Sales guide for Grundfos booster systems in water applications
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Preface

Packaged pump systems
Packaged pump systems are gaining popularity because they have benefits such as space saving design, simplified installation, a single source responsibility and advanced control options with communication ability.

The term “packaged” means that all the components needed for the pump system are mounted on a skid or base. With a packaged system, all components are in place and mounted on a skid, simplifying the installation. In many cases, the installation consists of connecting the system to the suction and discharge piping, and providing power to the packaged pump system.

Introduction
This is the first edition of the Booster Sales Guide. The purpose of the guide is to meet the requirements of different applications through the highest quality, most efficient and best supported booster system available on the market.

The document provides a quick overview of the Grundfos Booster Program. The strengths of each product are described and a short description of its functions is included. Most common booster applications are described to give an idea of the challenges the customer faces and an answer to how Grundfos solves them.
Grundfos is one of the world’s leading manufacturers of pumps and pump systems and was the first company ever to develop a multistage in-line centrifugal pump. The present-day CR pump series remains second to none in terms of efficiency, reliability and long-term operation costs.

These superior product features also characterize the Grundfos range of hydro boosters and contribute to making Grundfos boosters unrivalled on the market, both for commercial building projects and industrial applications.

Manufactured in USA
All the vital parts in a Grundfos Booster are designed and built by Grundfos. They have thus been combined with focus on quality and easy access to all service parts. Grundfos booster systems are manufactured in the USA in a ISO 9001 certified factory ensuring quality and short lead time.

Booster System Tests
Grundfos’ manufactured booster systems are tested as complete package pump systems before they leave the factory, to ensure the systems are ready for installation. These tests include a hydrostatic test to check for possible leaks in the system and a performance or functionality test to determine that the systems will operate correctly when installed. This will minimize the amount of common problems associated with built-up pump installations, which are not testable as complete systems until time of commissioning. All Grundfos boosters are certified and listed by UL (Category QCZJ – Packaged Pumping Systems) for conformance to U.S. and Canadian Standards. Grundfos booster systems have the California Low Lead certification approval, (AB1953), and are pending approval for NSF61 Annex G, (expected February 2011)

Grundfos boosters thereby offer superior reliability and minimum downtime. And if something does go wrong... our worldwide Sales and Service Staff is ready to help and assist you.

World leading manufacturer of pumps and systems!
CR pump is the bench mark of all other multistage pumps.
Decades of know-how
All vital components designed and produced by Grundfos!
Manufactured in the US
Short lead time
Worldwide service organization!
UL listed
Manifolds – Hygiene

**Material**
One of the key components in any booster is its manifold. Grundfos manifolds is made of 316TI stainless steel as standard. By using the 316TI as standard, we ensure that Grundfos booster sets live up to the highest quality standards in terms of endurance and hygiene.

**Craftsmanship**
Choosing the right material is not the only thing to consider when looking for quality in a manifold. Craftsmanship is just as important. Poorly manufactured manifolds pose a hygienic risk due to cavities and areas where water can stagnate. Grundfos manifolds are manufactured in a superior way, which creates a perfect product with smoothened edges and without cavities or dead corners.

This way of production gives the optimal flow in the manifolds and ensures that no water stagnates. Grundfos have tested the construction to determine that no water is stagnating in the manifolds, giving Grundfos boosters a clear hygienic advantage over other products on the market.

**Fig 1; Superior manufacturing method that leaves a perfect result!**

**Fig 2; Hydraulic test of the flow in manifolds showing that no water stagnates in the manifolds.**
Deciding on a Grundfos Pressure-Boosting system, is deciding to conserve water, energy, and other precious resources.

Sustainability
Sustainability has long been crucial to our developments, and we continue to pioneer innovative designs that support sustainability. On average, power consumption accounts for 85% of all costs incurred during a pump’s life span – nine times more than the initial purchase price and regular maintenance costs. Even the smallest improvement in efficiency can therefore generate sizeable savings.

The Hydro MPC
The Grundfos Hydro MPC booster system is based on the world-renowned CR-range of multistage centrifugal pumps. Grundfos was the first to develop this pump type, almost four decades ago, and the latest generation of the CR-range remains an unchallenged frontrunner in the world today. The outstanding reliability and efficiency of the CR-pumps provide the best possible base for our booster systems. For pressure boosting some pump-types are more suitable than others. Single impeller pumps typically have a flatter curve compared to the multiple impeller pumps, and are less forgiving in situations, where conditions change and the pumps become undersized.

In Changing Conditions
An oversized pump with VFD control can be electronically “trimmed”, where maximum speed is reduced to eliminate the risk of the pump running off its curve. The steeper curve of a multiple impeller pump will increase the chance of speed reduction at lower flows and allow the pump to adapt immediately to fluctuations in pressure requirements. In addition to the improved flexibility, multistage pumps are generally also more energy efficient than single stage pumps.

The ideal choice
The Grundfos CR multistage pump with VFD control is an ideal choice for variable flow pressure boosting. The CRE pumps are CR pumps with Grundfos’ integrated variable frequency drive motors that are specially designed for pump operation. This results in complete control, optimized flexibility of the booster output and unbeatable efficiency at all times. The E-motor’s built-in frequency converter is designed to get as much as possible out of every kWh. It thereby only consumes the energy amount that corresponds with the actual water demand.

This makes the CRE ideal for pressure boosting in almost any application, where the demand fluctuates during the day. Variable flow consumption means that the maximum required flow is only needed a few hours each day. The savings gained by following the demand and reducing speed in the low-flow periods are vast!!

Efficiency

High efficiency!
Minimizing costs of ownership!
Steep pump curve gives more flexibility!
Built in VFD!
Perfect adaption to demand with intelligent CRE-pumps!
Grundfos Booster Overview

Hydro Multi-E

Boosterpaq

CRE Plus
The BoosterpaQ® Hydro MPC is our most complete pressure boosting system. The system features all the relevant functions for a perfect choice in pressure boosting and many other pumping applications.

The BoosterpaQ is available in three different control layouts as standard:

**BoosterpaQ® Hydro MPC E**
2 – 6 CR pumps with either integrated or external variable frequency drive on each pump.
- Ideal for applications with large flow-fluctuations. (i.e. industrial, commercial building, and HVAC)

**BoosterpaQ® Hydro MPC F**
2 – 6 CR pumps with one common frequency drive that alternates between the pumps.
- Ideal for applications with medium flow-fluctuations. (i.e. municipal supply)

**BoosterpaQ® Hydro MPC S**
2 – 6 CR pumps connected directly to the mains.
- Maintains a pressure range by cutting the required number of pumps. (i.e. tank filling/water transfer)
Being able to monitor or even control the booster remotely is an important feature in many applications. The MPC’s digital input and output capability can be expanded to meet many requirements. The available SCADA bus protocols for integrating the controls into a building management system include the following options:

- Profibus
- Modbus
- LON
- BACnet
- GSM
- Grundfos Remote Management!
- Ethernet standard on controller!

Remote management
Beside these communication possibilities, the new Grundfos Remote Management is also available. Grundfos Remote Management is an internet-based remote management and reporting system. All your pumps and controllers are connected to your PC via a central server. You get a unique overview of all the many pump installations in your system, if you have outgrown mobile phone based monitoring.

The on-call schedule provides efficient alarm management. This new telemetry system ensures that alarms on onsite controllers go directly to the relevant people. From a PC anywhere, the system manager can log on and plan who may receive alarm messages from each installation at any given time of day. Managers can plan years ahead and easily handle daily exceptions to the schedule.

Track through graphs
Optimize service as maintenance needing changes in pump performance can be tracked using trend graphs automatically generated by the system. This can give an indication of wear and tear or damage in the installation and service and maintenance can be planned accordingly.

Ethernet Connection Possible
As standard, the MPC comes with Ethernet connection possibility. Ethernet is a networking standard derived from information technologies. It is the most popular and widest deployed network technology in the world. The Ethernet solution lets you easily import the booster interface to your PC screen, either by connecting it directly or by defining an IP address for the BoosterpaQ and logging on via the internet.
The BoosterpaQ®
Easy operation

The BoosterpaQ features the most advanced multi-pump controller in the market. It is also one of the most intuitive and easy to operate.

The start-up wizard guides you through the commissioning of the booster set, ensuring that the most relevant parameters are set up.

The ten buttons lights up whenever they are active so that you are never in doubt of where to press.

The controller “talks” to you in clear explanatory text.

By pressing the help button the controller explains the options in every menu.

The large backlit display offers great overview of the system and with the menu bar at the top of the screen it is easy to navigate between the four main menus.

Fig. 8: Wizard-guided start up
The BoosterpaQ®
CU351

The brain of the BoosterpaQ is the CU351 Multi Pump Controller (MPC). This control unit features lots of functionality, making it the most advanced controller on the market.

Low flow stop function
The BoosterpaQ regularly checks whether it is possible to stop the last running pump in the system. The pumps thus only run on demand. If the flow is low, it is more energy efficient to run start/stop control than actual speed control. The system therefore changes to start/stop mode until the flow increases again. This function can be activated in four different stop-parameter modes:

• Energy saving (factory setting)
• Medium flow
• Highest comfort level
• Customized.

Optimal number of pumps running
The way of determining how many pumps should be running is very unique in the BoosterpaQ. The 5-point pump curve in the controller ensures that the system can determine the flow rate very precisely. The curves also make it possible to calculate the optimal start speed of the pumps. It can therefore stop or start an extra pump, while being as energy effective as possible.

Discharge Pressure
The discharge pressure needed in pressure boosting is normally based on calculation of the pressure loss in the pipes, and the minimum required pressure in critical points of the system. To ensure the minimum pressure is used in these points, the calculations are normally made on data from high-flow situations where the pressure loss in the pipes is high. Therefore, in low-flow situations the calculated set-point might be unnecessarily high. As such, the system consumes unnecessary energy.

Proportional Pressure Function
The proportional pressure function makes the BoosterpaQ able to adjust to the previously mentioned low-flow situations. Here, it lowers the discharge set-point, without the pressure in the critical points of the system dropping below what is required. Furthermore, the possibility of lowering the pressure in low-flow situations also impacts the amount of non-revenue water. The lower pressure decreases the leakage from old and worn-out pipes, ensuring that more water reaches the recipient and less is lost.

Alternation
The BoosterpaQ® automatically switches between the pumps to ensure that running hours are the same on all pumps. Once a day, the system checks if any stopped pump(s) have fewer running hours than the running pump(s), switching between them if that is the case. The wear of the pumps is therefore equalized and service needs are prolonged. Standby pumps are also included in the variations, ensuring that a pump is not stopped for weeks, avoiding the risk of clogging up due to sediments in the water.

Redundant Sensors
In order to increase reliability, a redundant primary sensor can be connected as backup sensor. With the redundant sensor installed, the CU351 monitors both sensors, and in case of dissimilarity between the outputs of the sensors, the CU351 displays a warning. If a fault is registered on a sensor (i.e. the sensor output is out of range) the CU351 automatically switches to the other sensor.

If all sensors fail, the MPC offers a “second redundancy”, namely the possibility of making the CU351 perform different actions in this event. If set up, the pumps will operate at a user-defined speed ensuring some water flow.

Standby Pumps
The number of pumps that operate as standby pumps can easily be defined in the setup menu. In case of pump failure, the “Standby Pump Function” of the CU351 ensures that one of the standby pumps automatically takes over. To allow this, the system must incorporate some overcapacity in the design, making one or more pumps obsolete at normal operating conditions. You can choose as many as five standby pumps in a six-pump booster. The status of standby pumps shifts, as previously mentioned, between all pumps ensuring that running hours are distributed equally between them.

Min / Max Pressure Limits
Limits can be set to activate alarm or issue a warning if the pressure exceeds normal operating values.

Minimum Pressure
A minimum pressure value can be set to activate alarm or issue a warning if the pressure drops below a defined value. This function can be used in some applications to detect whether the piping is broken or if normally closed valves have opened. This can save the customer a lot of money which could have been used on lost water, flood damage and wasted energy.
Different Set-points
12 different set-points can be set in the controller. 6 for closed loop operation (pumps controlled by feedback from a sensor) and 6 for open loop operation (pump speed controlled from MPC without feedback). Via digital inputs it is possible to switch between these alternative set-points.

Set-point influence
If an external parameter has influence on the desired discharge pressure, one of the analog inputs can be used to adjust according to it. The function influences the set-point in the controller depending on the value of the defined analogue input.

Pump test run
In order to exercise and test non-operational pumps, the function Pump Test Run can be used. It is especially useful in applications where the pumps are in stand still for longer periods of time (i.e. in emergency boosting).

Clock program
Up to 10 time-controlled events can be set up in the controller. This means that the customer is able to set up wanted pressure depending on time of day or day of week. This is especially used in irrigation applications, where the system can be set to irrigate at specific intervals each day. In other applications where the pressure can be lowered in defined intervals, this function can save lots of money for the customer (i.e. in a mall where the pressure is not needed during closing hours).

Soft Pressure Build-Up
This function is designed to avoid water hammer and pipe bursts during the filling of empty pipes. When the function is activated, the BoosterpaQ starts up in a predefined speed, running at it until the pipes are full and the actual pressure build-up can begin.

Soft pressure build-up can be used in all applications where the electrical supply is irregular, and the system falls out from time to time. While the power is out, the water might drain from the piping. When the system then starts up again, it is important to fill the piping slowly to avoid damage. It is also commonly used in irrigation applications where it is normal to start up on empty pipes.

Operation Modes
The MPC operates in 6 modes. Switching between these is easy from the menu or via digital input:
1. Normal - The booster set adapts its performance to the requirement, running in a closed loop (pumps are controlled by discharge pressure).
2. Max. - The pumps run at a constant high speed, running in an open loop (pump speed is controlled as MPC ignoring sensor feedback).
3. User-defined - The pumps run at a constant speed set by the user. Usually it is a running somewhere between max. and min.
4. Min. - The pumps run at a constant low speed in an open loop. Normally one pump is running solo at a speed of 70%.
5. Stop - All pumps have been stopped.
6. Emergency run - This operation mode is designed for situations where water supply cannot be interrupted. The pumps will run at a predefined speed or set-point ignoring warnings and alarms.

Pilot Pump
The Pilot Pump is used in situations where the demand fluctuates extensively and where there are long periods with very low flow. However, by choosing the right diaphragm tank along with CRE pumps, this is made redundant.

Pump Outside Duty Range
This function issues a warning if the duty point of the pumps moves out of the defined range. This can, for instance, happen if the inlet pressure becomes lower than a minimum permissible value, thus causing a risk of cavitations for some pump types. The warning is given with a set time delay. It is possible to choose whether the warning is to be reset automatically or manually, when the duty point comes within the defined duty range. It is also possible to set a relay output to be activated when the warning is given, and deactivated when the warning is reset.

Dry Run Protection
The BoosterpaQ features a function for dry run protection. This can either function through means of a float switch, analogue level measurement in the supply tank or a pressure transmitter located in the suction manifold.

Pressure Relieve Valve
If the piping pressure, for some reason, has a tendency of becoming too high, it is possible to make the BoosterpaQ control a solenoid valve. If the system pressure exceeds a predefined set-point, the valve opens and lets out the excessive pressure/water.

Pi-Controller
The Pi-controller determines how the system reacts to changes in system pressure. The values are from factory configured for pressure boosting in general, but they can be changed if faster reaction is needed (i.e. in fast industrial applications).
The Multi-E combines 2-4 parallel mounted Grundfos CRE variable-speed pumps that carry the status of providing the ultimate in efficiency and reliability for increased energy savings and comfort. It is designed for commercial building supply and features the functions normally used for this application.

**Simple and Ready to Plug and Pump!**
The Multi-E is the ultimate plug and pump solution for commercial building services. Like all Grundfos booster-sets, the Multi-E arrives tested and ready to install. The initial set up is so quick and easy that the system is operational within a few minutes. The setting of the unit can either be done by the panel on the pump or via the R100 inferred remote controller. The simple program with few options makes it very easy to operate.

**Communication**
The Multi-E system is able to communicate with all standard BMS (building management systems).

**Possible communication interfaces:**
- Profibus
- Modbus
- LON
- BACnet
- GSM
- GRM (See description under BoosterpaQ section)

**Monitoring**
The Multi-E supplies the operator with information that can be valuable in the daily operation and maintenance of the system.

The R100 remote control can list the following:
- The total speed of the pumps.
- The actual power consumption along with the total lifetime consumed power.
- The running hours of each pump.

**Controlling the Multi-E**
The Multi-E can either be controlled by means of the R100 remote control that via IR lets the operator comfortably adjust the parameters of the system, or from the front panel of the first pump. The first pump has a simple two-button control panel and a display indicating the system set-point and warnings and alarms.
Functions
The Multi-E has fewer functions than the BoosterpaQ, but still features the most important functions for commercial building service.

Alternation
The Multi-E automatically changes between the pumps to ensure that running hours are the same on all pumps. This practically means that it always starts the pump with the fewest running hours first. Once a day, the system compares the running hours and alternates if necessary. In that way the wear of the pumps are equalized and time between services is prolonged.

Low-flow detection
The purpose of the stop function is to stop the Hydro Multi-E at very low-flow situations in order to avoid unnecessary power consumption. The function is only active when one pump is operating.

The low-flow detection is carried out by means of the built-in “low-flow detector”. The Hydro Multi-E will check the flow regularly by reducing the speed for a short period of time, thus checking the change in pressure. If there is no or a small change in pressure, the Hydro Multi-E will detect a low-flow.

Low-flow Stop
When the Hydro Multi-E detects a low flow, the speed will be increased until the stop pressure (actual set-point + 0.5 x ΔH) has been reached and the Hydro Multi-E stops. When the pressure has fallen to the start pressure (actual set-point – 0.5 x ΔH), the Hydro Multi-E will restart.

Operation Modes
The Multi-E operates with 3 modes that can easily be switched between from the R100.
1. Normal - The booster set adapts its performance to requirement, running in a closed loop (pumps are controlled by discharge pressure).
2. Max. – All pumps are running at 100% speed.
3. Stop – All pumps are stopped.

Cascade control
The Multi-E controls the pumps in cascade and cuts the appropriate number of pumps necessary to supply enough flow.

PI-controller
The PI-controller determines how the system reacts to changes in system pressure. The values are from factory configured for pressure boosting in buildings, but it can be changed if faster reaction is needed.

Dry run protection
The Multi-E features a function for dry-run protection. This can either be by using a float switch or a pressure switch located in the suction manifold.
Like the Multi-E, the CRE PLUS has an integrated variable frequency drive. It consists of a single CRE pump with pressure gauges, pressure sensor, inlet and outlet pipes, check and isolation valves and a low pressure inlet switch for dry-running.

**Functions**
The CRE Plus has almost the same functions as the Multi-E with the exception of pump alteration.

**Communication**
The CRE Plus has following optional communication interfaces:
- Profibus
- Modbus
- LON
- BACnet
- GSM
- GRM (For description, see BoosterpaQ section)

**Low-flow detection**
The purpose of the stop function is to stop the CRE PLUS at very low-flow situations in order to avoid unnecessary power consumption. The built-in “low-flow detection” checks the flow regularly by reducing the speed for a short period of time, thus checking the change in pressure. If there is no or a small change in pressure, the CRE PLUS will detect a low-flow.

**Low-flow stop**
When the CRE PLUS detects low-flow, the speed will be increased until the stop pressure (actual set-point + 0.5 x ΔH) is reached and the CRE PLUS stops. When the pressure has fallen to the start pressure (actual set-point – 0.5 x ΔH), the CRE PLUS will restart.

**Operation Modes**
The CRE operates with 3 modes that can easily be switched between from the R100 or the panel on the motor:
1. Normal – The booster set adapts its performance to requirement, running in a closed loop (pumps are controlled by discharge pressure).
2. Max. – Pumps are running at 100% speed.
3. Stop – All pumps are stopped.

**PI controller**
The PI-controller determines how the system reacts to changes in system pressure. The values are from factory configured for pressure boosting in buildings, it can be changed if faster reaction is needed.

**Dry-run protection**
The CRE PLUS features a function for dry-run protection. This can either be by using a float switch or a pressure switch located in the suction manifold.
In order to fully understand the needs and requirements of different booster applications, it is necessary to have knowledge about consumption profiles and load profiles.

Consumption Profile in Domestic or Commercial Buildings
The consumption profile describes how the demand fluctuates over the course of 24 hours. For many applications, the profile is more or less the same each day, weekends being the exception.

Consumption profiles for systems supplying domestic or commercial buildings are very predictable. This is because people tend to follow certain patterns in their water consumption. For instance, people often use lots of water in the morning (showering, bathroom visits) and less during the day when they are at work. In the late afternoon or in the evening, the consumption rises again when people get home (washing machines, dish washers, cooking).

Consumption Profile in Industry
Other applications have less predictable profiles (i.e. industry). Here, the Grundfos Pump Audit (see Retrofit) may be a good tool for determining the consumption profile. The consumption profile is used to determine which control is needed.

For applications with big or quick variations in flow during the day, speed controlled pumps is the wise choice. For applications with constant flow and steady demand, fixed speed pumps may be as good as the speed controlled solutions.

Load Profile
The Consumption profile can be converted into a load profile. The load profile describes how many hours a day specific flows are needed. This is why speed controlled pumps and packaged systems are the best solutions for pressure boosting. People are often surprised by how few hours of max. performance is needed.
Multi-story buildings

Pressure boosting in multi-storey buildings is necessary whenever the public water supply is inadequate, either because of too low pressure or because of too low flow to supply the building during peak consumption. The objective is to ensure a constant pressure throughout the building.

The profile depends of what the building is used for, but most multi-storey buildings are used for commercial matters. Commercial buildings have quite predictable variations during the day. The Multi-E is normally the perfect choice for this application. It has the capability to follow the fluctuations of demand because of the 2-4 speed controlled pumps, but also the reliability and user-friendliness that is needed for multi-storey buildings.

Application
Whenever water has to be moved from ground-level and upwards in a building, there is always a risk of a pipe bursting due to the pressure. The soft pressure build-up function in the MPC protects the piping during start-up of the system, and provides the user with protection from costly flooding.

Reliability is a big issue in multi-storey buildings. Many people depend on the water from the booster system. This is why many multi-storey installations have standby pumps. The BoosterpaQ has the advantage of switching the standby status between the pumps. This keeps a pump from being stopped for days or weeks, thus preventing it from being seized up from the sediment in water. To further ensure the water supply, a redundant pressure sensor can be installed. It is a very low-cost option, and it can save the building operator a lot of worries.

Characteristics:
- Large variations in flow
- Rather slow changes
- What is important:
  - Reliability
  - Redundancy
  - Constant pressure
  - Adaptable to varying demands
  - Avoiding water hammer and pressure spikes
  - Easy installation and low maintenance

![Consumption Profile](image)

Fig 13: Consumption profile multi-storey building
Piping in multi-story buildings can be made in various ways. When designing the piping, it is always a compromise between initial costs, lifetime cost, user comfort, energy consumption, space requirements and safety of supply. Below, the most commonly used layouts are described:

**Single Booster System**
A water tank placed before the pump system is filled with water from the mains. This allows the capacity of the mains to be lower than the building’s peak demand, ensuring constant pressure even in peak-flow situations. The break tank is filled with water during low consumption periods and ensures uniform water supply to the booster pumps at all times.

**Advantages:**
- Water always “in stock”
- No space required for boosters on upper levels
- Only one (or a few) riser pipe in the building.

**Disadvantages:**
- High static pressure on the booster pump system
- Pressure relief valves have to be fitted
- High operational costs
- High pressure-graded pipes
- Sensitive to electricity fall-outs

**Roof-tank Systems**
Roof tanks ensure both water pressure and water supply in case of power failure. This solution requires pressure reduction valves on each floor, in order to avoid undesired high static pressures at the tap. A static pressure with more than approximately 75 psi at the use point creates unacceptable noise.

In this model, the upper six floors require a separate booster system in order to create sufficient pressure. The static pressure on those floors is too low due to the insufficient geodetic height to the roof tank.

**Advantages:**
- Mature technology
- Only one discharge from booster set to top
- Space saving

Disadvantages:
- Water pumped further than it is required
- Insufficient pressure at uppermost floors
- Excessive pressure on lowest floors
- Pressure reduction valves have to be fitted
- High pressure-graded pipes
- Space required for tank
- Risk of microbiological growth in roof tank
Multi-story buildings

Series connected systems with intermediate break tanks draw on several other systems, utilizing centrally-placed break tanks to supply both the taps in its own boosting zone and all the zones above it. With this system, a building is divided into smaller and more manageable pressure zones of 12 floors each. Every zone is then served by its own booster set. No pressure reduction valves are required, and in case of electrical breakdown the tanks will be able to supply pressure and water for up to 12 hours. However, the tanks take up valuable space within the building, reducing the room available for revenue generation. In case of electrical breakdown, the tanks will be able to supply the building with water for 12 hours.

Advantages:
• Low operational costs
• Reduced load on power grid
• Low pressure in each zone
• Manageable pressure zones
• High system resilience
• Less sensitive to electrical fail-outs
• Low pressure-graded pipes.

Disadvantages:
• High initial investment
• Booster sets and tanks require space on service floors
• Loss of potential revenue-generating space
• Risk of micro-bacterial growth in break tanks.

Series-Connected System
A series-connected system operates on the same principles as the previously described system, but without the intermediate break tanks. This enables an effective usage of power because the water is only pumped up to the zone where it is used and not past it. However, complete control is very important. When a consumer draws water on the upper floors, the booster system must deliver the water from the bottom of the building.

Advantages:
• Low operational costs
• Reduced load on power grid
• No space required for tanks
• Low pressure in each zone
• Manageable pressure zones
• Low pressure-graded pipes.

Fig 16; Series connected system with breaktanks

Fig 17; Series-connected system
Public water supply for a city or a large area is often referred to as municipal water supply. Usually, water is pumped from wells or lakes into large buffer tanks. From here, booster systems are used to move the water through the distributing pipes and to the consumer. In vast areas with elevation changes, several booster units can be placed strategically in the distribution network.

The consumption profile often looks a bit like the profile for domestic and commercial building service. There are peaks in the morning and in the evening, but the flow demand in the middle of the day and at night time varies depending of the composition of the area that is supplied.

Application
Municipal domestic water pump systems tend to have a substantial amount of requirement dedicated to pipe friction loss. Combine VFD pump control and proportional pressure control (pipe friction loss compensation) and large savings can be acquired. Proportional pressure control provides better pressure control throughout the flow range and can help reduce problems associated with too high pressure. Too high pressure can happen when flow rates are low compared to the design conditions.

Non-Revenue Water
The amount of non-revenue water (in network piping leakage) can be drastically reduced through proportional pressure control. The amount of non-revenue water varies from 10% in very efficient systems to 40-50% in older systems. By lowering the pressure in periods of low consumption, the leaking and wearing of pipes is reduced, thus also reducing costs of both energy and maintenance.

Characteristics:
- Large variations in flow
- Rather slow changes
- What is important:
  - Proportional Pressure
  - Soft Pressure Build-up
  - Reliability
  - Redundancy
  - Constant pressure
  - Communication
  - Adaptable to varying demands
  - Easy installation and low maintenance

Communication Systems
In municipal supply, many people are dependent on safe and sufficient water supply. Therefore it is crucial that any faults or breakdowns are addressed as quickly as possible. Many waterworks use SCADA communication systems that Grundfos boosters can easily communicate with, but smaller booster stations might enjoy great benefit with the GSM based GRM system, which Grundfos can deliver.

Standby pumps and redundant sensors are often used in the application as well.
A Grundfos Hydro MPC booster system can help conserve water and optimize crop yields by responding to pre-set minimum and maximum levels. It also automatically adapts the performance to any number of sprinklers at any pressure zone during the irrigation cycle. It is benefits like these which make Grundfos the perfect choice for irrigation systems.

In irrigation applications, the flow is controlled by the operator. The demand goes from nothing to max. instantly. BoosterpaQ is ideal for this application because of its built-in functions that relate to irrigation.

Application
In irrigation applications, the operator more often adjusts and stops and starts the system than in other applications, where the need for adjustments seldom occurs. This, of course, means that the system has to be easy to operate and monitor.

Toro SitePro
The BoosterpaQ can be linked to and integrated in the Toro SitePro, which is a widely used PC program for irrigation management i.e. for golf courses. This allows a site manager (e.g. a green keeper) to perform real-time monitoring of the pump station directly from his office.

With SitePro, it is possible to see the pressure and estimated or measured flow from the pump station, along with status information, such as alarms. If the customer does not have a system for monitoring his irrigation, the GRM system can provide data via GSM directly to the operator’s computer.

Characteristics:
- Variable, but relatively well-known consumption
- Whole system divided into zones
- A lot of pressure build-up in empty pipe net
- What’s Important:
  - Soft Pressure Build-up, Clock Program
  - Easy to operate
  - Integrates to Toro software
  - Automatic detection of pipe bursts
  - Controlled pressure build-up
  - Easy set up pressure zones
  - Communication
  - Service response- and lead-time

The Clock Program
The Clock Program of the BoosterpaQ is used in irrigation as well. This means that the operator can control it all in a weekly schedule, instead of going to the booster to change the set-point.

In irrigation, the pipes are often emptied when not used. Therefore, the soft pressure build-up function is a good solution. When this is enabled, the risk of pipes bursting due to start-up pressure surges is eliminated.

The Minimum Pressure Function
The minimum pressure function is also a valuable function in irrigation. If the main pipe breaks in almost any other application, there is always someone who complains. But when the end users are crops, there is no one to bring the problem to the operators notice. When the minimum pressure is set up correctly, the BoosterpaQ either gives a warning or an alarm goes off, stopping the booster if it is not able to sustain the set-point pressure. This might have indicated a broken pipe or sprinkler.
Retrofit

In water supply, systems with variable flow demand a lot of energy. This can be saved through VFD controlled pump systems. These pump systems use multiple pumps to meet maximum usage conditions and use fewer or even a single pump to meet minimum usage rates.

Energy Consumption
It is possible for existing pump installations to discover what the current pump(s) energy consumption and current demand is, by performing a pump audit on the pumping installation. This information is extremely beneficial because it will determine actual usage rates or the consumption flow profile, and current energy usage that the installation is experiencing during normal operation. Wouldn’t it be nice to have a pump or a pump system that is ideal for the application? Acquiring a flow profile for an existing pumping installation provides the precise data required to design/select the optimal pumping system for the application.

Typical Sizing Systems
New installations typically use plumbing fixture counts and Hunter’s Curves for sizing the pump system as recommended or required by inspectors or local codes. Sizing based on these methods can lead to oversized pumps or pump systems. Additionally, these methods do not address the variable flow requirement for domestic water supply.

Flow Profile
Determining a flow profile, whether it is an estimate or actual empirical data, will greatly enhance the prospect of designing a pump system that will be the most efficient, resulting in the least ownership costs.
Industry covers a whole range of pressure boosting applications.

- **General pressure boosting**
- **Boiler feed & HVAC**
- **Wash and clean**
- **Pressure boosting of process liquids**

Depending on which industrial application is used, the consumption profile varies. But commonly, it is applications with big and sudden changes in demand. For this, the BoosterpaQ E system is the best choice because it is able to follow the quick changes in demand, and only delivers the needed pressure or differential pressure in HVAC applications.

**Application**
Reliability is a key factor in industrial applications. Downtime often costs a lot of money, especially if it causes a production stop. Therefore, the boosters are often fitted with both standby pumps and redundant discharge pressure sensors.

**PI-Controller**
The control unit of the BoosterpaQ features a PI-controller which turns the input signal from the pressure transducer into a control signal for the pumps. For quick industrial applications it is possible to adjust the value of this PI-controller to make the BoosterpaQ react immediately to any changes in demand.

**Characteristics:**
- Large variations in flow
- Random and sudden changes
- What’s Important:
  - Reliability (No downtime allowed!)
  - Quick adaption
  - Constant Pressure
  - Easy installation and low maintenance
  - Flexible parameter setup

**Pump Stop Function**
The pump stop function in the BoosterpaQ is by default set up for a time interval designed for commercial boosting. However, due to the much quicker flow changes in industrial applications, this value can be changed to ensure that the pumps stop much quicker, therefore using less energy.

Ramp time can be adjusted as well, and all these adjustable parameters make the BoosterpaQ extremely versatile and flexible, and can be optimized to fit almost any industrial application.
Domestic water supply systems typically have variable flow demands and can save energy through variable frequency drive (VFD) controlled pumps. Pump systems use multiple pumps to meet maximum usage conditions and use fewer or even just a single pump to meet minimum usage rates. This ensures that the pump system is operating efficiently when at the periods of time when the flow is much lower then maximum design flow.

VFD controlled pump systems offer smooth pressure control, low energy consumption, and the greatest flexibility to meet changing design conditions. Multiple pumps can more closely match the required flow through the pumps’ operating efficiency range.

**Typical Sizing Systems**

New installations typically use plumbing fixture counts and Hunter’s Curves for sizing the pump system as recommended or required by inspectors or local codes. Sizing based on these methods can lead to oversized pumps or pump systems. Additionally these methods do not address the variable flow requirement for the domestic water supply.

**Flow Profile**

Determining a flow profile, whether it is an estimate or actual empirical data, will greatly enhance the prospect of designing a pump system that will be the most efficient, resulting in the least ownership costs.
Sizing

When choosing the right pump(s) for pressure boosting, there are things to be considered. Pump selection for variable flow applications is a little different than choosing a pump for a single duty point. Variable flow applications are just as the name describes – delivering variable flow.

BEP
A pump selected for a single duty point is a pump that meets the duty point or very near the best efficiency point (BEP). Pumps are “happiest” when they run near their BEP. They are the most efficient and have the highest life expectancy. But what about variable flow applications?

There is not just one duty point for the pump(s). Instead there is a range of duty points. Selecting pump(s) for variable flow service is more of an art since several considerations has to be taken into account:
- NPSH available
- Possibility of pump system to be oversized or undersized
- What type of pump - single impeller or multiple impeller

Selecting Variable Flow Pumps
When selecting a pump for variable flow service, the duty point used to select the pump should be to the right of the BEP. The BEP is typically near the center of the pump curve, with efficiency dropping as you look to the left and right of the BEP along the pump curve. Selecting a pump to the right of BEP will allow the pump(s) to spend more time within the best efficiency range and with the variable flow demand.

It should still be considered that selecting a pump to the right of BEP, generally puts it in an area of the pump curve where the pump has an increased NPSH requirement. Because of this, not every pump selection for variable flow should be to the right of BEP.

Parallel flow
Pump systems utilize the parallel flow principle. A booster system is a parallel application of pumping, where multiple pumps are connected to a common suction and common discharge manifold. In parallel applications, the flow of each pump will be added together and the head will remain the same, (neglecting system losses).
Sizing

The above curve for the single CR15-3 pump shows that at a flow rate of 100 gpm the pump produces 140 ft of head pressure. If three CR15-3 pumps are connected in parallel, the resulting flow at a head of 140 ft would be 100 + 100 + 100 = 300 gpm. See figure below.

Reversing the parallel flow principle is a method of selecting booster systems manually. The maximum design flow can be divided by the desired number of pumps on the system to determine the size of the multiple identical pumps on the system.

Example:
Design condition 300 gpm @ 140 ft

If the desired number of pumps in the system is three, the individual pumps in the system need to be capable of delivering 300 / 3 = 100 gpm @ 140 ft head (neglecting frictional losses). The individual pump requirement can be used to select the pumps in the system, by selecting the appropriate pump capable of meeting the divided flow requirement. In this example, the individual pump requirement is 100 gpm @ 140 ft which corresponds to a duty point that a CR15-3 pump would meet, as shown in figure 24 above.
Sizing

When pump redundancy is required, an additional pump can be added to the pump system to build in the redundancy. In this example, if an additional fourth pump is added to the system, it would have a quantity of four 33% pumps, giving the system an additional 33% in redundancy.

System Pressure Loss
The total system pressure drop should be calculated to ensure that the pump system is capable of meeting the maximum design condition. A common method in calculating the total system pressure drop requires a hydraulic data book with information on pipe friction pressure loss and various fittings’ pressure loss information.

The total system pressure loss consists of the following:
• Suction manifold losses due to water passing through the manifold with interconnected piping connections.
• Manifold exit loss
• Suction isolation valve loss
• Check valve loss
• Discharge isolation valve loss
• Manifold entry losses due to water passing though the manifold with interconnected piping connections

For more information about calculating total system pressure drop please reference BoosterpaQ Hydro MPC Product Guide (L-BPQ-PG-01).

More information

All relevant information regarding Grundfos Booster Systems can be found on the BoosterpaQ homepage:

www.BoosterpaQ.com

For more information on Grundfos in general visit the homepage:

www.Grundfos.com

From Grundfos.com there is access to webcaps which contain product guides and Installation & Operation guides for all Grundfos pumps and systems.
SEE THE BIGGER PICTURE

Grundfos is a global leader within water handling technology. Our passion is to bring you all the products you require to create and operate pump systems that combine reliability, cost-efficiency – and innovation. Our products are for use in water supply and wastewater infrastructure on any scale.

Grundfos has a full line of products and systems for the intake, treatment and distribution of drinking water and for the transport and treatment of wastewater. We also offer expertise and industry insight that can increase reliability and reduce lifecycle costs for water utilities.

Key product areas include:

- Submersible pumps
- Surface pumps
- Sewage pumps
- Mixers, flowmakers & recirculation pumps
- Pumping stations
- Monitoring & controls
- Dosing & disinfection
- Aeration equipment

Our products are the result of decades of engineering expertise. Supported by a worldwide service network. Visit www.grundfos.com/water-utility for more.

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