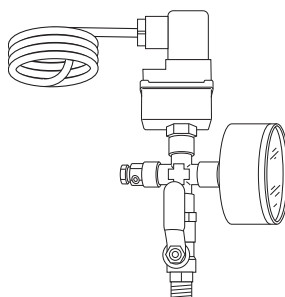
Note:

With fire protection systems, local regulations must be observed (fire prevention).

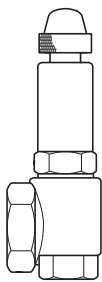
Protection against low water level (WMS) with direct connection type



Wilo WMS low-water cut-out switchgear



Low-water cut-out switchgear for direct connection, comprising pressure switch, pressure gauge, shut-off device



Angle safety valve, spring-mounted, liftable and with compressible seal

Important:
Safety valves are the only approved safety fitting.

Important:
Note static head difference between safety valve ↔ component with the lowest rated pressure; reduced the response pressure of the SV if needed.

Safety features and fittings

Maximum pressure rating

All components in the pressure boosting system must be rated for at least PN 10, except where higher permitted operating pressures call for higher pressure ratings.

Shut-off valves

Shut-off valves must be fitted before and after every pump so that each pump can be removed without interrupting the water supply.

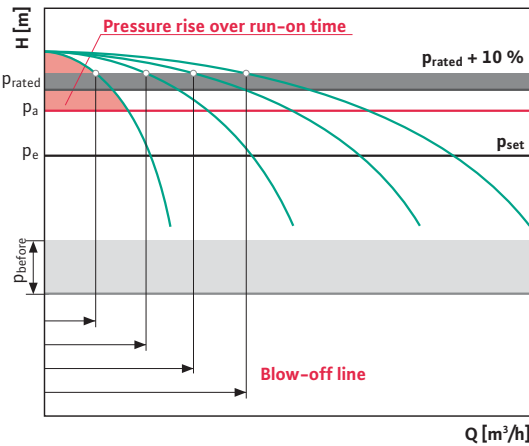
Non-return valves

Non-return valves must be in accordance with DIN 3269, Part 1 and 2.

Safety valves (SV)

If the system pressure exceeds 1.1 times the maximum permitted operating pressure for the entire building installation, an SV must be installed. The system pressure is the sum of the maximum supply pressure and maximum delivery pressure of the pressure boosting system (PBS). The building installation generally includes pipes, fittings, pressure vessels and the secondary hot water system.

Diagram of SV response pressure



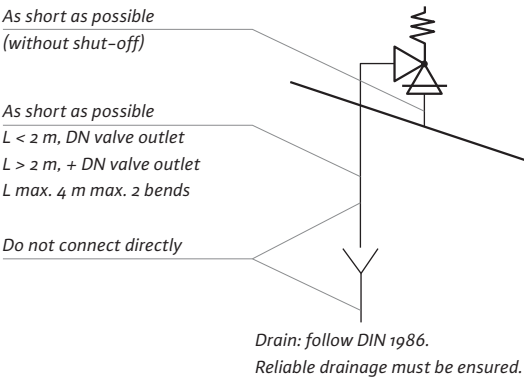
The SV must be tested in accordance with AD-Merkblatt A2. It must be dimensioned so that, at the response pressure (1.1 times the maximum permitted operating pressure), it can blow off the volume flow capacity of the pressure boosting system (PBS). The stream of water flowing out of the SV must be able to be conducted away safely (in accordance with EN 12056, DIN 1986-100).

During normal operation, adherence to the maximum permitted pressure must be ensured by other suitable means, e.g. pressure reducers.

With pressure boosting systems, the maximum permitted pressure can be exceeded in the following ways:

- Incorrect configuration
- Changed intake conditions (see adjacent graph)
- Incorrect operation
- Improper modifications

Installation and configuration instructions for SV



Inspection and maintenance of SV

Functional inspection by checking responsiveness: During operation of the system, the lifting mechanism of the SV should be operated from time to time. Observe whether the valve closes again when the lifting mechanism is released and whether the water behind the valve flows away completely through the funnel or blow-off line.

Inspection interval

Every six months by the operator or a specialist technician.

Water-level-controlled valves

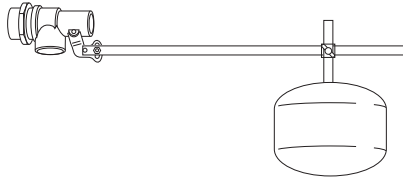
If water-level-controlled valves (e.g. float valves) need to be used, select only types which do not open or close suddenly. The opening or closing time must be longer than 0.5 sec.

A shut-off device must be installed before these valves on the vessel. If necessary, a pressure reducer should be installed (note: maximum 5 bar static pressure).

With float valves, the maximum nominal diameter is limited to DN 50. If the volume of water flowing out of a float valve is not sufficient:

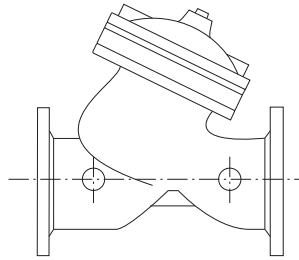
- Install several valves next to one another. Their floaters should be set to different water levels (cascade), while making sure that the floaters can move freely. Or:
- Install diaphragm valves for free discharge with pilot control.

Float valve



*Float valve for utilisation for level control in open break tanks (preliminary tanks) with up to 1,000 l useable volume
Float valve R 1/2 as control valve in conjunction with diaphragm valve*

Diaphragm valve



Diaphragm valve for utilisation for level control in open break tanks (preliminary tanks) starting with 1,500 l useable volume in conjunction with a float valve R 1/2 as control valve

Pressure reducers

The criteria for the installation of pressure reducers are specified in DIN 1988, Part 5.

A pressure reducer does the following:

- Limits excessive supply pressure
- Keeps system pressure steady even when the input pressure (supply pressure) is fluctuating
- Has a water saving effect, as less water flows out of extraction points when the pressure is lower
- Prevents disruptive flow noise

Important:
Pressure reducers should be avoided if possible in fire water pipes. However, the local fire protection requirements must always be observed (fire prevention).

Examples of all types of pressure reducers



Pressure reducers Do6F and D15P from Honeywell Braukmann

Pressure reducers should be installed in the following situations:

- If the static pressure at the extraction points can exceed 5 bar in the area of application of DIN 4109, Part 2 (noise control in building construction)
- If the operating pressure in the consumption lines needs to be limited; in other words, if the highest possible static pressure at any point in the potable water consumption system reaches or can exceed the maximum operating pressure permitted at that point, or if devices and fittings are installed which can only be subjected to a lower pressure
- The static pressure before a safety valve can exceed 80 % of its response pressure
- To supply a building, it is necessary to set up several pressure zones because the entire building is being supplied via a pressure boosting system. The pressure reducers are then installed either in the pipes supplying particular floors or in the rising pipe leading from one zone to the next.

Example:

A pressure reducer must be installed if, for a safety valve response pressure of 10 bar, the static pressure of 8 bar is exceeded.

Determining the nominal diameter of pressure reducers

Nominal diameter	Residential Peak flow V_g		Industrial plants Peak flow V_g	
DN 15	0.5 l/s	1.8 m³/h	0.5 l/s (0.35*)	1.8 m³/h (1.3*)
DN 20	0.8 l/s	2.9 m³/h	0.9 l/s	3.3 m³/h
DN 25	1.3 l/s	4.7 m³/h	1.5 l/s	5.4 m³/h
DN 32	2.0 l/s	7.2 m³/h	2.4 l/s	8.6 m³/h
DN 40	2.3 l/s	8.3 m³/h	3.8 l/s	13.7 m³/h
DN 50	3.6 l/s	13.0 m³/h	5.9 l/s	21.2 m³/h
DN 65	6.5 l/s	23.0 m³/h	9.7 l/s	35.0 m³/h
DN 80	9.0 l/s	32.0 m³/h	15.3 l/s	55.0 m³/h
DN 100	12.5 l/s	45.0 m³/h	23.3 l/s	83.0 m³/h
DN 125	17.5 l/s	63.0 m³/h	34.7 l/s	125.0 m³/h
DN 150	25.0 l/s	90.0 m³/h	52.8 l/s	190.0 m³/h
DN 200	40.0 l/s	144.0 m³/h	92.0 l/s	330.0 m³/h
DN 250	75.0 l/s	270.0 m³/h	139.0 l/s	500.0 m³/h

* Safety valve group

Determining the nominal diameter of pressure reducers

The factor determining the nominal diameter (DN) of the pressure reducer is the maximum peak flow V_g at the point of use as defined by DIN 1988 Part 3.

Pressure reducers must not be dimensioned according to the pipeline diameter.

To determine the size of a particular pressure reducer, use the table as specified in DIN 1988, Part 5, ensuring that the actual maximum flow comes as close as possible to the table values but does not exceed them.

The table distinguishes between systems which need to fulfil the noise control requirements of DIN 4109, Part 5 (e.g. residential buildings) or do not need to fulfil them (e.g. industrial plants).

Pressure drop in pressure reducers

It is recommended to install pressure reducers with a relatively high C_v value in order to keep pressure drop to a minimum especially when it is possible that the input pressure (supply pressure) can fall below the set output pressure.

In addition, the EN 1567 standard must be observed, which states that pressure drop cannot be greater than 2.2 bar in relation to the set output pressure if the input pressure falls 1 bar below the setpoint and a volume of water is extracted equivalent to a velocity of 2.0 m/s as determined by the nominal diameter.

Example:

Nominal diameter	DN 25
Set output pressure p_{eE}	3 bar
Available input pressure p_{eA}	2 bar
Flow at 2.0 m/s	3.6 m ³ /h

Permitted minimum output pressure $p_{min} = 0.8$ bar

This is also and especially applicable to large pressure reducers downstream from fire extinguishing systems. In case of fire, recommended flow velocities are no longer relevant. The important thing is that a lot of water is available at the highest possible pressure. As the pressure reducers are 100 % open at extremely high water flow rates, resistance and thus also pressure drop must be as low as possible, which can only be guaranteed with a high C_v .

Identification marking of pressure reducers

Identification marking of pressure reducers is in accordance with DVGW Arbeitsblatt (code of practice) W375.

Installation of pressure reducers

Pressure reducers are generally installed in the consumption line after the water meter installation.

In a building installation which includes mixers, decentralised pressure reduction (e.g. pressure reducers in the secondary hot water cylinder intake) should be replaced by centralised pressure reduction (e.g. installation directly after the pressure zone division point).

To ensure trouble-free operation of a pressure reducer, a piece of pipe of the same nominal diameter and a length of at least $5 \cdot DN$ should be fitted to it on the output side as a run-on section.

For more detailed information regarding:

- Installation and maintenance
- Special identification marking for hot water
- Installation criteria
- System protection using safety valves
- Bypass lines

... see DIN 1988, Part 5, section 5.4, Part 8, Appendix A8, and the manufacturer's documentation.

Maintenance of pressure reducers

Pressure reducers are devices with relatively low actuating forces and are therefore particularly sensitive to contaminants (DIN 1988, Part 8, Appendix A8) and require annual maintenance by the operator or a specialist contractor.

Important:
Pressure reducers are not safety valves. If certain pressures must not be exceeded in the downstream system, a safety valve must be installed.

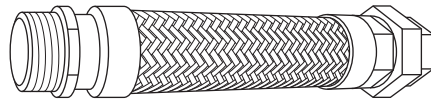
Note:
Be mindful of the differing pressure conditions between hot and cold water installations.

Installation location and conditions

Pressure boosting systems must be housed in non-freezing, well-ventilated, lockable rooms which are not used for any other purpose. These

The flexible connecting line ensures that the systems are connected stress-free.

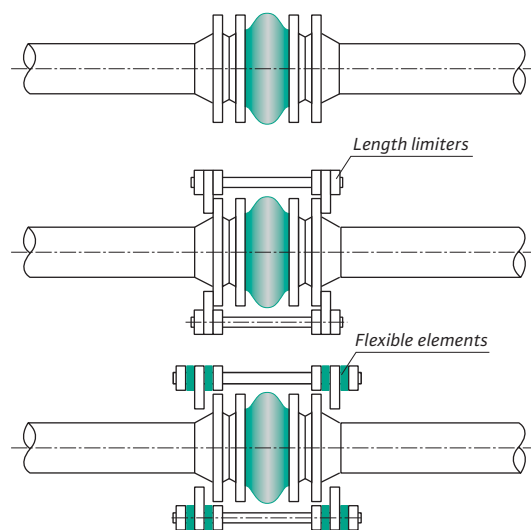
Flexible connection line (flexible hose)



*Expansion joint without length limitation
(should be avoided due to force transmission)*

Expansion joint with length limitation without flexible elements (lateral expansion joint)

Expansion joint with length limitation using flexible elements



rooms must be equipped with drainage connections of adequate size. Harmful gases must not be able to enter the room.

The DPVs for the pressure boosting system must be installed so that:

- Name plates are easily readable
- They can be viewed from as many sides as possible
- They are easily accessible for their internal inspections

Rooms in which pressure boosting systems are to be installed should be selected so that they are not in the immediate vicinity of sleeping or living areas (DIN 4109 specifies max. 30 dbA in neighbouring rooms). Recommendation: installation of a pressure boosting system with glandless pumps (Wilo Multivert MVIS or MVISE).

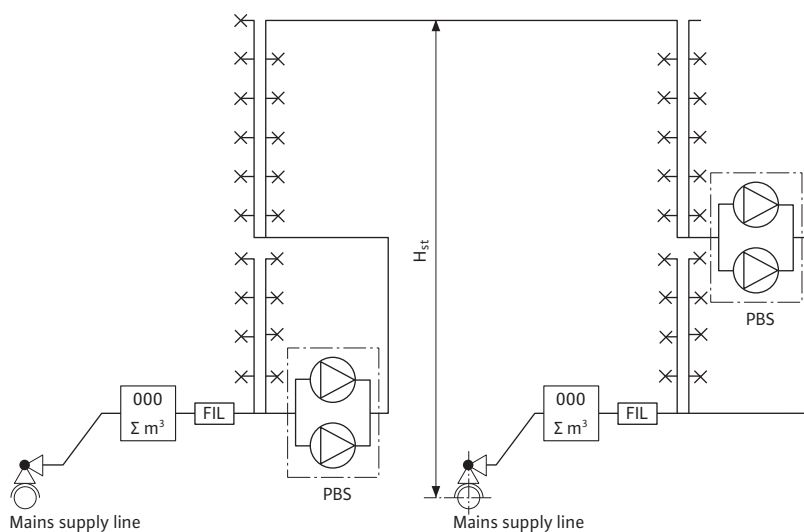
As a general rule, pressure boosting systems must always be installed without mechanical or hydraulic stress (e.g. incorrectly selected anchor points).

If flexible connections are installed using length-limited bellow expansion joints or flexible hoses to absorb vibrations, make sure that they are laid out so that they can be easily replaced, on account of their relatively limited life expectancy.

Note:

Follow the installation and maintenance instructions of the manufacturer of the bellow expansion joints and flexible hoses.

Schematic diagram of a pressure boosting system (PBS) with diaphragm pressure vessel (DPV)



Different installation location for the pressure boosting system (PBS) without diaphragm pressure vessel (DPV) on the suction and discharge sides of the system.

Delivery pressure and installation location of the pressure boosting system

Pressure boosting system without diaphragm pressure vessel on the suction or discharge side

The level of installation has no effect on the delivery pressure Δp_V of the pumps.

To prevent unacceptable low pressures or excess pressures in the pipe system, the following requirements apply to the installation location:

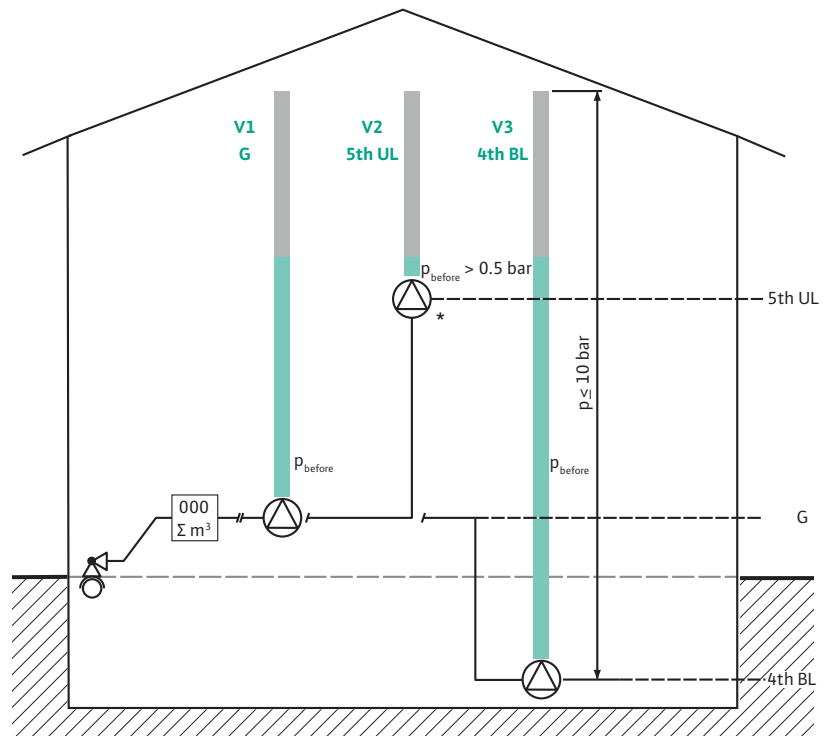
- The supply pressure (p_{before}) of 0.5 bar must be guaranteed even at higher locations.

$$p_{\text{before}} > 0.5 \text{ bar}$$

- The height must be greater than the height in the system at which the operating pressure after the pump could become greater than 10 bar under any potential operating conditions.

$$p_{\text{after}} < 10 \text{ bar}$$

Effects of the level of installation



* Experience-based recommendation > 1.5 bar

Notification requirements

In Germany, the building owner or his/her representative must present all planning calculations and drawings showing all system components and the overall layout to the relevant authority (usually the water supply company) for inspection/approval in accordance with DIN 1988, Part 5.

In the case of fire extinguishing systems, the approval of the competent fire protection authority is also required (fire prevention). The operational readiness of the system must be demonstrated in the same way. Before commissioning the specialist contractor who installed the entire pressure boosting station must demonstrate that the connection requirements have been met.



Basic principles of fire protection systems

This chapter deals with fire protection systems involving fire hose reel installations for use by building occupants.

General remarks

In relation to the potable water installations discussed in this chapter which are simultaneously used for fire extinguishing purposes, the potable water protection requirements defined in TrinkwV 2001 take precedence. For this reason, fire hose reel installations are facilities for fire prevention and not for domestic use (EN 1717-3.9). They are used exclusively for protecting people and fighting fire.

Fire hose reel installations have either potable or non-potable water in their pipe systems. If directly connected to the potable water system, they are subject to special hygiene requirements (DIN 1988-6). The most important objective here is to prevent stagnation of the potable water.

Before beginning refurbishment or new construction work, approval must be obtained from the competent fire protection authority, following submission of a fire protection plan. Furthermore the volume of water to be supplied must be agreed with the water supply company.

Preliminary enquiries regarding the requirements of the local fire protection authority must always be made as the requirements differ from region to region.

The following points must be clarified with the fire protection authority:

- Fire protection plan, type of system, fire suppression devices for occupant use
- Specification of break tank size and calculations
- Number and type of hose reel installations (volume/pressure)
- Simultaneity factor
- Equipped with or without system transfer
- Signalling provided for and/or forwarding of signals to a graphic annunciator (yes/no)
- System equipped with or without standby pump
- Limit switch (yes/no)

Identification marking

According to DIN 1988, identification marking is obligatory for the following:

- Potable water (PW) pipes and non-potable water (NPW) pipes as specified by DIN 2403
- Risers and fittings as specified by DIN 4066

Note:

Sprinkler systems are not covered in detail by this planning guide.

Terms as defined by DIN 1988-6

Fire protection plan:

A fire protection plan contains specifications for the layout and requirements of the fire extinguishing and fire protection systems.

Fire prevention:

Measures taken to prevent fires starting and spreading.

Fire fighting:

Measures taken to combat threats from fire to life, health and property.

Potable water (PW):

Potable water with properties as defined by TrinkwV 2001.

Fire water:

Non-potable water (NPW) after the transfer point.

Fire hose outlet installations on premises:

Water distribution installations on building premises consisting of buried pipes connected to hose outlets at both above-ground and below-ground level.

Extinguishing system with open nozzles:

Water distribution installation with fixed pipes, in which nozzles are fitted at regular intervals. Not filled with water until the system operates.

- Water spray systems as specified by DIN 14434
- Tank operating system as specified by DIN 14495

Sprinkler system:

Automatic fire extinguishing system with fixed pipes with closed nozzles (the sprinklers)

- Wet-pipe sprinkler system:
System where the pipework is constantly filled with water. When a sprinkler is activated, water flows from it without delay.
- Dry-pipe sprinkler system:
The pipework is filled with compressed air and the pipework is filled with water when the pressure drops (frost-free system).
- Pre-action sprinkler system:
The pipework is filled with compressed air. When activated, there is first an alarm, and then the pipework is filled with water.

Fire water for fire hose reels:

- Fire water for fire hose reels, wet risers:
Pipe is constantly filled with water
- Fire water for fire hose reels, wet/dry risers:
Pipes which can be fed with water by remote activation of valves when needed
- Fire water for fire hose reels, dry risers:
Water is fed into pipes only by the fire brigade

Fire hose reel:

Facility for connection and mounting of a fire extinguishing hose in accordance with DIN 14461-1 or DIN 14461-6, equipped with either a semi-rigid or lay-flat hose.

Fire hose reel, type F:

Fire hose reel intended for use by building occupants and by the fire brigade, not integrated into a potable water installation (100 l/min, up to 3 bar).

Fire hose reel, type S:

Fire hose reel intended exclusively for use by building occupants with hose connection valve and integrated backflow preventer, and semi-rigid hose. Integrated into a potable water installation (100 l/min and 3 bar or 200 l/min at 4.5 bar).

Types of system

Fire hose installations on building premises consist of buried pipes connected to hose outlets at above-ground or below-ground level.

Pipe installations for fire hose reels supplied by a common rising pipe can be divided into the following categories:

Type S

Fire hose reel installation for use by building occupants as defined by DIN 14461-1. Allows fighting of incipient fires by non-professionals.

Type F

Fire hose reel installation for use by building occupants (non-professionals) and by the fire brigade, as defined by DIN 14461-1.

Risers are fixed pipes with closable outlets for connecting fire hoses. There are different types, which can be classified as follows:

Wet riser (DIN 14462-1)

Non-potable water (NPW) pipe as defined by DIN 1988-1, which is constantly filled with water and where there is insufficient water circulation, or potable water (PW) pipe where there is sufficient water circulation.

Advantages:

- Immediate availability of fire water
- No risk of contaminating potable water
- Possible infeed from external water sources
- No electrical cabling to the fire hose reels
- Riser does not need to be installed vertically or on a gradient, lowest-point drainage fittings not required

Disadvantages:

- Vulnerable to freezing
- Space requirements
- External energy (electricity) required

Dry riser (DIN 14462-1)

Fire water is fed in by the fire brigade when needed. Must not be connected directly to the potable water mains.

Advantages:

- Lower cost
- No contamination risk
- Can be used in freezing conditions

Disadvantages:

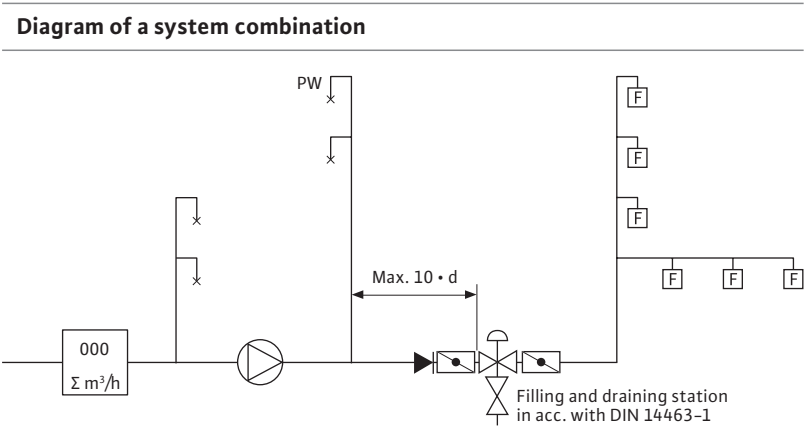
- Delayed availability of fire water
- Supply is dependent on the fire brigade
- Pipes must be installed on a gradient (for drainage)
- Restricted area of application (max. building height 40 m)

Wet/dry riser (DIN 14462-1)

Filled with water from potable water mains by means of remote activation of valves when needed.

The use of a filling and draining station means that:

- Fire water is available from the potable water mains with no or minimal delay
- Drainage of the riser prevents stagnation of potable water
- There is no risk of the riser freezing



PW normal zone, PW pressure zone and wet/dry riser with direct connection via filling/draining station

Filling and draining station, in accordance with DIN 14463-1

Facility for separating potable water (PW) pipe systems from wet/dry risers. It fills the riser with water by means of remote activation when needed and drains the riser automatically after use.

Advantages:

- Low contamination risk
- Can be used in freezing conditions

Disadvantages:

- Delayed availability of fire water (up to 60 sec.)
- Dependent on the public potable water mains
- Additional cable routing (limit switch wiring)
- Electricity supply in some cases needs battery backup
- Pipeline needs to be installed vertically or on a gradient (for drainage); additional lowest-point drainage fittings required in some cases
- Filling speed can cause problems at the water meter (building connection)
- Can cause pressure surges

Filling and draining station with mark of conformity



Filling and draining station with DIN/DVGW mark of conformity in accordance with DIN 14463-1 from Gloria

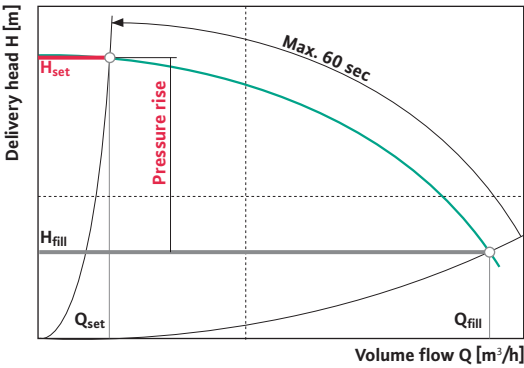
With wet/dry risers, the size of the pump is calculated according to the greater volume flow capacity value; generally the filling volume flow is greater than the extinguishing volume flow.

If the pump is too small, there is a risk that the motor may be overloaded or that filling may take too long.

If the difference between filling and extinguishing is too great, cascading over several pumps is recommended.

Observe the regulations of the local fire protection authority (e.g. in some cities the standby pump must not switch on when filling wet/dry risers).

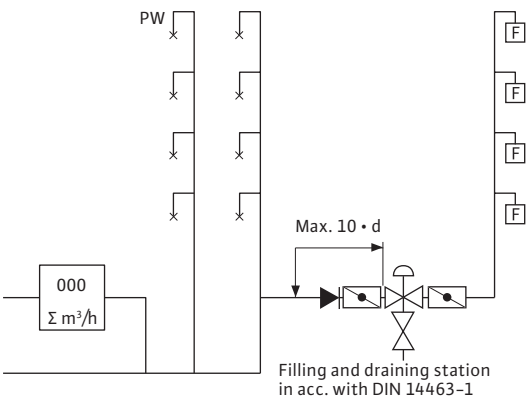
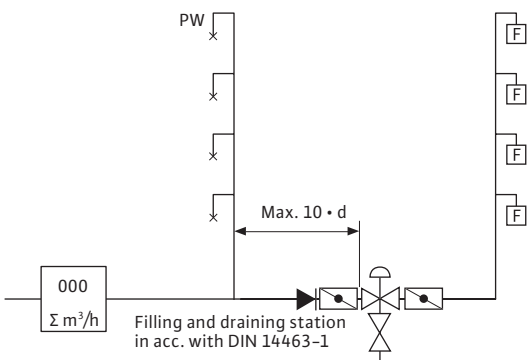
Filling characteristics of wet/dry installations



Requirements for wet/dry risers and the filling and draining station:

- The riser must always be filled and drained by means of a remotely activated filling and draining station.
- The overall system must be dimensioned so that the required fire water flow is available at the least favourably located hose outlet after max. 60 s. Particular attention must be paid here to the filling and draining facility.
- The riser must always be at a minimum gradient of 0.5 % towards the draining facility to ensure reliable drainage.
- If pipes need to be connected below the draining level of the filling and draining station, lowest-point drainage fittings must be provided on those pipes.

Diagrams of fire extinguishing systems

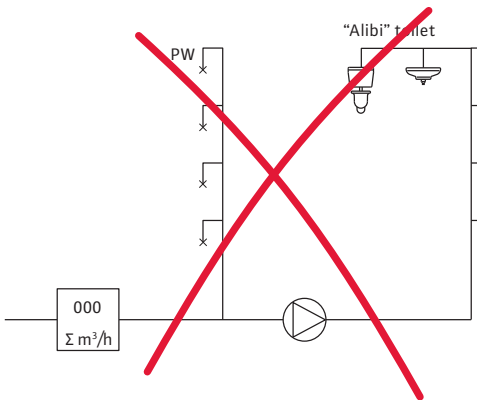


Example systems with wet/dry riser with filling and draining station with maximum length of feeder pipe to prevent microbial contamination.

Planning and refurbishment criteria

Diagram of a system in breach of regulations

Example configuration of an improper fire protection and fire extinguishing system with direct connection to the PW mains without system separation, using a so-called "alibi" extraction point.



New construction

Planning of new construction must be in line with current rules of practice. In addition, the applicable regional construction regulations, design laws, directives and guidelines must be followed.

Refurbishment of existing buildings

Existing installations can only continue to be used if it can be guaranteed that all relevant current hygiene requirements for the protection of potable water (PW) are being met.

The installation must be checked to determine whether there is adequate water circulation. If adequate water circulation cannot be ensured, the installation must be refurbished in accordance with DIN 1988-6:2002-05.

It is advisable to have the installation checked by a specialist to determine whether safe operation of the potable water installation can be guaranteed.

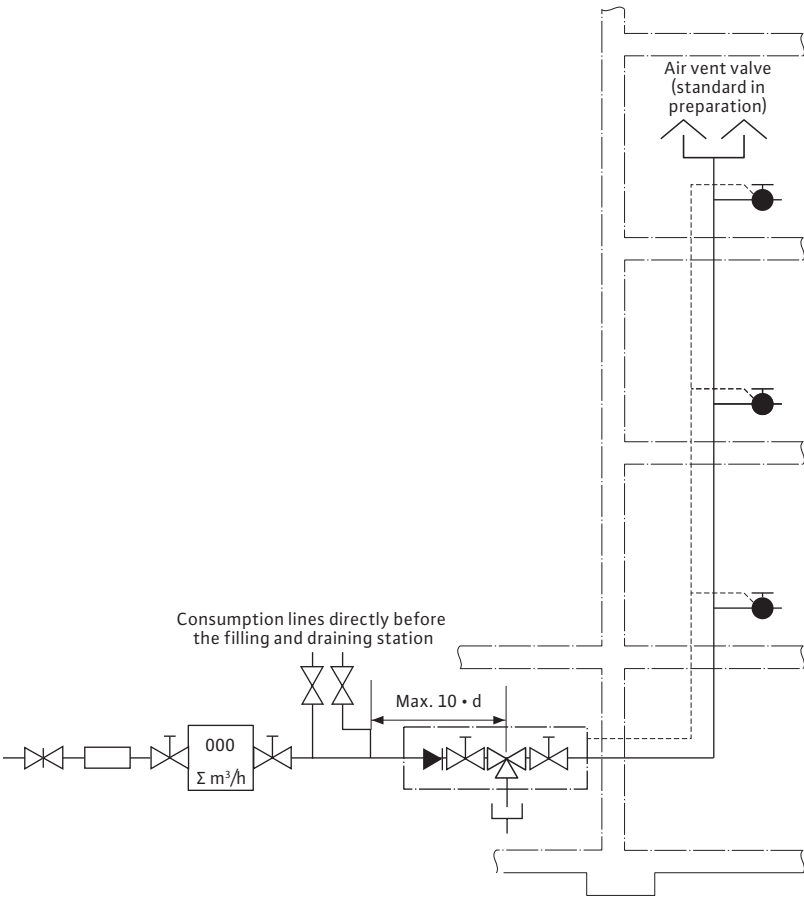
Connection line

There is a requirement that fire water and consumption lines on a premises must be supplied through a common connection line. The dimensions of the connection line must be such that the fire water line is not at risk from potable water extraction from the consumption lines.

To ensure adequate water circulation in the consumption line, a significant proportion of the potable water should generally be extracted before the fire extinguishing and fire protection system.

Diagram of a system in compliance with regulations

Potable water extraction before the fire extinguishing and fire protection system (example: wet/dry riser with filling and draining station)



Types of connection

Indirect connection

As a general rule, for the protection of potable water (PW), fire extinguishing and fire protection systems which carry NPW or in which adequate circulation in all system parts cannot be guaranteed must always be connected indirectly.

An indirect connection via a break tank is recommended if the peak flow for fire extinguishing could present a risk to the upstream potable water system, e.g. due to pressure surges or pressure drops.

An indirectly connected system also allows the option of infeed from external NPW sources, e.g. fire water ponds and wells.

Direct connection

The general rule is that NPW cannot be fed into systems connected directly to the potable water mains.

With systems connected directly to the potable water mains, system separation by means of a filling and draining station is recommended.

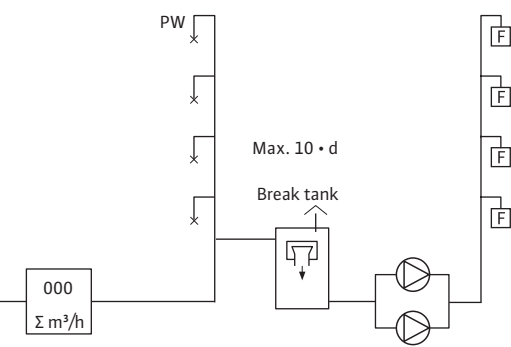
System separation using a type GB pipe disconnect or a type BA backflow preventer is only permissible when refurbishing if system separation via a filling and draining station or break tank is not feasible on the site.

Direct connection of fire extinguishing and fire protection systems to potable water without system separation is only permissible in exceptional cases where the potable water demand is greater than the fire water demand and the potable water extraction points are located after the fire protection facilities.

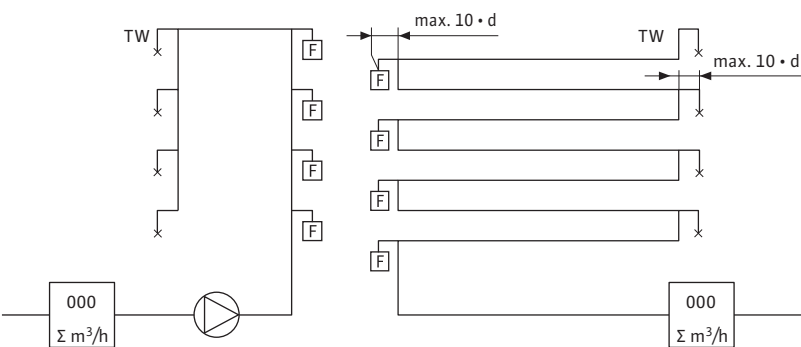
Important:
Feeding from external water sources is never permissible.

Important:
The requirements of TrinkwV 2001 regarding hygiene and prevention of stagnation must be complied with at all times.

Diagram of a system with system separation



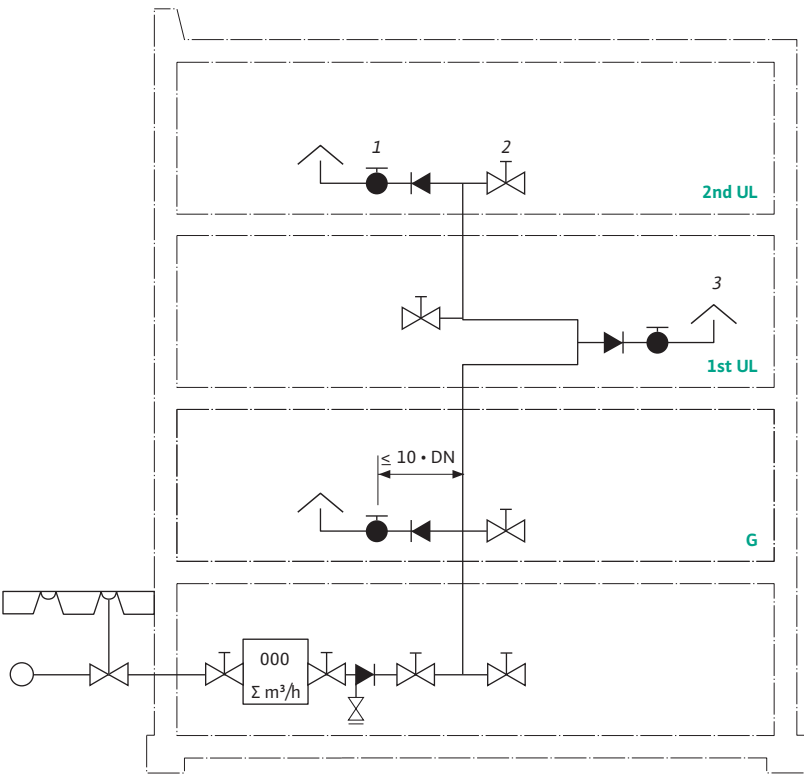
Diagrams of systems without system separation



Example configurations of a fire protection and fire extinguishing system with direct connection to the PW mains without system separation

Fire hose reel installation

Diagram of connection possibilities



Possible connection of floor supply lines and fire hose reels

The pipe system must be designed so that all fire hose reels and floor supply pipes are supplied by a common rising pipe.

Only fire hose reels with semi-rigid hoses should be used (DIN 14461-1).

Type S fire hose reels (for building occupant use)

- Design flow: maximum 2 • 24 l/min at 2 bar
- Type C backflow preventer, with combination of non-return valve and air inlet valve
- Feeder pipe to combination backflow preventer: maximum 10 • DN

Type F fire hose reels (for building occupant use and use by the fire brigade)

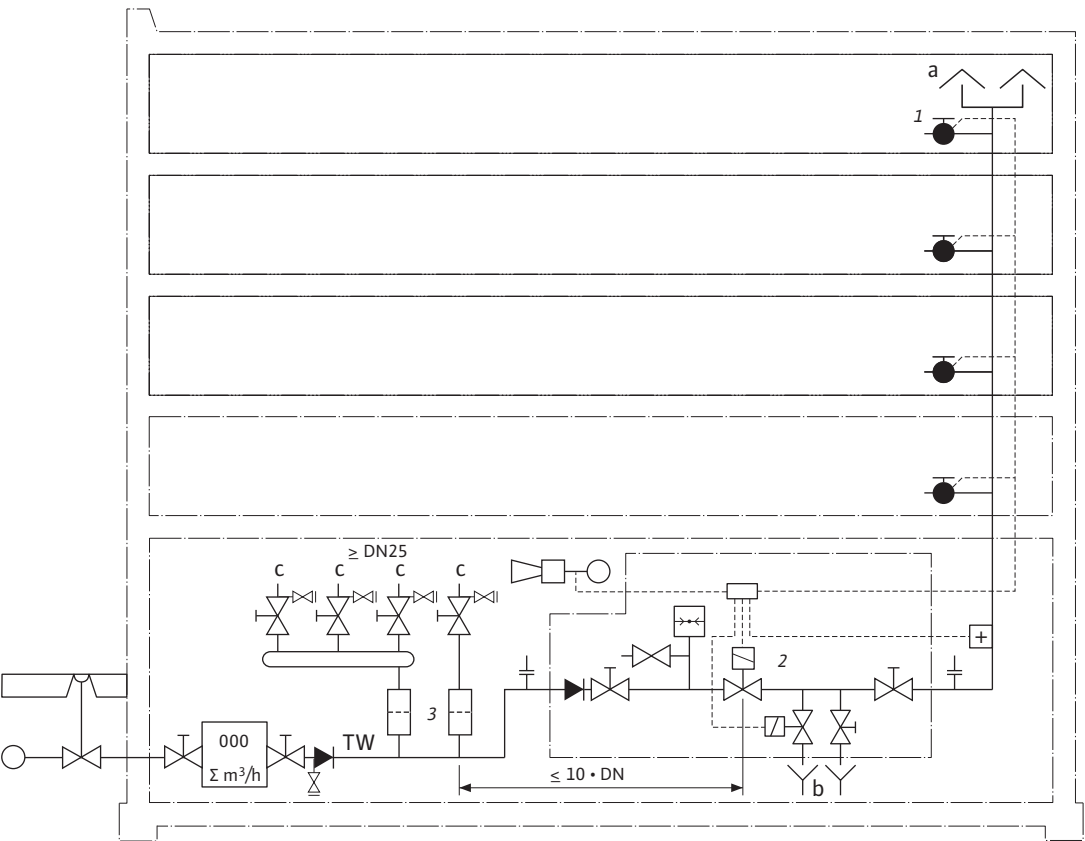
- Design flow: 3 • 100 l/min at 3 bar (maximum 8 bar on handwheel)
- Feeder pipe: maximum 10 • DN

Requirements of regional construction regulations and the local preventative fire protection authority may be in conflict with the design flow specified by DIN 1988-6.

- Legend
- 1 Fire hose reel
 - 2 Intrinsically safe valves
 - 3 Type C air inlet

Diagram of a wet/dry riser

- Legend
- 1 Fire hose reel
 - 2 Filling and draining station
 - 3 Filters
 - a Air vent valve (standard in preparation)
 - b Drainage in accordance with DIN EN 12056-1
 - c Continual consumers



Wet/dry risers with filling and draining station

Break tank (BT)

Function

Water storage and system separation in accordance with DIN 1988/EN1717 and with due regard to TrinkwV 2001. The volume of replenishing water must be greater than or equal to the volume of water extracted otherwise the water storage volume must be determined in accordance with the cumulative consumption curve.

The water supply company must be consulted regarding the intake conditions; potable water filters and water meters for the greatest water demand volume may need to be adjusted.

There are no special provisions or guidelines in DIN 1988-6 governing a BT for indirect connection of a fire protection system to the potable water mains.

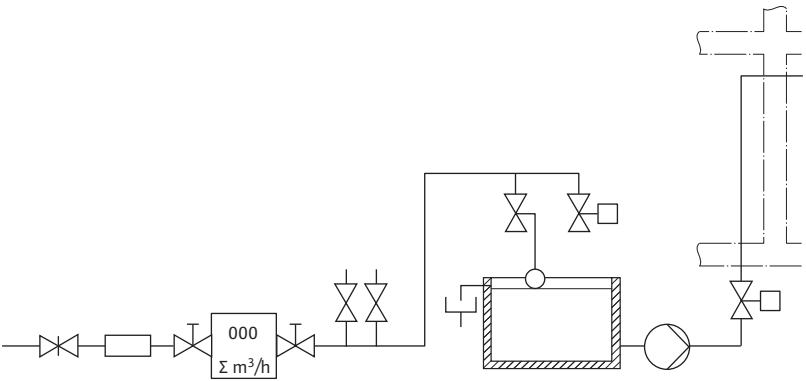
The tank should be configured according to the specifications of DIN 1988-5 if the supply pipe, i.e. the one replenishing the BT, is adequate.

When a filling and draining station is used, the BT must provide for complete filling of the riser (example: requirement in Berlin for V_{BT} : at least 2,000 l)

An automatic flushing device must be fitted in the supply line to the BT to provide enough water circulation to prevent stagnation of the PW (illustration). The supply line should be drained automatically each week (automatic flushing), with 1.5 times the water volume of the supply line being drained. The volume flow during flushing should be about 20 to 50 % of the design flow. If the supply line to the BT has a length of no more than $10 \cdot DN$, a flushing device is not needed.

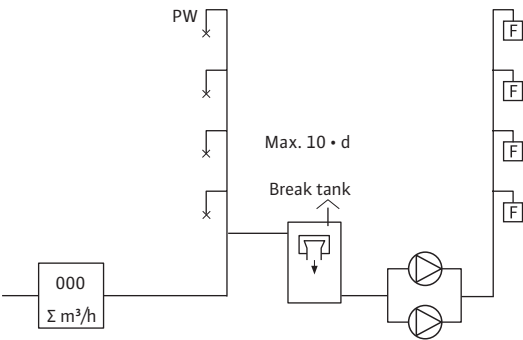
See cumulative consumption curve chart in the appendix

Diagram of an automatic flushing device



Automatic flushing device (e.g. controlled by time switch) before the fire extinguishing and fire protection system

Diagram without flushing device



Maximum length of supply line without flushing device $10 \cdot DN$ to BT of a fire extinguishing and fire protection system

Low water indicator/cut-out switchgear

DIN 1988-6 does not separately address the issue of protection against low water levels. Therefore you need to clarify with your local fire protection authority whether low water cut-out switchgear is required, or prohibited.

If a graphic annunciator is used, a low water indicator should definitely be incorporated.

Hygiene, commissioning, maintenance and test run

Hygiene

Fire extinguishing and fire protection systems are only used in the event of a fire or a test run. If they are constantly filled with water and circulation is not sufficient, there is a risk of stagnation and consequently the risk of microbial contamination of the potable water. When such systems are directly connected to the potable water main, they pose a risk to the potable water. When planning, implementing and operating fire extinguishing and fire protection systems with direct connection to potable water mains, make sure that potable water stagnation is prevented e.g. through layout of looped mains, adherence to the 10 • DN rule for feeder pipes etc.

According to the applicable regulations, systems in which additive extinguishing agents are used may only be connected indirectly.

Non-potable water may only be fed into indirectly connected systems.

Test run

The pumps in a fire extinguishing and fire protection system must be given a test run daily (every 24 hrs). The time of the test run can either be fixed in advance or can be set by a timer on a 24-hr cycle.

Commissioning

DIN 1988-6 states that when commissioning systems with wet/dry risers, a functional test of all system parts must be carried out in the presence of the system manufacturer and operator.

Furthermore, the maintenance personnel must be appointed and instructed at that time. The operating manual must be kept in the immediate vicinity of the filling and draining station at all times.

Maintenance

The maintenance intervals set out in DIN 1988-8 must be adhered to.

Real-world example: Philharmonie, Berlin

The pressure boosting system in the Philharmonie building in Berlin consists of two large pressure boosting pumps of the type Wilo-COR-2 MVIE 5203/VR along with a small, parallel-integrated pilot or jockey pump (Wilo-COR-1 MVIE 208-2G/VR-S). Everything is installed on the one compact base frame. Likewise, both pump types are connected to shared suction and pressure pipes.

A pressure transmitter ensures transmission of the signals to the pumps. A second, standby transmitter goes into action if its companion breaks down. For even more reliability, there is an additional solenoid valve control.

The pilot pump takes care of day-to-day tasks in this system, making sure that the pressure always remains constant; for example, it compensates any pressure drop caused by leaks and regulates the pressure when small quantities of water are extracted, e.g. for cleaning and for watering the garden areas. If a sprinkler head should open accidentally, once again the pilot pump comes into play to restore the required pressure balance. The large pressure boosting pumps on the other hand are only activated in emergencies such as a fire, for extinguishing purposes. That prevents the two pressure boosting pumps from continually cutting in and out, which would severely stress the pump motor.

A combination system of this kind can be used not only for fire extinguishing systems, but also for pressure boosting systems for water supply. In such cases the pilot pump is responsible for small volumes of water, such as that required by individual water taps, toilets etc. If the pilot pump is overloaded by arising volume flow – e.g. during the interval of a musical performance – the main pumps of the pressure boosting system cut in. This takes place purely hydraulically, in other words without any additional control systems.



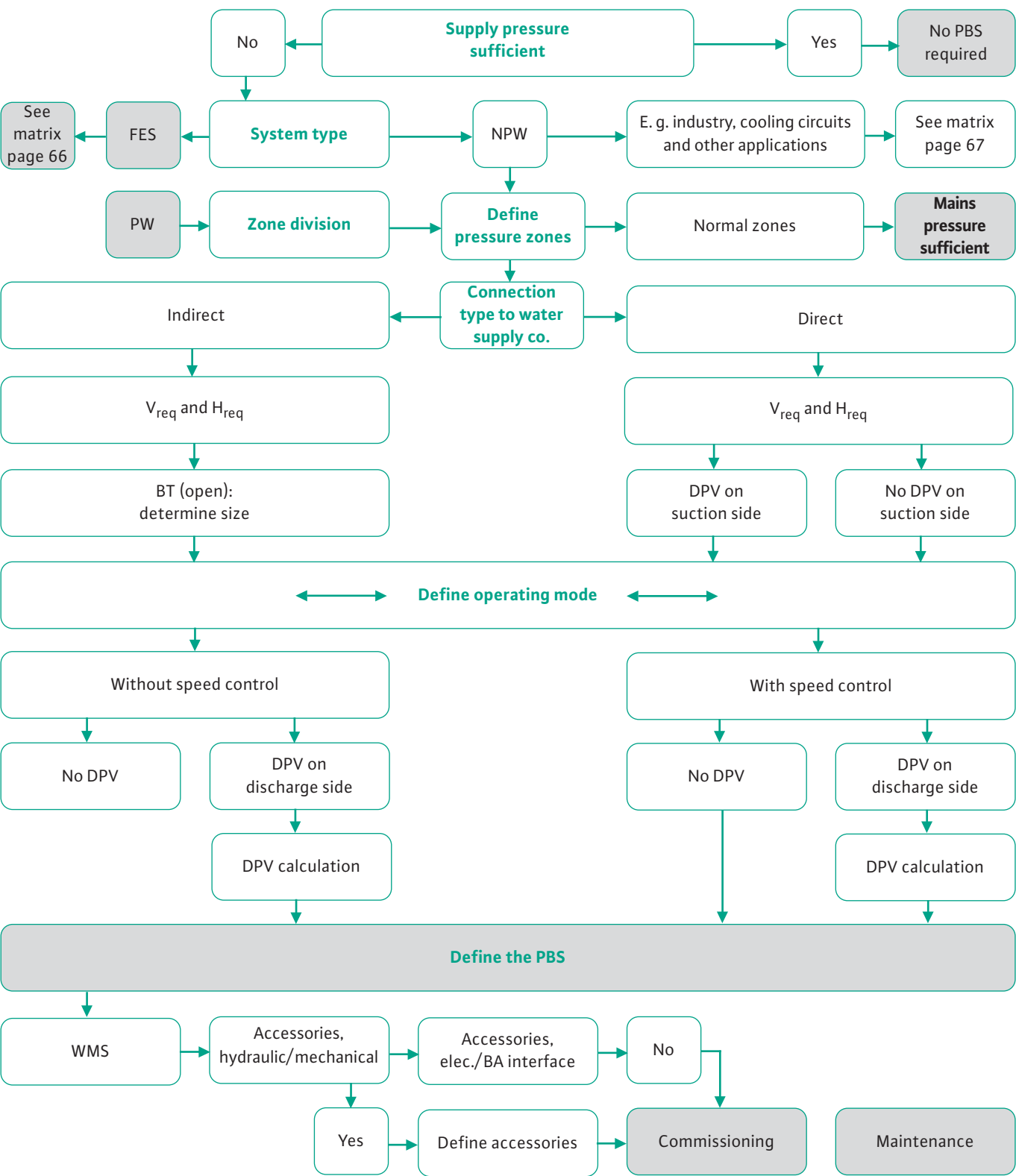
The core of the fire extinguishing system in Berlin's Philharmonie: The tailored combination system comprises a small pilot pump, two pressure boosting pumps, and a pressure transmitter along with a standby transmitter.



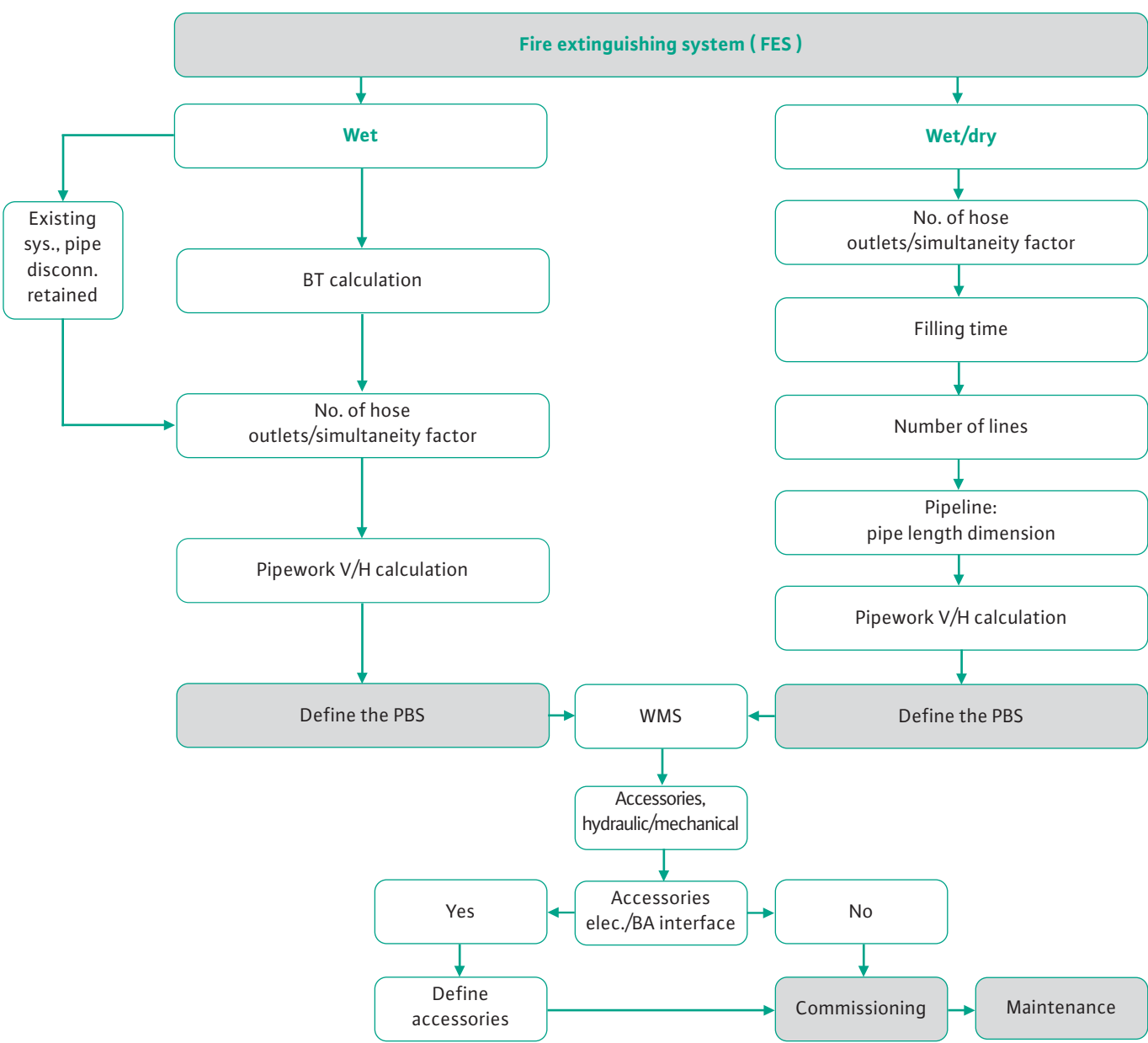


Planning, configuration and example calculations

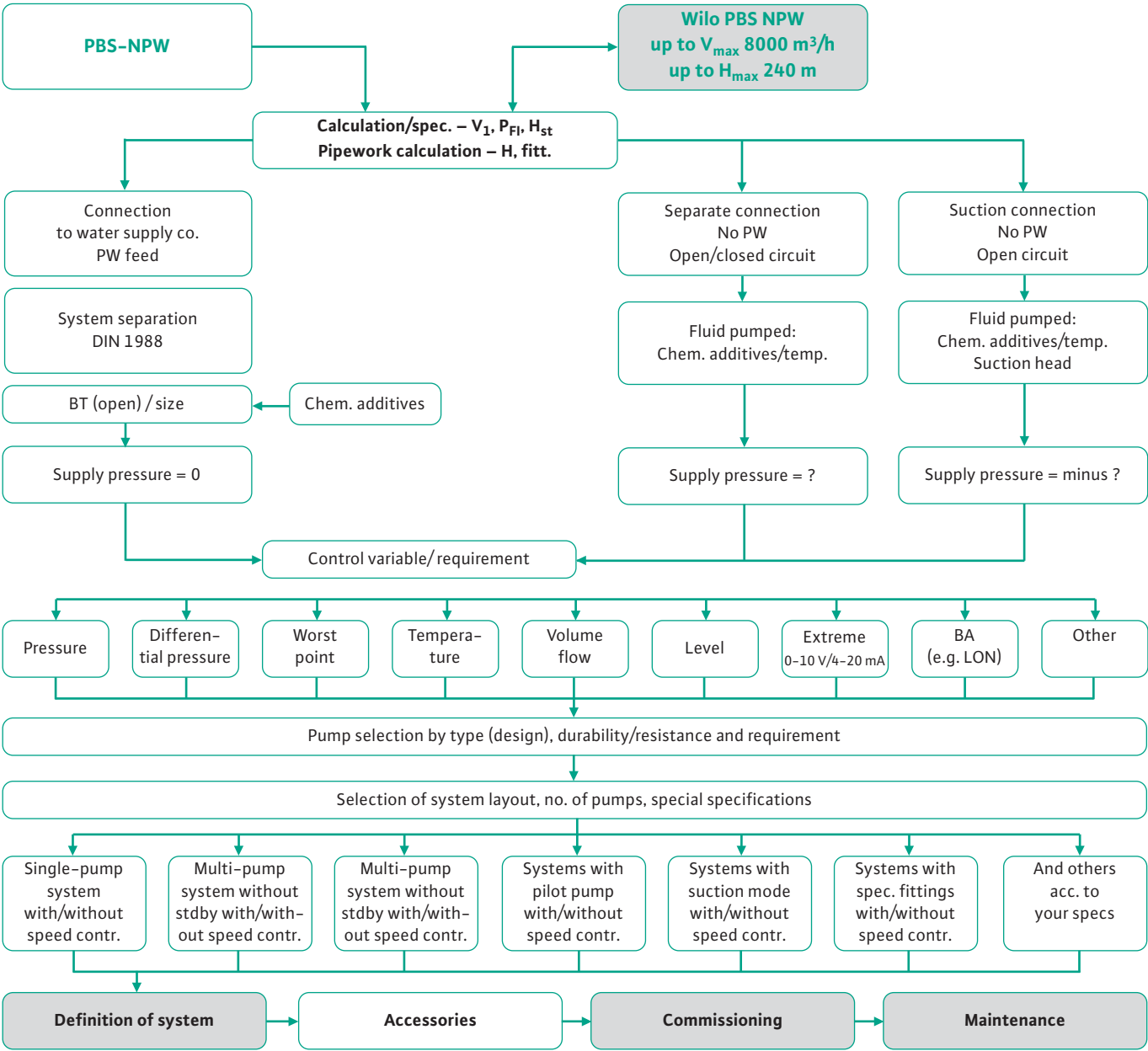
Defining a pressure boosting system (PBS) for potable water supply



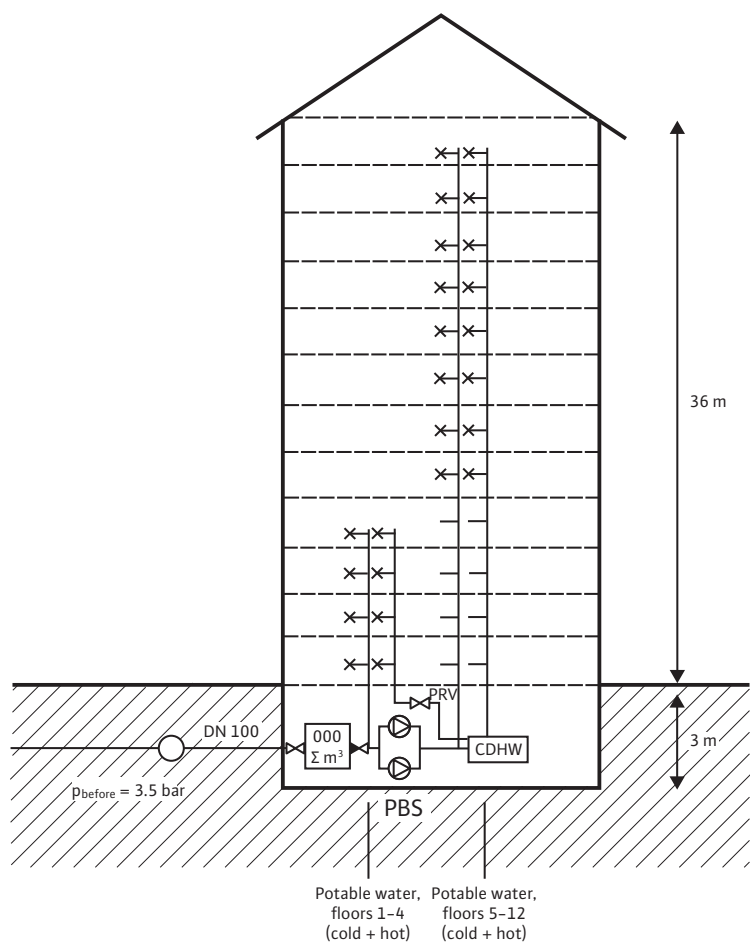
Defining a pressure boosting system (PBS) for fire extinguishing purposes



Defining a pressure boosting system (PBS) for non-potable water supply



Calculation of a pressure boosting system (PBS) in a residential building



Characteristics			
12 floors	– floor height	3 m	= 36 m
1 basement	– floor height	3 m	= 3 m
		H_{st} = 39 m	
48 residential units (RU), 4 RU per floor fitted with (standard fittings):			
	Connection	Cold water	Hot water
1 WC cistern	DIN 15	1	–
1 washstand	DIN 15	1	1
1 shower	DIN 15	1	1
1 kitchen sink	DIN 15	1	1
1 washing machine	DIN 15	1	–
1 dishwasher	DIN 15	1	–
Pipeline length from the pressure boosting system to the extraction point			
		60 m	
Minimum intake pressure (p _{min})		3.5 bar	
Maximum pressure fluctuations		+ 0.3 bar	
Flow pressure desired			
per extraction point		1 bar	

Step 1: Zone division

Normal zone: Intake pressure 3.5 bar
Flow pressure 1.0 bar
= **2.5 bar ≙ 25 m**

Pressure losses (head loss)

Water meter + filter ≤ 0.5 bar
Pipeline friction losses ≈ 15% of H_{st} ≈ 0.4
 ≈ 15% of 25 m ≈ 4 m

Calculation

Normal zone 3.5 bar
Flow pressure 1.0 bar
Pressure loss (0.5 bar + 0.4 bar) = 0.9 bar
 = 1.6 bar ≙ 16 m

Important:
Losses vary depending on the
type of water meter

The basement and four floors can be supplied
via the normal zone.

Step 2: Connection type

Specified by the local water supply companies
Connection: direct (check according to the following table)

Maximum flow velocities in building connection lines

Nominal diameters of building connection lines	Maximum total flow to the PBS and to consumption lines without PBS	Maximum volume flows for direct connection to PBS without pressure vessel on the suction side	
		II a	II b
		Q _{max}	Q _{max} PBS
		At Tv ≤ 0.15 m/s	At Tv ≤ 0.5 m/s
DN	At Δv ≤ 2 m/s [m³/h]	[m³/h]	[m³/h]
25/1	3.5	0.26	0.88
32/1 1/4	5.8	0.43	1.45
40/1 1/2	9	0.68	2.3
50/2	14	1.06	3.5
65	24	1.8	6
80	36	2.7	9
100	57	4.2	14
125	88	6.6	22
150	127	9.5	32
200	226	17	57
250	353	26.5	88
300	509	38	127

Step 3: Volume flow calculation

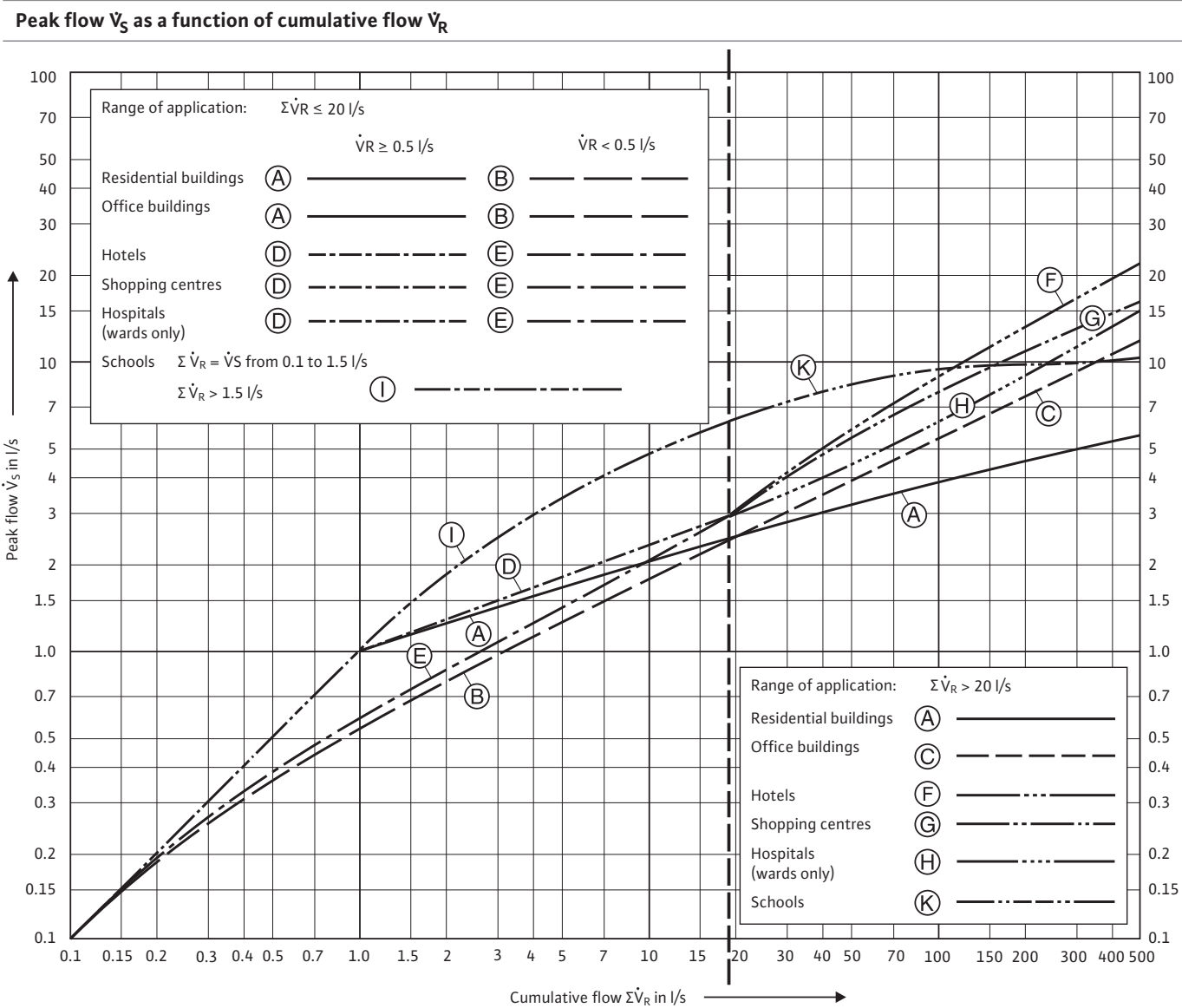
Determine V_{maxP} = cumulative flow in accordance with DIN 1988, Part 3
Connection: direct (check according to the following table)

Standard values for minimum flow pressures and design flows of conventional potable water extraction points

Minimum flow pressure P _{min FI}	Type of potable water extraction point	Design flow when extracting		
		Mixed hot and cold*		Only cold or only hot water
		V _{R cold}	V _{R hot}	V _R
		[l/s]	[l/s]	[l/s]
[bar]				
1.0	Household washing machine DN 15	–	–	0.15
1.0	Household washing machine DN 15	–	–	0.25
	Mixing tap for			
1.0	Shower cubicles DN 15	0.15	0.15	–
1.0	Kitchen sinks DN 15	0.07	0.07	–
1.0	Washstands DN 15	0.07	0.07	–
0.5	Toilet cistern in acc. with DIN 19542DN 15	–	–	0.13

* The design flows for mixed water extraction are based on 15°C for cold potable water and 60°C for heated potable water.

Determine $\dot{V}_{\max P}$ = peak flow in accordance with DIN 1988, Part 3



Note:
Cold water in the normal zone
does not need to be considered
when selecting the pressure
boosting system (PBS).

Cumulative flow for hot water in the normal zone
4 floors • 4 residential units = 16 residential units

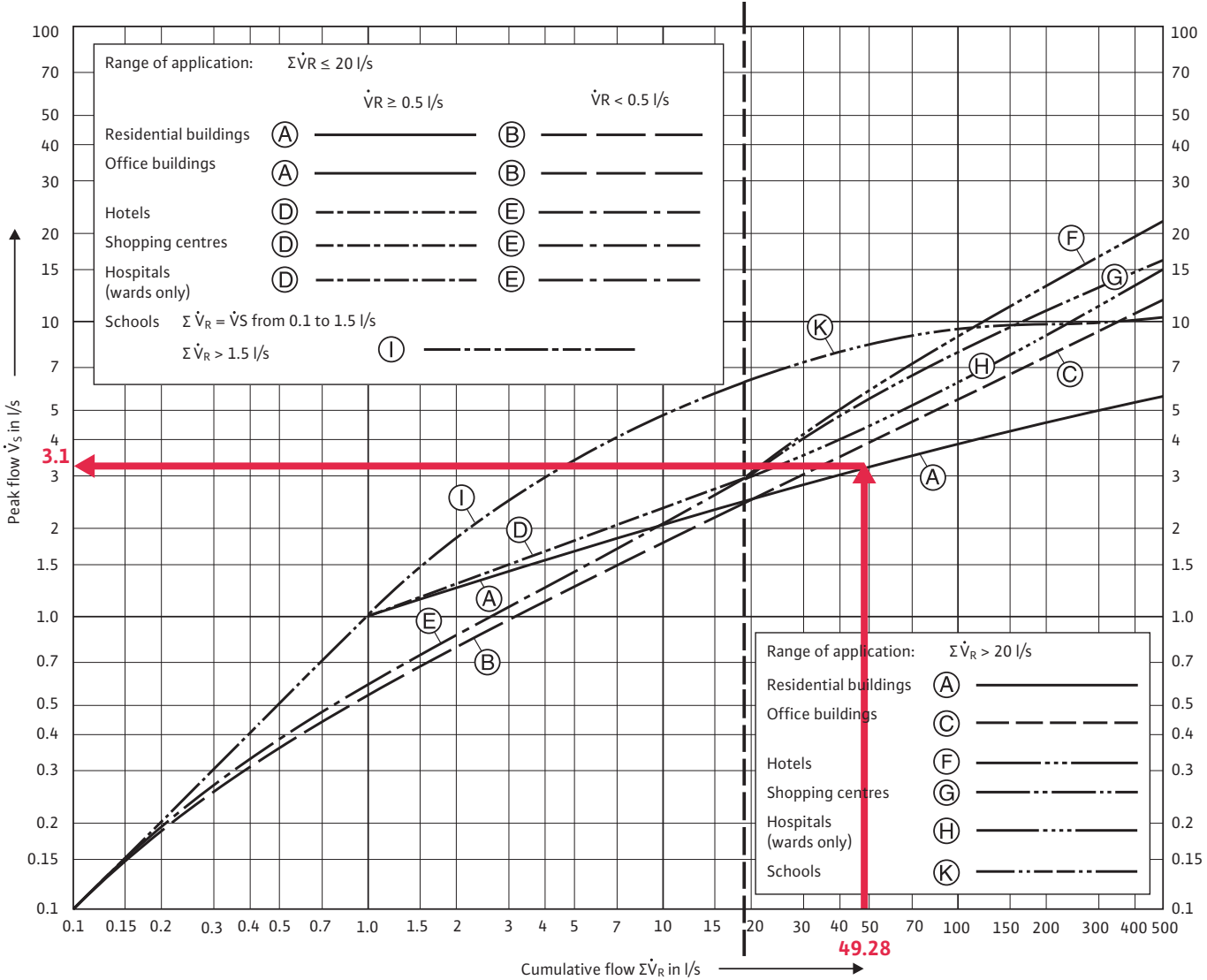
Standard solution

Cold water + hot water = 1.11 l/s • 32 RU = 35.52 l/s
Cold water only = 0.89 l/s • 16 RU = 13.76 l/s

$\Sigma \dot{V}_{\max P}$ total = 49.28 l/s

Peak flow according to DIN 1988, Part 3

Peak flow \dot{V}_S as a function of cumulative flow \dot{V}_R



Result

$\dot{V}_S = 3.1 \text{ l/s}$

Step 4: Delivery head calculation

$$\begin{aligned}\Delta p_P &= H_{\text{req}} + P_{\text{min FI}} + \Sigma (l \cdot R + Z) + (\Delta p_{\text{fitt}} + \Delta p_{\text{WM}}) - P_{\text{min V}} \\ &= 39 \text{ m} + 10 \text{ m} + (60 \text{ m} \cdot 0.15) + 5 \text{ m} - 35 \text{ m} \\ &= 28 \text{ m}\end{aligned}$$

Step 5: Valid volume flow criteria for a pressure boosting system according to DIN 1988, Part 3

Maximum flow velocities in building connection lines

Nominal diameters of building connection lines	Maximum total flow to the PBS and to consumption lines without PBS	Maximum volume flows for direct connection to PBS without pressure vessel on the suction side	
		II a	II b
		Q _{max}	Q _{max} PBS
DN	At Δv ≤ 2 m/s [m³/h]	At Δv ≤ 0.15 m/s [m³/h]	At Δv ≤ 0.5 m/s [m³/h]
25/1	3.5	0.26	0.88
32/1 1/4	5.8	0.43	1.45
40/1 1/2	9	0.68	2.3
50/2	14	1.06	3.5
65	24	1.8	6
80	36	2.7	9
100	57	4.2	14
125	88	6.6	22
150	127	9.5	32
200	226	17	57
250	353	26.5	88
300	509	38	127

Important:
Speed-controlled systems enable pumps to cut in and out without pressure surges, meaning that the requirements of column IIa in the table on page 69 above can be ignored.

$$\begin{aligned}V_{\text{maxP}} &= 11.16 \text{ m}^3/\text{h} : 4.2 = 2.657 \text{ pumps} \\ &\text{i.e. 3 pumps + 1 standby pump} \\ &= 4 \text{ pump systems}\end{aligned}$$

Step 6: System selection



- Speed-controlled system, since this continuously adjusts to demand, allowing the diaphragm pressure vessel on the discharge side to be omitted.
- Recommendation:
Wilo-Comfort-Vario-COR-3 MHIE 403-2G/VR
- Alternative system using low-noise glandless technology (less than 45 dB [A]):
Wilo-Comfort-N-Vario-COR-3 MISE 404-2G/VR

Step 7: Required accessories

- Low-water cut-out switchgear (WMS) because connection is direct

Step 8: Static pressure check

Neutral zone: up to 4th above-ground floor

High pressure zone: 5th above-ground floor

For checking, the most unfavourable criteria must be applied.

These are:

Maximum intake pressure: $3.5 \text{ bar} + 0.3 \text{ bar} = 3.8 \text{ bar}$

Delivery head of the system at $Q = 0 \text{ m}^3/\text{h}$:

For fixed speed system = 54 m

For speed-controlled systems = not required, since constant value (28 m)

Pipe and fitting friction losses are not included since the volume flow = $0 \text{ m}^3/\text{h}$

Fixed speed system

$$\begin{aligned}
 & p_{\max Z} + p_{\max Pp} - H_{st} \\
 & \quad \quad \quad (\text{at } Q = 0 \text{ m}^3/\text{h}) \\
 = & 38 \text{ m} + 54 \text{ m} - 18 \text{ m} \\
 = & \text{74 m} \\
 = & \text{7.4 bar}
 \end{aligned}$$

Result

The maximum possible static pressure on the 5th above-ground floor is 7.4 bar (74 m). This is higher than the permitted maximum 5 bar static pressure. Therefore: a pressure reducer must be applied in conjunction with pressure zone division.

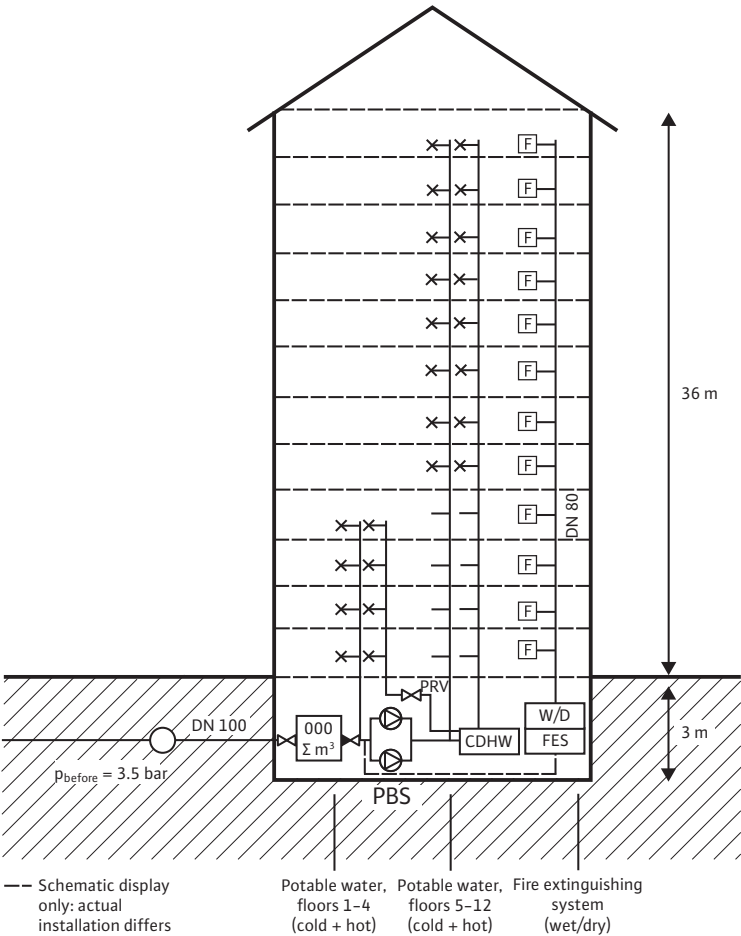
Speed-controlled system

$$\begin{aligned}
 & p_{\max Z} + p_p(\text{const.}) - H_{st} \\
 = & 38 \text{ m} + 28 \text{ m} - 18 \text{ m} \\
 = & \text{48 m} \\
 = & \text{4.8 bar}
 \end{aligned}$$

Result

No further pressure zone division and no use of pressure reducers is required.

Calculation of a fire extinguishing system in a residential building:
Wet/dry installation



Characteristics		
12 floors	– floor height	3 m = 36 m
1 basement	– floor height	3 m = 3 m
		H_{st} = 39 m
48 residential units (RU), 4 RU per floor		
According to the fire protection plan, a wet/dry installation is required.		
12 hose outlets, type F		
(for building occupant use)		100 l/min and 3 bar
Simultaneity factor		2
Nominal diameter of pipe		DN 100
Pipe length to		
highest hose outlet		45 m
Minimum intake pressure (p _{min})		3.5 bar
Maximum pressure fluctuations		+ 0.3 bar
Nominal connection diameter, inlet		DN 100

Step 1: Volume flow calculation

$V_{\max P}$ = Simultaneity factor 2 • 100 l/min (per hose outlet)
= 200 l/min
= 12 m³/h

Step 2: Delivery head calculation

$\Delta p_p = H_{\text{req}} + p_{\text{min FI}} + \Sigma (l \cdot R + Z) + (\Delta p_{\text{fitt}} + \Delta p_{\text{WM}}) - p_{\text{min v}}$
= 39 m + 30 m + (0.7 m) + 8 m – 35 m

= 49 m

Step 3: Checking the filling time (< 60 seconds)

$$\begin{aligned}
 &= \text{pipe length} \cdot \text{water capacity} \\
 &= 45 \text{ m} \cdot 5.03 \text{ l/m} \\
 &= 226 \text{ l} \\
 &= 226 \text{ l} > 200 \text{ l}
 \end{aligned}$$

Comment:

The maximum filling time of 60 seconds is maintained despite the minimal difference.
During filling, the system volume flow increases, i.e. a higher volume flow is put through.

Duty chart on the right: > 12 m³/h (up to maximum 25 m³/h)

Note:

Single pipelines to transfer points, feeder pipe maximum 10 d; 1.5 l.

If > 10 d; 1.5 l, suitable measures (flushing device) are to be planned. These are to be designed such that automatic flushing replaces at least 1.5 times the water volume of that pipeline every week. A minimum flow speed of 1 m/s must be reached in the flushing process.

Step 4: System selection

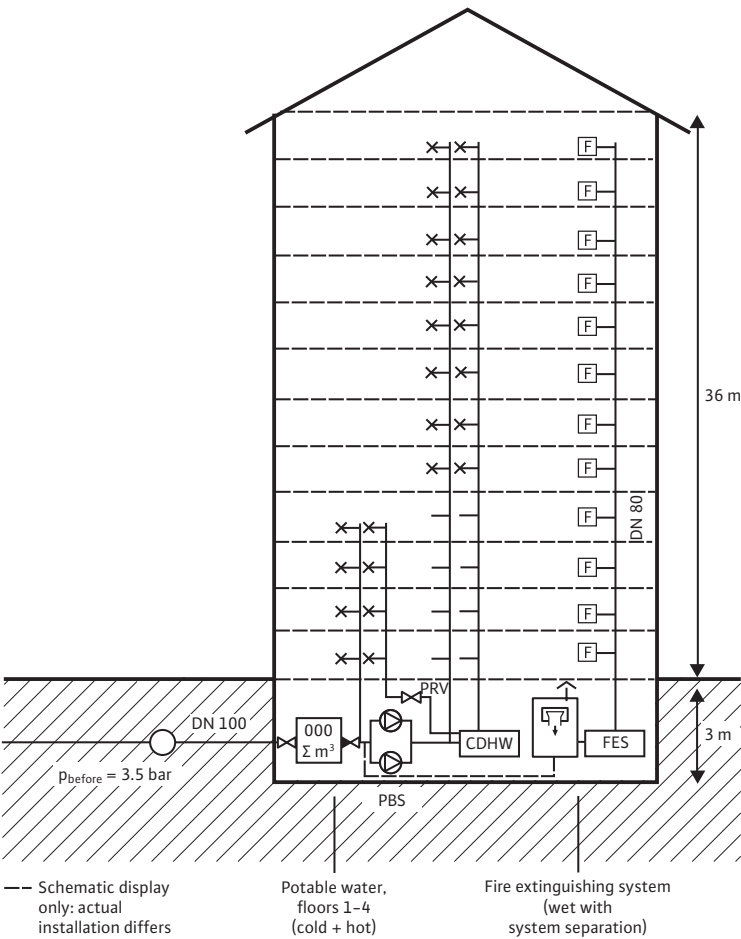
- Fixed speed system
- Recommendation:
Wilo-Economy-CO-1 MVI 1605-6/ER
System in complete compliance with DIN 1988, Part 6



Step 5: Recommended accessories

- As specified by the fire protection plan
(e.g. emergency power supply, low-water cut-out switchgear etc.)
- Filling and draining station

Calculation of a fire extinguishing system in a residential building:
Wet installation with system separation



Characteristics		
12 floors	– floor height	3 m = 36 m
1 basement	– floor height	3 m = 3 m
		H_{st} = 39 m
48 residential units (RU), 4 RU per floor		
According to the fire protection plan, a wet installation is required.		
6 hose outlets, type F		
(for building occupant use)		100 l/min and 3 bar
Simultaneity factor		1
Nominal diameter of pipe		DN 80
Pipe length to highest hose outlet		40 m

Step 1: Volume flow calculation

$V_{\max P}$ = Simultaneity factor1
= 100 l/min
= 6 m³/h

Step 2: Delivery head calculation

$\Delta p_P = H_{\text{req}} + p_{\text{min FI}} + \Sigma (l \cdot R + Z) + (\Delta p_{\text{fitt}} + \Delta p_{\text{WM}}) - p_{\text{min v}}$
= 39 m + 30 m + (6 m) + 0 m - 0 m

= 75 m

Step 3: Defining the atmospherically ventilated break tank (preliminary tank) in acc. with EN 1717 and DIN 14462

$$\begin{aligned} V_B &= 0.03 \cdot V_{\max P} \\ &= 0.03 \cdot 6 \text{ m}^3/\text{m} \\ &= 0.180 \text{ m}^3 \\ &= 180 \text{ l} \end{aligned}$$

Tank selection:

BT 300 l + float valve R 1 1/2

Note:

Single pipelines to transfer points, feeder pipe maximum 10 d; 1.5 l.

If > 10 d; 1.5 l, suitable measures (flushing device) are to be planned. These are to be designed such that automatic flushing replaces at least 1.5 times the water volume of that pipeline every week. A minimum flow speed of 1 m/s must be reached in the flushing process.

Step 4: System selection

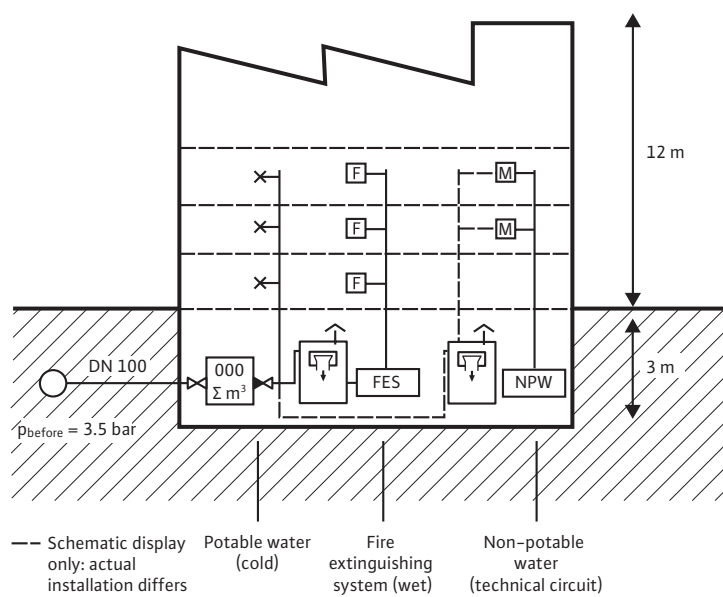
- Fixed speed system
- Recommendation:
Wilo-Economy-CO-1 MVI 807/ER
System in complete compliance with DIN 1988, Part 6
- Comment:
At volume flow $Q = 0 \text{ m}^3/\text{h}$, the maximum permitted pressure of 7 bar is exceeded at the extraction point. Since a static pressure of 7 bar is exceeded at the lower extraction points, there must be pressure zone division in accordance with the fire protection plan.



Step 5: Recommended accessories

- As specified by the fire protection plan (e.g. emergency power supply, low-water cut-out switchgear etc.)
- Dry-running protection system (included as standard in break tank)
- Signals, indicators etc.
- Flushing device

Calculation of a non-potable water system in an industrial plant



Characteristics			
4 floors	– floor height	3 m	= 12 m
1 basement	– floor height	3 m	= 3 m
			H_{st} = 15 m
Fluid pumped		Process water	
Intake pressure for 2 machines		4.2 bar	
Nominal diameter of pipe		DN 40	
Pipe length to highest hose outlet		30 m	
Intake pressure for replenishment water (potable)		3.5 bar	

Note:
Single pipelines to transfer points, feeder pipe maximum 10 d; 1.5 l.
If > 10 d; 1.5 l, suitable measures (flushing device) are to be planned. These are to be designed such that automatic flushing replaces at least 1.5 times the water volume of that pipeline every week. A minimum flow speed of 1 m/s must be reached in the flushing process.

- Preliminary remark:**
- Transfer of potable water ends at the free outlet of the atmospherically ventilated break tank, in accordance with EN 1717.
 - The size of the tank depends on the water capacity of the downstream system.

Step 1: Delivery head calculation

Specifications for the process water: 2 • max. 4.5 m³/h = 9 m³/h
P_{FI, machine} = 4.2 bar

$$\begin{aligned} \Delta p_P &= H_{st} + p_{min FI} + \Sigma (l \cdot R + Z) - \text{intake pressure} \\ &= 15 \text{ m} + 42 \text{ m} + 2.2 \text{ m} - 0 \text{ m} \\ &\quad (\text{Cu, DN40, 9 m}^3/\text{h, 30 m long}) \\ &= \textbf{59 m} \end{aligned}$$

Step 2: Consideration of customer requirements

- High operating reliability; 2 duty pumps and 1 standby pump
- Intake pressure at consumer should be constant
- Due to the consistency of the process water, material quality 1.4404 and Viton is required

Step 3: System selection

- Speed-controlled system
- Recommendation (individual Wilo offer):
Wilo-Comfort-Vario-COR-3 MVIE 208/VR-S
Special version (S): all metallic parts in contact with the fluid with at least material quality 1.4404, all elastomers made of Viton



Step 4: Recommended accessories

- Atmospherically ventilated break tank (preliminary tank) in accordance with EN 1717 – size specifications determined by customer or by water capacity of the system
- Float valve for replenishment – depends on the replenishment volume
- Dry-running protection system in the break tank
- Flushing device

Approximate dimensioning of a pressure boosting system – potable water system for residential construction

This approximate dimensioning is necessary if, for example, a system replacement is being planned.

Procedure

Determine or estimate performance data (volume flow and delivery head).

Step 1: Volume flow calculation

- Determine number of residential units (RU) – e.g. by the number of doorbells at the building entrance
- Example: 48 doorbells = 48 residential units
- Variant 1: 48 • standard residence with 1 l/s
Cumulative flow $\Sigma V_R = 48 \text{ l/s}$
Determine peak flow $V_S = 3 \text{ l/s} = 10.8 \text{ m}^3/\text{h}$
(according to DIN chart – see page 70)
- Variant 2: Determine volume flow using old DVGW code of practice Arbeitsblatt W 314
 $48 \text{ RU} = 9.3 \text{ m}^3/\text{h}$
- Conclusion: In the volume flow calculation according to DIN or DVGW code of practice Arbeitsblatt W 314, standbys are always taken into account. Systems determined according to these selection criteria should meet real-world requirements.

Step 2: Delivery head calculation

- Determine number of floors from the installation location to last extraction point – 3 m height per floor can be assumed for calculation (note: may not apply to unusual building structures)
- Example: 12 floors + 1 basement = $13 \cdot 3 \text{ m} = 39 \text{ m } H_{st}$
- Estimated head loss from pipe and fitting friction:
about 10–15 % of $H_{st} \approx 5 \text{ m}$
- Enquire about the intake pressure or read off of pressure gauge (in basement);
also enquire about possible pressure fluctuations (e.g. from the building superintendent/
caretaker)
- Selected flow pressure for residential construction, if more precise information not available
= 1.5 bar
- In the case of decentralised hot water heating (e.g. using instantaneous water heaters), select
higher flow pressure
= 2.5 bar

$$\begin{aligned}\Delta p_P &= H_{req} + \Delta p_{loss} + \Delta p_{FI} - p_{rar} \\ &= 39 \text{ m} + 5 \text{ m} + 15 \text{ m} - 35 \text{ m} \\ &= 24 \text{ m}\end{aligned}$$

Step 3: System selection

- For approximated systems, only speed-controlled systems should be selected, for the following reasons:
 - No fluctuating pressures at different volume flows
 - No pressure rise at $Q = 0 \text{ m}^3/\text{h}$
 - Compensation of supply pressure fluctuations
 - Easy adaptation to real conditions
 - High ease of use and highly precise control
 - Especially in residential construction, a glandless pressure boosting system is recommended as these are low-noise and low-maintenance (no wearing part = mechanical seal)
- Recommendation:
Wilo-Comfort-Vario-COR-3 MHIE 403-2G/VR
- Alternative system using low-noise glandless technology (less than 45 dB [A]):
Wilo-Comfort-N-Vario-COR-3 MISE 404-2G/VR





Further information for planning

Local and regional regulations

Planning and implementation must always be based on the EN standards and (in Germany) the DIN standards and the Trinkwasserverordnung (Drinking water regulations). Beyond that, there are more detailed regulations for particular regions and local areas which may deviate from or supplement the aforementioned standards. Contact local and national authorities for information on these regulations.

Non-potable water systems

Non-potable water systems include all pressure boosting systems which are not used as potable water systems and/or are used as fire extinguishing systems and which require system separation.

These can be systems which are controlled via:

- Pressure for greywater circulation
- Differential pressure for cooling circuits
- “Worst point” for buildings with extensive line branching for industrial applications, with simultaneous worst-point monitoring
- Temperature for process plants, thermal storage tank or cooling circuits
- Volume flow for constant water consumption and constant volume flow in production testing systems
- Level for tank control (e.g. elevated tank with variable level)
- External interventions from a control desk, e.g. 4–10 or 4–20 mA

For other applications not listed here, please contact us.

Electrical information

Generally speaking, the electrical systems should be implemented in accordance with the latest EN standards and (in Germany) the latest DIN VDE regulations, as well as with established rules of practice. Ensure that all work complies with applicable safety rules and accident prevention regulations. All inspection and assembly work must be conducted by authorised and qualified specialist personnel.

Work must never be carried out on devices or systems which carry live voltage (see VDE 0105, Part 100). In other words, electrical devices must be isolated from the power supply before starting work and secured to prevent reactivation. Before working on installations, switch off or unscrew the fuse or circuit breaker for the relevant circuit.

The fuse or circuit breaker must be protected from being switched back on by third parties. To this end, a warning sign should be fitted to the relevant fuse or circuit breaker on the distribution board. The cartridge of a screw-in fuse-link and its holder must not be placed just anywhere in the fuse box, but must be put away and the opening taped over.

Before starting any work, make sure that the line is voltage-free. Use suitable instruments to test this. As a general rule, no work should be carried out unless the person carrying it out is absolutely sure of the correct procedure for doing so. The work should always be carried out by a trained professional.

Damaged, worn-out or obsolete parts or devices must never be used. Use only materials which comply with the applicable standards and regulations.

In addition, EMC must be considered. When installing residual-current-operated protection switches in conjunction with frequency converters, bear in mind that only universal-current-sensitive residual-current-operated protection switches as per DIN/VDE 0664 are to be fitted.

In addition to these rules, further regulatory aspects apply in Germany:

- In the event of any change or new installation in an electrical system, the VDE regulations must be followed. One of the most important of these is VDE 0100, which contains regulations governing protective measures.
- Anyone working on electrical systems and devices must be aware of the contents of these regulations.

Noise control

Noise control in buildings is of great significance for the health and well-being of their occupants. Noise control in residential construction is of special importance, as a person's residence should not only provide rest and relaxation but should also insulate the person's own domestic area from that of neighbours.

Noise control is also important in schools, hospitals, hotels and office buildings, if they are to fulfil their intended purpose.

DIN 4109 sets out requirements to protect persons in buildings from unacceptable stress from noise transmission.

Low-noise operation is therefore regarded as a defining feature of the latest generation of pressure boosting systems.

Technical solutions can include the following:

- The best technical solution currently available is the use of the latest glandless technology in pressure boosting pumps, which operate at very low noise levels and are up to 50 % quieter than conventional pumps (no need for noise-insulating casings)
- Buffering the surface on which the pressure boosting system is mounted by means of height-adjustable vibration dampers
- Connection of piping on the suction and discharge sides with bellow expansion joints
- Decoupling of pipes
- Optimum dimensioning of the pressure boosting system to prevent increased flow velocities in the pressure pipes (flow noise)

Comparison: noise stress



Real-world example: Europa Passage, Hamburg

Between Jungfernstieg and Mönckebergstrasse, Hamburg's biggest inner-city mall offers a stylish shopping experience in a class of its own. On five levels and with a length of 160 metres, the Europa Passage tempts customers with 110 exclusive stores and refined cuisine. The building with its west façade in simple natural stone integrates seamlessly into the surrounding architecture, a feat which gained it the Mipim Award.

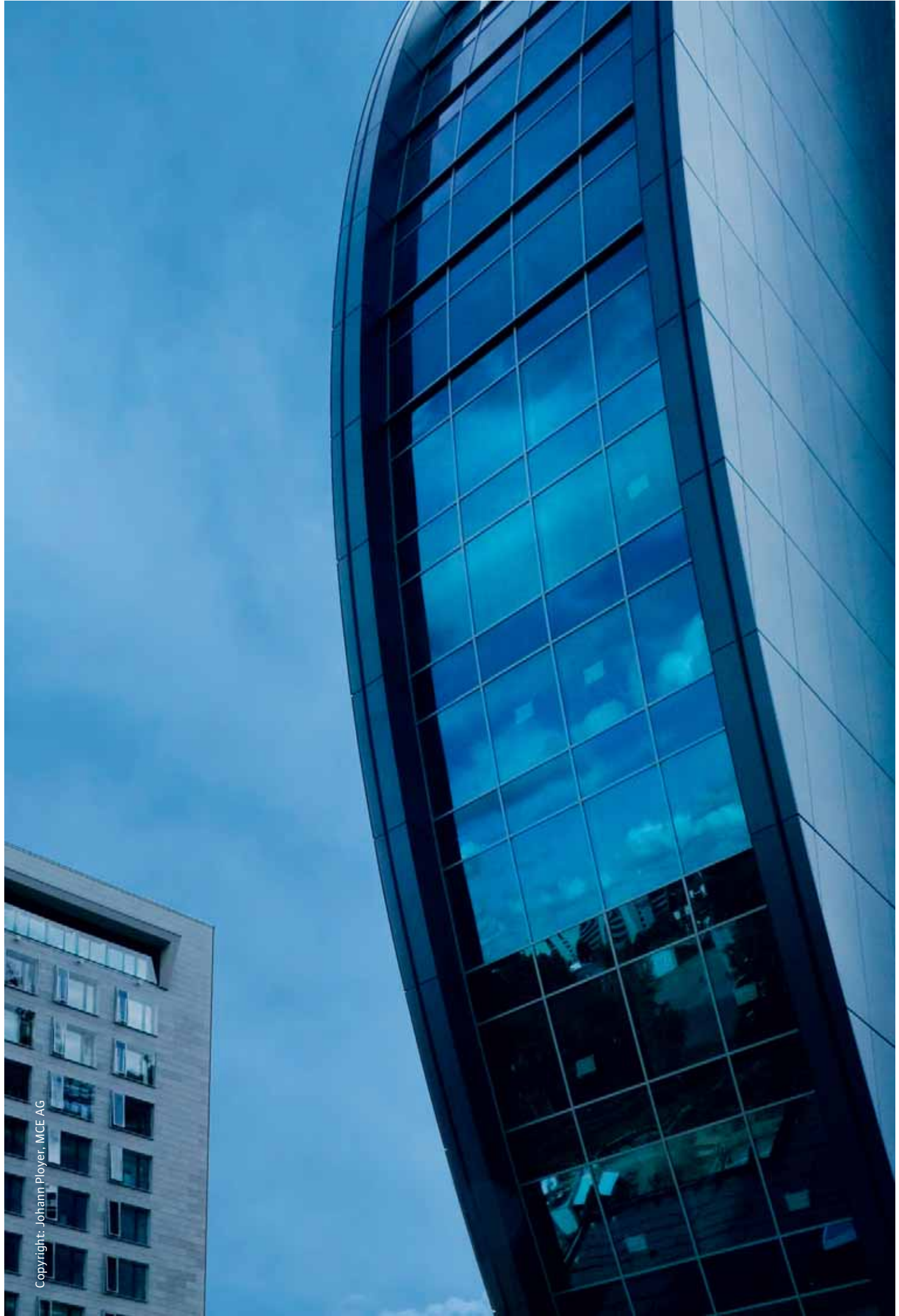
The potable water supply of the Europa Passage likewise measures up to exacting standards. The two Wilo-Comfort-N installations for pressure boosting are equipped with the Wilo CC System electronic controller: for future-oriented building management.

The pumps are fully automatically controlled by the frequency converter in the Wilo CC System: the pump speed is intelligently adjusted in response to current demands. This pump control ensures that a constant pressure is maintained at all times even in greatly varying extraction situations. As an additional plus, the high-pressure centrifugal pumps from the Wilo Multivert MVIS series with glandless technology are up to 20 dB (A) quieter than conventional pumps with comparable hydraulic output – making for relaxed shopping in a perfectly peaceful environment.



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For your information

Definition of switch-on pressure and switch-off pressure of pressure boosting systems (PBS) with fixed speed (pressure-controlled)

The switch-on pressure p_{ON} is the sum of the following:

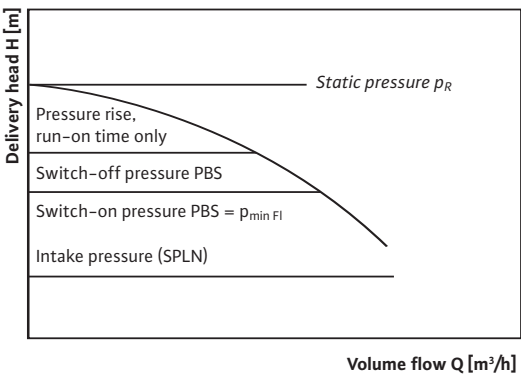
- Head loss from static head differential Δp_{st}
- Head loss from friction losses in fittings, valves and pipelines Δp_{fitt}
- Minimum flow pressure $p_{min FI}$ at the least favourable point in the system

The switch-off pressure p_{OFF} for pressure-controlled systems (determined in principle by the precision of the pressure switch) is about 1 bar above the switch-on pressure.

However the actual switch-off pressure is determined by the gradient of the pump curve after Q_0 , the required run-on time and under certain circumstances by fluctuations in intake pressure.

The run-on time is required to prevent chatter (frequent cutting in and out of pumps). It prevents the maximum switching frequency defined by DIN 1988 (20 switching operations per hour) and the maximum permitted switching frequency for the electric motors from being exceeded.

Definition of switch-on pressure and switch-off pressure of pressure boosting systems (PBS) with fixed speed (pressure-controlled)



With fixed-speed systems, a diaphragm pressure vessel in the flow on the discharge side is recommended.

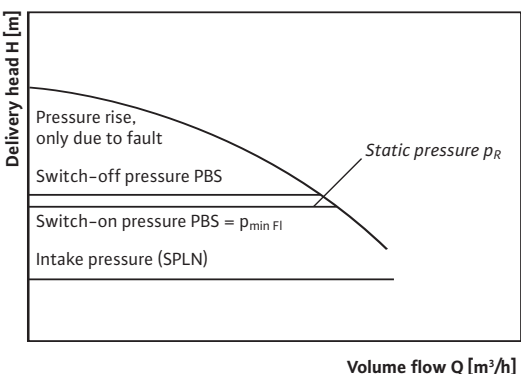
Definition of switch-on pressure and switch-off pressure of pressure boosting systems (PBS) with variable speed

The switch-on pressure p_{ON} is the sum of the following:

- Head loss from static head differential Δp_{st}
- Head loss from friction losses in fittings, valves and pipelines Δp_{fitt}
- Minimum flow pressure $p_{min FI}$ at the least favourable point in the system

The switch-off pressure p_{OFF} for speed-controlled systems is generally at almost the same level as the switch-on pressure. There can and should not be any difference from the start-up pressure since constant pressure is the specific aim of speed-controlled systems. These systems are normally switched off by means of the volume flow. With pressure boosting systems (PBS) from Wilo, the 0-flow switch-off is implemented electronically, as follows: when the pump has run for a defined time with the speed unchanged, that is to say with the volume flow unchanged, the speed is increased by 1–2 Hz and so too the pressure by 0.1–0.2 bar. The speed is then reduced; if the pressure then stays at the same level, that is recognised as a parameter for volume flow 0. The pump cuts out.

Definition of switch-on pressure and switch-off pressure of pressure boosting systems (PBS) with variable speed (pressure-controlled with speed control)



A diaphragm pressure vessel has no effect in speed-controlled systems and is therefore not required.

Control response of pressure boosting systems using the example of the Wilo Comfort Vario controller

Functional description

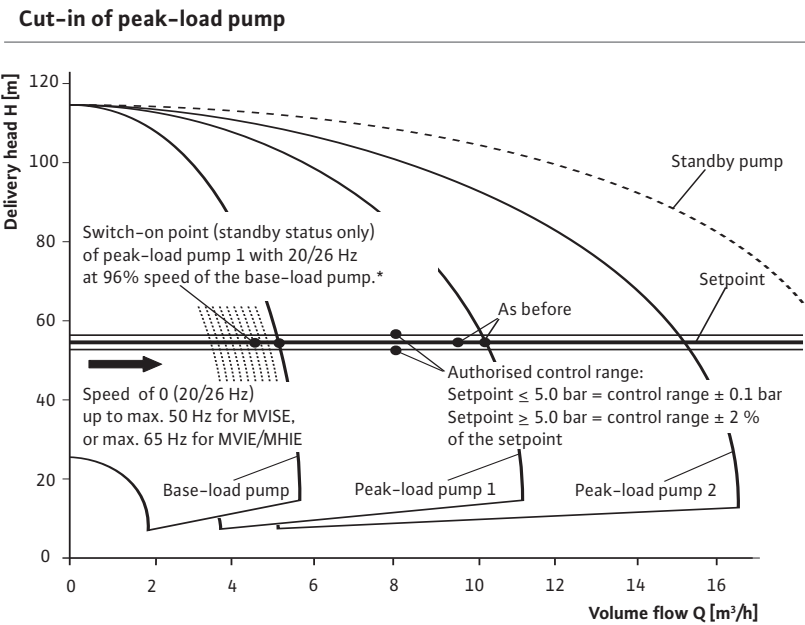
The Wilo Comfort Vario pressure boosting system is controlled and monitored by the Comfort Vario controller in conjunction with various pressure and level sensors. The pumps will be switched on or off in the cascade mode under pressure-dependent control within the control range according to water requirements. Splitting the total duty over a number of pumps, each of which featuring infinitely variable speed control by integrated/adapted frequency converters, will ensure a continual duty adaptation to the ever-changing consumption/load statuses within the specified pressure control range width. The authorised control range is up to a setpoint of 5.0 bar ± 0.1 bar. For setpoints greater than 5.0 bar the authorised control range amounts to $\pm 2\%$ of the preset setpoint value. A precondition for this is that the rate of change of volume flow on water extraction is not greater than the control reaction speed of a pump, (ramp run-up time of the frequency converter 1 s), or on overload on a pump = ramp time + time delay on starting the peak-load pump(s).

Activation of base-load pump

The base-load pump starts without delay if the setpoint pressure drops below the programmed setpoint value. The pump-integrated frequency converter will, within the control range, control its performance (from 0 to maximum flow) matching it infinitely variably to the load status of the system. Series MVICE pumps allow a speed range in the frequency range from 20 Hz to 50 Hz.

Cut-in of peak-load pumps

In the presence of rising water requirements, the base-load pump will first run up to its maximum speed. Speed control is blocked at this point to allow this pump to operate at optimum efficiency. Peak-load pump 1 now assumes the control function. It had already been started by the Comfort Vario controller at 96% speed of the base-load pump. But this only takes the form of a standby function (20/26 Hz operation) so that the control function can be assumed without delay in the event that the power of the base-load pump is exceeded. This ensures that the pressure surge that normally occurs is reliably prevented even when the peak-load pump cuts in. If a steady state ensues after the 1st peak-load pump has been activated, i.e. there is no further recording of rising water requirements, the peak-load pump is shut down again after a period of 15 s has elapsed, thus avoiding unnecessary waste of electric power. During the period that peak-load pump 1 is on standby it has no influence whatsoever on the hydraulic performance of the overall pressure boosting system due to its low speed in 20 Hz operation. The start of additional peak-load pumps is initiated in the same way as in the above description. Previously operating pumps will be locked at maximum speed and the control function is assumed by the newly started pump. Economical operation at rated full speed and optimum efficiency is thus achieved on the already fully loaded pumps.

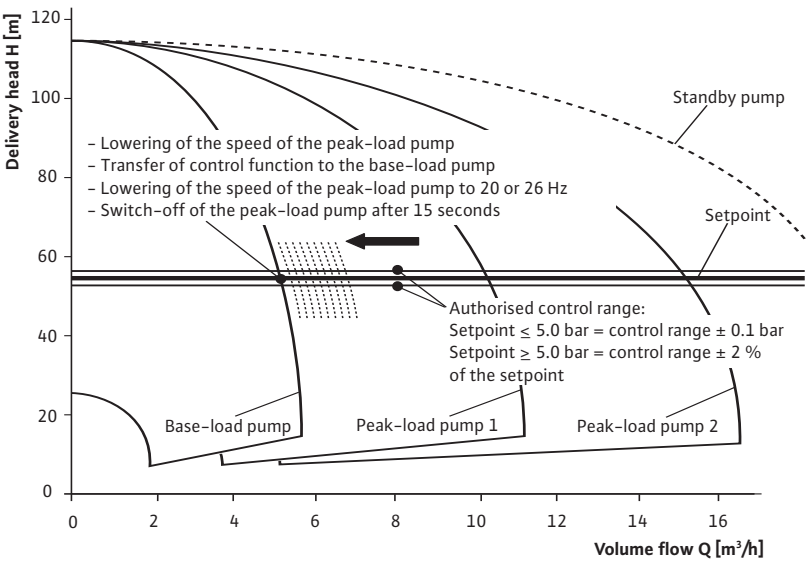


* If the base-load pump stays at this speed = deactivation of peak-load pump after 15 seconds

Cut-out of peak-load pumps

When water requirements drop, the peak-load pump in operation is first run down until it no longer has any influence on the hydraulic performance of the pressure boosting system. This is the case when, because of the change in speed, its delivery head falls below the setpoint delivery head in the duty point and thus under the power range of the base-load or peak-load pump which up to that point was still running at locked maximum speed. The Comfort Vario controller will then actuate the transfer of the next peak-load pump or the base-load pump (as applicable) to automatically controlled variable speed operation. The speed of the already run-down peak-load pump will be reduced to the minimum (20 Hz). The peak-load pump will cut out completely after a time delay of 15 seconds. If water requirements continue to drop, other still running peak-load pumps will cut out successively in the same way as described above.

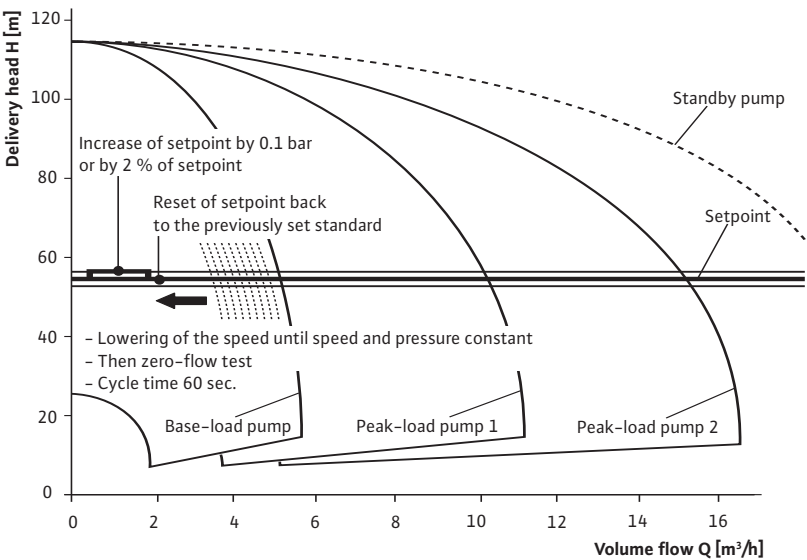
Cut-out of peak-load pump



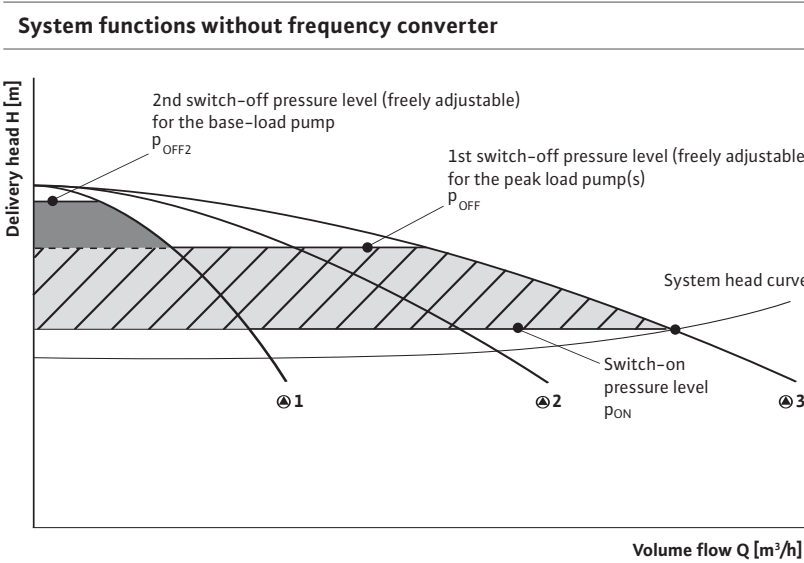
Zero-flow test: deactivation of base-load pump

In order to prevent the system from hunting, possibly leading to pressure fluctuations, the Comfort Vario controller deactivates the entire pressure boosting system only when there is no water drawn off whatsoever. The preconditions for this state are established by the so-called zero-flow test as carried out by the Comfort Vario controller. The minimum requirements are that only the base-load pump is still running and the system pressure and the speed of the base-load pump have remained constant for a specific, parameterisable timeframe. The zero-flow test is initiated and performed by the Comfort Vario controller if these requirements are satisfied. The test involves increasing the setpoint pressure value by 0.1 bar (with setpoint pressure values ≤ 5.0 bar) for 60 seconds. With setpoint pressure values > 5.0 bar, the increase is 2% of the nominal value. After that the setpoint is set back to its original level. If the actual system pressure remains at the increased setpoint level, the pressure boosting system is deactivated as water is no longer being drawn off. However, if the actual pressure drops by a minimum of 0.1 bar relative to the increased setpoint level, the base-load pump continues to operate as water is still being drawn off.

Zero-flow test: deactivation



Control response of pressure boosting systems using the example of the Wilo Comfort controller CC

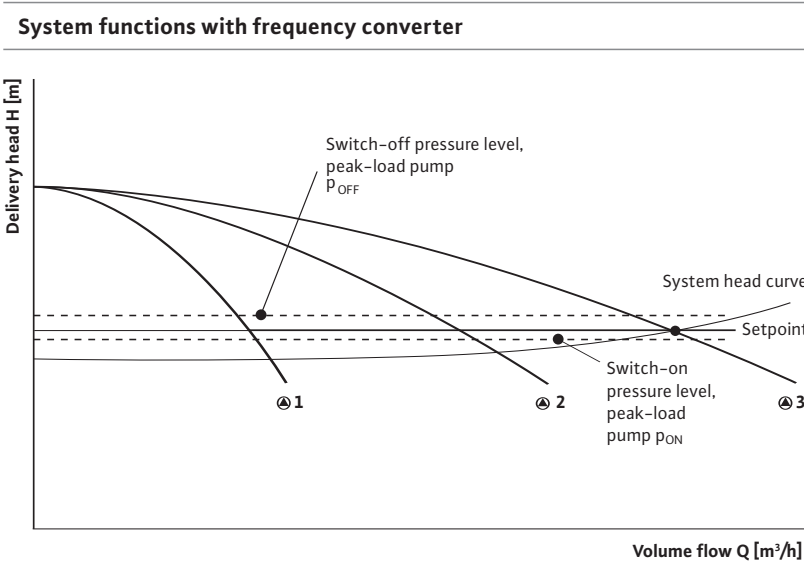


System functions without frequency converter

During operation without a frequency converter, the system's operating range is between the switch-on level p_{ON} applicable to all the pumps and the switch-off pressure level p_{OFF2} for a) the base-load pump and b) the switch-off level p_{OFF1} for the peak-load pumps.

Once the 2nd switch-off pressure level (p_{OFF2}) and a minimum run time of 0–180 seconds have been attained, the system is switched off at almost $Q = 0$ m³/h. As a result, pressure surges and unnecessary switching on and off of the system for minimal extraction amounts is reduced to the greatest extent possible.

The base- and peak-load pumps are activated when the preset setpoint pressure level p_{ON} is reached.



System functions with frequency converter

When used with a frequency converter, the operating range of the unit will remain at set-point value. Only on reaching the 100% speed limit of each operating pump will the pressure fall to the switch-on level p_{ON} for cut-in of the next (peak-load) pump. The same applies to cut-out of peak-load pumps: the pressure will only rise to the required switch-off level p_{OFF} on reaching the 100% speed limit. Any excessive pressure surges due to switching the peak-load pumps on or off will be mainly compensated for by the frequency converter lowering or raising the speed of the base-load pump, thus ensuring a soft transition in line with load variations commonly encountered in building services.

The pressure boosting system switches on without delay when the system pressure drops to the switch-on pressure level p_{ON} , with the base-load pump starting softly under control of the frequency converter.

The pressure boosting system is switched off by means of the processor at $Q = 0$ m³/h. Fluid hammer caused by immediate switch-ons following premature switch-offs is thereby fully eliminated.

Real-world example:
Blue Heaven, Frankfurt-on-Main

A building services strategy which was not only technologically advanced but also economical thanks to high energy efficiency has been proving its worth since the end of 2005 in the new 87-metre-high Blue Heaven luxury hotel in Frankfurt-on-Main. Key functions in all areas were taken over by modern pumps and pressure boosting systems. They supply heating, cooling and cold and hot water to around 37,500 square metres of floor space, 440 exclusively appointed rooms, generously-sized wellness and conference facilities and a ballroom. In addition to that, they also supply rainwater to tap connections in outdoor areas.

A particular challenge was presented by the potable water system, which needed to supply a swimming pool on the 18th floor, as well as its other duties. The potable water pipes run for a total length of fourteen kilometres. From the centralised sanitation facilities on the second lower ground floor to the tap connections, the system had to overcome some considerable head differences. The hot water heating facilities are also centralised, with storage capacity of around 20,000 litres. Due to the height of the building, the water supply had to be implemented in two pressure stages using separate pressure boosting systems, with the system divided between cold and hot water.

Two electronically controlled compact Wilo-COR-3 MVIE/VR pressure boosting systems are used to supply cold water to the hotel rooms, with a further two supplying the hot water. These systems each contain three identical electronically controlled high-pressure multistage centrifugal pumps of the type Wilo-Multivert MVIE, with rated flow capacities of 8 and 16 m³/h respectively for adequate water supply to the extraction points. The speed of the pumps is controlled in accordance with the current demand in the cold and hot systems, ensuring smooth, energy-optimised delivery to the extraction points. Pumps cut in and out automatically depending on the load, with the electronic speed control fine-tuning the flow to the preset setpoint.



Blue Heaven luxury hotel in Frankfurt-on-Main with its absolute highlight – the swimming pool on the 18th floor





Appendix

Abbreviations, symbols and units

Terms and their abbreviations

Abbreviation	Meaning
AISI	American Iron and Steel Institute
BL	Basement level
BT	Break tank, also called a "preliminary tank"
CDHW	Central domestic hot water heating
Cv	Friction coefficient (pipeline friction loss)
DIN	Deutsches Institut für Normung e.V. (German Institute for Standardization)
DN	Nominal diameter
DPV	Diaphragm pressure vessel
DVGW	Deutscher Verband für Gas- and Wasserwirtschaft (German Technical and Scientific Association for Gas and Water)
EN	European standard
FC	Frequency converter
FI	Residual-current device
FES	Fire extinguishing system
G	Ground floor
GRD	Mechanical seal
IP	International protection rating
KTW	Authorisation for products with plastics, for utilisation in potable water applications
MSL	Above MSL = above mean sea level / specification of elevation
NPSH	Net positive suction head
NPSHR	Net positive suction head required
PW	Potable water
NPW	Non-potable water
NRV	Non-return valve
PBS	Pressure boosting system
pc	Pressure constant
SHW	Secondary hot water
Slip	Difference in speed between a stator's rotating magnetic field and the rotor (usually given as % of the magnetic field speed)
SV	Safety valve
TrinkwV	Trinkwasserverordnung (Drinking water regulations)
TRWI	Drinking water supply system
UL	Upper level (floor above ground floor)
VDE	Verband der Elektrotechnik, Elektronik and Informationstechnik (Association for Electrical, Electronic & Information Technologies)
W/D	Filling and draining station (for wet/dry risers)
WMS	Low-water cut-out device
WSC	Water supply company

Symbols used

Symbol	Meaning	Unit
d_i	Inside pipe diameter	mm
H	Delivery head or pressure (conventional symbol)	m
H_0	Zero-delivery head	m or bar
H_f	Head loss in the suction line	m
H_{st}	Static delivery head	m
H_{max}	Maximum delivery head	m or bar
H_{min}	Minimum delivery head	m or bar
H_{opt}	Optimum delivery head of a high-pressure centrifugal pump	m or bar
H_s	Margin of safety	m
H_v	Vapour pressure of the fluid at the relevant temperature	m
l	Length of pipeline	m

Symbols used

Symbol	Meaning	Unit
k	Roughness of pipe inner wall in working condition (experience-based value)	mm
n	Speed	rpm
n_{min}	Minimum speed	rpm
P_a	Test pressure of pressure reducers	bar
P_{OFF}	Switch-off pressure/head of a pressure boosting system	bar or m
P_{absOFF}	Absolute switch-off pressure of a pressure boosting system	bar
P_{Amb}	Absolute ambient air pressure or the system pressure in the case of closed systems	bar
P_{ON}	Switch-on pressure/head of a pressure boosting system	m or bar
P_{eA}	Available input pressure for pressure reducers	bar
P_{eE}	Set output pressure for pressure reducers	bar
P_{FI}	Flow pressure, static gauge pressure existing at a measuring point in the pipe system when water is flowing	bar
pH_{diff}	Delivery head differential of pump	bar or m
$P_{max R}$	Maximum static pressure	bar
$P_{min FI}$	Minimum flow pressure	bar
$P_{min V}$	Minimum supply pressure, maximum static gauge pressure at the point where the water supply company's connection line connects to the building's supply line; specified by the water supply company	bar
$P_{min before}$	Minimum supply pressure before the pressure boosting system	bar
P_{after}	Gauge pressure after the pressure boosting system	bar
P_{vmin}	Minimum volume flow of pump	l/s
P_{vmax}	Maximum volume flow of pump	l/s
P_{before}	Gauge pressure before the pressure boosting system	bar
P_{min}	Permitted minimum output pressure for pressure reducers	bar
P_0	Supply pressure to the diaphragm pressure vessel	bar
Q	Volume flow (conventional symbol)	m ³ /h
Q_{max}	Maximum volume flow	l/s
Q_{min}	Minimum volume flow	l/s
R	Pipe friction loss	Pa/m
s	Switching frequency; number of times a pump in a pressure boosting system cuts in and out per hour	1/h
v	Flow velocity at peak flow	m/s
V_E	Total volume of the diaphragm pressure vessel on the discharge side of a pressure boosting system	l
V_{En}	Useable proportion of the diaphragm pressure vessel volume	l
V	Volume flow (acc. to standard)	m/h
V_B	Useable volume of the atmospherically ventilated break tank	
V_{max}	Maximum volume flow	m ³ /h
V_{maxP}	Maximum volume flow of a pressure boosting system	m ³ /h
V_S	Peak flow	m ³ /h
Z	Resistance of all pipe parts and fittings in a pipe system	
ΔH_{diff}	Delivery head differential	
Δp	Differential pressure	bar or m
$\Delta p_{(OFF-ON)}$	Switching pressure differential; difference between switch-off and switch-on pressure in a pressure boosting system	m or bar
Δp_{fitt}	Head loss in fittings	m or bar
$\Delta p_{fitt after}$	Head loss in fittings after the pressure boosting system	m or bar
$\Delta p_{fitt before}$	Head loss in fittings before the pressure boosting system	m or bar
Δp_{st}	Static head loss	m or bar
$\Delta p_{st after}$	Static head loss after the pressure boosting system	m or bar
$\Delta p_{st before}$	Static head loss before the pressure boosting system	m or bar
$\Delta p/l$	Mean pressure drop for the pipe system	m or bar
Δp_p	Delivery pressure, difference between pressure on the discharge side of the pumps in a pressure boosting system and the pressure available before the pressure boosting system when pumps are at maximum volume flow	bar or m
Δp_v	Volumetric flow differential	l/s
Δp_{TE}	Loss in hot water heaters	mbar
Δp_{verf}	Available pressure difference	bar
Δp_{WM}	Head loss due to the water meter	m or bar
Δv	Change in flow velocity	bar
η	Efficiency	
ξ	Loss coefficient for a isolated point of resistance	cm/l
$\Sigma (l \cdot R + Z)$	Sum of losses	

Regulations, standards and guidelines

Potable water systems

TrinkwV 2001

This regulation governs the quality of water for human consumption. It does not apply:

- Natural mineral water as defined by regulations governing mineral and bottled water
- Spa water as defined by pharmaceutical regulations.

For installations and water from installations which are intended for the extraction or dispensing of water which does not have the quality required for human consumption and which are used in households in addition to the water supply systems, this regulation applies only insofar as it explicitly refers to such installations.

Cited standards and guidelines

DIN standard	Description
DIN 1988-1	Drinking water supply systems (TRWI); General; DVGW code of practice; DIN standard
DIN 1988-2	Drinking water supply systems (TRWI); Design and installation; components; appliances; materials; DVGW code of practice; DIN standard
DIN 1988-3	Drinking water supply systems (TRWI); Pipe sizing; DVGW code of practice; DIN standard
DIN 1988-4	Drinking water supply systems (TRWI); Drinking water protection; drinking water quality control; DVGW code of practice; DIN standard
DIN 1988-5	Drinking water supply systems (TRWI); Pressure boosting and reduction; DVGW code of practice; DIN standard
DIN 1988-6	Drinking water supply systems (TRWI); Fire fighting and fire protection installations; DVGW code of practice; DIN standard
DIN 1988-7	Drinking water supply systems (TRWI); Prevention of corrosion and scaling; DVGW code of practice; DIN standard
DIN 1988-8	Drinking water supply systems (TRWI); Operation; DVGW code of practice; DIN standard
DIN 2000	Central drinking water supply: Guidelines for drawing up requirements for the design, construction, operation and maintenance of public drinking water supply systems; DVGW code of practice; DIN standard
DIN 2001	Drinking water supply from small units and non stationary plants – Guidelines for drinking water; DIN standard
DIN 3269-1	Valves for domestic drinking water installations; Check valves PN 10; Requirements
DIN 3269-2	Valves for domestic drinking water installations; Check valves PN 10; Testing
DIN 4046	Water supply; Terms; DVGW code of practice; DIN standard
DIN 4109	Sound insulation in buildings; Requirements and testing
DIN 4109-5	Sound insulation in buildings, Sound insulation from noise from domestic plant and machinery
DIN 4807-5	Closed expansion tanks with membrane for drinking water installations; Requirements; Testing; Configuration and labelling; DIN standard
DIN 14463-1	Water systems for fire extinguishing – Filling and draining devices operated by remote control; Part 1: For “wet/dry” hose reel systems; Requirements; Testing; DIN standard
DIN EN 806-1	Specifications for installations inside buildings conveying water for human consumption; General; DIN standard
DIN EN 806-2	Specifications for installations inside buildings conveying water for human consumption; Design; DIN standard
DIN EN 1074-3	Valves for water supply; Fitness for purpose requirements and appropriate verification tests; Check valves
DIN EN 1567	Building valves – Water pressure reducing valves and combination water pressure reducing valves; Requirements and tests; DIN standard
DIN EN 1717	Protection against pollution of potable water installations and general requirements of devices to prevent pollution by backflow; DIN standard
DIN EN 12056	Gravity drainage systems inside buildings
VDI	Hygiene-conscious planning;
Guideline 6023	Design and maintenance of drinking water supply systems; DIN standard
W 375	DVGW Arbeitsblatt: Construction and testing of pressure reducing valves to DN 50

Tables and charts for the calculation examples

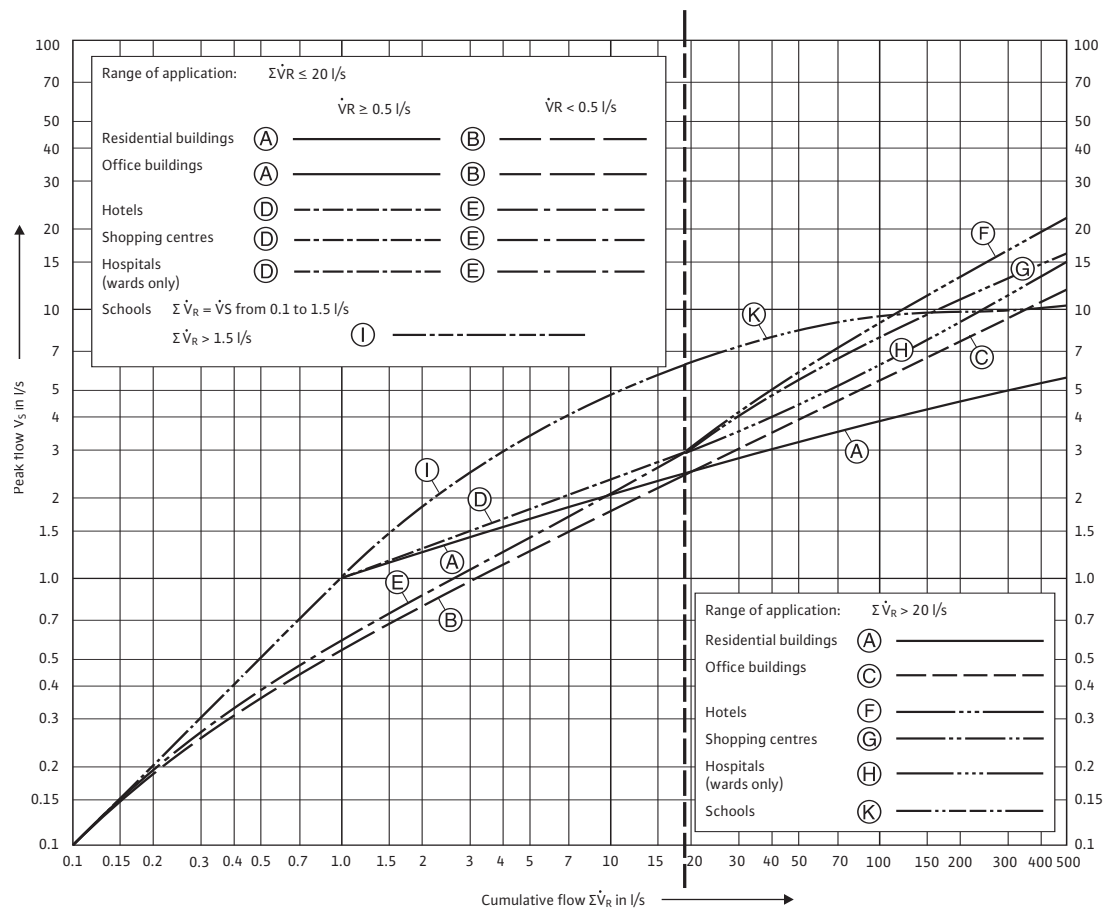
Standard values for minimum flow pressures and design flows of conventional potable water extraction points					
Minimum flow pressure P _{min FI}	Type of potable water extraction point		Design flow when extracting		
			Mixed hot and cold ¹		Only cold or only hot water
			V _R cold	V _R hot	V _R
[bar]			[l/s]	[l/s]	[l/s]
	Plug valves				
0.5	Without air bubbling ²	DN 15	-	-	0.30
0.5		DN 20	-	-	0.50
0.5		DN 25	-	-	1.00
1.0	With air bubbling	DN 10	-	-	0.15
1.0		DN 15	-	-	0.15
1.0	Spray nozzles for pressurised spray cleaning	DN 15	0.10	0.10	0.20
1.2	Flushing valves				
	in acc. with DIN 3265, Part 1	DN 15	-	-	0.70
0.4	Flushing valves				
	in acc. with DIN 3265, Part 1	DN 20	-	-	1.00
1.0	Flushing valves				
	in acc. with DIN 3265, Part 1	DN 25	-	-	1.00
0.4	Flushing valves for urinals	DN 15	-	-	0.30
0.5	Angle valve for urinals	DN 15	-	-	0.30
1.0	Household dishwasher	DN 15	-	-	0.15
1.0	Household washing machine	DN 15	-	-	0.25
	Mixer tap for				
1.0	Shower cubicles	DN 15	0.15	0.15	-
1.0	Bathtubs	DN 15	0.15	0.15	-
1.0	Kitchen sinks	DN 15	0.07	0.07	-
1.0	Washstands	DN 15	0.07	0.07	-
1.0	Bidets	DN 15	0.07	0.07	-
1.0	Mixer tap	DN 20	0.30	0.30	-
0.5	Toilet cistern				
	in acc. with DIN 19542	DN 15	-	-	0.13
1.0	Electric kettle	DN 15	-	-	0.10 ³

¹ The design flows for mixed water extraction are based on 15 °C for cold potable water and 60 °C for heated potable water.

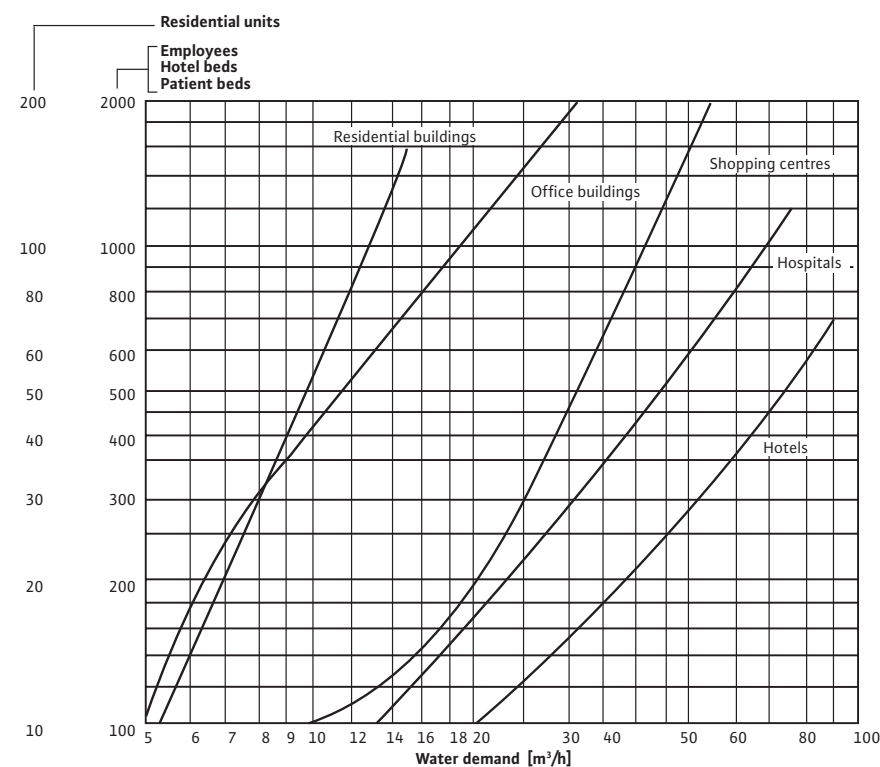
² For plug valves without air bubbling and with hose unions, the pressure loss in the hose (up to 10 m long) and the connected fitting (e.g. garden sprinkler) is accounted for as a fixed amount added to the minimum flow pressure. In these cases, the minimum flow pressure is increased by 1.0 bar to 1.5 bar.

³ With flow control screw open.

Peak flow V_S as a function of cumulative flow V_R



Water demand chart in accordance with Arbeitsblatt W 314 DVGW



Flow values from nozzles or spout nozzles						
Pressure		Inside diameter d [mm]				
p	4 ¹	6 ²	8	9 ³	10	12 ⁴
bar	Water flow Q [l/min]					
3.0	18	41	73	93	115	165
3.5	20	45	79	100	125	180
4.0	21	48	85	105	130	190
4.5	22	50	90	115	140	200
5.0	24	53	95	120	150	215
6.0	26	58	105	130	160	235
7.0	28	63	110	140	175	250

According to DIN 14365 Part 1:

- ¹ Equal to DM spout with nozzle (d5 = 4).
- ² Equal to CM spout with nozzle (d5 = 9).
- ³ Equal to DM spout with nozzle (d2 = 6).
- ⁴ Equal to DM spout with nozzle (d2 = 12).

Commonly used flow values for fire hose outlets	
Fire hose reel with solid C coupling ¹	Flow ² [l/min]
For C connection	100 to 200
For D connection	25 to 50

- ¹ Flow pressure at fire hose reel at least 3 bar at a flow rate of 100 l/min.
- ² Water volumes in standard use in the fire protection industry (25, 50, 100, 200, 400, 800 and 1600 l/min).
First figure = minimum flow
Second figure = maximum flow
The flow depends on the spouts and fire extinguishing pumps used.

Head loss Δp_{WM} from water meters (standardised values)		
Meter type	Rated flow V_n [m³/h]	Maximum head loss Δp at V_{max} [mbar] acc. to DIN ISO 4062, Part 1
Impeller meter	< 15	1000
Vertical turbine meter (WS)	≥ 15	600
Parallel turbine meter (WP)	≥ 15	300

Connection, rated flow and maximum flow of water meters in acc. to DIN ISO 4064, Part 1

Meter type	Connection		Rated flow*	Maximum flow
	Connection thread acc. to DIN ISO 228, Part 1	Connection size, nominal diameter	V _n [m³/h]	V _{max} [m³/h]
Volumetric meter and impeller meter	G 1/2 B	–	0.6	1.2
	G 1/2 B	–	1	2
	G 3/4 B	–	1.5	3
	G 1 B	–	2.5	5
	G 1 1/4 B	–	3.5	7
	G 1 1/2 B	–	6	12
	G 2 B	–	10	20
Turbine meter	–	50	15	30
	–	50	15	30
	–	65	25	50
	–	80	40	80
	–	100	60	120
	–	150	150	300
	–	200	250	500

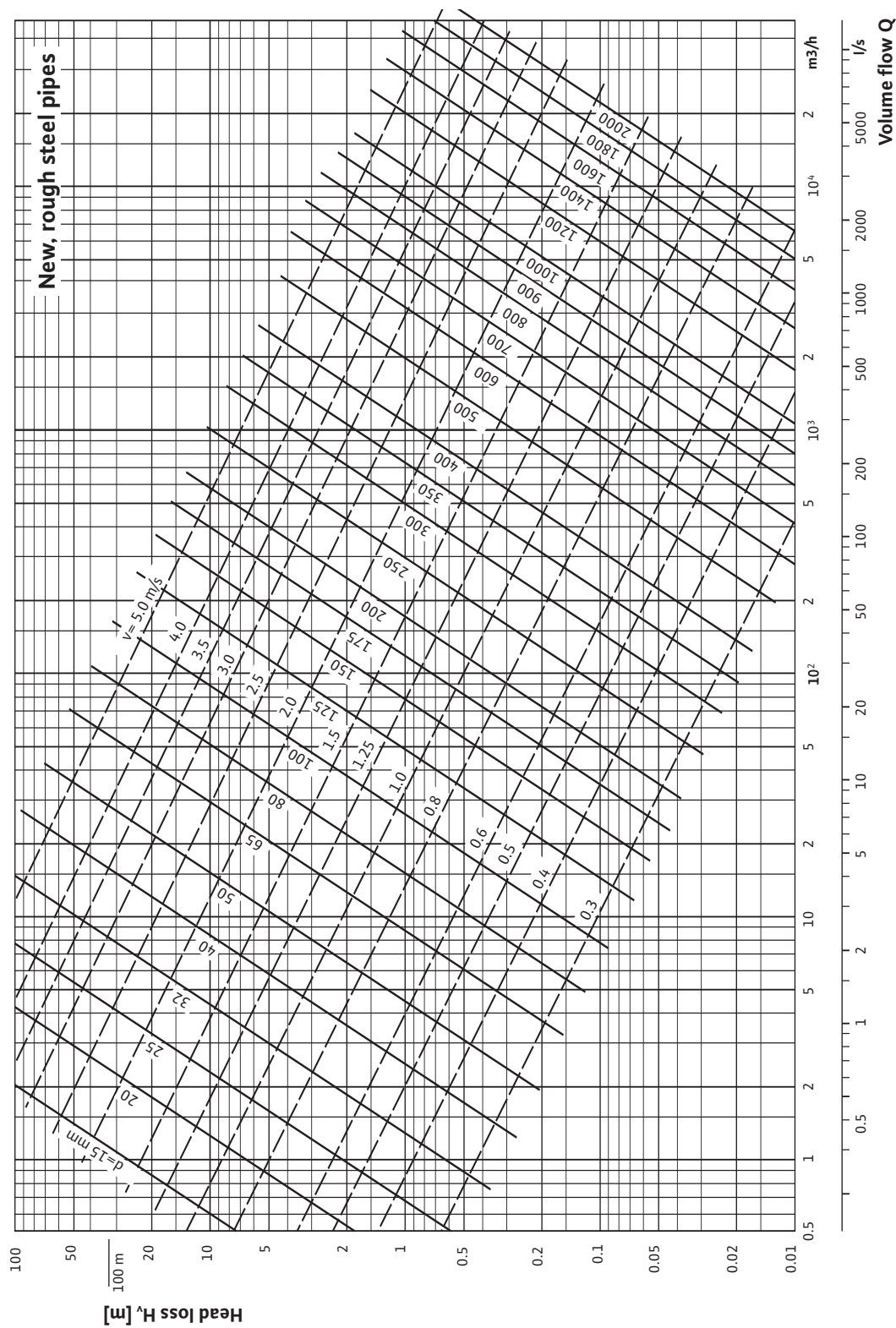
* Used for identification of the meter. For a given rated flow V_n DIN ISO 4064, Part 1 permits using a connection thread from the next highest or lowest row in the table instead of the assigned value.

Standard values for head loss Δp_{TE} of group hot water heaters

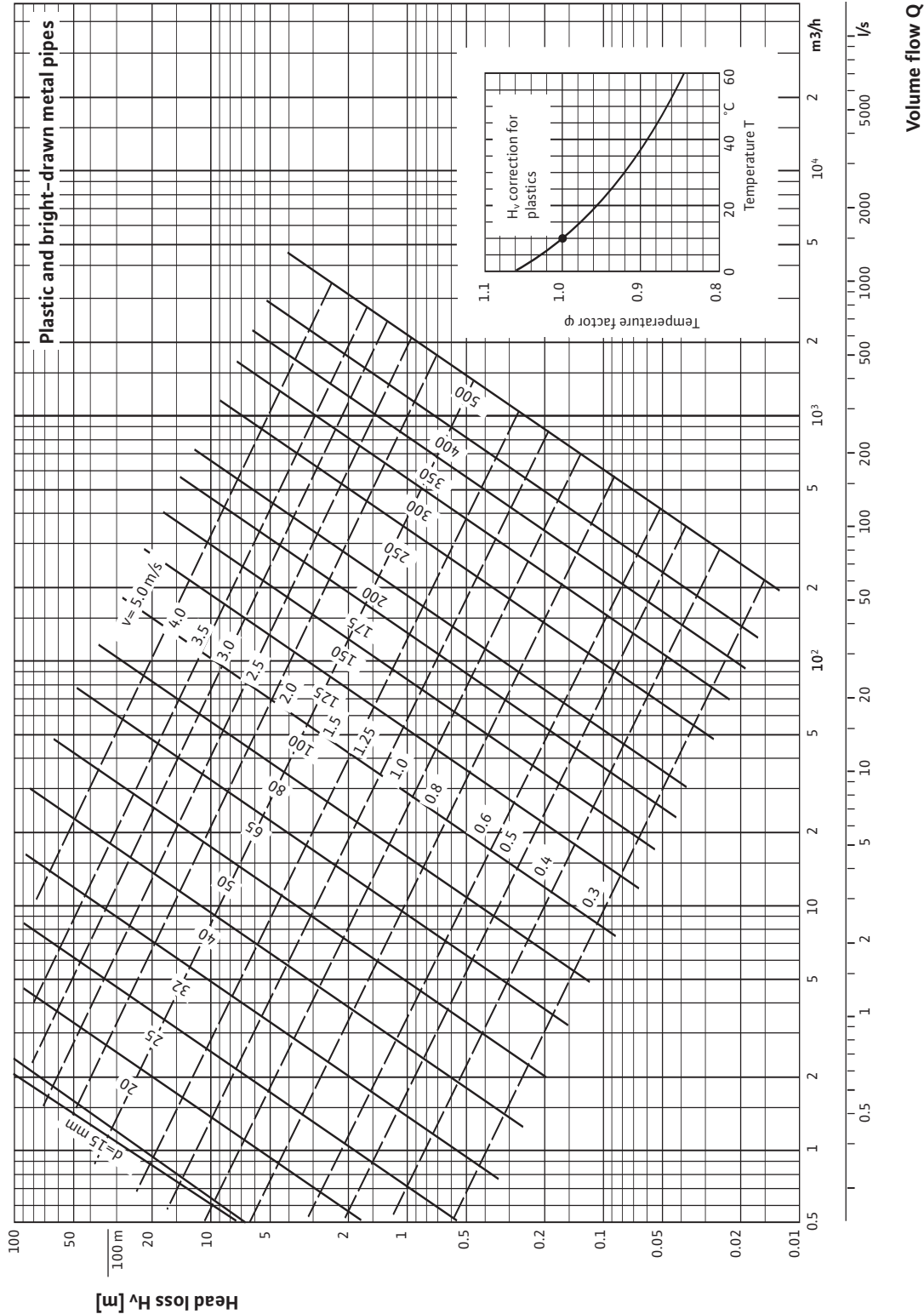
Device type	Head loss Δp _{TE} ¹ bar
Electric instantaneous water heater, thermally regulated	0.5
hydraulically controlled ²	1.0
Electric or gas hot water cylinder rated volume up to 80 l	0.2
Gas instantaneous water heater and Gas combination water heater in acc. with DIN 3368, Part 2 and Part 4	0.8

¹ The head loss for the safety and connection valves is not included in the values.
² Corresponds to the required switching pressure differential.

Head loss in steel pipes



Head loss in hydraulically smooth pipes



Form for determining the peak flow via the cumulative flow

Construction project:

Company:

Completed by:

Date:

Sheet No.:

Rising pipe (line) No.	Floor	Quantity	Extraction valve, combination extraction valve	Minimum flow pressure, Head loss $p_{\min \text{ FI}}$ [mbar]	Date:			Cumulative flow			
					Proportion		Mixed $\Sigma \dot{V}_R$ l/s	Floor supply pipe (line)		Rising pipe	
					PW	SHW		PW	SHW	PW	SHW
					\dot{V}_R l/s	\dot{V}_R l/s		$\Sigma \dot{V}_R$ l/s	$\Sigma \dot{V}_R$ l/s	$\Sigma \dot{V}_R$ l/s	$\Sigma \dot{V}_R$ l/s
1	2	3	4	5	6	7	8	9	10	11	12

Specifications for calculating the available pipe friction loss R_{verf}

Construction project

Company:

Completed by:

Date:

Sheet No.:

Potable water, cold: ☐ Potable water, hot: ☐

System: a) Connection to the incoming main b) Central hot water heater: ☐

Direct: ☐ Indirect: ☐ Group hot water heaters: ☐

No.	Description	Symbol	Unit	1	2	3	4	5	
1	Minimum supply pressure or output-side pressure after pressure reducer or pressure boosting system	$p_{\text{min V}}$	mbar						
2	Head loss from static head differential	Δp_{st}	mbar						
3	Head loss in fittings, e.g.								
	a) Water meter (see table on p. 98, bottom)	Δp_{WM}	mbar						
	b) Filter	Δp_{Fil}	mbar						
	c) Softening equipment	Δp_{EH}	mbar						
	d) Dosing/dispensing system	Δp_{Dos}	mbar						
	e) Group hot water heater (see table on p. 99, bottom)	Δp_{TE}	mbar						
	f) Other fittings	Δp_{fitt}	mbar						
4	Minimum flow pressure	$\Delta p_{\text{min FI}}$	mbar						
5	Head loss in floor supply lines and individual feeder lines	Δp_{flr}	mbar						
6	Total of head losses from No. 2 to No. 5	$\Sigma \Delta p$	mbar						
7	Available for head loss from pipe friction and isolated points of resistance, value from No. 1 less value from No. 6	Δp_{verf}	mbar						
8	Estimated proportion for isolated points of resistance at ... %	-	mbar						
9	Available for head loss from pipe friction, value from No. 7 less value from No. 8	-	mbar						
10	Pipeline length	l_{tot}	m						
11	Available pipe friction pressure drop, value from No. 9 divided by value from No. 10	R_{verf}	mbar/m						

Inspection and maintenance



The operator is recommended to conclude a maintenance contract for the potable water systems with an installer company.

The following tables list the essential system parts and the maintenance, inspection and servicing they require. The recommendations given here for time intervals for inspection and maintenance and for performance of the various tasks should be followed by the operator as it is in the operator's own interests to do so.

The operation and maintenance specifications of the manufacturer should be followed as well.

Maintenance tasks		
Task	Inspection	Maintenance
Free outlet in break tank (level controller)	Check the safety margin (water level setting), the inlet valve and the overflow when inlet is fully open; check the air inlet/outlet if applicable (visual inspection).	
Anti-vacuum device	When water is flowing through the valve, water must not run out of the air inlets (visual inspection).	
Pipe disconnecter, installation type 2 and 3	a) Check for proper functioning: visual inspection when an upstream shut-off valve is closed. The pipe disconnecter should go into disconnection position when the valve is closed. b) Check for leaks: visual inspection; water should not escape when in flow position.	
Pipe disconnecter, installation type 1	a) Check for proper functioning: close a shut-off valve upstream from the pipe disconnecter. Open an extraction fitting to relieve the pressure in the shut-off section. Visually inspect to see whether the pipe disconnecter goes into disconnection position. b) Check for leaks: visual inspection; water should not escape when in flow position. c) Check safety function: open an extraction valve downstream from the pipe disconnecter. Relieve the input pressure on the pipe disconnecter by slowly closing an upstream shut-off valve. At the response pressure shown on the name plate, the pipe disconnecter should go into disconnection position. Check that the response pressure is as specified by means of a pressure gauge fitted between the shut-off valve and the pipe disconnecter.	
Non-return valve (in pipe)	To check for watertight closure, shut off the pipe before the non-return valve in the direction of flow. Opening the testing fixture on the input side of the non-return valve will show whether water is coming out. For the test to work, the consumption lines following the non-return valve must be filled with water. The closure is watertight if no water comes out of the test fitting.	

Task	Inspection	Maintenance
Air inlet valve, flow-through form (type C)	If not already connected, connect a hose about 1 m long to the outlet downstream from the air inlet. Open the check valve upstream from the air inlet valve far enough to cause a small amount of water to emerge from the hose. Then raise the end of the hose above the air inlet valve, close the check valve and lower the hose. The water in the hose should flow out, and the air inlet valve should audibly draw in air through the air inlet openings.	
Air inlet valve, with and without drip limitation and discharge (types D and E)	Close the upstream fitting closest to the air inlet valve being tested and open a downstream outlet which does not have a non-return valve (first remove jet regulator if fitted). As this is done, the air inlet valve should audibly draw in air through the air inlet openings. The water comes out of the extraction point quickly. Check for leaks: visual inspection: when water is flowing through the valve, water must not run out of the air inlets. The function of the air inlet valve with drip limitation and discharge can also be checked with the aid of a glass filled with water. The outlet end of the drip overflow bend on the air inlet valve is placed in the water-filled glass. If the air inlet valve is functioning correctly, the water will be drawn up when the test described above is carried out.	
Safety valve	a) Functional inspection by checking responsiveness: actuate the lifting mechanism of the safety valve from time to time during operation of the system. Observe whether the valve closes again when the lifting mechanism is released and whether the water behind the valve flows away completely through the funnel or blow-off line. b) In the case of safety valves installed before water heaters, observe whether the safety valve responds when the water heater heats up. The valve has responded if water flows out of the blow-off line.	If no water comes out when the water heater heats up or the safety valve has a permanent leak, try to unblock the valve or flush foreign bodies out of the seal section by actuating the lifting mechanism several times. If that does not work, have the valve repaired by an installer company. If the valve seat or sealing disc is damaged, the safety valve must be replaced completely.
Pressure reducer	Check the set output pressure on the pressure gauge (visual inspection) at zero flow and peak flow (large extraction volume).	Pressure reducers are controllers with relatively low actuating forces and are therefore particularly sensitive to contaminants. The strainer must be cleaned and replaced if necessary. Take out the internal parts and check that they are in proper working condition; replace if needed.
Pressure boosting system	See manufacturer's operating instructions.	See manufacturer's operating instructions.
Backwashable filter	If the water flow is reduced due to increased pressure loss, backwash it in accordance with the manufacturer's maintenance instructions.	See inspection.
Non-backwashable filter	Check the deposits on the filter cloth by visual inspection of filters with transparent filter cups or check the flow resistance on filters with non-transparent filter cups.	Replace the filter element in accordance with the manufacturer's maintenance instructions. When putting back into service, the first run-off water must be drained off by briefly opening a nearby extraction point.
Dosing/dispensing device	Visual inspection, check of reservoir contents, replace dispensing reservoir if empty. Follow the manufacturer's specifications regarding expiry and storage of the dispensed substance.	See manufacturer's operating instructions.

Task	Inspection	Maintenance
Water softener installation	<p>Monitor the amount of salt consumed at regular intervals depending on the volume of water used.</p> <p>Add regenerating salt as needed (use only salt of quality specified by DIN 19604). When adding salt, ensure proper hygiene. For example, the salt packages should be cleaned before use so that contaminants cannot enter the salt dispenser. Pour the regenerating salt directly into the salt dispenser from the opened package. Make sure that the salt dispenser is not overfilled and that it is closed again carefully after filling. The storing of opened packages should be avoided. The salt should be stored in a clean and dry place.</p> <p>If needed, compare the clock timer on the automatic control with the actual time, measure the reduced water hardness, add disinfectant substances for the specific system if needed.</p>	<p>See manufacturer's operating instructions. Minimum scope of maintenance work:</p> <ul style="list-style-type: none">- Check regeneration trigger mechanism. Clean injector and strainer. Check control valve for leaks, replace wearing seal if needed. Check drive motor of the control valve for proper functioning.- Check brine control and program setting; adapt to new water use pattern if required.- Check the amount and state of regenerating salt and the brine level.- Check seals and gaskets and hose unions, replace if needed.- Check untreated water hardness, and soft/reduced water hardness; adjust reduced water hardness setting if necessary. Enter the adjustment of the setting in the log book.- Read off the water meter and enter the reading in the log book.- Check the mechanisms required for device disinfection / add system-specific disinfectant substances.- Check that the device connection fittings are functioning correctly to prevent backflow.- Hand over the system to the operator together with the log book. <p>All tasks performed during maintenance and any repairs carried out should be entered in the log book supplied by the manufacturer.</p>
Hot water heater	<ul style="list-style-type: none">- Check the set temperature and compare with the actual temperature of the heated water.- Check the safety valve for proper functioning (see safety valve).	<p>Pressure test: for heat carriers class 1 or 2 and operating pressure in the heating system > 3 bar and for class 3, carry out a pressure test as follows to test the heat exchanger for leaks:</p> <p>a) Pressure test on the potable water or heat carrier side at the applicable permitted operating pressure of the system with simultaneous relief of pressure to atmospheric on the other side, or</p> <p>b) Shutting off the flow and return lines for the heat carrier with simultaneous extraction of heated potable water and pressure inspection on an operating pressure gauge. The cooling of the heating surface should result in lowering of the gauge pressure in the heat exchanging space to 0. If the pressure does not fall, check by carrying out a pressure test.</p>
Additional specifications for intermediate hot water heaters	<p>With hot water heater of design type D (intermediate heat exchanger, see DIN 1988, Part 2), check that the safety system is working properly in accordance with the specifications of the manufacturer.</p> <p>If the intermediate fluid needs to be replenished, use only the fluids specified by the manufacturer for that purpose.</p>	<p>In accordance with manufacturer's specifications and operating conditions.</p>

¹ See Lebensmittel- und Bedarfsgegenständegesetz (Food and Consumer Goods Law)

² If tests must be carried out by approved specialists in order to fulfil statutory requirements, the inspection tasks may be incorporated into those tests

Task	Inspection	Maintenance
Cleaning and descaling	<p>To keep the system in proper working condition, make sure that deposits (anode sludge, scale) are removed. If cleaning agents or descaling agents are used for this purpose, these must be such that their proper or intended use poses no risk to health due to their chemical composition, particularly due to toxic substances or contaminants.¹ This requirement is considered to be met if the manufacturer of the cleaning agent or descaling agent confirms the suitability of the product in terms of the Lebensmittel- und Bedarfsgegenstände-gesetz (Food and Consumer Goods Law) and specifies the method of cleaning and rinsing.</p> <p>The manufacturer of the hot water heater is obliged to specify agents suitable for use for cleaning and descaling and suitable cleaning and rinsing methods, in the light of the materials used in manufacturing the heater.</p>	<p>Addition of corrosion protection:</p> <p>Substances used for coating surfaces in contact with potable water must be such that their proper or intended use poses no risk to health due to their chemical composition, particularly due to toxic substances or contaminants.¹</p> <p>No substances should be able to be transferred from the coating substance to the potable water unless the amounts would have no detrimental health, odour or taste effects and are technically unavoidable.</p>
Fire water supply and fire protection facilities	<p>For fire water supply and fire protection facilities, acceptance tests and repeat tests are subject to the requirements of the local fire protection authority or the insurer.</p> <ul style="list-style-type: none">- The date of inspection, name of the inspecting person, all tests carried out and any faults discovered should be entered in the log book (in accordance with DIN 1988, Part 6/12.88, section 4).- Discovered faults must be rectified without delay.- The date of fault rectification and the name of the rectifier (company name) should also be entered in the log.- If a new log book is started, the previous one must be kept for at least one year. <p>Minimum scope of inspection²:</p> <ul style="list-style-type: none">- Check the filling valve (closed, watertight).- Check the draining fixtures (clean, functioning properly).- Check for damage to the safety elements designed to prevent unauthorised activation.- Check the control voltage.- Functional check of the pump for the actuating pressure of hydraulic systems.- Check for adequate actuating pressure and leak-tightness of the actuation pressure system.- Check the batteries (charging state and full state).- Check the functioning of the acoustic and visual alarms.- Check water pressure.- Check the running of the pressure boosting pump(s) – if installed – including check of the direction of rotation.- Functional check of the forced actuation of the filling valve and draining fixtures.- Check the operation of the filling valve, automatic opening if the control fails, activation of the acoustic and visual alarms.- Check the operation of all extraction valves (fire hose outlets) (damage, mobility of the operating elements; dry check permitted).- Check the nozzles on the sprinkler system (not blocked, clean; dry check permitted).- Check the system for corrosion damage.- If there is a strainer in the filling and draining station, check and clean it.- Check the functioning of the bypass fitting with operating element and then put safety element (to prevent misuse) back in place.- Check the supply of water to the filling and draining station.	See inspection.
Pipelines	Removal of inspection sections, visual inspection of the inner surface.	

Inspection and maintenance schedule							
No	Component, fitting	Inspection			Maintenance		
		Monthly	Yearly	Done by	Monthly	Yearly	Done by
1	Free outlet		1	O	X		
2	Anti-vacuum device		1	O	X		
3	Pipe disconnecter, inst. type 2 and 3	6		O	X		
4	Pipe disconnecter, inst. type 1		1	O	X		
5	Non-return valve		1	O	X		
6	Air inlet valve		5	O	X		
7	Safety valve	6		O	X	1	X
8	Pressure reducer		1	O	X	1 to 3	X
9	Pressure boosting system		1		X	1	X
10	Filter, backwashable	2		O	X	2	O
	Filter, non-backwashable	2		O	X	6	O
11	Dosing/dispensing device	6		O	X	1	X
12	Softening equipment	2		O	X	6 ¹	1
13	Hot water heater		1		X		X
14	Fire water supply and fire protection facilities	1		O	X		
		6		O	X		
15	Pipelines		1		X		
16	Cold water meter	1		O		8	X
17	Hot water meter	1		O		5	X

¹ For shared (communal) installations

The figures in the “Monthly” and “Yearly” columns refer to time intervals, e.g. 6: every six months, 2: every two years
Done by: O: operator, X: installer company, manufacturer, water supply company



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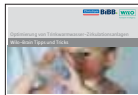
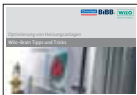
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