Choosing a pressure-boosting set

Required quantity of water

The public water-supply system is normally capable of supplying water at an adequate pressure and capacity level to the various outlets connected to it.
In those cases where a water-supply system is non-existent or insufficient for correct operation of the various facilities, a pressure-boosting system has to be installed to ensure an acceptable level of pressure and capacity also at the outlets in the most unfavourable positions.
The size of the water-supply unit is determined according to the quantity of water and pressure required.

Residential buildings

The main data needed for calculation of the quantity of water required is given in the following list:
- the number of outlets
- consumption per each type of outlet (Tab.1)
- the contemporaneity factor (Fc)

Table 1: Maximum consumption at points of demand

Outlet	Qu. delivered (l/min)
Sink	10
Wash-basin	10
Bath/whirlpool tub	18
Shower	12
WC - flush-tank type	7
WC - fast-feed type	90
Bidet	6
Washing machine	12
Kitchen sink	12
Dishwasher	8
Outlet w/ 1/2" tap	20
Outlet w/ 3/4" tap	25

The maximum theoretical requirement is given by the sum of the quantities of water delivered to the various outlets of an appartment multiplied by the number of appartments. In practice, it is generally found that only some of the outlets are used simultaneously.
The contemporaneity factor (Fc) allows for definition of the real maximum delivery that may be required by the outlets.
The following formulae are used to calculate the Fc factor. The value "Ut" is the total number of outlets (the number of outlets in an appartment multiplied by the number of appartments).

Appartments with 1 toilet - flush-type tank: $Fc = \frac{1}{\sqrt{0,85 \times Ut}}$

Appartments with 1 toilet - fast-feed type: $Fc = \frac{1}{\sqrt{0,7 \times Ut}}$

Appartments with 2 toilets - flush-type tank: $Fc = \frac{1}{\sqrt{1,1 \times Ut}}$

Appartments with 2 toilets - fast-feed type: $Fc = \frac{1}{\sqrt{0,83 \times Ut}}$

Diagram **A** gives the values of actual delivery, which depend on the number of appartments connected to the water-supply system. Seven outlets are hypothesized for one-bathroom appartments and ten outlets for two-bathroom appartments.

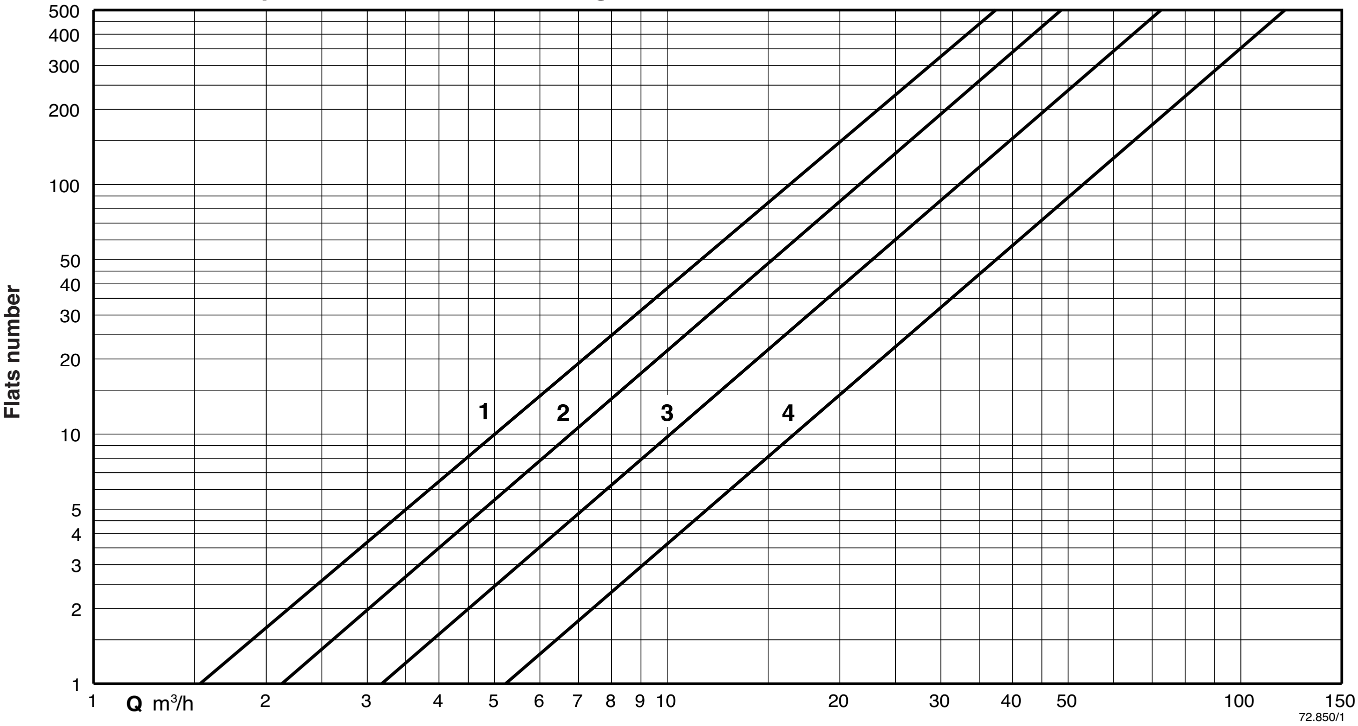
Non-residential buildings

For calculation of quantities of water required, the following types of building are considered:
- offices
- shopping centres
- hospitals
- hotels

These buldings require quantities of water greater than those needed in residential buildings.
Diagram **B** shows the values of actual delivery for the main types of building. The values are based on hypothetical numbers of persons present in these buildings.
These values offer a guideline and may vary in accordance with particular requirements of projects.

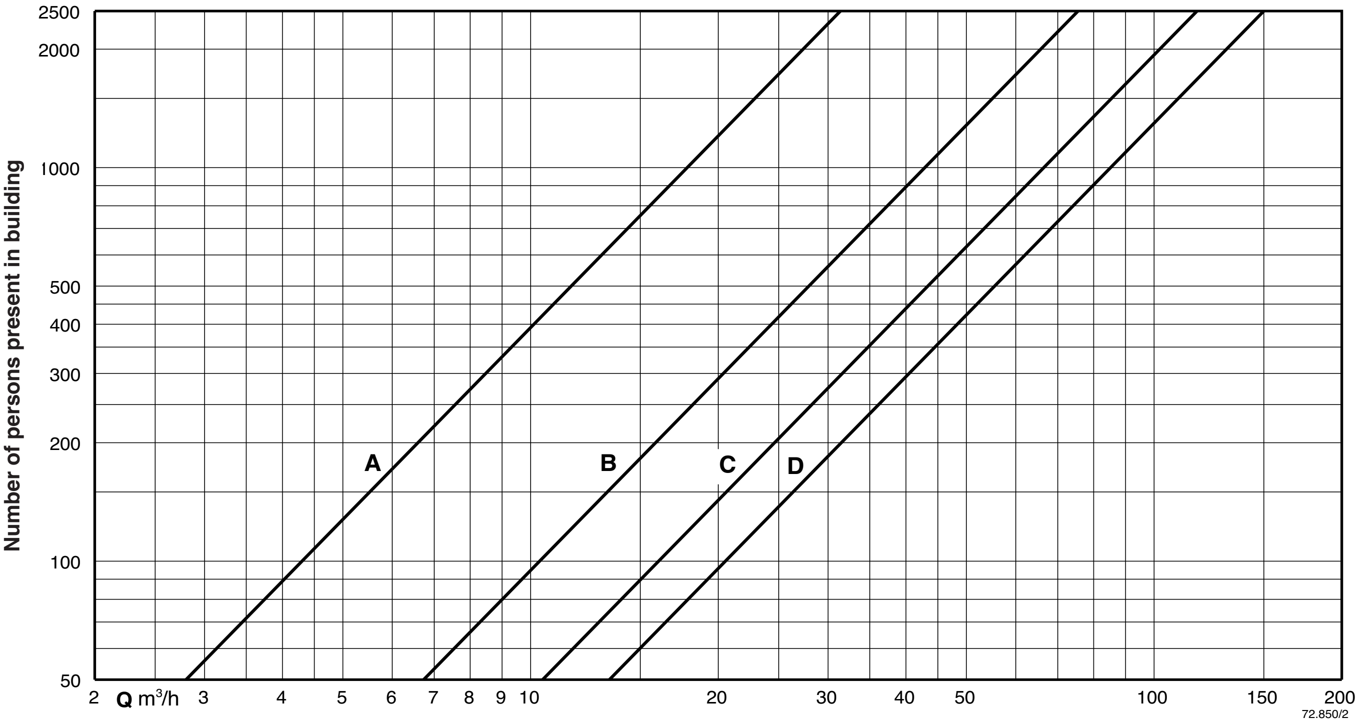
Choosing a pressure-boosting set

A Consumption in residential buildings



1 Appartments with one toilet, flush-tank type
2 Appartments with two toilets, flush-tank type
3 Appartments with one toilet, fast-feed type
4 Appartments with two toilets, fast-feed type

B Consumption in non-residential buildings



A Offices
B Shopping centres
C Hospitals
D Hotels

Choosing a pressure-boosting set

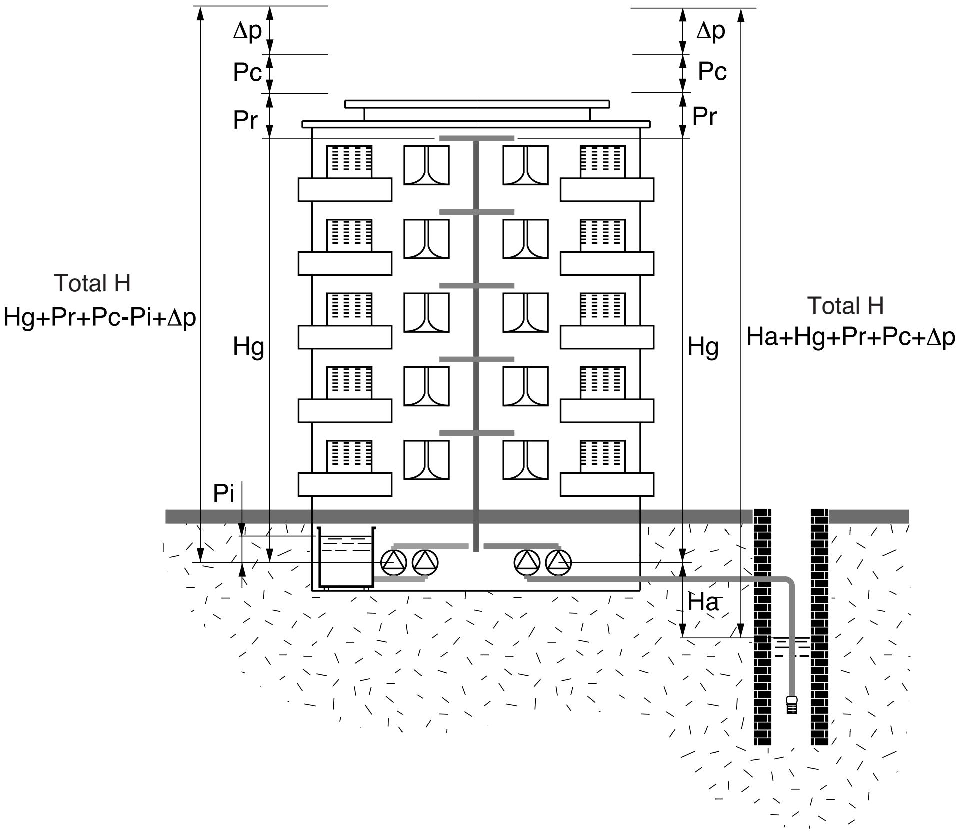
Delivery head

The outlet pressure required for proper operation of electrical appliances must not be lower than 1.5 bar and not greater then 4-5 bar.

When the pressure level is insufficient and to such a degree that it impedes operation of domestic appliances, a pressure-boosting system must be installed to ensure adequate pressure also at the more unfavourably—located points of demand.

The values to consider for calculation of the pressure level are the following:

- **Hg** the geodetic head between the pressure-boosting unit and the highest outlet.
- **Ha** the suction lift.
- **Pi** the initial pressure (or positive suction head).
- **Pr** the minimum residual pressure at the highest outlet (normally 1.5 bar).
- **Pc** the system head loss.
- **Δp** the difference in pressure between starting and stopping pumps.



When the pumps draw water from a well, the dynamic height difference (Ha), when pumps are operating, should not exceed 4 m.
A greater suction head or erroneous sizing of the suction pipe may cause improper operation of the pumps - e.g. cavitation and priming loss.
The pumps are installed with a positive suction head when they are connected to a raised tank or a pressurized primary collection tank.

The pumps therefore have an initial pressure at the suction port which can vary from 0.1 bar (suction with a collection tank) to 2-3 bar (with suction from a pressurized primary collection tank).
When choosing a pressure-boosting system, the positive value of the initial pressure (Pi) must be considered as a value to be subtracted from the height (Hg).

The system head loss (Pc) are given by the sum of the losses of the pipes (including the suction pipe) added to the losses due to gate valves, non-return valves, water purifiers, counters, filters, elbows etc.

Head loss in the tubes, caused by the friction of the water against the inner surface of the pipelines, may be quantified as 0.5 m per floor in the case of new systems and 1 m per floor in the case of old systems.

To avoid pressure levels greater than 4-5 bar arriving at outlets on the lower floors of apartment blocks and other buildings with a height greater than 30 m (about 10 floors), pressure reducers must be installed at the offtake point of the lower floors or otherwise two pressure-boosting units can be installed: one for the lower floors and one for the upper floors.

Surge tanks

The purpose of surge tanks is to retain a quantity of water, under pressure, thus avoiding continuous pump starts, as water is demanded.
The selection of the vessel must be made in-line with the pump flow and pressure and number of starts allowed by the motor.
For water pressure units with more than one pump, the selection of the vessel should refer to the data for one pump only.

The surge vessel may be of the following type:
a) Air cushion vessels
b) Membrane vessels

Air cushion vessels
In this type of vessels the air and water are in contact with each other. This will therefore result in a decrease of air as it dissolves into the water.
The installation will therefore require an automatic air feed (“Ariamat” air feeder, compressor or auto valve connected to existing compressed air network).
Air cushion vessels are normally manufactured from hot galvanized sheet steel, with rated pressures from 6 to 12 bar and capacity from 100 to 5000 ltrs, complete with safety valves, pressure gauge and level indicator.

Membrane vessels
These vessels are fitted with an inner membrane separating the water and air. When installed , they must be pre-charged at a pressure in-line with the pressure switch settings.

Calculation to size an air cushion vessel.

$$Vt = \frac{1.25 \times Qm \times (P1 + 10)}{4 \times Z \times (P1 - P2)}$$

where:
Vt = Total volume of air cushion vessel in m^3
Qm = Average pump flow in m^3
P1 = Maximum set pressure of pressure switch
P2 = Minimum set pressure of pressure switch
Z = Maximum number of starts/hour allowed by the motor (see table).

Qm flow is the average between the flow at starting pressure (Q min) and the flow at stop pressure (Q max):

$$Qm = \frac{Qmin + Qmax}{2} \quad (m^3/h)$$

Exemple: Pump MXV 40-807
P1 = 70 m
P2 = 50 m
Qm = 9,45 m^3/h
Z = 23 starts/hour

$$Vt = \frac{1.25 \times 9{,}45 \times (70 + 10)}{4 \times 23 \times (70 - 50)} = 0{,}514\ m^3$$

From the calculation, it would result in the selection of a 500 litre vessel.

Calculation to size a membrane vessel

$$Vt = \frac{Qm}{4 \times Z} \times \frac{1}{1 - \frac{(P2 - 2)}{P1}}$$

where:
Vt = Total volume of air cushion vessel in m^3
Qm = Average pump flow in m^3
P1 = Maximum set pressure of pressure switch
P2 = Minimum set pressure of pressure switch
Z = Maximum number of starts/hour allowed by the motor (see table)

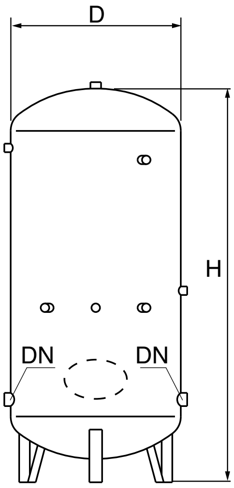
Exemple: Pump MXV 40-807
P1 = 70 m
P2 = 50 m
Qm = 9,45 m^3/h
Z = 23 starts/hour

$$Vt = \frac{9{,}45}{4 \times 23} \times \frac{1}{1 - \frac{(50 - 2)}{70}} = 0{,}327\ m^3$$

From the calculation it will result in the selection of a 300 litre membrane vessel.

CE 97/23 PED APPROVED PRESSURE VESSELS (Air tanks)

Hot galvanized vessels

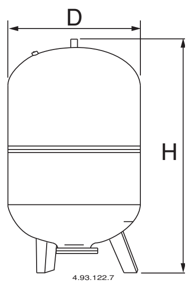


TYPE	Dimensions D x H mm	DN	Weight kg
100- 5	400 x 1020	G 1	32
200- 5	450 x 1440	G 1	48
300- 8	550 x 1500	G 1 1/2	65
500- 8	650 x 1820	G 2	105
800- 8	800 x 1900	G 2	145
1000- 8	800 x 2150	G 2 1/2	160
1000- 12 ▲	800 x 2300	G 2 1/2	203
1500- 5	950 x 2500	G 2	190
1500- 8 ▲	950 x 2500	G 2	255
2000- 8 ▲	1100 x 2570	G 2 1/2	330
2000- 12 ▲	1000 x 2780	G 2 1/2	387
3000- 8 ▲	1250 x 2930	G 3	470
3000- 12 ▲	1200 x 2930	G 3	596
4000- 8 ▲	1450 x 3090	G 3	620
4000- 12 ▲	1450 x 3090	G 3	880
5000- 8 ▲	1450 x 3590	G 4	715
5000- 12 ▲	1450 x 3590	G 4	1020

The vessels are suitable for water up to 50 °C

They are all approved at manufactureris premises and are supplied complete with safety valve, tested pressure gauge and fittings.

CE 97/23 PED APPROVED MEMBRANE VESSELS



TYPE	Pressure bar	Dimensions D x H mm	DN	weight kg
SM 60 V	10	382 x 845	G 1	-
SM 80 V	10	450 x 850	G 1	-
SM 100 V	10	450 x 950	G 1	-
SM 200 V	10	550 x 1255	G 1 1/2	-
SM 300 V	10	630 x 1405	G 1 1/2	-
SM 500 V	10	780 x 1550	G 1 1/2	-
SM 750 V	10	780 x 1940	G 1 1/2	-
SM 1000 V	10	980 x 1970	G 2	-

EPDM diaphragm
Temperature -10 ÷ +100 °C
With safety valve and pressure gauge 0÷10 bar