# Technical information

## GP-GPE PRESSURE BOOSTER SETS

### DEFINITION AND USE OF THE PRESSURE BOOSTER SETS

If the public water distribution system is non-existent, or insufficient for the correct functioning of equipment, it is necessary to install a pressure booster set to guarantee an acceptable water quantity and pressure even in the most penalised points. Pressure booster sets are used wherever the pressure needs to be increased or the water supply needs to be kept pressurised. EBARA's GP pressure booster sets are small, automatic systems with 2 pumps or more working in parallel. They are designed and built to meet the most common water pressure maintenance requests in a simple and reliable way in blocks of flats, hotels, centres, offices and schools, and for auxiliary services in the industrial and agricultural context.
They stand out for their robustness, compact design, high performance and quiet operation.
The GP units are designed to be connected to membrane or air cushion pressure tanks.
Pump start-up is controlled by a 4-20mA pressure transducer or by suitably calibrated pressure switches (activated from an electric control panel).

### OPERATING PRINCIPLE OF THE GP PRESSURE BOOSTER SET

When water is requested, it is initially taken from the autoclave tank. This water consumption (or in any case the removal of water from the system), with the pumps stationary, lowers the pressure until it reaches a value where the control system (pressure transducer or pressure switches) intervenes to activate the first electric pump. If the outward flow is greater than the flow rate of one pump, the pressure continues to fall and so the second pump is activated as well (in cascade).
This applies to all the electric pumps that make up the unit.
When the outward water flow stops or diminishes, the pressure level rises; this gradually stops all the pumps that are working, until the whole unit has stopped completely.
The reversal of the motor activation order reduces the number of hourly start-ups of the individual pumps, which means they are all used to the same degree.
N.B. By connecting a float or minimum pressure switch to the panel (for taking water both from the primary tank and from the hydraulic circuit), the most common cause of electric pump failure - a lack of intake water - can be avoided.

### OPERATING PRINCIPLE OF THE GPE PRESSURE BOOSTER SET

The GPE units, with E-SPD+, are designed to start up each single pump with an inverter device installed on the motor.
GPE units with E-SPD+ keep a constant pressure value in the water supply and also optimise energy consumption and pump wear, lengthening the pump lifespan and reducing the need for maintenance.
When the pressure changes, the first pump is activated with a controlled acceleration ramp. The inverter device modulates the motor speed to vary pump performance, thereby controlling and maintaining the required pressure level in the system. If the water request exceeds the capacity of the pump that has been activated, the second pump will begin working as well. The speed of both pumps is synchronised by the relative inverter devices to optimise the work load and stabilise the system pressure.
In pressure booster sets with E-SPD+, 2 different pressure values can be set; the switchover between the 2 is managed by the switching of a digital input that can be controlled via an external command such as a pressure switch, a standard switch, or a control unit (e.g. irrigation). This function allows two pressure values to be controlled with the same unit.

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### CONDITIONS OF USE

The standard versions of the EBARA GP-GPE pressure booster sets can be used for domestic, industrial and agricultural applications, and in particular for:

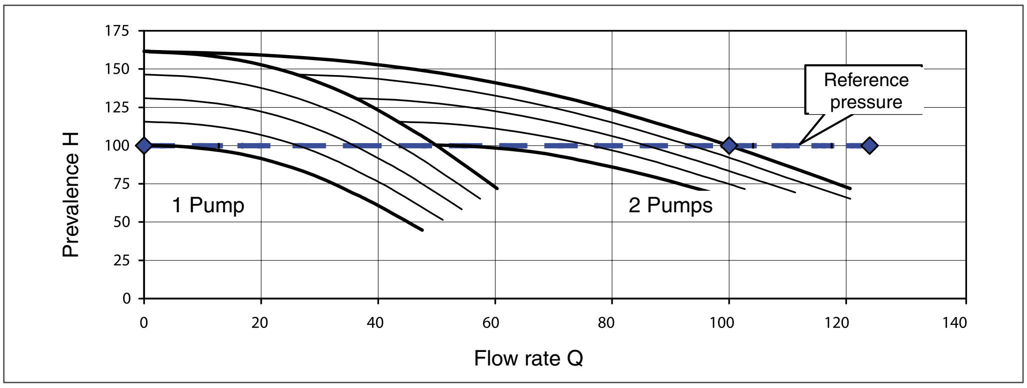
- lifting or moving water
- air conditioning
- heating
- irrigation
- washing systems

The pumped liquid may be clean water, drinking water, rainwater, groundwater, mixed water, or in any case free of solid bodies or suspended fibres and free of aggressive chemical substances. The units must be installed in a covered place and protected from bad weather and freezing temperatures.

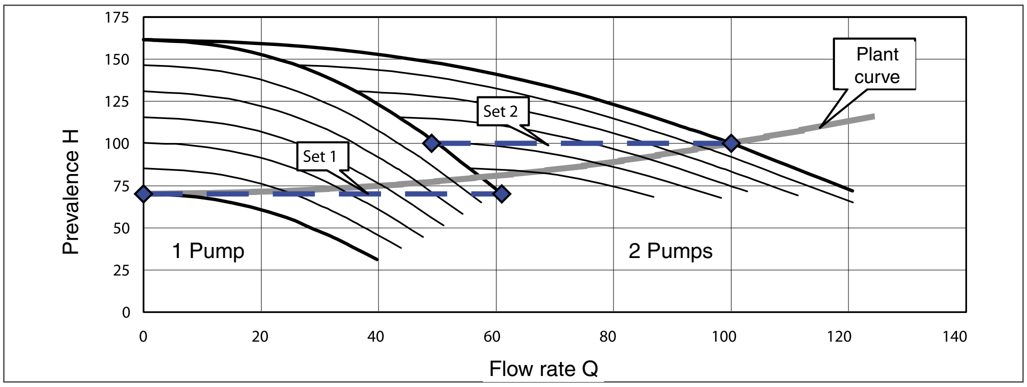
- The temperature of the pumped water must respect the limits of the pump in question.
- The ambient operating temperature is 0°-40°C at a maximum altitude of 1000m above seal level.
- Maximum relative humidity 50% at +40°C.

N.B. It is useful to remember that the intake height (negative suction head installation) falls as the altitude and temperature increase. These characteristics, on the basis of the pump NPSH (see page 54), must be taken into consideration when sizing a system in order to avoid cavitation or insufficient productivity: the system NPSH available must be greater than the NPSH requested by the pump. For applications with different technical characteristics, types of use or weather conditions (type of liquid pumped, marine environment, aggressive industrial applications), contact our sales network.

### 2-PUMP UNIT WITH CONSTANT PRESSURE ADJUSTMENT




### 2-PUMP UNIT WITH PRESSURE ADJUSTMENT BASED ON TWO SETTINGS



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## GP-GPE PRESSURE BOOSTER SETS

### CONDITIONS OF USE

The pressure booster sets are supplied complete with:

- electric pumps
- a pressure gauge
- a pressure transducer or pressure switches (depending on the model)
- intake and delivery manifolds
- shut-off valves on intake and delivery
- check valves on the intake side for fixed speed GP units, and on the delivery side for variable speed GPE units
- miscellaneous fittings
- a control panel or device
- a single base
- anti-vibration supports (not on all sizes)

### GENERAL TESTS AND ACCEPTANCE TESTS

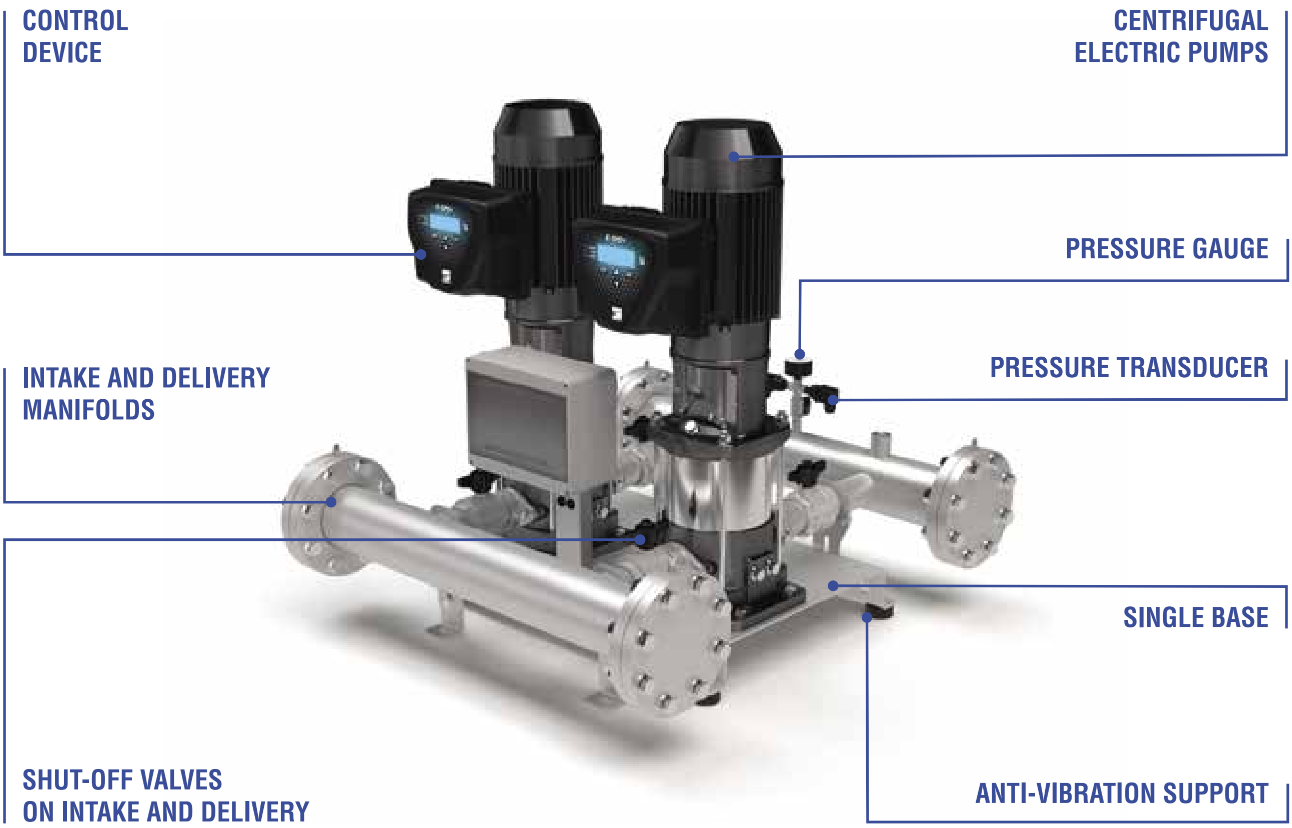
All EBARA pressure booster sets are subjected to hydraulic, mechanical and electrical tests before being packaged.

### HYDRAULIC AND MECHANICAL TESTS

- Calibration of pressure switches (if fitted)
- Check of pump rotation direction
- Mechanical testing of moving parts, and noise check (on each pump)
- Seal test with delivery inlet closed, and check of rated head value
- Operating test in MANUAL mode (using the button on the electric panel) for each single pump
- Operating test in AUTOMATIC mode (using the switch on the electric panel) for the unit

### ELECTRIC TESTS

- Earth circuit continuity check
- Test with applied voltage
- Insulation resistance test



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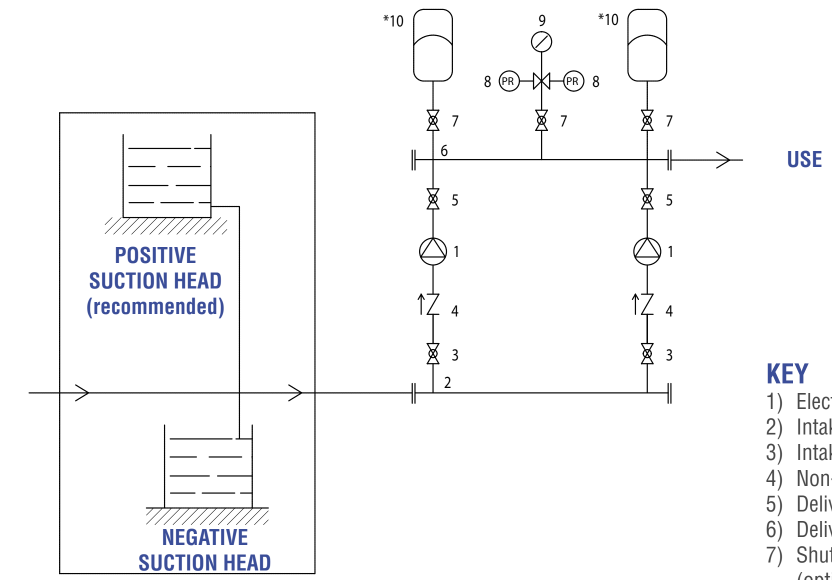
## GP-GPE PRESSURE BOOSTER SETS

### HYDRAULIC LAYOUT OF THE FIXED SPEED GP PRESSURE BOOSTER SET

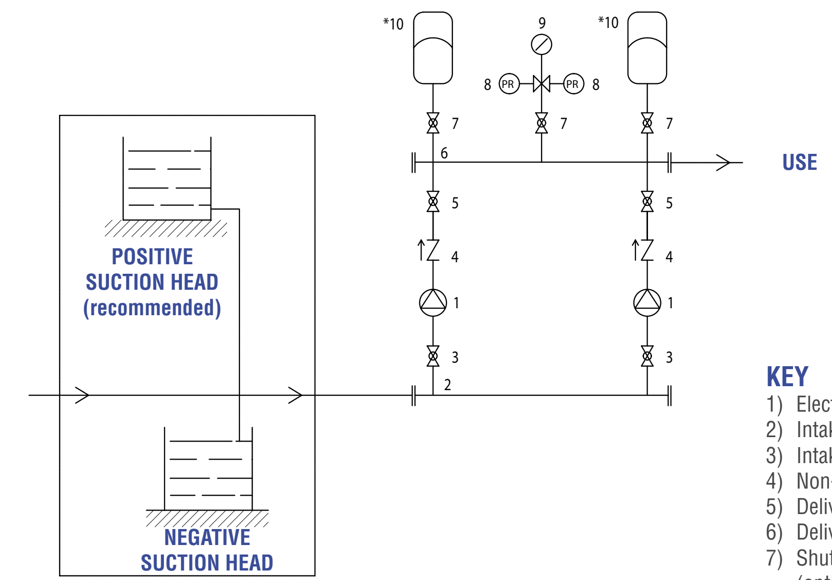



SUPPLY SYSTEM UPSTREAM OF THE UNIT
AT THE DISCRETION OF THE CUSTOMER
OR SYSTEM DESIGNER

**KEY**

1) Electric pump
2) Intake manifold
3) Intake shut-off valve
4) Non-return valve
5) Delivery shut-off valve
6) Delivery manifold
7) Shut-off valve for expansion tank installation (optional)
8) Pressure switches for pump command/regulation
9) Pressure gauge
10) Membrane expansion tank (optional)

### HYDRAULIC LAYOUT OF THE VARIABLE SPEED GPE PRESSURE BOOSTER SET




SUPPLY SYSTEM UPSTREAM OF THE UNIT
AT THE DISCRETION OF THE CUSTOMER
OR SYSTEM DESIGNER

**KEY**

1) Electric pump
2) Intake manifold
3) Intake shut-off valve
4) Non-return valve
5) Delivery shut-off valve
6) Delivery manifold
7) Shut-off valve for expansion tank installation (optional)
8) Pressure switches for pump command/regulation
9) Pressure gauge
10) Membrane expansion tank (optional)

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### CHOOSING A PRESSURE BOOSTER SET

a. When choosing the unit, take into account the maximum flow rate (Q) and head (H) values that the water system will require during operation, especially in the most highly penalised point of use.
b. To avoid operation outside the performance curve, and purchase and running costs higher than expected, the pressure booster set must not be oversized.
c. When sizing the system and choosing the unit, apply the basic criteria of economics and energy savings (e.g. water consumption, usage time, electricity).
d. The unit operating point at the maximum flow rate envisaged must not correspond to its maximum productivity point; it must be further to the right so that, in normal operating conditions (at a lower flow rate), the productivity is still high.
e. To avoid cavitation, it is advisable to make sure that the unit operating point at the maximum flow rate is not in the area where the NPSH bend increases rapidly, or outside that area.

### NPSH (NET POSITIVE SUCTION HEAD)

A pump installed above the surface of the water can “suck in” the water using the effect of the atmospheric pressure on the surface itself; this pressure corresponds to approximately 10 m of water column. This means that, however great the intake capacity of a pump, the height from which it can suck in water is always limited to 10 m. In reality however, the limit is lower than this owing to the pressure drop in the intake tube, the kinematic height of the current, and the dynamic effect of the pump impeller. Attempting to take in water beyond these limits will give rise to the phenomenon of cavitation in the pump, which not only seriously damages the pump components but also prevents any increase in the flow rate.
Cavitation involves the sudden formation and collapse of cavities, formed mainly of vapour, during the flow of a liquid. These cavities build up in areas where, at the operating temperature, the pressure of the liquid is close to the vapour pressure at that temperature. In the case of centrifugal pumps, the phenomenon occurs mainly at the point of entry of the impeller blades, where the sudden acceleration of the current reduces the pressure level. The vapour cavities that form are transported by the flow and then implode in the areas where the pressure of the liquid rises again. The implosion of the vapour bubbles is accompanied by a pressure wave that creates a shock or hammering effect on the surfaces involved. This can produce phenomena of fatigue and plastic deformation, and the removal of material from the surface. The effect may be speeded up by the corrosive action of the fluid processed by the pump.

To characterise the behaviour of a pump in the case of cavitation, the NPSH (Net Positive Suction Head) value is determined. It represents the height, or absolute load (net of the liquid vapour tension) that must be present during pump intake in order to avoid cavitation.

It is immediately clear how important it is to make sure that the net absolute height available in the system (available NPSH) is greater (by at least 1m) than that requested by the pump. The available NPSH is calculated with the formula:

$$NPSH = z_1 + \frac{p_0}{\gamma} - Hr_1 + \frac{p_b - p_v}{\gamma}$$

Where:

$z_1$ = level difference (in m) between the axle of the pump intake point and the surface of the liquid in the supply tank, and which will be: **negative** in the case of operation under the head, or **positive** with operation above the head

$p_0$ = any possible relative pressure (in Pa) on the surface of the liquid in the supply tank. If the intake is from an “open” tank (i.e. in contact with the atmosphere), $p_0$ is equal to 0

$\gamma$ = the specific weight of the liquid (in $N/m^3$) at the pumping temperature

$Hr_1$ = pressure drops (in m) on the whole intake duct

$p_b$ = barometric pressure (in Pa) in the system where the pump is installed

$p_v$ = vapour tension (in Pa) of the liquid at the pumping temperature

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**Reduction of the level difference during intake, with variations in the temperature of the water**

| Temperature °C | Intake drops in metres (kt) |
|---|---|
| 25 | 0 |
| 30 | 0.4 |
| 40 | 0.8 |
| 50 | 1.3 |
| 60 | 2.0 |
| 70 | 3.2 |
| 80 | 4.8 |
| 90 | 7.1 |

**Reduction of the level difference during intake, based on the position above sea level**

| Position m | Intake drops in metres (kt) |
|---|---|
| 0 | 0 |
| 500 | 0.55 |
| 1000 | 1.1 |
| 1500 | 1.65 |
| 2000 | 2.2 |
| 2500 | 2.75 |
| 3000 | 3.3 |

### DETERMINING THE FLOW RATE (Q)

This is the amount of fluid that passes through a cross-section with area “A” within the set time. The first data item to be calculated when sizing a pressure booster set is the total quantity of water that must be supplied in order to meet the maximum theoretical need (i.e. the total of the water consumption values in each supply point).

The table shows the maximum simultaneous water flow rate values per number of flats with 1 or 2 toilets with cisterns.

| No. of flats | Toilets with cisterns | |
|---|---|---|
| | 1 | 2 |
| | Flow rate [l/min] | Flow rate [l/min] |
| 1 | 30 | 40 |
| 2 | 40 | 55 |
| 3 | 52 | 65 |
| 4 | 60 | 75 |
| 5 | 70 | 85 |
| 6 | 75 | 90 |
| 7 | 80 | 100 |
| 8 | 85 | 110 |
| 9 | 90 | 115 |
| 10 | 95 | 120 |
| 11 | 100 | 130 |
| 12 | 105 | 135 |
| 13 | 110 | 140 |
| 14 | 115 | 145 |
| 15 | 120 | 150 |
| 16 | 125 | 155 |
| 17 | 130 | 160 |
| 18 | 135 | 165 |
| 19 | 140 | 170 |
| 20 | 145 | 175 |
| 22 | 150 | 180 |
| 24 | 155 | 185 |
| 26 | 160 | 190 |
| 28 | 165 | 195 |
| 30 | 170 | 200 |
| 32 | 175 | 205 |
| 34 | 180 | 210 |
| 36 | 185 | 220 |
| 38 | 190 | 230 |
| 40 | 195 | 240 |
| 45 | 205 | 260 |
| 50 | 215 | 270 |
| 55 | 225 | 280 |
| 60 | 235 | 290 |
| 65 | 245 | 300 |
| 70 | 255 | 310 |
| 75 | 265 | 320 |
| 80 | 275 | 330 |
| 85 | 280 | 340 |
| 90 | 285 | 350 |
| 95 | 290 | 360 |
| 100 | 300 | 380 |
| 110 | 315 | 400 |
| 120 | 330 | 420 |
| 130 | 345 | 440 |
| 140 | 360 | 460 |
| 150 | 375 | 480 |
| 160 | 390 | 500 |
| 170 | 405 | 520 |
| 180 | 420 | 540 |
| 190 | 435 | 560 |
| 200 | 450 | 580 |
| 220 | 465 | 600 |
| 240 | 480 | 620 |
| 260 | 495 | 640 |
| 280 | 510 | 660 |
| 300 | 525 | 680 |
| 320 | 540 | 700 |
| 340 | 555 | 720 |
| 360 | 570 | 740 |
| 380 | 585 | 760 |
| 400 | 600 | 780 |

NB: in the case of seaside areas, the flow rate is 20% higher

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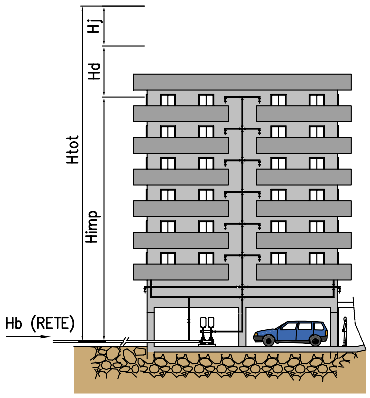
## GP-GPE PRESSURE BOOSTER SETS

### DETERMINING THE HEAD (H)

The head is the maximum lifting level difference (in relation to the point where a fluid is picked up) to which a pump can push that fluid.
It includes the level difference between the pump and the extraction basin (if the latter is at a lower level), plus the level difference between the pump and the destination basin higher up. The path followed by the tubes has no effect on the level difference that can be travelled, as this depends entirely on the difference in the piezometric position between the intake liquid surface and the depositing one. The head is commonly expressed as metres of water. Pump head is the energy - per unit of weight - applied to the fluid by the pump. In a closed circuit, the head is used to overcome the pressure drops in the circuit, caused by friction.




$$H_{tot} = H_{imp} + H_d + H_j$$

**Example:** $H_{imp} = 20$
$H_d = 15$
$H_j = 2$
$H_{tot} = 20 + 15 + 2 = 37$

$H_{imp}$ = geodetic height from the pump intake axle to the highest service point
$H_d$ = geodetic height at the minimum pressure required at the highest service point
$H_j$ = total of the continuous and localised pressure drops

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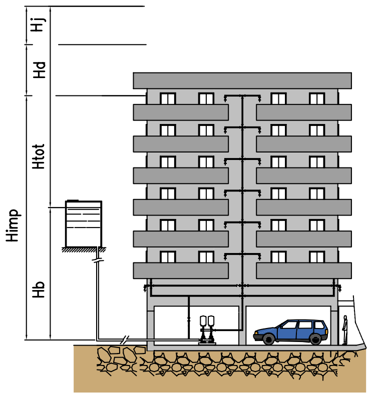
POSITIVE SUCTION HEAD




$$H_{tot} = H_{imp} - H_b + H_d + H_j$$

**Example::** $H_{imp} = 20$
$H_b = 15$
$H_d = 15$
$H_j = 2$
$H_{tot} = 20 - 15 + 15 + 2 = 22$

$H_{imp}$ = geodetic height from the pump intake axle to the highest service point
$H_b$ = geodetic height under head, or height corresponding to the minimum mains water pressure
$H_d$ = geodetic height at the minimum pressure required at the highest service point
$H_j$ = total of the continuous and localised pressure drops

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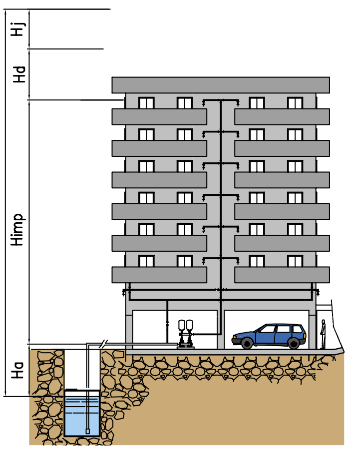
NEGATIVE SUCTION HEAD




$$H_{tot} = H_{imp} + H_a + H_d + H_j$$

**Example:** $H_{imp} = 20$
$H_a = 5$
$H_d = 15$
$H_j = 2$
$H_{tot} = 20 + 5 + 15 + 2 = 42$

$H_{imp}$ = geodetic height from the pump intake axle to the highest service point
$H_a$ = geodetic height above head
$H_d$ = geodetic height at the minimum pressure required at the highest service point
$H_j$ = total of the continuous and localised pressure drops