



**DESIGN  
ENVELOPE<sup>®</sup>**

## Intelligent Pumps

with cloud-based  
Active Performance  
Management<sup>®</sup>

### SOLUTION OUTLINE



# DESIGN ENVELOPE

## ENGINEERED BEYOND THE OBVIOUS

Design Envelope technology is a demand-based, intelligent control solution that:

Models equipment and system behaviour

Monitors actual system conditions

Dynamically adjusts equipment operation to match system demand



Whether driven by social, environmental or fiscal responsibility, forward-thinking organizations must embrace energy-saving technologies and practices on their path to Net Zero.

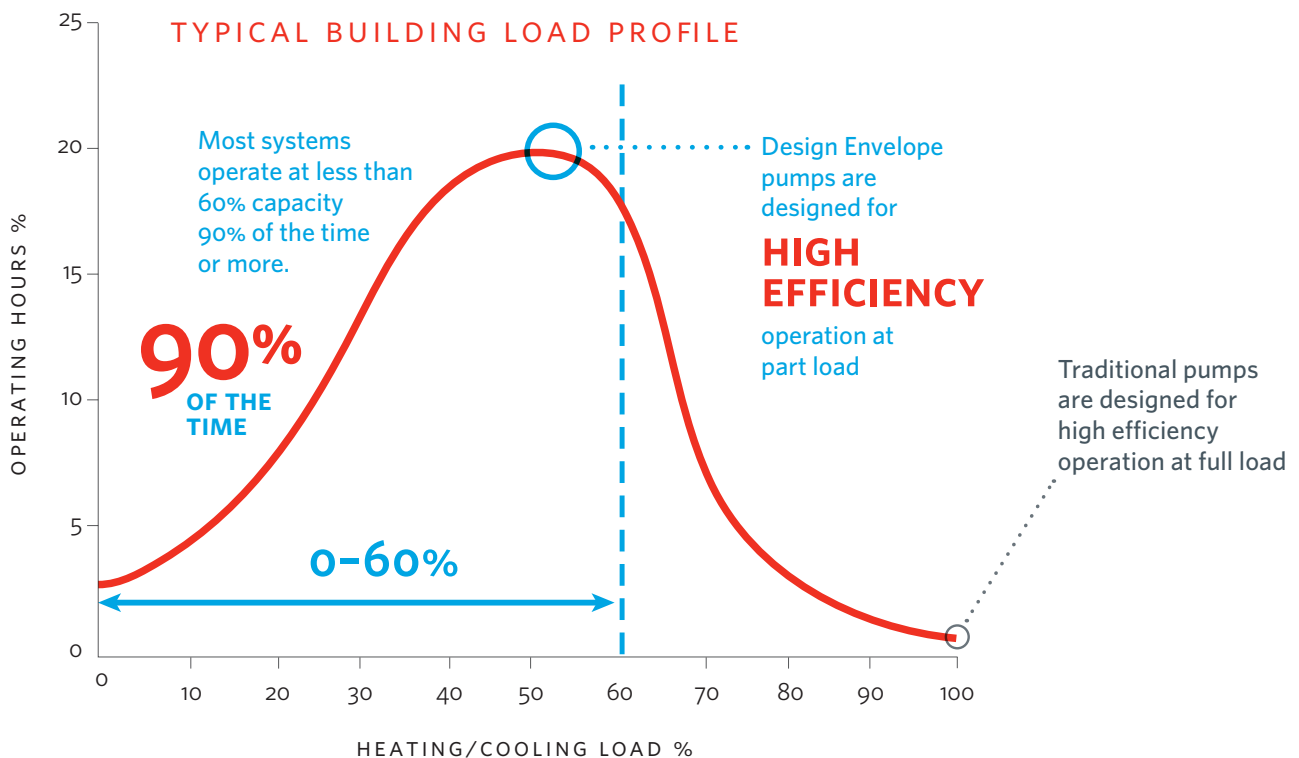


Armstrong Design Envelope pumps are a complete solution for heating, cooling and plumbing systems. The integration of a perfectly matched hydraulics, motive power and intelligent control creates the highest value pumping solution.

# MAXIMUM ENERGY AND COST SAVINGS



- 1 Technology benefits
- 2 How it works
- 3 The solutions
- 4 Armstrong services
- 5 Solution range



## Sizing and selecting for lowest energy consumption

Design Envelope solutions reduce pumping costs through demand-based operation — consuming only the energy required, based on current system demand. Design Envelope pumps use a combination of optimized impeller size, speed control and Active Performance Management for lowest energy use within a given performance envelope. The performance envelopes are selected for

lowest energy consumption where variable flow systems operate most often. This ensures a building's pumping system consumes as little energy as possible. It also helps to ensure that the installation meets or exceeds ASHRAE 90.1 guidelines requiring 70% energy savings at 50% of peak load.

\*Compared to a fixed speed system

# 1

## TECHNOLOGY BENEFITS

### FLOW INFORMS

**T**he rate of fluid flow in an HVAC system is crucial to understanding how the different components are operating. Without information on system flow, it's difficult to diagnose and optimise performance. With accurate flow information, the picture changes entirely. Armstrong can optimise each component and the overall system.

Design Envelope Pumps monitor flow so accurately they function as a flow meter. Industry standards recommend balancing system flows to  $\pm 5\%$  accuracy. Design Envelope pumps deliver accuracy of  $\pm 5\%$ .

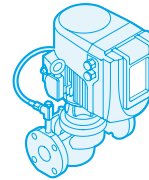
**Highly accurate and reliable:** no issues with fouling, so no need to service or re-calibrate.

**Low installation cost:** easy installation for retrofits.

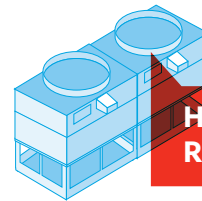
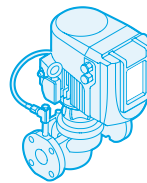
**Integral to pump:** no additional space or wiring required.

**Energy savings:** accurate flow data informs optimisation of an entire HVAC system.

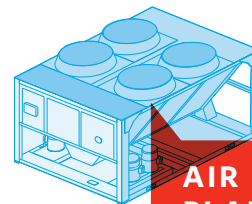
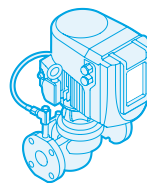
For evaluating an HVAC system, just two flow values and four temperature points provides all the data needed to understand flow rates, heat loads and operating efficiency.



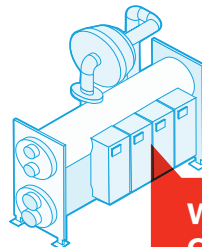
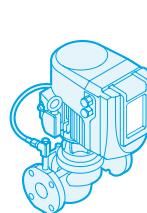
**PUMPING SYSTEMS**



**HEAT REJECTION**



**AIR COOLED PLANT**



**WATER COOLED PLANT**

**$\pm 5\%$**

**FLOW MEASUREMENT ACCURACY**

**ARMSTRONG** 

Flow **34.70 l/s**





# ACTIVE PERFORMANCE MANAGEMENT™

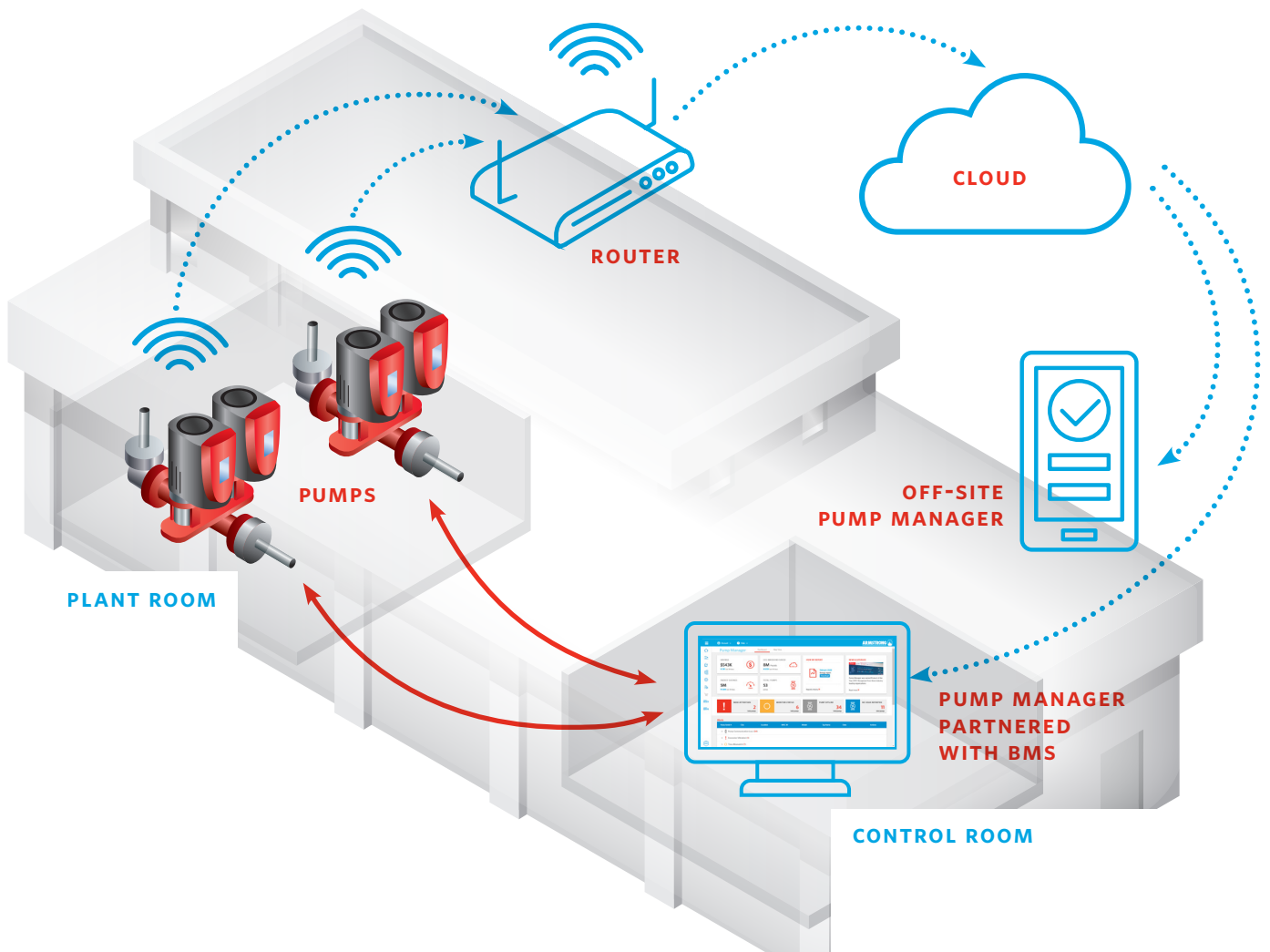
Active Performance Management is a systems management approach that optimises HVAC systems at any stage of a building's life-cycle by continually learning from a broad network of installations and responding to changing HVAC requirements.

The combination of smart commissioning with real-time alerts and system transparency addresses performance drift and maintains occupant comfort.

Bring performance drift under control

With Active Performance Management at the plant level, you can save up to

**40%** Annual cost savings



# THE RESULTS

ENERGY SAVINGS UP TO

90%+



**LOWEST ENERGY USE**

1

Armstrong Design Envelope Pumps provide you with highest energy efficiency.



**LOWEST INSTALLED COST**

2

Design Envelope Pumps provide lowest installed equipment cost, plus savings in infrastructure such as transformers, switch gear, power cables, concrete and cabling.



**LOWEST OPERATING COST**

3

Design Envelope Pumps provide lowest operating and maintenance cost.

## CASE STUDY | National Grid

ANNUAL ENERGY SAVINGS



70%

Armstrong recently completed a project in the United Kingdom, retrofitting pumps in a commercial office building belonging to National Grid. The retrofit included new pump sets that reduced energy consumption by 70%, saving over £22,400 annually.

### ANNUAL ENERGY COST

BEFORE	AFTER
32,152	9,752
£	£
AVERAGE	AVERAGE

ANNUAL COST SAVINGS **22,400** £

### CO<sub>2</sub> EMISSIONS

BEFORE	AFTER
82,309	24,967
kg CO <sub>2</sub>	kg CO <sub>2</sub>
AVERAGE	AVERAGE

ANNUAL CO<sub>2</sub> EMISSION REDUCTION **57,342** kg CO<sub>2</sub>



**FACILITY TYPE**  
Commerical office



**LOCATION**  
Solihull, Birmingham



**SIZE**  
Three-storey building



4

Design Envelope Pumps provide buildings with the lowest operational and embodied carbon.

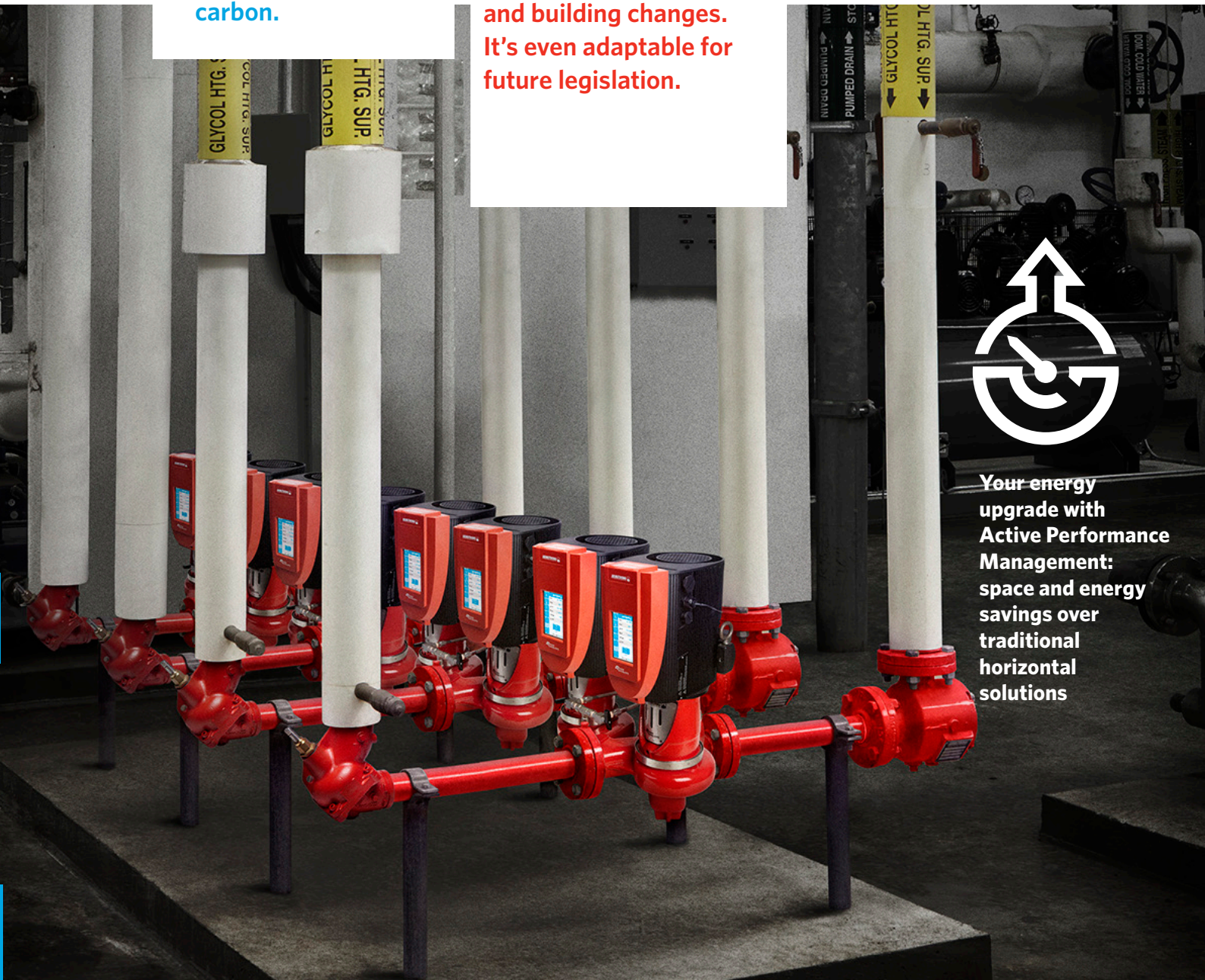


5

Design Envelope Pumps provide lowest project and operating risk, with solutions adaptable to design and building changes. It's even adaptable for future legislation.



Together, these five key benefits of Design Envelope technology provide customer value far beyond alternative variable-speed or constant-speed solutions.



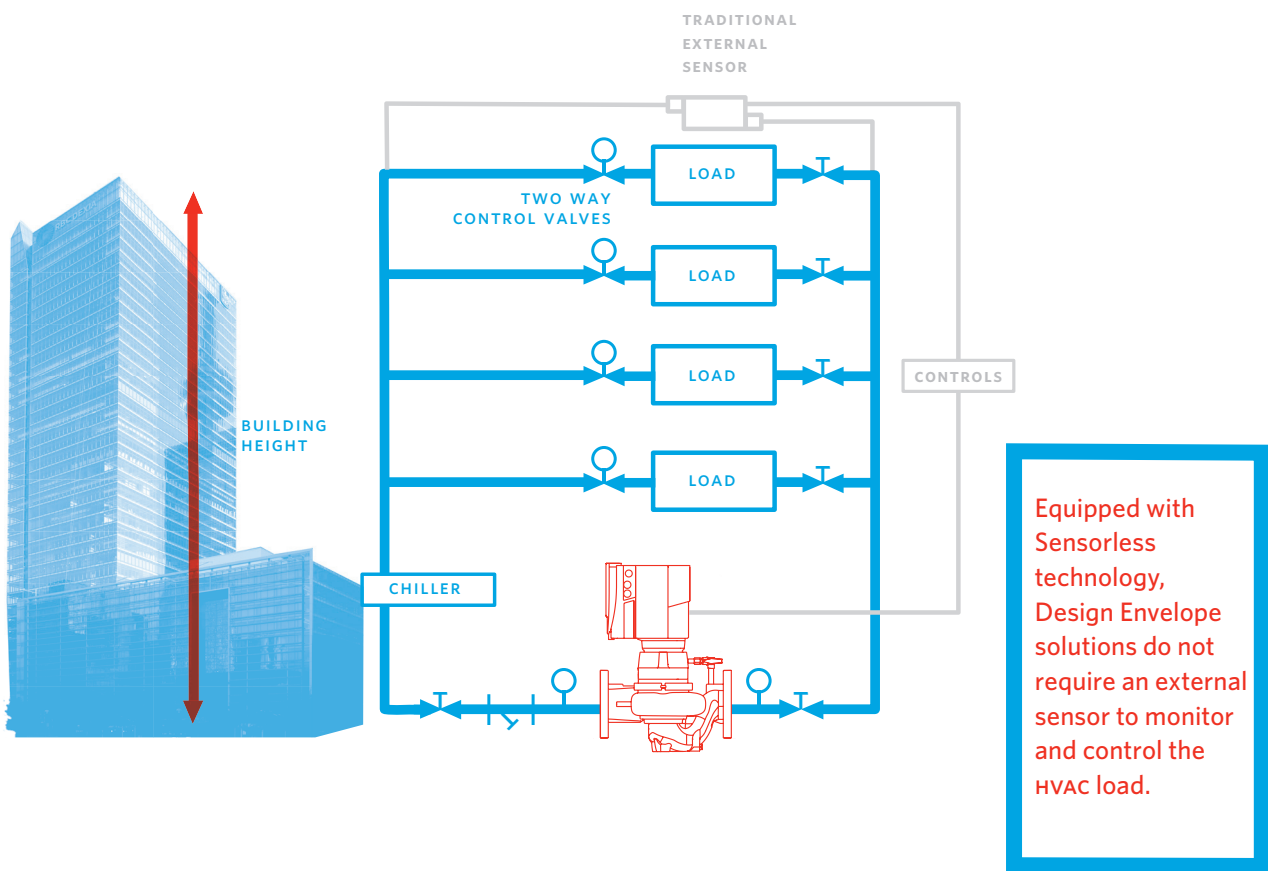
Your energy upgrade with Active Performance Management: space and energy savings over traditional horizontal solutions

# 2

## HOW IT WORKS

### SENSORLESS TECHNOLOGY

# THE SENSOR WITHIN



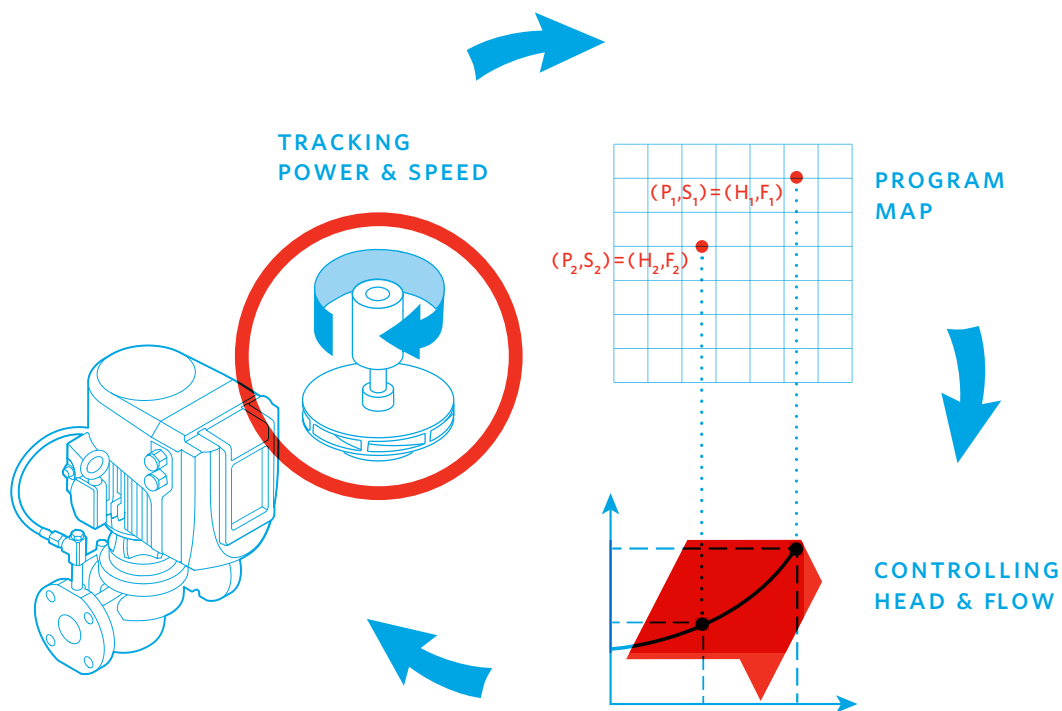
Using Sensorless technology, a Design Envelope pump's performance data (power draw and RPM) and operating curve are pre-programmed into the controller. During operation, the controller monitors the power draw and RPM of the pump and establishes the hydraulic performance and position of the pump's head-flow condition relative to the system requirements.

As the building's control valves open or close to regulate flow to the cooling coils and maintain building occupant comfort, the Sensorless controller automatically adjusts to match the required system pressure and flow.



# MONITOR POWER & SPEED

# CONTROL HEAD & FLOW



**Equipped with Sensorless technology, Design Envelope solutions do not require an external sensor to monitor and control the HVAC load.**

In a chilled water system, a building's temperature controls influence the local flow of control valves that modulate the flow to the cooling coils (load). As the control valves open for more chilled water flow, the differential pressure across the valve decreases.

The controller reacts to this change by increasing the pump speed. If the control valves close to reduce the chilled water flow, the differential pressure across the valve increases and the controller reduces the pump output.

# PARALLEL SENSORLESS

SAVE UP TO **30%**

ON OPERATING COSTS

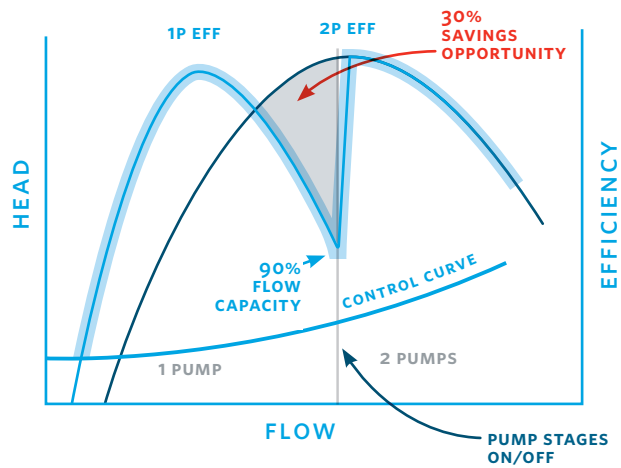
**P**arallel Sensorless Pump Control (PSPC) is a patented technology that improves the efficiency of a multi-pump installation through optimised load sharing.

The traditional approach to control in a multi-pump installation involves staging pumps on the basis of motor speed. Parallel Sensorless Pump Control technology stages pumps based on operating efficiency rather than motor speed and improves the efficiency of the full pump array by up to 30% over traditional multi-pump installations.

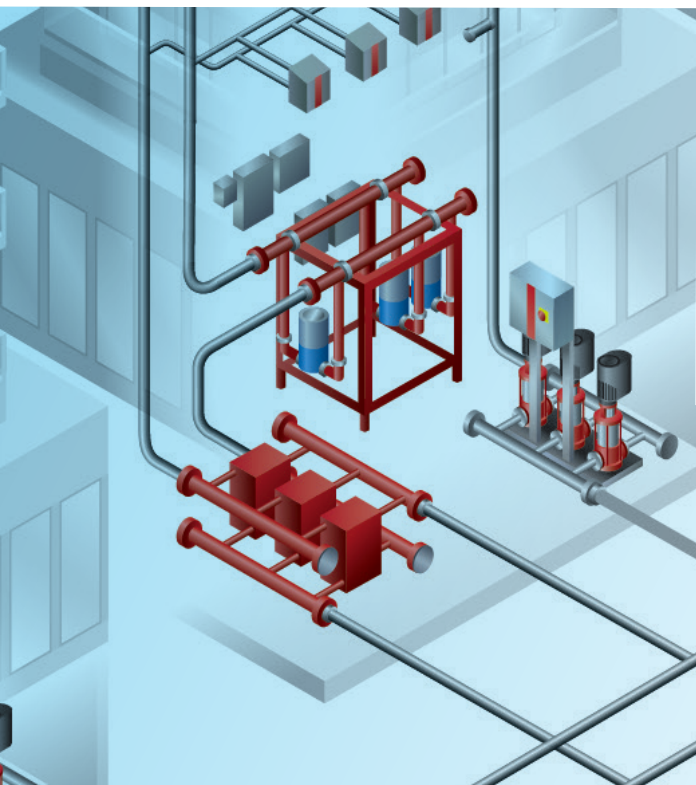
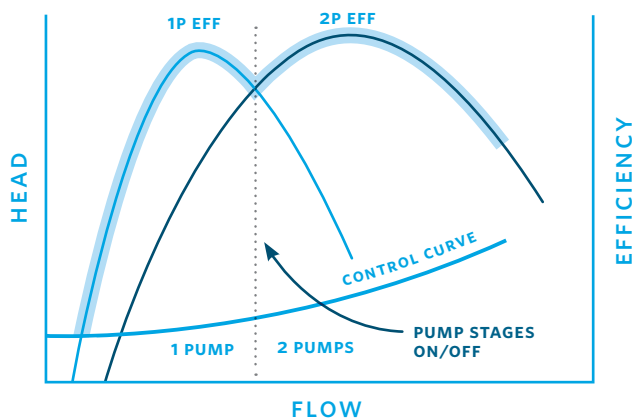
HVAC loads and flow requirements change throughout the day. In the graphs to the right, the grey dotted line intersecting the pump efficiency curves represents the flow level at which one pump in the array should be staged on or off. The solid grey line, however, indicates where staging often occurs with speed-based control, which forces the pump array to operate at efficiency levels that are less than optimal.

In an installation of (up to four pumps) Parallel Sensorless Pump Control monitors pump speed and stages pumps at the correct flow levels to optimise efficiency, as shown in the bottom-right graph.

## TRADITIONAL SPEED-BASED STAGING



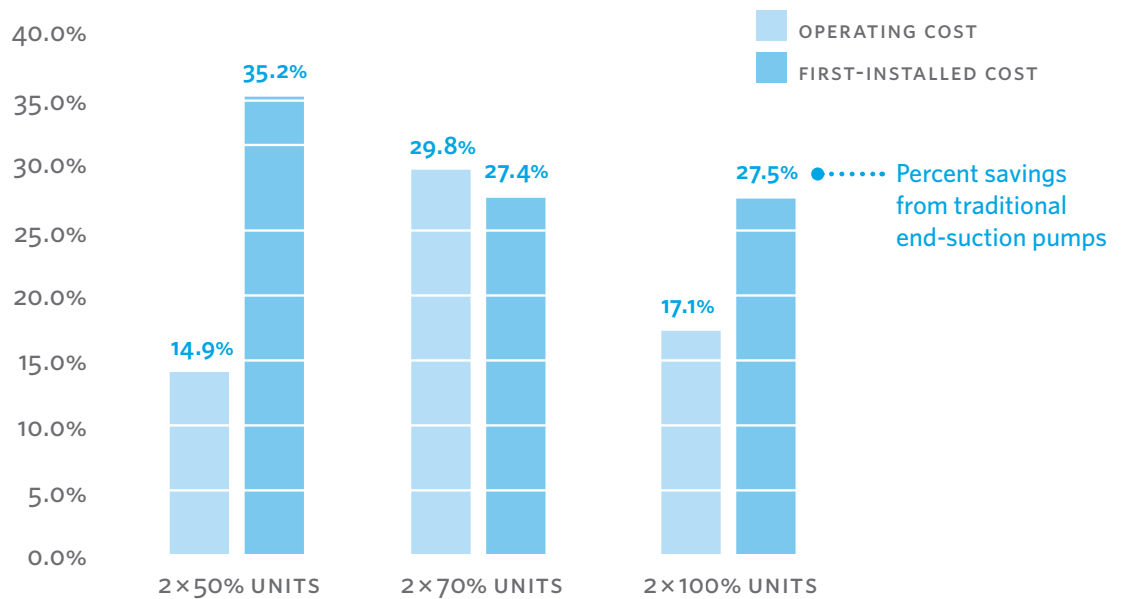
## PARALLEL SENSORLESS PUMP CONTROL BEST-EFFICIENCY STAGING



Because HVAC pumping systems mostly operate at part-load, a design using two or more smaller pumps is more efficient than one larger pump. In a two-pump system, if one pump fails, the remaining pump can serve the system

requirements with up to 70% flow redundancy. The capacity split can be adjusted based on the building type and duty requirement.

## REDUNDANCY AND SAVINGS WITH PARALLEL PUMPING



### REDUNDANCY AND SAVINGS WITH PARALLEL PUMPING

CAPACITY SPLIT	FLOW REDUNDANCY	DUTY REQUIREMENT	TYPICAL BUILDING EXAMPLES
Two pumps running at <b>50%</b>	If one pump fails, the other will operate at <b>70%</b>	Generic duty	Schools Apartments
Two pumps running at <b>70%</b>	If one pump fails, the other will operate at <b>85%</b>	High comfort sensitivity	Hotels Offices Outpatient clinics
Two pumps running at <b>100%</b>	If one pump fails, the other will operate at <b>100%</b>	Mission critical	Blood banks Hospitals Data centers

3

## THE SOLUTIONS

# TANGO

DESIGN ENVELOPE | TECHNOLOGY



Available for outdoor operation

Advanced hydraulic design supports industry-leading flow efficiency

Built-in Parallel Sensorless pump control saves up to 30% more energy

Armstrong DEPM motor technology delivers an additional 6-20% efficiency, meeting IE5 efficiency standards

Control algorithm constantly reviews operating conditions and adjusts output to meet immediate flow requirements at minimum energy consumption

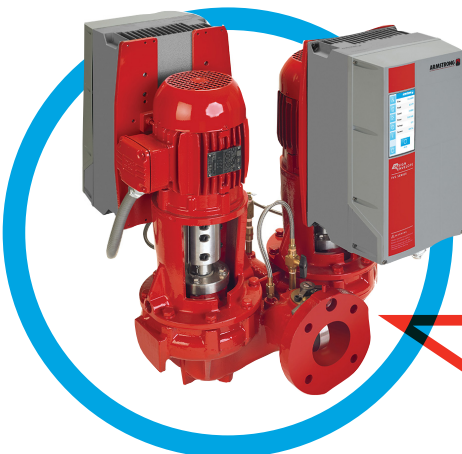
15 minutes to replace the mechanical seal with no need for realignment, saving up to £700

## THE NEED FOR AVAILABILITY

Most building HVAC systems operate at the design point (100% load) less than 1% of the time. Traditional system design applies 100% redundancy and duplication of components to ensure that the design point can always be met. This creates huge over capacity and higher costs.

The traditional duty/standby approach to redundancy in HVAC systems inflates the installed costs for equipment and labour, and adds to the carbon footprint of the building. Tango's dual-pumping configuration modernises the approach to redundancy. Pumps and motors are selected from a range of sizes to achieve a level of redundancy that matches the requirements of the application.

With the proper approach to redundancy, HVAC requirements can be met for all but the most extreme days of the year; and for those few days, variation in temperature will be minimal.



### Dual-Arm Pumps

For pumps larger than 10hp/7.5kW use dualArm pumps for lowest installed cost, lowest life cycle operating cost achieved with Parallel Sensorless, and increased serviceability with built-in isolation valves

# FOR ALL DESIGN ENVELOPE SOLUTIONS

## Advanced performance control

Armstrong has reinvented and redesigned pumping solutions to include connectivity and performance management services. Design Envelope Pumps provide optimal lifetime efficiency through:

Expanded performance range (and options)

One-touch auto-flow balancing

Pump speed modulation based on an adjustable quadratic control curve for better part-load efficiency

Flow monitoring accuracy (+/- 5%)

Operating data and notifications to support diagnostics and service

Advanced onboard control functions

## PERFORMANCE PACKAGES

## FUNCTIONS INCLUDED



**Sensorless Bundle (standard)**

- Sensorless control
- Flow meter
- Constant flow
- Constant pressure



**Parallel Sensorless (standard on Tango and dualArm)**

- Parallel Sensorless control



**Energy Performance Bundle**

- Auto-flow balancing
- Maximum flow control



**Protection Bundle**

- Minimum flow control
- Bypass valve control



**Zone optimisation**

- Accept up to two dP sensor control signals



**Dual-season setup**

- Pre-set heating and cooling parameters for two-pipe systems

## CASE STUDY | Delta Hotel

ANNUAL ENERGY SAVINGS  
**40%**



The Delta Hotel commissioned an upgrade of one of their existing pumps to a new Tango. New control algorithms and performance management of the Tango pump proved that the upgrade was the right choice.

The total annual energy cost savings amounted to over \$2,295 with a total kWh savings of 22,957 kWh: a 40% savings overall.



**FACILITY TYPE**  
Hotel



**LOCATION**  
Toronto, Canada



**SIZE**  
300,000 ft<sup>2</sup>

### ANNUAL ENERGY COST

BEFORE	AFTER
5,659	3,364
\$ CAD	\$ CAD
AVERAGE	AVERAGE

ANNUAL COST SAVINGS **\$2,295<sub>CAD</sub>**

### CO<sub>2</sub> EMISSIONS

BEFORE	AFTER
7,923	4,709
kg CO <sub>2</sub>	kg CO <sub>2</sub>
AVERAGE	AVERAGE

ANNUAL CO<sub>2</sub> EMISSION REDUCTION **3,214 kg CO<sub>2</sub>**

# VERTICAL IN-LINE PUMPS (VIL)

DESIGN  
ENVELOPE

TECHNOLOGY

## Mechanical room space savings

Pumps require minimal floor space or can be installed overhead

## Reduced vibration

Optimally-designed, dynamically-balanced impeller and shaft assembly operates with minimum vibration

## Lowest installed cost and embodied carbon

Component, Material and Labor savings: fewer fittings and no housekeeping pad required

## Reliability

Vertical In-Line design requires less maintenance, at a lower cost, than any other pump configuration

## Easy maintenance

15 minutes to replace the mechanical seal: no need for realignment; saves up to £500



For a 10 hp/7.5 kW pump, save £1,500 with pipe mounting and no inertia base



DEPM Single-Phase Pumps  
Available in  
1-phase 200-230v  
up to 2hp

# NEW DEPM IVS



AVAILABLE IN SIZES  
UP TO 45 KW

35-65% lower operating costs over conventional integrated pumps

Smaller motor and controls size on 40% of hydraulic selections for lower pump and infrastructure costs

Simplified handling with single point lifting

Meets Ultra Premium (IE5) Efficiency motor levels

50% weight reduction and 50% embodied carbon reduction

Available for outdoor operation



## CASE STUDY | Carlson Court

ANNUAL ENERGY SAVINGS



87%

Armstrong replaced six constant speed pumps with new Vertical In-Line pumps. Combining Design Envelope technology and Pump Manager, Armstrong optimised pump operations for annual energy savings of 87%.



**FACILITY TYPE**  
Large Office Complex



**LOCATION**  
Toronto, Canada



**SIZE**  
300,000 ft<sup>2</sup>

### ANNUAL ENERGY COST



BEFORE

AFTER

\$140,072

\$18,380

CAD

CAD

AVERAGE

AVERAGE

ANNUAL COST SAVINGS

\$121,692 CAD

### CO<sub>2</sub> EMISSIONS



BEFORE

AFTER

150,847

19,794

kg CO<sub>2</sub>

kg CO<sub>2</sub>

AVERAGE

AVERAGE

ANNUAL CO<sub>2</sub> EMISSION REDUCTION

131,053 kg CO<sub>2</sub>

# END SUCTION

DESIGN ENVELOPE | TECHNOLOGY

**NO INERTIA BASE NEEDED\***  
= SAVINGS OF

**£ 1,500** \*10hp / 7.5kW or smaller



**HVAC pumping systems are expected to operate smoothly and quietly.**

Although it's practical to mount pumps on the floor, this practice can also transmit noise or vibration to the rest of the building. Concrete and inertia bases have traditionally been used to mitigate vibration, but this adds excess weight and cost to the installation.

The new Design Envelope End Suction pump with integrated vibration isolation:

**Eliminates the need for inertia bases**

**Reduces installed costs and operating cost**

**Adds more value than any other horizontal pump**

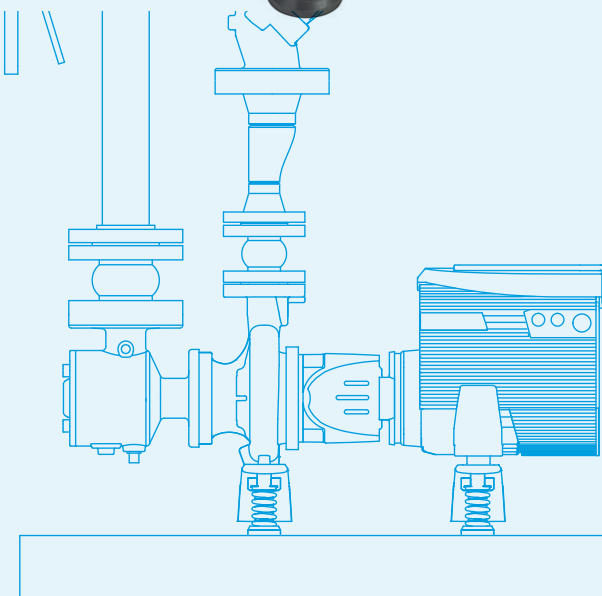
## EQUIPMENT AND MATERIAL SAVINGS

**No inertia base, concrete and curing time required**

**Rigid pump design needs no steel baseplate**

**No differential pressure sensors required**

**Less concrete means a lower carbon footprint**





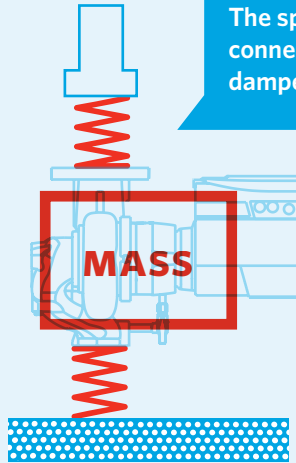
Integral vibration isolation eliminates the need for inertia bases or baseplates. The following features minimise the transmission of vibration:

**Balanced rotor design**

**Soft start controls**

**Direct coupling to motor**

**Reduced overall weight**

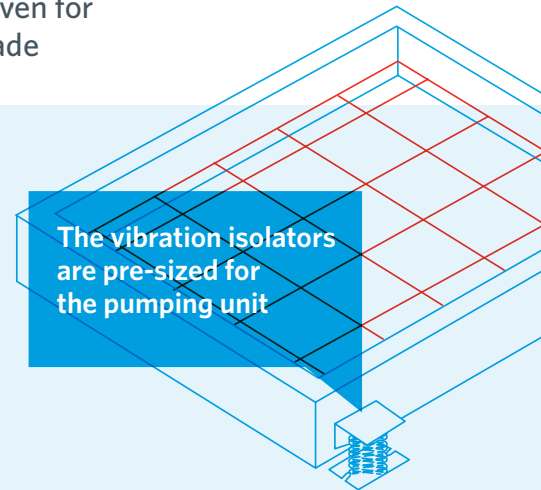


With flex connectors separating the pump from the piping, and vibration isolators between the pump and the ground, the pump floats in an isolated spring system.



The ASHRAE handbook recommends the use of inertia bases even for pump installations on grade

In pumps over 7.5 kW the integrated design with baseplate has a lower installed cost than a traditional pump with a wall-mounted drive



## CASE STUDY | Texas Christian University

ANNUAL ENERGY SAVINGS



63%



In 2018 Armstrong upgraded three constant-speed pumps in the Recreation Center. As a result of the retrofit project, TCU is saving over \$7,500 per year.

### ANNUAL ENERGY COST



BEFORE

AFTER

\$12,106

\$4,525

USD

USD

AVERAGE

AVERAGE

ANNUAL COST SAVINGS

\$7,581 USD

### CO<sub>2</sub> EMISSIONS



BEFORE

AFTER

80,792

30,193

kg CO<sub>2</sub>

kg CO<sub>2</sub>

AVERAGE

AVERAGE

ANNUAL CO<sub>2</sub> EMISSION REDUCTION

30,193 kg CO<sub>2</sub>



FACILITY TYPE  
Recreation Centre



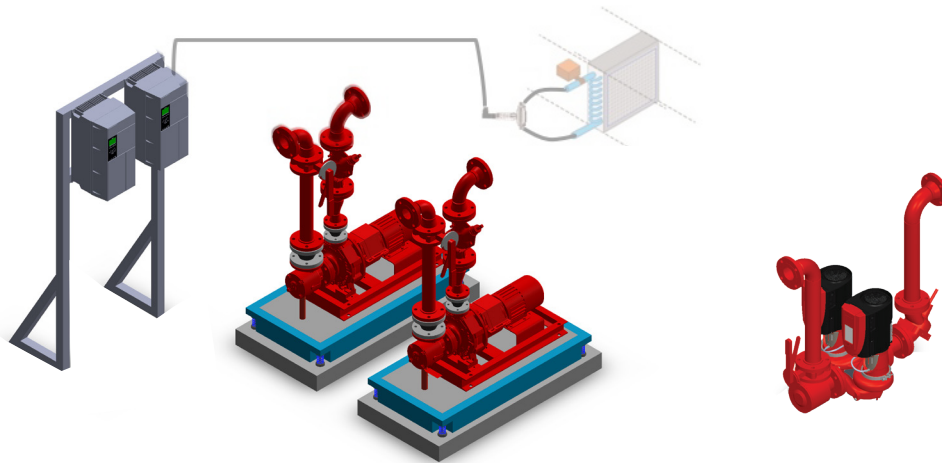
LOCATION  
Fort Worth, Texas







SIZE  
179,831 ft<sup>2</sup>

# CHOOSE YOUR CONFIGURATION

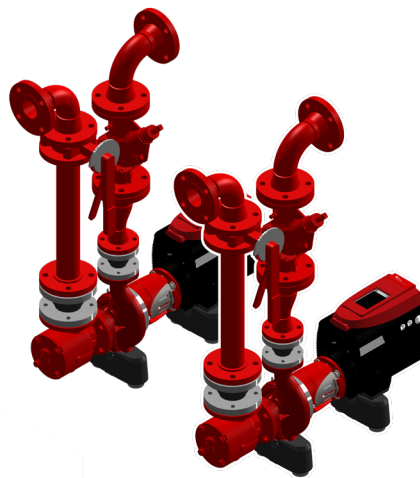
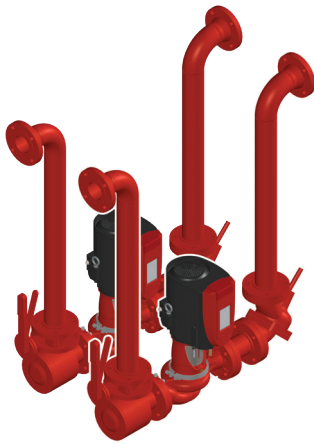
## INSTALLATION COST COMPARISON



	2 × End Suction with drive on wall and remote pressure sensor 100% duty/standby	1 Tango pump with sensorless and parallel sensorless control 2 × 50% capacity split, parallel operation
 Total pump weight	309.3 kg	41.3 kg <b>87% savings</b>
 Installation weight	1007.4 kg	236.3 kg <b>76% savings</b>
 Installation footprint	2.47 m <sup>2</sup>	0.54 m <sup>2</sup> <b>78% savings</b>
 Installation cost	£ 7,163	£ 1,455 <b>80% savings</b>
	<ul style="list-style-type: none"> <li>• Legacy design</li> <li>• Base case for comparison</li> <li>• Time-intensive seal change</li> </ul>	<ul style="list-style-type: none"> <li>• Managed redundancy and parallel operation replaces duty/standby</li> <li>• Smaller units are easier to handle</li> <li>• Two rotating devices sharing one casing</li> <li>• Reporting and proactive management</li> <li>• Optimised lifetime performance</li> </ul>

Complete integrated solutions offer the lowest installed cost and add value in lifetime energy and maintenance savings

## DESIGN ENVELOPE CONFIGURATION OPTIONS



2 × Design Envelope Vertical Inline with sensorless control 100% duty/standby*	2 × Design Envelope End Suction with sensorless control 100% duty/standby*
98.0 kg 68% savings	89.8 kg 71% savings
339.3 kg 66% savings	435.9 kg 57% savings
1.14 m <sup>2</sup> 54% savings	1.68 m <sup>2</sup> 32% savings
£ 3,312 54% savings	£ 3,903 46% savings
<p>Eliminates the need for: housekeeping pads, inertia base, flex connections, grouting and alignment</p> <ul style="list-style-type: none"> <li>• Reduced installation labour costs</li> <li>• Smaller mechanical room footprint (50-75%)</li> </ul>	<p>Eliminates the need for: housekeeping pads, inertia base, flex connections, grouting and alignment</p> <ul style="list-style-type: none"> <li>• Reduced installation labour costs</li> <li>• Smaller mechanical room footprint (50-75%)</li> </ul>

\*May also be sized 2 × 50% parallel

# 4

## ARMSTRONG SERVICES & PARTS

**A**rmstrong's 360 Service and Support provides complete solution support for engineers, contractors and owners. Working with our network partners, we provide support to help you get the best possible performance from fluid-flow systems.



Rapid response attention

**MATCHED TO YOUR NEEDS.**

**+ 24/7 GLOBAL RAPID RESPONSE**



## ARMSTRONG PARTS KITS: ENGINEERED AND PRE-ASSEMBLED

**A**rmstrong Parts Kits are engineered combinations of genuine replacement parts — planned, selected and packaged based on solution types and sizes. Use Parts Kits for maintenance projects to add value to your building operators and service personnel.



## CASE STUDY | Commercial Towers

**T**he owners of this pair of commercial towers recently completed an HVAC upgrade, replacing three constant speed pumps with new Design Envelope pumps with Pump Manager.

Along with the energy savings, Pump Manager provided system warnings that helped avoid expensive repairs and energy losses.

SOLUTION EMPLOYED

**DESIGN ENVELOPE**

VERTICAL IN-LINE PUMP



ANNUAL ENERGY SAVINGS

**77%**



ANNUAL ENERGY COST

BEFORE	AFTER
<b>\$68,185</b> CAD	<b>\$15,918</b> CAD
AVERAGE	AVERAGE

ANNUAL COST SAVINGS

**\$52,267** CAD



FACILITY TYPE  
Commercial office tower



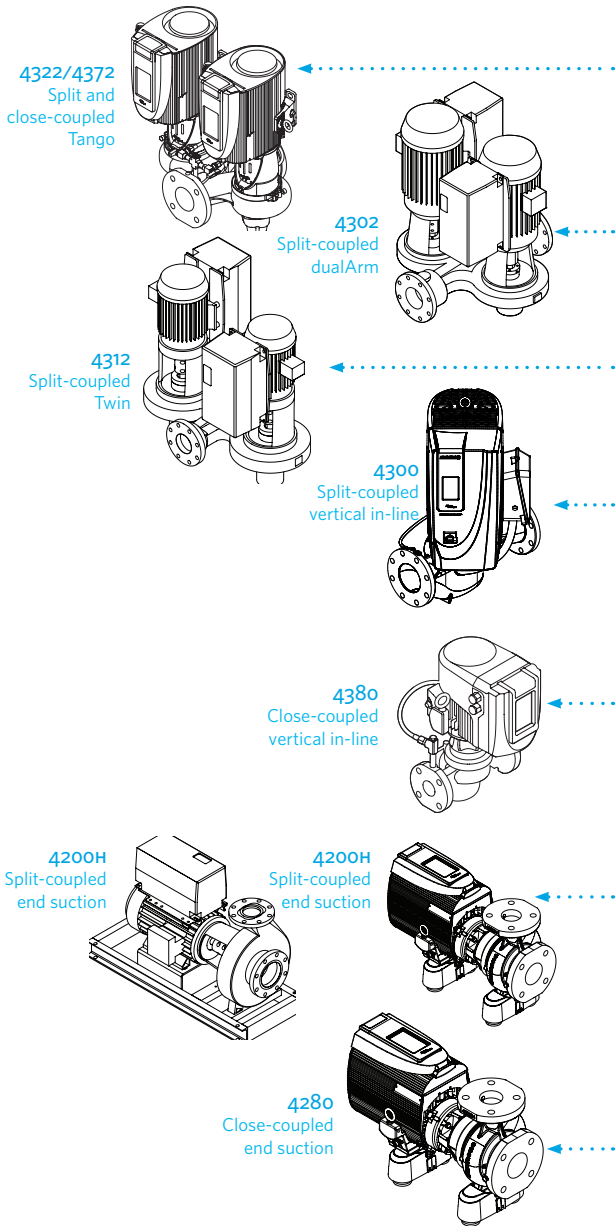
LOCATION  
Toronto, Ontario



SIZE  
18 floors,  
20,000 ft<sup>2</sup>  
per floor

# 5

## DESIGN ENVELOPE PUMP RANGE



INDOOR	OUTDOOR
0.25-7.5 kW	0.25-7.5 kW
11-75 kW	11-75 kW
11-30 kW	0.75-30 kW
0.25-335 kW 355 kW - 932 kW with Standalone control	0.25-90 kW
0.25-7.5 kW 0.75-1.5 kW in Stainless Steel	N/A
0.75-7.5 kW with integrated vibration isolators 11-90 kW	N/A
0.75-7.5 kW with integrated vibration isolators	N/A

**PUMP MODELS  
DESIGNED AND  
ENGINEERED  
FOR OUTDOOR  
OPERATION**

IP66 rated controls enclosure  
Equipped with overhead weather shield to prevent pump from icing in cold weather conditions and overheating when exposed to direct sunlight



# OUR SERVICE TO THE PLANET



## PLANET PROPOSITION

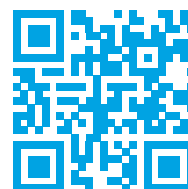
**T**hrough our Planet Proposition charter, Armstrong has committed to minimising our impact on the environment. Around the world, Armstrong's Planet Proposition teams have taken on projects that are helping us meet our targets. Two examples of successful projects are:

### NET ZERO CARBON BUILDINGS COMMITMENT

The Net Zero Commitment positions energy efficiency as a central component to achieving decarbonization globally. In signing the Net Zero Carbon Buildings Commitment, Armstrong has pledged to ensure our entire portfolio of buildings operates at net zero carbon by the year 2030.



WATCH THE VIDEO



See how we achieved a key target in reducing greenhouse gas emissions by 2 millions tons



#### TORONTO

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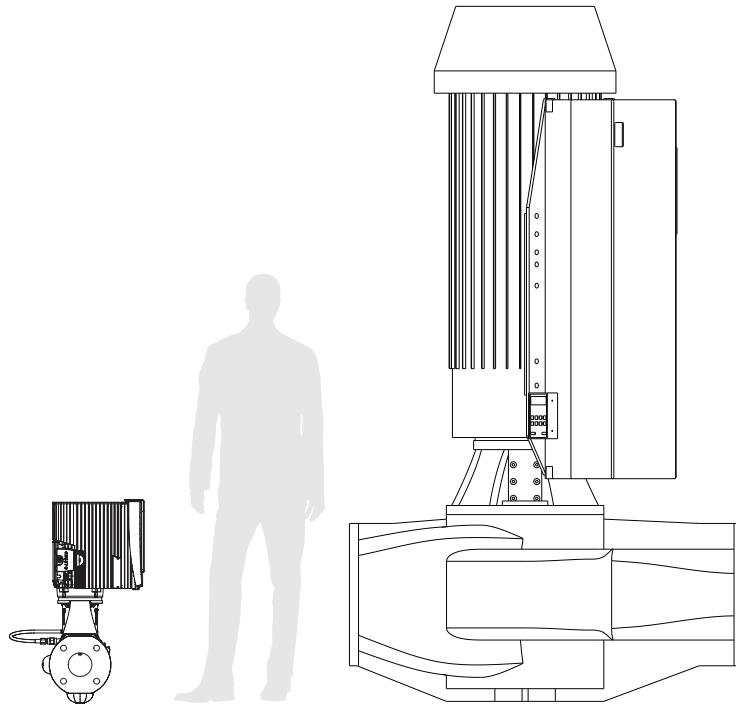
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