

ARMSTRONG DESIGN ENVELOPE | FAQ

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Q1 **Armstrong Design Envelope is the greenest, most cost effective and most flexible building mechanical solution on the planet.** Why is this so?

A1 This answer should be divided into the three areas when compared to other building mechanical solutions.

1 **Sustainability** - Armstrong Design Envelope solutions intelligently deliver only the capacity required by the system at a given point in time, through unparalleled integration based on our expertise in four distinct areas (demand-based control, fluid flow, heat transfer and variable speed). This ensures system components are correctly sized and matched and optimizes energy consumption.

In addition to pump intelligence, our manufacture and installation processes contribute to decreased carbon emissions. Off-site, controlled manufacturing reduces energy consumption and production of waste. Design Envelope pumps are generally installed without the use of large concrete inertia bases and housekeeping pads, eliminating the emission of carbon associated with concrete manufacture and disposal

2 **Most cost effective** - Armstrong Design Envelope solutions provide the lowest installed cost and the lowest life cost. By utilizing Armstrong core competencies the equipment is smaller for the same capacity, designed as a complete solution, manufactured in a factory environment, easier to commission and maintain and consumes the least energy. Design Envelope solutions even save infrastructure cost in a building.

3 **Most flexible** - Armstrong Design Envelope technologies are designed and selected for an **envelope** of operation meeting today's and future energy legislation requirements. The Design Envelope solutions operate efficiently over the envelope of operation and therefore continue to be effective when design conditions change and even when site requirements change over time.

Q2 What is Design Envelope technology?

A2 Armstrong Design Envelope technology integrates the latest selection, control, and hydronic tools into intelligent variable load heat-transfer solutions that naturally accommodate changes in building design and operating demand — system performance is at an optimum at any given time.

Q3 What Customer Value does Design Envelope Technology provide?

A3

1 Armstrong Design Envelope technology provides the customer with a solution for the lowest cost, both the First Installed Cost and Life Cycle cost.

2 At the same time all Design Envelope products;

- A** Reduce design risk,
- B** Reduce operating and regulatory risks,
- C** Optimize energy and environmental performance, and
- D** Enable an increase in occupant comfort.

Q4 Why can Design Envelope Technology provide more customer value than traditional industry approaches for variable speed control?

A4 Normal Variable speed control implementation simply operates on top of a traditionally designed constant speed equipment in a system. Armstrong Design Envelope solutions draw on an intimate knowledge of fluid flow, pump efficiency, heat transfer and demand-based control combined with variable speed technology to produce intelligent equipment with on board controls. The mechanical, and electrical design is different from what standard practice would lead to, and the resulting efficiency creates more value for customers than traditional design approaches.

Q5 What additional value over industry normalized variable speed control does Design Envelope provide?

A5 Beyond increased efficiency, Armstrong design envelope solutions offer value through a smaller physical footprint, easy installation, reduced vibration, easy maintenance, increased reliability and reduced cost of additional components. Through the innovative sensorless technology that provides variable speed operation without the use of remotely installed pressure sensors, Armstrong design envelope solutions provide improved reliability, and greater control accuracy. Lastly, because of the flexibility that design envelope solutions provide, system designs are subject to reduced risk, and buildings are **future proofed** against changes in HVAC demand due to shifts and tenant makeup or environmental conditions.

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Q6 How do Design Envelope solutions save building infrastructure cost?

A6 Design Envelope solutions can save infrastructure cost in many ways:

- 1** Design Envelope pumps often utilize smaller motor and controls than traditional pumping equipment due to the use of load limiting logic. This results in major electrical infrastructure savings.
 - A** Smaller electrics result in less power being provided by the motor control center out to and including the substation or transformer and therefore smaller equipment in a building. Potential savings are shown as follows:

Project size	Installed pump HP savings over traditional installation	Infrastructure cost savings (motor control centre out to substation or transformer)	Savings in percentage of pump cost
Small	10	\$ 450	2.5%
Medium	40	\$ 5,400	7.0%
Large	650	\$ 130,000	35%

Design Envelope Pumps result in savings in motor control centre to substation / transformers infrastructure of between 2.5% to 35% of the value of the pump cost depending on the size of the project

- B** There are also savings in wiring cost from the piece of equipment to the motor control centre. This savings can be divided into two areas.
 - I** If the motor and control is smaller a smaller wire is required. The difference in wiring cost between a 40 and 30 hp motor is estimated to be \$50 or 1% of the pump cost.
 - II** Design Envelope pumps enable wiring to go direct to the pumping unit and not to a variable speed drive on a wall and then over to the pump. A typical savings for this for a 30hp motor is estimated to be \$340 per pump or 6% of the pump cost.
- C** There can also be electrical infrastructure savings as Design Envelope pumps incorporate built in DC link reactors which are equivalent in Harmonic suppression to a 5% line reactor. For a 30hp pump this equates to a savings of \$440 or 7.3%.
- D** Design Envelope pumps do not require shaft grounding rings to protect the motor bearings. This is assured by a 3 year warranty. For a 30hp motor shaft grounding rings cost about \$270 or 4.5% of the pump cost.

Design Envelope pumps depending on the project size save between 21 and 54% of the pump cost in electrical infrastructure cost. This is in addition to the other infrastructure savings in civil, mechanical and control infrastructure.

Q7 Can you provide an example of how Armstrong Design Envelope technology produces smaller equipment?

A7 On board intelligence enables us to employ Load limiting logic. In the example of a Design Envelope pump, this intelligence will prevent the pump from operating beyond the motors rated horsepower for the full length of the entire curve. We are no longer forced to select oversized motors, and this often results in smaller motors and power supplies on Design Envelope pumping units compared to traditional pump selections and a wall mounted vfd. In addition, for Design envelope chiller plants, or Fluid Management Systems, similar rules apply that lead to product selections optimized for energy usage of the system, and result in smaller chilling and pumping equipment.

Q8 Can you provide examples of how Armstrong Design Envelope technology uses less energy than normal variable speed?

- A8**
 - 1** Design Envelope Chiller Plants employ patented plant automation intelligence to maximize the thermal performance of the plant equipment (minimize the electrical power draw for a given cooling load) with an all-variable plant control sequence that permits unique combinations of equipment speed and operating equipment ratios. This can't be achieved with traditional feedback control technology or traditional equipment selections. This control technology ensures that the plant as a whole performs at its best efficiency. Real installations have shown 25% or greater efficiency levels relative to other best in class results.
 - 2** In Design Envelope pumps the selection process leads to a pump that operates at the best efficiency area of its performance curve during part loading, giving them an inherent operating advantage for the majority of their operating hours.

Q9 What are the Design Envelope Technologies that enable the Capabilities?

A9

1 Digital

- A** **Patented intelligent integrated controls** - Armstrong uses patented technology for chiller plant and sensorless pump control together with patent pending technology for operating pump sensorless control in parallel, pump selection and optimizing plant and pump control to site conditions.
- B** **Economical variable-speed drives** - Variable speed drives have been available to industry for over 50

years however since approximately 2000 have become sufficiently economical to be incorporated in all HVAC rotating equipment

- c On-board intelligence** - The above economical logic and hardware enables equipment manufacturers to incorporate their intimate knowledge of equipment operation into the equipment itself.

- 2 Factory configuration** - progression in factory technology, transportation and site lifting enables even the largest HVAC plants to be factory designed and constructed in controlled environments.

3 Modeling

- A Selection software** - HVAC equipment selection software today is very sophisticated and is used in web based, mobile and desk hardware applications. This same capability can now be incorporated into the equipment itself and used in its control logic and intelligence.
- B In-house 3D design** - 3D design enables factory build equipment to optimize the 3 dimensions and even consider interference with other equipment on a site.
- c Economical control logic** - customized logic and application specific printed circuit boards were required up until about 1990. In the 90's off the shelf programs and hardware became available such that control logic can be incorporated in all HVAC equipment.

Q10 What are the Design Envelope capabilities?

A10

- 1 Demand-based control** - Enables equipment output to be varied dependent on system requirements. No PID loops are required to achieve proper output. The equipment provides only the amount of cooling or heating required by the space - no instances of over shooting or wasted energy.
- 2 All variable load/speed** - Enables varying equipment output by slowing down or speeding up dependent on system demand. The equipment provides only the amount of cooling or heating required by the space - no instances of over shooting or wasted energy.
- 3 Plug and play** - The equipment electronically tunes itself to the system right from the get go without mechanical adjustments. Start -up calibration assures users that the equipment is properly set up for the lowest energy use.
- 4 BMS-ready/independent** - Equipment which works with or without a central building management system. Equipment installation becomes easier resulting in rapid installation and commissioning.

- 5 Commissioning by controls** - This eliminates the need for mechanical adjustment to optimize the system and verify the operating point. Elimination of specialised contractor personnel to co-ordinate multiple pieces of equipment in order to achieve specified performance.
- 6 Self-regulating** - Design Envelope solutions are able to operate independently or networked. Changes to the occupant profile do not require system changes
- 7 Automatic data/meter reading** - The ability to accumulate operation data which can be analysed both by the intelligence in the equipment itself as well as remotely to optimize operation.
- 8 Internal diagnostics (incl. data storage)** - The ability to assess equipment performance at total-system or individual-device levels which results in Improvement of long term building performance and early detection of operational issues>
- 9 Increased capacity/ 'sweet spot'** - Design envelope solutions provide an area of efficient operation rather than a single design point for maximum load. Equipment flexibility reduces the need for redesign and customization work.
- 10 Component match-up** - Design envelope solutions integrate perfectly matched components and coordinate the operation of components electronically. Matched and optimized components ensure optimal energy performance

Q11 Which Capabilities must be present in a Design Envelope solution?

A11

- 1** Demand-based control
- 2** All variable load/speed
- 3** Plug and play
- 4** BMS-independent
- 5** Commissioning by controls
- 6** Self-regulating
- 7** Increased capacity/ 'sweet spot'
- 8** Component match-up
- 9** Proper selection of variable flow system equipment

Q12 Which Capabilities are available in Some Design Envelope solutions only?

A12

- 1** Sensorless
- 2** BMS ready
- 3** Automatic data / meter reading
- 4** Internal diagnostics

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Q13 What are the Design Envelope products available from Armstrong?

A13

- 1 Design Envelope chiller plants (DE-CHW)
- 2 Design Envelope pumps
- 3 Design Envelope plant automation (DE IPC)
- 4 Design Envelope intelligent prefabricated fluid management systems (DE IFMS)
- 5 Design Envelope Boosters
- 6 Design Envelope Circulators

Q14 How can I specify this technology for my project, as I am bound through practice to specify technologies that are not sole sourced;

A14 The consulting engineer can specify performance where kw per ton is specified if a chiller plant control specification or specify that a traditional pump solution is acceptable providing the pump manufacture includes in his bid Wiring from Drive to wall, Sensor remotely mounted in the system and wiring back to the pumping unit, If horizontal pumps, inertia bases, spring mounts and flex connectors and finally re-design costs.

As an alternative it can be shown that competitors do have a pump design with integrated control (not all the design envelope capabilities) but choose not to make it available in the customers area. Slides or copies of literature can be used from Wilo, Grundfos, Xylem, KSB and Taco all showing they offer an integrated product. If parallel sensorless is required, where we are unique the specification should require that they must include the cost of all controls and wiring.

Q15 What are the issues that Design Envelope addresses for lowest first cost?

A15 Design Envelope solution

All utilize the latest the technology such that commissioning is by controls and not mechanical resulting in site savings. Also the use of the latest technologies ensures costs are minimized.

The equipment is sized for optimum energy utilization across the load profile which often results in equipment which is smaller than that used traditionally

Components are **matched** together, Meaning mechanical and electrical integration is the most economical possible.

Assembly takes place in a factory environment which is clean and organized. Methods are optimized to assure quality and low cost.

Increased capacity or **sweet spot** ensures equipment produces the maximum possible output for that size of mechanical and electrical components.

Q16 Why are Design Envelope solutions less affected by changing project specification criteria?

A16 Design Envelope solutions have a larger efficiency range or sweet spot within which they operate effectively. This means that the same equipment will often meet the revised pumping requirements required by a specification change. In addition Design Envelope solutions exceed today's sustainability requirements meaning that they often meet the requirements of upgrades to building codes. Shifts in HVAC demand due to building design changes can frequently be accommodated with no change to the equipment.

Q17 My customers want the same vFD brand through out the building, I want to specify Design envelope, but I must address my customer's concern.

A17 Armstrong Design Envelope solutions integrate specially designed controls similar to many chillers, fans and cooling towers today. Standardizing on a drive manufacturer means that integrated controls on any of these pieces of equipment cannot be installed resulting in a loss of efficiency and lost opportunities for cost savings.

Integrated equipment is factory set and site adjustment by operators is not necessary, so there's no need for concerns related to learning to operate a new drive or a different control platform.

The practice of standardization started in the 1970's due to the low reliability of drives. Today, controls are far more reliable - in some cases more reliable often more reliable than the mechanical equipment they operate - and standardization is unnecessary.

Q18 Who can service these new products? Can anyone, or does the service work require a team or vendor with specialized skills?

A18 Adjustments to equipment settings can be carried out by a knowledgeable on-site resource. The requirements for these types of adjustments are minimal, due to the advanced nature of the Design Envelope technology.

Commissioning and service of design envelope solutions should be carried out by factory trained and authorized service technicians. Armstrong has a network of factory-trained and authorized service technicians available for this.

- Q19** How many installations of Design Envelope equipment are there? I don't want to be the first test case.
- A19** Armstrong has been supplying design envelope solutions since 2007 and many of the unique technologies since 2004 or earlier. Depending on the Design Envelope solution Armstrong, has between 50 and tens of thousands installations globally. Design Envelope solutions are well proven and are constantly upgraded to incorporate the latest innovations and improvements.
- Q20** Why don't other manufacturers do the same thing?
- A20** Armstrong's four core competencies and manufacturing role combine to give us a unique perspective on optimizing the device or system by balancing and tuning the mechanical, electrical and controls trade offs within the devices. Although, many manufacturers and designers have incorporated variable speed in their designs, they have taken traditional technology and developed variable speed capability on top of it. This equipment can produce energy savings from traditional installations. Armstrong utilizes all four of its core competencies when developing Design Envelope technologies. The first core competency is variable speed technologies. Two more are fluid flow and heat transfer technologies which Armstrong has been developing for almost 80 years and the newest demand based control which Armstrong has been developing for 10 years. By incorporating the four core competencies Armstrong views complete developments in light of the new technologies available which means a completely new way of thinking. Armstrong Design Envelope solutions incorporate many patented or patent pending technologies in areas such as demand-based control, equipment selection, sensorless pump control, auto adjustment to systems and parallel sensorless control. Design Envelope technology look at solutions in a brand new way. Simply adding variable speed on top of traditional solutions cannot achieve the same results.
- Q21** Whose drive do you use on your pump?
- A21** Armstrong Design Envelope pumps do not use a traditional drive. Design Envelope pumps use an integrated control that is UL certified as part of the pump and uses proprietary control methods. The integrated control components are made to Armstrong specifications for Armstrong.
- Q22** Is it necessary to proportionally water balance systems when using Design Envelope technology?
- A22** Yes, for Optimum building performance and occupant comfort, proportional balancing is required to ensure that adequate flow can reach all zones being served by the Design Envelope pumps. ASHRAE 90.1 requires that systems be proportionally balanced and Armstrong supports this requirement. It is also a legal requirement in many North American jurisdictions. Armstrong balancing valves are an excellent solution that complements the use of Armstrong Design Envelope pumps. Armstrong Design Envelope pumps make flow balancing easier and most energy efficient by enabling the pump to operate at a constant reduced speed in lieu of throttling for traditional constant flow designs. For variable flow sensorless design the design point head can be reduced on site by easily changing two keypad parameters to adjust to site conditions.
- Q23** How can the system operate without sensors? How can it know the pressure at the furthest point and adjust accordingly?
- A23** Sensorless pump speed control in variable flow distribution systems with two way valves on the load devices works on four parameters, Power, Speed, Flow and Head. The metering in the pump allows the controller to monitor power input and operation speed. For every power and speed point there is a unique head and flow point. (ie $(P_1, S_1) = (F_1, H_1)$). At the factory every Design Envelope Pump is fully tested and the Power, Speed, Head and Flow parameters are mapped into the control's intelligence. In addition the controller when in **sensorless mode** allows the pump to operate only on the programmed **control curve**. As control valves in the system open and close to meet conditioned space requirements the intelligent design envelope pump constantly vary their output to match the head and flow requirement of the system by monitoring the power input and operation speed. The minimum head of the control curve is set to approximate the pressure required to satisfy the furthest load.
- A complete description is available in the Armstrong technical paper **Armstrong Design Envelope pumping with Integrated Sensorless control**.

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Q24 Do Design Envelope solutions need commissioning?

A24 Yes Design Envelope solutions need commissioning by authorized and factory trained locally available service personnel. While Armstrong Design Envelope solutions are designed to ensure commissioning is minimal, easy to do and very quick, due to the uniqueness of the technology and final site dependent adjustments to optimize the operation, commissioning is recommended. For Design Envelope pumps, the commissioning is typically 30 minutes whereas a constant speed pump typically takes 15 minutes to startup. In addition Design Envelope solutions have features which ensure commissioning is retained. For example sensorless systems require periodical (3 year typical) calibration of the sensor. Design Envelope pumps with sensorless control do not depend on sensors and therefore this periodical calibration of sensors is eliminated.

TORONTO

+1 416 755 2291

BUFFALO

+1 716 693 8813

BIRMINGHAM

+44 (0) 8444 145 145

MANCHESTER

+44 (0) 8444 145 145

BANGALORE

+91 (0) 80 4906 3555

SHANGHAI

+86 21 3756 6696

SÃO PAULO

+55 11 4781 5500