ARMSTRONG

The Armstrong Design Envelope IVS pump or a variable speed drive mounted on a wall

White paper

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Questions on Data Center Cooling Efficiency?
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The Armstrong Design Envelope IVS pump or a traditional pump with variable frequency drive mounted on a wall?

FIG. 1 Armstrong Design Envelope IVS pump

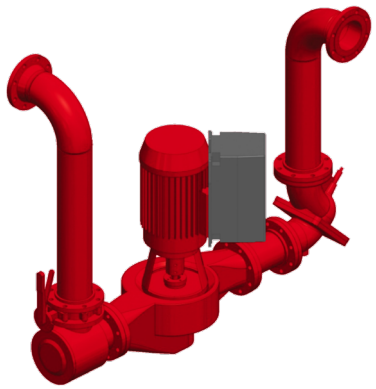
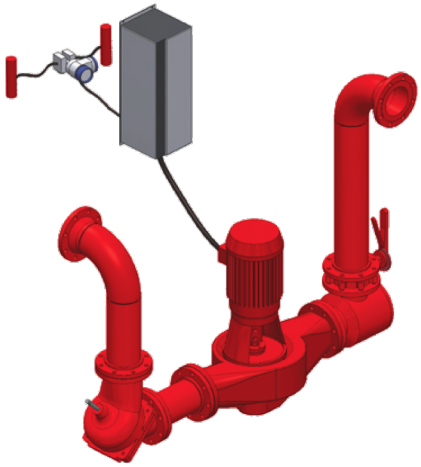


FIG. 2 Traditional pump with variable frequency drive mounted on a wall



The Armstrong Design Envelope IVS pump is a unique solution available with integrated controls up to 350 HP / 250 kW. Configuring a pumping solution to use integrated controls has many advantages over a traditional pump controlled by a variable frequency drive mounted on a wall. These advantages include:

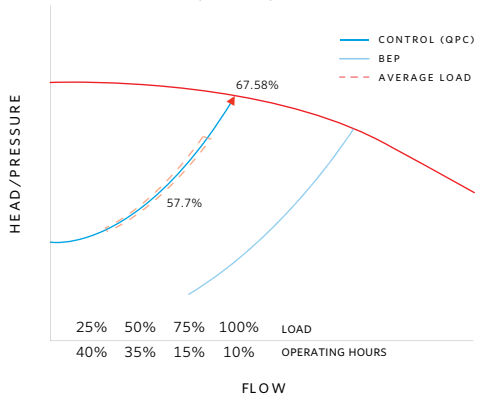
Design Envelope IVS advantages

1 Selections save energy and cost
2 Impeller trim saves energy and cost
3 Superior control
4 Smaller size motor and control
5 Wiring VFD mounting bracket savings
6 Harmonic distortion
7 Emission and immunity requirements
8 Reflected wave voltage
9 Envelope selection reduces risk and cost
10 Energy metering capability
11 Saves wall space

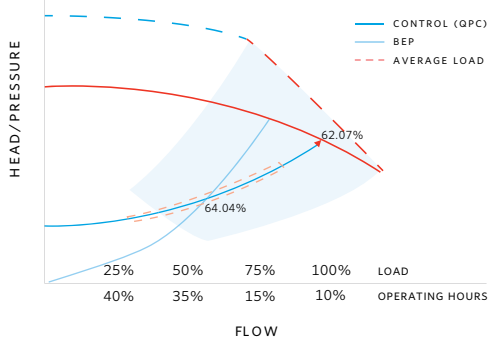
DESIGN ENVELOPE IVS PUMP SELECTIONS SAVE ENERGY AND COST

Design Envelope IVS pumps are selected to minimize energy costs over a typical HVAC load profile. This generally results in pump selections with the design point located to the right of the best efficiency point (BEP) so that during part-load (where the pump operates the majority of the time), the pump operates at higher efficiencies near the center of the curve. A traditional pump selection ignores energy costs over the HVAC load profile and often does not meet the modern requirements of building codes such as ASHRAE 90.1. **A Design Envelope selection is often smaller and in a typical example saved 7% in pump cost and 9% in energy costs.**

TRADITIONAL PUMP WITH DESIGN POINT TO LEFT OF BEP



DESIGN ENVELOPE IVS PUMP WITH DESIGN POINT TO THE RIGHT OF BEP

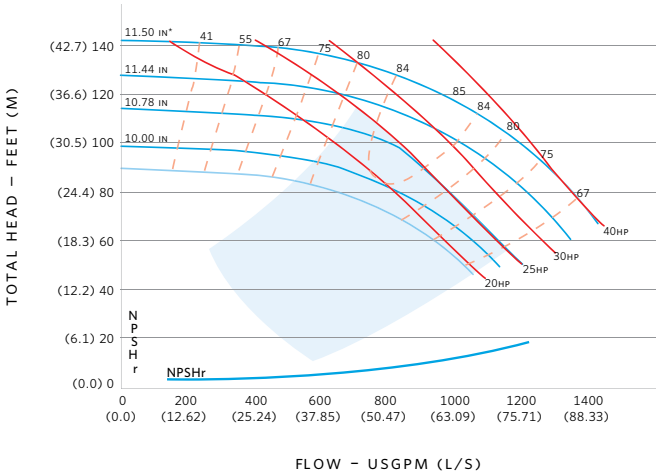


DESIGN ENVELOPE IVS IMPELLER TRIM SAVES ENERGY AND COST

Design Envelope IVS pumps have their impellers trimmed to optimize efficiency and capacity by using the load limiting ability of the controls. Where a traditional pump is trimmed to the customer's design point, the impeller in a Design Envelope selection are generally trimmed at the BEP point for a power draw matching the motor size,. This offers two key benefits:

I. This increases the capacity of the pump by up to 10% such that a smaller pump can be selected for a portion of the range.

II. By using a larger impeller trim and reducing speed to meet the customer's design point, **the Design Envelope IVS pump can be over 5% more efficient.**



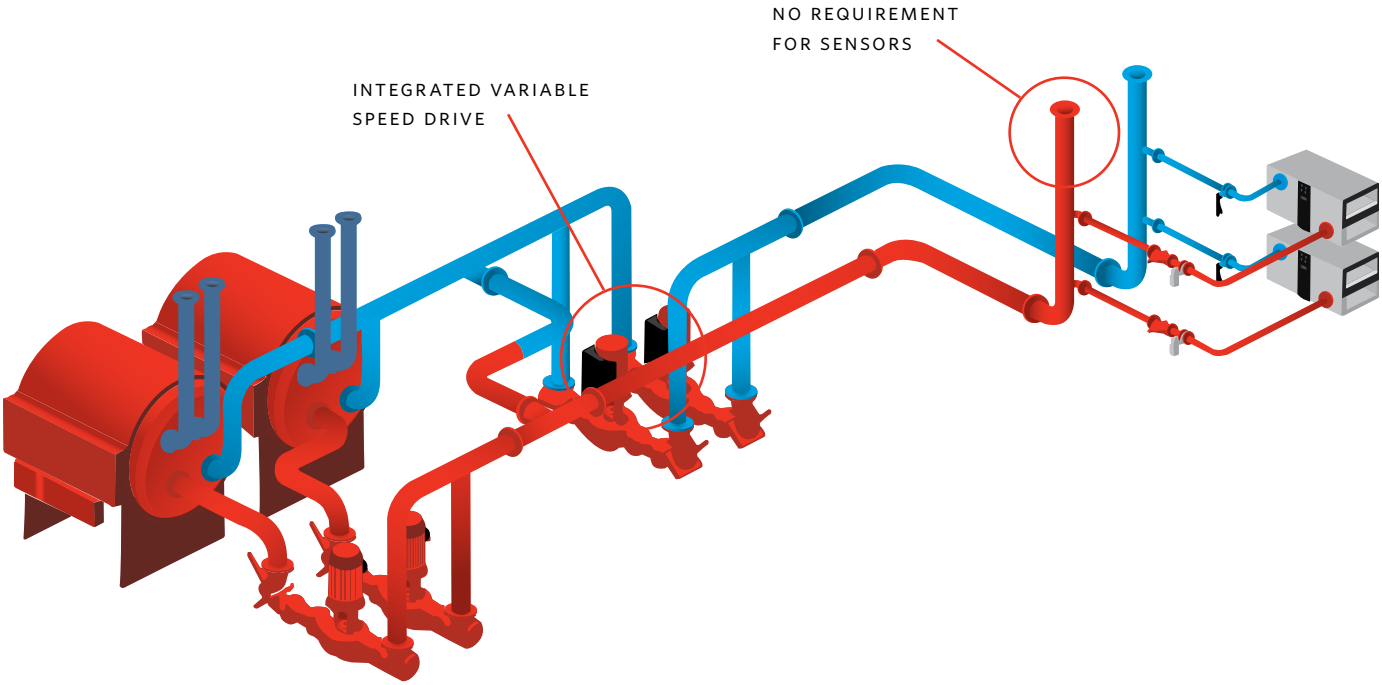
SUPERIOR CONTROL

For duty / stand by applications in which one pump operates alone at any given time, Sensorless control is available. Sensorless control enables a pump to decrease or increase speed to match system requirements without any external signal. Customer values include:

I. Energy savings equivalent to placement of a sensor across the most remote heat exchanger, typically saving 49% more energy than a sensor in the mechanical room

II. **Cost savings of $2000 in installation, wiring, and sensor costs**

III. Easy adjustment and trouble-shooting at the pump, as opposed to at the remote sensor in the building. Simplified commissioning alone is estimated to save $600 per pump

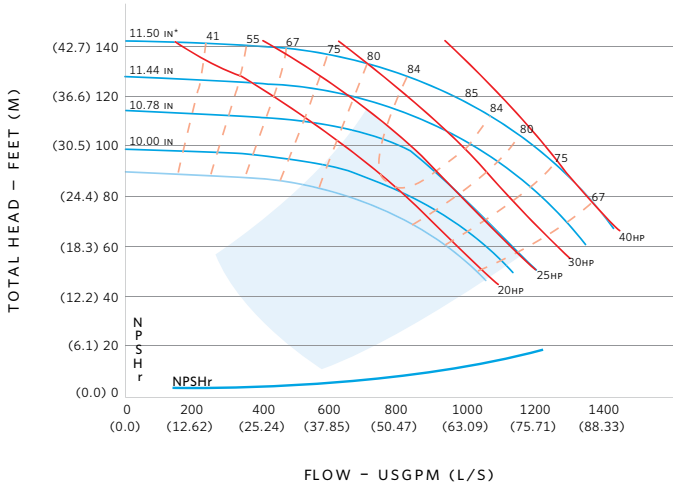


The pump flow and head is available visually on the control keypad read out and digitally when using the LONWorks communication protocol. Many customers appreciate how this flow readout can eliminate the need for an expensive flow meter.

Pump specific control functions and menus – generic variable frequency drives are used in many different applications including pumps, fans, material handling, lifts etc. Design Envelope IVS pumps use integrated controls specifically for pumping applications. The integrated controls can display real-time load and even differential pressure settings when available from the customer pre-set to the site requirement. Menu interfaces and instructions are factory programmed for the pumping units which result in quicker, easier commissioning and energy efficient operation.

SMALLER SIZE MOTOR AND CONTROL

Traditional pumps are selected for non-overloading power to the end of curve, which often results in using larger motor and controls than necessary for the design point. Furthermore, if a bypass is installed on the drive then the motor must be oversized for situations in which the bypass is activated and the motor is operating at full speed. Design Envelope pumps are selected such that they maximize the motor's full capability while the controls use electronic load limiting logic to prevent overloading. This typically results in a smaller size motor and control. In the example below, a duty point of 900 gpm at 90 ft results in a 25 HP /20 kW versus a 30 HP /25 kW motor selection. The cost savings between a 25 HP / 20 kW and a 30 HP / 25 kW motor and drive is 9%.



WIRING AND VFD MOUNTING BRACKET SAVINGS FROM THE DRIVE ON THE WALL TO THE PUMP

Wiring and VFD mounting bracket savings from the drive on the wall to the pump – As the control is integrated with the pumping unit there is no power wiring required from the drive mounted on a wall to the pumping unit. For a pump with 40HP motor and controls, the savings are estimated to be $340 per pump.

HARMONIC DISTORTION

A Harmonic distortion is directly proportional to motor size. As described above, motor selections for Design Envelope IVS pumps are generally smaller than selections for fixed speed pumps. Harmonic distortion is reduced by 16.6% between a 25 HP / 20 kW versus a 30 HP / 25 kW motor.

B Design Envelope IVS pump controls include built-in DC line reactors. If a drive on a wall is installed without built in DC line reactors, an external AC line reactor often must be installed. The external AC line reactor requires space and a 10 HP is estimated to cost $500.

EMISSION AND IMMUNITY REQUIREMENTS

Design Envelope IVS pumps include RFI filters to ensure compliance to low emission and immunity requirements EN61800-3 to the 1st environment class CI (EN55011 unrestricted sales class B). Wall-mounted drives often do not include these and must be provided as an extra.

REFLECTED WAVE VOLTAGE

If the distance between the motor and the control is long; a standing wave can form between the motor and control. These waves can increase the voltage at the motor terminals causing the motor to fail prematurely. Locating the control near the motor can prevent this problem.

DESIGN ENVELOPE SELECTION REDUCES RISK AND COST

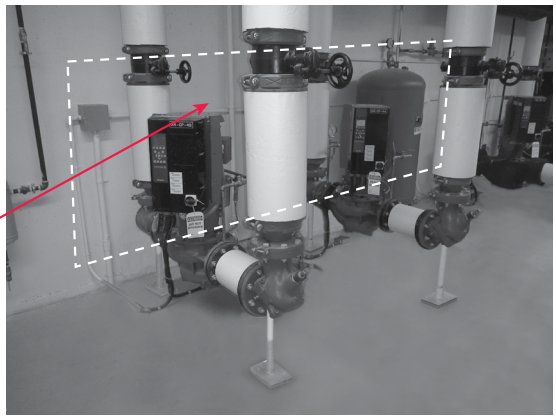
Pumping selections can change many times during a typical construction project. After the building is occupied, the load changes many times during the building life due to exterior exposure changes and building use changes. Design Envelope IVS pumps are selected for a large envelope of efficient operation. This envelope typically covers changes during design, construction and operation. Traditional pumps are selected for a specific design point and impellers are trimmed to that point. With fixed speed pumps, load changes usually involve a change in impeller trim and sometimes even motor sizing resulting in engineering time to specify the changes and the cost of equipment changes. On a recent major installation it was estimated that **Design Envelope IVS pumps avoided schedule delays and saved $25,000 during the construction phase alone due to the ability to accommodate changes to the building load.**

ENERGY METERING CAPABILITY

Design Envelope IVS pumps incorporate the ability to record and cumulate pumping unit energy consumption. Normal wall-mounted drives do not have this ability.

SAVES WALL SPACE

Wall space is as valuable as floor space! Using Design Envelope IVS pumps with integrated controls means valuable wall real estate is not used. Equipment can be positioned closer to the mechanical room perimeter because the walls are kept clear. Also it is often not possible to mount wall drives in the optimum location and wiring costs are increased due to longer distances.



Conclusion: The Armstrong Design Envelope IVS Pump offers many advantages over a traditional pump with a wall-mounted VFD. The key advantages are cost savings, reduced harmonics, energy savings, reduced design work and improved control.

Other Armstrong reference materials include:

1. June 2011 Engineering visit power points
   - Edmonton Airport case study
   - Meet IEEE 519 Harmonics
   - Meet ASHRAE 90.1 and 189.1

2. **Value Proposition Sheet** – VIL with wall-mounted drive vs. Armstrong Design Envelope IVS pump (documents a 25% savings in installed cost)

The Armstrong DE IVS pump or a variable speed drive mounted on a wall

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