**Design Envelope 4200H & 4280**

File No: 100.192

Date: June 14, 2018

Supersedes: 100.192

Date: January 17, 2018

Typical Specifications

ARMSTRONG GUIDE NOTE: This master specification section includes ARMSTRONG GUIDE NOTEs identified as “ARMSTRONG GUIDE NOTE” for information purposes and to assist the specification writer in making appropriate decisions. The ARMSTRONG GUIDE NOTE always immediately precedes the text to which it is referring. The section serves as a guideline only and should be edited with deletions and additions to meet specific project requirements.

ARMSTRONG GUIDE NOTE: This specification section follows the recommendations of the Construction Specifications Institute, Project Resource Manual including MasterFormat™, SectionFormat™, and PageFormat™. Optional text is indicated by square brackets [ ]; delete the optional text including the brackets in the final copy of the specification. Delete the ARMSTRONG GUIDE NOTEs in the final copy of the specification. Trade/brand names with appropriate product model numbers, styles and types are used in ARMSTRONG GUIDE NOTEs and in the specification text Article or Paragraph titled “Acceptable Material”.

1. GENERAL
	1. SUMMARY OF WORK
2. This Section specifies single stage, single suction type, [split coupled] [close coupled] horizontal end-suction design pumps with integrated intelligent controls.
	1. RELATED REQUIREMENTS

ARMSTRONG GUIDE NOTE: Include in this Paragraph only those sections and documents that directly affect the work of this section. If a reader of this section could reasonably expect to find a product or component specified in this section, but it is actually specified elsewhere, then the related section number(s) should be listed in the Paragraph below. Do not include Division 00 Documents or Division 01 Sections since it is assumed that all technical sections are related to all project Division 00 Documents and Division 01 Sections to some degree. Refer to other documents with caution since referencing them may cause them to be considered a legal part of the Contract. Edit the following paragraphs to suit specific project conditions.

* + 1. Section [23 05 29 – Hangers and Supports for HVAC Piping and Equipment: pump supports].
		2. Section [23 05 48 – Vibration and Seismic Controls for HVAC: vibration isolation and seismic restraints].
		3. Section [26 05 00 – Common Work Results for Electrical: electrical connections].

ARMSTRONG GUIDE NOTE: In the following Article, include only those reference standards which appear in the finished version of the project specification.

* 1. REFERENCE STANDARDS
		1. American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME).
			1. ANSI/ASME B16.5- [2009], Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.
		2. American National Standards Institute/International Electrical Commission (ANSI/IEC).
			1. IEC 60529- [2004], Degrees of Protection Provided by Enclosures (IP Code).
		3. American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE).
			1. ASHRAE 90.1- [2007], Energy Standard for Buildings except Low-Rise Residential Buildings.

ARMSTRONG GUIDE NOTE: The following standard is ANSI approved and is co-sponsored by the US Green Building Council and the Illuminating Engineering Society of North America.

* + - 1. ASHRAE 189.1P- [2009], Standard for the Design of High-Performance Green Buildings except Low-Rise Residential Buildings.
		1. ASTM International (ASTM).
			1. ASTM A48/A48M- [2003 (2008)], Standard Specification for Gray Iron Castings.
			2. ASTM A536- [1984 (2009)], Standard Specification for Ductile Iron Castings.
			3. ASTM A582/A582M- [2005], Standard Specification for Free-Machining Stainless Steel Bars.
			4. ASTM B584- [2011], Standard Specification for Copper Alloy Sand Castings for General Applications.
		2. CSA International (CSA).
			1. CAN/CSA STD C22.2 No.108- [2014], Liquid Pumps.
		3. German Institute for Standardization **(**DIN).
			1. DIN EN 61800-3- [2004], Adjustable Speed Electrical Power Drive Systems - Part 3: EMC Requirements and Specific Test Methods.
		4. Institute of Electrical and Electronics Engineers (IEEE).
			1. IEEE 519- [1992],Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.
		5. National Electrical and Manufacturers Association (NEMA).
			1. NEMA MG-1 Standard- [2009, Revision 2010], Motors and Generators, Revision 1.
		6. Underwriter’s Laboratories (UL).
			1. UL STD 778- [2011], Motor-Operated Water Pumps.
		7. US Green Building Council (USGBC).
			1. LEED® NC Version 2.2- [2009], LEED (Leadership in Energy and Environmental Design): Green Building Rating System Reference Package for New Construction and Major Renovations
		8. Office of Statewide Health Planning and Development (OSHPD)
		 Facilities Development Division – Pre-Approval Programs
		 OSHPD Special Seismic Certification Preapproval (OSP)
	1. ADMINISTRATIVE REQUIREMENTS
		1. Co-ordination: Co-ordinate work of this Section with work of other trades for proper time and sequence to avoid construction delays.
		2. Pre-installation Meeting: Convene pre-installation meeting after Award of Contract and one week prior to commencing work of this Section to verify project requirements, substrate conditions and coordination with other building sub-trades, and to review manufacturer’s written installation instructions.
			1. Comply with Section 01 31 19 ‑ Project Meetings and co-ordinate with other similar pre‑installation meetings.
			2. Notify attendees 2 weeks prior to meeting and ensure meeting attendees include as minimum:
				1. Owner;
				2. Consultant;
				3. Mechanical Subcontractor;
				4. Manufacturer’s Technical Representative.
			3. Ensure meeting agenda includes review of methods and procedures related to hydronic pump installation including co-ordination with related work.
			4. Record meeting proceedings including corrective measures and other actions required to ensure successful completion of work and distribute to each attendee within 1 week of meeting.

ARMSTRONG GUIDE NOTE: Article below includes submittals of relevant data to be furnished by Contractor.

* 1. ACTION AND INFORMATIONAL SUBMITTALS
		1. Make submittals in accordance with Contract Conditions and Section 01 33 00 ‑ Submittal Procedures.
		2. Product Data: Submit product data including manufacturer’s literature for hydronic pump, controls, components and accessories, indicating compliance with specified requirements and material characteristics.
			1. Submit list on pump manufacturer’s letterhead of materials, components and accessories to be incorporated into Work.
			2. Include pump performance curves indication where project pumps appear in curve range with pre-defined performance envelope showing optimum efficiency region.
			3. Include product names, types and series numbers.
			4. Include contact information for manufacturer and their representative for this Project.
			5. Include information on costs for wiring of pump to motor, and wiring pump mounted (internal/external) or remotely mounted differential pressure sensor(s). Also include costs for piping and commissioning of differential pressure sensor(s).
		3. Shop Drawings: Submit shop drawings indicating dimensions and materials for pump components and controls.
			1. Show pump and control enclosure dimensions on shop drawings.
			2. Include control system wiring diagrams.
		4. Test Reports:
			1. Submit test reports with each Design Envelope pump showing compliance with specified performance characteristics and physical properties including structural performance by conducting a vibration sweep over the speed range, while still in the test rig piping.
			2. Test reports shall also detail the accuracy of the controls flow and head readout, compared with the test rig calibrated instruments. .
		5. Field Reports: Submit manufacturer’s field reports within 3 days of each manufacturer representative’s site visit and inspection.
		6. Sustainable Design (LEED).
			1. LEED Submittals: In accordance with Section [01 35 21 – LEED Requirements].
		7. Installer Qualifications:
			1. Submit [verification of manufacturer’s approval of installer] [letter verifying installer’s experience with work similar to work of this Section].
	2. CLOSEOUT SUBMITTALS
		1. Operation and Maintenance Data: Supply maintenance data including marked performance curves for each hydronic pump for incorporation into manual specified in Section 01 78 00 ‑ Closeout Submittals.

ARMSTRONG GUIDE NOTE: If LEED is not a part of the project delete the following Paragraph in its entirety.

* + 1. Sustainable Design Closeout Documentation (LEED).
			1. Provide calculations on end-of-project recycling rates, salvage rates, and landfill rates for work of this Section demonstrating percentage of construction wastes which were recycled.
			2. Submit verification from recycling facility showing receipt of materials.
		2. Record Documentation: In accordance with Section 01 78 00 ‑ Closeout Submittals.
			1. List materials used in hydronic pump work.
				1. Include marked up performance curves for each pump.
			2. Warranty: Submit warranty documents specified.
	1. QUALITY ASSURANCE
		1. The pump shall be an intelligent variable speed pumping unit with on-board controls and power converter, integrated by the manufacturer in the factory, including assembly, wiring, programming and testing. Sensorless control data, for each suitable pumping unit, shall be mapped in the integrated controls using tested performance measurements for each specific pump. Actual flow reading on site, from the pump, is to be available digitally for the BMS and on the pump local keypad. The use of catalog data for pump control data mapping will not be acceptable.
		2. The complete pumping unit assembly shall be [Underwriter’s Laboratories listed and carry 3rd party UL778 approval] [CSA listed and carry 3rd party CSA C22.2 No 108-14 approval)
		3. Sustainability Standards Certification (LEED).
			1. LEED NC Version 2.2 submittals: In accordance with Section [01 35 21 ‑ LEED Requirements].
		4. The complete pumping unit assembly shall Office of Statewide Health Planning and Development (OSHPD) Special Seismic Certification Preapproval (OSP)
		5. A test report shall accompany each pumping unit shipped to site. The test report shall contain:
			1. Test compliance with specified performance characteristics and physical properties including structural performance by conducting a vibration sweep over the speed range, while still in the test rig piping.
			2. Test reports shall also detail the accuracy of the controls flow and head readout, compared with the test rig calibrated instruments.

ARMSTRONG GUIDE NOTE: The following Article although not part of Quality Assurance, can be used to enhance the quality of materials by ensuring that they are delivered and handled properly at the work site.

* 1. DELIVERY STORAGE AND HANDLING
		1. Delivery and Requirements:
			1. Deliver material in accordance with Section 01 61 00 Common Product Requirements.
			2. Deliver materials and components in manufacturer’s original packaging with identification labels intact and in sizes to suit project.
				1. Include manufacturer's name, job number, pump location, and pump model and series numbers on identification labels.
		2. Storage and Handling Requirements: Store materials off ground and protected from exposure to harmful weather conditions and at temperature conditions recommended by manufacturer.
			1. Exercise care to avoid damage during unloading and storing.
			2. Leave pump port protection plates in place until pumps are ready to connect to piping.
			3. Do not place cable slings around pump shaft or integrated control enclosure.
		3. Packaging Waste Management:

ARMSTRONG GUIDE NOTE: For smaller projects that do not have a separate Section for waste management and disposal, delete the following paragraph.

* + - 1. Separate and recycle waste packaging materials in accordance with Section 01 74 19 Construction Waste Management and Disposal.
			2. Remove waste packaging materials from site and dispose of packaging materials at appropriate recycling facilities.

ARMSTRONG GUIDE NOTE: For smaller projects that do not have a Waste Management Plan, delete the option referring to a Waste Management Plan.

* + - 1. Collect and separate for disposal paper and plastic material in appropriate on-site storage containers for recycling [in accordance with Waste Management Plan].
	1. FIELD CONDITIONS

ARMSTRONG GUIDE NOTE: To avoid the controls unit getting overheated, the ambient temperature is not to exceed 113°F / 45°C when installed at sea level. Operating in higher ambient temperatures will require de-rating of the pumping unit. Verify maximum temperatures with manufacturer for elevations other than sea level.

* + 1. Ambient Temperature: [113°F] [45°C] daily average at [sea level] [up to [3,300 feet] [1,000m] above sea level].
		2. Relative Humidity: [95] % maximum.
	1. WARRANTY
		1. Project Warranty: Refer to Contract Conditions for project warranty provisions.
		2. Manufacturer’s warranty: Submit, for Owner’s acceptance, manufacturer’s standard warranty document executed by authorized company official. Manufacturer’s warranty is in addition to and not intended to limit other rights Owner may have under Contract Conditions.

ARMSTRONG GUIDE NOTE: Coordinate article below with manufacturer’s warranty requirements. Note that Armstrong’s Design Envelope units carry an 18 months warranty from date of shipment, or 12 months from date of installation, whichever comes first. To receive an additional 6 months of standard coverage, Owner may register the pump unit at www.armstrongfluidtechnology.com/warrantyregistration

* + 1. 1.10.3. Warranty period: [18] months from date of shipment, or [12] months from date of installation, whichever comes first. To receive an additional [6] months of standard coverage, Owner may register the pump unit at <http://armstrongfluidtechnology.com/registration>
1. PRODUCTS

ARMSTRONG GUIDE NOTE: Included in this section are specification items for [2] similar pump types in that they are both end suction units with similar hydraulic performance for each pump size. The 4200H series describes a split-coupled shaft design which allows mechanical seals to be removed without disturbing the pump, motor or controls. (Recommended for above 7.5hp motors) The 4280 series contain close-coupled pumps where the mechanical seal can be serviced without disturbing the casing connections (Recommended for 7.5hp and smaller motors).

* 1. MANUFACTURER
		1. Armstrong Fluid Technology, 23 Bertrand Avenue, Toronto, Ontario, M1L 2P3, Canada, Phone: (416) 755‑2291, FAX: (416) 759-9101, e-mail: info@armstrongfluidtechnology.com, URL: [www.armstrongfluidtechnology.com](http://www.armstrongfluidtechnology.com).
		2. Armstrong Fluid Technology, 93 East Avenue, North Tonawanda, New York, 14120-6594, U.S.A, Phone: (716) 693-8813, FAX: (716) 693-8970, e-mail: info@armstrongfluidtechnology.com, URL: [www.armstrongfluidtechnology.com](http://www.armstrongfluidtechnology.com).
	2. DESCRIPTION
		1. Single stage, single suction type, end-suction horizontal design intelligent variable speed, self-regulating pump.
			1. Seals: [4200H Split-coupled] serviceable without disturbing motor or piping connections] [4280 Close-coupled] serviceable without disturbing piping connections.
			2. Include casing drain plug and ¼ inch suction and discharge gauge ports.
			3. Controls:
				1. Power converter
				2. Power harmonics regulation
				3. Graphic users interface
				4. Serial communication
				5. Demand based feed-forward control
		2. Acceptable Material: ARMSTRONG, [Design Envelope 4200H Pump] [Design Envelope 4280 Pump].
	3. DESIGN CRITERIA
		1. Design pump for variable flow, constant flow or constant pressure applications and selected for hydraulic design conditions and minimum system pressure with [sensorless demand based control] [pressure sensor across most remote load] [BMS control/IPS control panel].

ARMSTRONG GUIDE NOTE: Use the following paragraph for variable flow applications Sensorless control or IPS control panel / BMS control. (Note that constant flow or constant pressure applications can also be served by intelligent controls operating at appropriate speed to match actual system head [Constant Flow] or system flow [Constant pressure]) Pump head can be specified at design conditions and maximum head capability at design flow for the specific pump selected. The maximum head is displayed on the selection software pump curve and it could be specified that the data be detailed on submittals.

* + - 1. Select hydraulic design conditions and minimum maintained pressure with [sensorless load control] [pressure sensor across most remote load].
			2. For Sensorless control the operating control curve shall be [quadratic with adjustable minimum system pressure setting] [constant pressure] [Constant flow] [not operative to allow BMS or IPS control panel operation]

ARMSTRONG GUIDE NOTE: Use the following paragraph [2.3.2] only for the quadratic operating control curve option in 2.3.1.2

* + 1. Meet or exceed energy saving requirements of ASHRAE 90.1 by pump selection, based on optimum performance at part load, to save 70% of design flow energy at 50% part-load.
		2. Supply pumping units with Office of Statewide Health Planning and Development (OSHPD) Special Seismic Certification Preapproval (OSP)
		3. Design pumps to UL STD 778 & CSA STD C22.2 No.108.
		4. Pump Operating Conditions:
			1. Pump head: [\_\_\_\_\_\_] minimum [\_\_\_\_\_\_] maximum capability.
			2. Pump capacity: [\_\_\_\_\_\_] minimum [\_\_\_\_\_\_] maximum capability.

ARMSTRONG GUIDE NOTE: Use [100 psig at 300°F / 175 psig at 140°F] [7bar at 150°C / 12bar at 60°C] pressure / temperature range for ANSI/ASME Class 150 flanged piping systems. [175 psig at 140°F] [12bar at 60°C] for lower temperatures and [100 psig at 300°F] [7bar at 150°C] maximum for fluid temperatures higher than 140°F/60°C

ARMSTRONG GUIDE NOTE: Use [275 psig at 300°F / 375 psig at 100°F pressure] [19bar at 150°C / 26bar at 38°C] temperature range for ANSI/ASME Class 300 flanged piping systems. [375 psig at 100°F] [26bar at 38°C] for lower temperatures and [275 psig at 300°F] [19bar at 150°C] maximum for fluid temperatures higher than 100°F/38°C

* 1. MATERIALS

ARMSTRONG GUIDE NOTE: Use Cast iron casing for ANSI/ASME Class 150 flanged piping systems and ductile iron casing for ANSI/ASME Class 300 flanged piping systems.

* + 1. Casing: [Cast iron to ASTM A48, Class 30] [Ductile iron ASTM A536].
			1. Test casing to 150 % maximum working pressure. [Sect 2.3.4]
			2. Ensure casing is radially split to allow for removal of rotating element without disturbing pipe connections.
			3. Drill and tap casing for gauge ports on both inlet and outlet connections.
			4. Drill and tap casing on bottom at lowest point for drain port.
		2. Impeller: ASTM B584, bronze, [Stainless Steel] fully enclosed and dynamically balanced to ANSI G6.3 and fitted to shaft with key. Use two-plane balancing when installed impeller diameter is less than 6 times impeller width.
		3. Pump Shafts:
			1. [4200H] Split Coupled: Stainless steel to ASTM A582/A582M, Grade 416.
			2. [4280] Replaceable Shaft Sleeve: Stainless steel to ASTM A276, Type 316

ARMSTRONG GUIDE NOTE: Use the following paragraph for 4200H split coupled pumps only. Note that rigid couplings allow simple and quick seal replacements and maintain permanent shaft alignment. NO FIELD SHAFT ALIGNMENT IS NECESSARY ON ARMSTRONG DE 4200H pumping units

* + 1. Coupling: Rigid spacer type, high tensile aluminum.
			1. Design coupling for easy removal on site to reveal space between pump and motor shaft.
				1. Ensure revealed space is sufficient for removal of mechanical seal components without disturbing pump, motor or controls
			2. Include an OSHA compliant coupling guard.
			3. Include a seal flush line from the pump discharge and a seal chamber throttle bushing to ensure seals maintain positive cooling and lubrication.

ARMSTRONG GUIDE NOTE: Use the following paragraph where extra seal chamber cleanliness is required. Note that a sediment separator requires a minimum of 70ft / 30psig / 2bar pump differential head to provide effective operation

* + - 1. Include sight flow indicator in the flush line to the mechanical seal with a [50-micron cartridge filter to suit system working pressure] [maintenance- free sediment separator]

ARMSTRONG GUIDE NOTE: Flanges are suitable for the following system pressures with ambient temperature fluid: ANSI 125 rating is suitable to 175psig / 12bar; ANSI 250 is suitable to 375psig / 25bar

* + 1. Flanges: To ANSI/ASME B16.1, Class [125] [250].
		2. Flush Line: ⅜ inch braided stainless steel complete with air vent.
		3. Gasket: Synthetic fiber.

ARMSTRONG GUIDE NOTE: Select split-coupled seal options for DE 4200H and close coupled seal options for DE 4280. For split-coupled pumps in most HVAC applications specify Type AB2, outside balanced seals.

For Armstrong seal details visit: http://armstrongfluidtechnology.com/~/media/documents/specifications/submittal-data/4300-vertical-in-line-vil-single-pumps/43-50\_mechanical\_seal\_data\_submittal.pdf?la=en

* + 1. Mechanical Seal: [Potable] [Non-potable], Type AB2 outside balanced and rated to [potable] 200°F / 93°C [non-potable] 300°F / 150°C maximum.

ARMSTRONG GUIDE NOTE: Use the following five paragraphs only when specifying close-coupled pumps. Delete the paragraphs if close-coupled pumps are not included in the project.

ARMSTRONG GUIDE NOTE: Specify seal rotating face as resin bonded carbon for potable and general non-potable water systems to 200°F / 93°C. For non-potable higher temperature to 300°F / 150°C specify Antimony loaded carbon and for glycols above 30% concentration by weight and / or abrasives above 2000ppm, specify Sintered Silicon Carbide.

* + - 1. Rotating face: [Resin bonded carbon] [Antimony loaded carbon] [Sintered Silicon Carbide].
			2. Stationary seat: Sintered Silicon Carbide
			3. Secondary seal elastomer: [Viton® to 200°F / 93°C] [Aflas to 300°F / 150°C]
			4. Spring: Stainless steel.
			5. Rotating hardware: Stainless steel.
		1. Baseplate
			1. Align the rigid coupled pump rotating assembly onto a rigid fabricated steel baseplate
			2. Baseplate must be designed to ANSI/HI I.3.5.7 rigidity standards for free-standing bases
			3. Lifting points must be marked on the baseplate for installers’ use
	1. MOTOR
		1. NEMA Premium® Motor: To ANSI/NEMA MG 1
			1. Horsepower: [\_\_\_\_\_\_] HP.
			2. Enclosure: TEFC.
			3. Efficiency: NEMA Premium Efficiency to NEMA MG-1 table 12.12
			4. Power supply: [208V] [230V] [460V] [575V], 60 Hertz, 3-phase or 230 V, 60 Hertz, 1-phase input power to 7.5hp
	2. PUMP CONTROLS AND POWER UNIT

ARMSTRONG GUIDE NOTE: All integrated controls need a minimum of UL type12/IP54 enclosure as water splashes may occur.

* + 1. The intelligent pumping unit shall comply with the following control and electrical design criteria:
		2. Enclosure rating shall be UL type12/IP54 minimum rating complete with [fused disconnect switch and] menu-driven graphical interface.
			1. Provide near unity displacement power factor (cosØ) without need for external power factor correction capacitors at all loads and speeds using VVC-PWM type integrated controls
				1. Incorporate DC link reactors for reduction of mains borne harmonic currents and DC link ripple current to increase DC link capacitor lifetime.
				2. On 3-phase units fit RFI filters as standard to ensure integrated controls meets low emission and immunity requirements.

ARMSTRONG GUIDE NOTE: Controls with saturating (non-linear) DC link reactors shall require an additional 3% AC line reactor to provide acceptable harmonic performance at full load, where harmonic performance is most critical.

* + - * 1. Ensure additional 3% AC line reactor is available for controls with saturating (non‑linear) DC link reactors.

ARMSTRONG GUIDE NOTE: If minimum maintained system pressure (Equivalent to a remote sensor setting) is not known, default to 40% of design head.

* + - 1. On-board controls shall enable minimum system pressure to be maintained: [\_\_\_\_\_\_] [feet][kPa] minimum.

ARMSTRONG GUIDE NOTE: Armstrong pump controls support [Default setting] BACnet™ MS/TP, BACnet™ TCP/IP, and Modbus RTU.

* + - 1. Serial communication shall enable: [BACnet™ MS/TP] [BACnet™ TCP/IP] [Modbus RTU]
			2. On-board speed control shall allow override by a BAS/BMS control signal.
			3. On-board controls shall enable [Manual pump control] [Closed loop PID control]
			4. EMI/RFI Power Quality Control shall include an integrated filter designed to DIN EN61800-3.

ARMSTRONG GUIDE NOTE: The IVS intelligent variable speed drive is a low harmonic drive via built-in DC line reactors. This does not guaranty performance to any system wide harmonic specification or the costs to meet a system wide specification. If supplied with the system electrical details, Armstrong will run a computer simulation of the system wide harmonics. If system harmonic levels are exceeded Armstrong can also recommend additional harmonic mitigation and the costs for such mitigation.

* + - 1. Harmonic Power Quality suppression: Shall include a Dual DC-link reactor (Equivalent: 5% impedance AC line reactor) to mitigate harmonics to support IEEE 519 system requirements.
			2. Programmable skip Frequencies and adjustable switching frequency for noise and vibration control.
			3. Cooling: Internal fans shall provide the necessary cooling with quiet operation of less than 50dba at 1-meter.
			4. Ambient working conditions: [14°F to 113°F] [-10°C to 45°C] 24-hr average, up to [3300ft] [915m] above sea level.
			5. Analog I/O: 2 Current or voltage inputs minimum, 1 speed output.
			6. Digital I/O: 2 inputs programmable, 2 programmable outputs.
			7. Pulse inputs: 2 programmable minimum.
			8. Relay outputs: 2 programmable minimum.
			9. Communications ports: 1- RS485.
			10. One volt free contact.
			11. Auto alarm reset.
		1. Control algorithms must ensure software can be configured through the pump graphical user interface for sensorless speed control including automatic speed control in variable volume systems without need for pump mounted (internal/external) or remotely mounted differential pressure sensor.
			1. Operating mode under sensorless speed control: Quadratic Pressure Control (QPC).
				1. Ensure head reduction with reducing flow conforms to quadratic control curve.
				2. Head at zero flow: [40] % minimum of design duty head and is to be adjustable.
			2. Linear or Proportional Pressure Control without sensor is unacceptable.
			3. Ensure control mode setting and minimum/maximum head setpoints are user adjustable using built-in programming interface.
			4. Ensure integrated control software is capable of controlling pump performance for non-overloading power at every point of operation.
			5. Ensure the pumping unit is capable of flow rate display and serial communication data output of ±5% accuracy to BAS/BMS.
			6. Ensure the Pumping unit can display and digitally transmit real-time flow values.

ARMSTRONG GUIDE NOTE: The following paragraph may contribute towards LEED credits. Energy metering capability could replace an energy meter

* + 1. Include energy monitoring log function to ASHRAE 189.1P.
		2. For parallel pump configuration, the pumping units shall be capable of [duty/standby] [parallel Sensorless best efficiency staging by ensuring the optimal number of running pumps].

ARMSTRONG GUIDE NOTE: The following refers to Parallel Sensorless Pump Control (Best efficiency staging program) and should be deleted if not applicable.

* + 1. Parallel pump staging will be provided without the use of BAS/BMS or speed/ frequency based staging, these shall not be acceptable. The pump mounted intelligent controller shall be used for best efficiency staging up to 4-pumps.
		2. Parallel pump speed control shall be performed without the need for differential pressure sensors in the mechanical room or remotely installed in the system.
		3. The Parallel Sensorless Pump Control will have in-built redundancy features including:
			1. ‘Daisy-chained’ power connection to each pump controller
			2. No external power source will be allowed
			3. Controller ‘offline’ operational protection preventing loss of system flow

ARMSTRONG GUIDE NOTE: The following refers to optional Energy Performance Bundle and should be deleted if not applicable. Provides energy savings on oversized systems by adjusting pump parameters to on-site conditions. Includes Auto-Flow Balancing and Maximum Flow Control functions. Open all valves and use the Auto-Flow Balancing function to tune the pump to on-site system conditions. Only available if sensorless control is enabled.

* + 1. Energy Performance Bundle: [Yes] [No]
			1. Auto-flow balancing - Automatically determines control curve between design flow at on-site system head, and minimum (zero-head) flow for energy savings
			2. Maximum flow control – Limits flow rate to pre-set maximum for potential energy savings

Maximum flow rate: [\_\_\_\_\_\_] [gpm] [L/s]

ARMSTRONG GUIDE NOTE: The following refers to optional Protection Bundle and should be deleted if not applicable. Protects other flow sensitive equipment by setting limits of pump operation.

* + 1. Protection Bundle: [Yes] [No]
			1. Minimum flow control – Attempts to maintain flow rate to pre-set minimum to protect equipment in system

Minimum flow rate: [\_\_\_\_\_\_] [gpm] [L/s]

* + - 1. Bypass valve control – Actuates a bypass valve to protect flow sensitive equipment if pre-set minimum flow rate is reached

ARMSTRONG GUIDE NOTE: The following refers to optional Zone Optimization Bundle and should be deleted if not applicable. Controls pumps to ensure multiple zones are satisfied for heating or cooling.

* + 1. Zone Optimization Bundle: [Yes] [No]
			1. 2 Sensor Control – Controls pumps in a 2-zone application to ensure both zones are always satisfied for heating or cooling

ARMSTRONG GUIDE NOTE: The following refers to optional Dual Season Setup and should be deleted if not applicable. Pre-sets heating and cooling parameters for pumps in 2-pipe systems.

* + 1. Dual Season Setup [Yes] [No]
			1. Cooling Design Flow: [\_\_\_\_\_\_] [gpm] [L/s]
			2. Cooling Design Head: [\_\_\_\_\_\_] [feet] [psig] head
			3. Cooling minimum system pressure to be maintained: [\_\_\_\_\_\_] [feet] [psig] head
			4. Heating Design Flow: [\_\_\_\_\_\_] [feet] [psig] head
			5. Heating Design Head: [\_\_\_\_\_\_] [feet] [psig] head
			6. Heating minimum system pressure to be maintained: [\_\_\_\_\_\_] [feet] [psig] head
	1. PUMP MOTOR AND CONTROLS PROTECTION
		1. Include protection as follows:
			1. Motor phase to phase fault.
			2. Motor phase to ground fault.
			3. Loss of supply phase.
			4. Over voltage.
			5. Under voltage.
			6. Motor over temperature.
			7. Inverter overload.
			8. Over current
		2. The pumping unit shall have automatic motor adaptation (AMA) for superior motor protection and control in response to the changing conditions.
		3. The pumping unit shall have automatic energy optimization (AEO) to maximize energy consumption reduction at part load operation
	2. FACTORY FABRICATION
		1. The pumping unit onboard controls and power converter shall be installed at the factory for use with BAS/BMS for energy logging to ASHRAE 189.1P.
		2. The pumping unit controls shall be program configured for each pump before the pump leaves factory.
			1. Install vent flush line in factory.
				1. Ensure vent flush line runs from seal chamber to pump discharge.
			2. The pumping unit shall be marked with coordinated identification of sub-components, including the casing and power unit and controls.
	3. ACCESSORIES
		1. Pipe Flanges: To ANSI/ASME B16.5, Class [150] [300].
		2. Hangers and Supports: in accordance with Section [23 05 29 – Hangers and Supports for HVAC Piping and Equipment].

ARMSTRONG GUIDE NOTE: Use the following paragraph only when vibration isolators or isolation pads are deemed absolutely necessary to meet unique project requirements. S.A. Armstrong recommends piping system designs that do not require vibration or isolation pads for inline pumps.

* + 1. Vibration isolators, neoprene isolation pads in accordance with Section [23 05 48 – Vibration and Seismic Controls for HVAC].

ARMSTRONG GUIDE NOTE: Use the following paragraph if required by seismic criteria applicable to project location.

* + 1. Seismic restraint in accordance with Section [23 05 48 – Vibration and Seismic Controls for HVAC].
		2. Suction Diffuser: For [ANSI 150 flange and ANSI 125 pump flange] [grooved pipe and ANSI 125 pump flange] [ANSI 300 flange and ANSI 250 pump flange].

ARMSTRONG GUIDE NOTE: Specify SG for ANSI 150 Flange, SGG for Grooved Pipe and SGHH for ANSI 300 flange.

* + - 1. Acceptable Material: ARMSTRONG, [SG] [SGG] [SGHH].

ARMSTRONG GUIDE Note: Armstrong recommends using FTVs for variable flow applications. There are instances where the pump may operate off the curve. Varying the speed does not bring the duty point back on the pump curve. In these cases, throttling may be required. Normally the Flo-Trex valve throttling feature would NOT be used or only with constant speed pump applications as sanctioned by ASHRAE 90.1

* + 1. Triple Duty Valve: [Cast grey] [Ductile] iron valve body, tight shut-off, spring -closure type silent non-slam check valve with effective throttling design capability.
			1. Valve stem: Stainless steel with flat surfaces for adjustment with open-end wrench.
			2. Acceptable Material: ARMSTRONG, Model FTV Flo-Trex Combination Valve
			3. Valve must be capable of drip-tight isolation, non-slam check and throttling features
		2. Pressure Gauges: 4½ inch diameter sized to meet system pressure requirements.
	1. PRODUCT SUBSTITUTIONS
		1. Substitutions: [In accordance with Section 01 23 13 - Product Substitution Procedures] [No substitutions permitted].
			1. Ensure materials and installation costs are supplied by single manufacturer.
1. EXECUTION
	1. INSTALLERS
		1. Use only installers with 2 years minimum experience in work similar to work of this Section.
	2. EXAMINATION
		1. Verification of Conditions: Verify that conditions of piping previously installed under other Sections or Contracts are acceptable for pump installation in accordance with manufacturer’s written recommendations.
			1. Visually inspect piping, piping configuration and piping location in presence of Consultant.
			2. Inform Consultant of unacceptable conditions immediately upon discovery.
			3. Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant.
	3. PREPARATION
		1. Weld pipe flanges to piping system for installation of pump.
			1. Ensure suction and discharge pipe flanges are aligned and square to pipe.
	4. INSTALLATION

ARMSTRONG GUIDE NOTE: Note that Design Envelope pumps are always supplied with controls and power converters and, as such, have inherent soft-start and typically operate at lower than maximum frequency; thus do not require the ‘normal’ 3-times pumping unit weight inertia base. Lighter vibration mounts or vibration pads will be suitable for these pumping units

* + 1. Install pumps level in accordance with pump manufacturer’s written recommendations.
			1. Support pumping unit on the specified foundation using vibration isolation mounts or neoprene isolation pads to meet project conditions in accordance with Section [23 05 48 – Vibration and Seismic Controls for HVAC].
			2. Ensure there is no strain imposed on pump flanges. Flexible pipe connectors must be used to connect the pump connections to the piping

ARMSTRONG GUIDE NOTE: Use the following paragraph if required by seismic criteria applicable to project location.

* + - 1. Use seismic restraint to meet project conditions in accordance with Section [23 05 48 – Vibration and Seismic Controls for HVAC].
		1. Install Flo-Trex valve after recommended length of spool piece on discharge connection from pump.
		2. Install suction guides on pump suction connection.
		3. Install pressure gauges on suction and discharge pump connections.
		4. Install hangers and supports in accordance with Section [23 05 29 – Hangers and Supports for HVAC Piping and Equipment].
			1. Adjust hangers and supports after pump is installed to ensure proper support.
		5. Align pipe flanges with pump flanges and bolt together in accordance with pump manufacturer’s written recommendations.

ARMSTRONG GUIDE NOTE: A sensor is not acceptable in the mechanical room. The costs and labor for wiring to the most remote load and the sensor itself should be incorporated. If the controls are not integrated to the pumping unit, additional wiring material and wiring installation will be required.

* + 1. Connect pumps and integrated control system to electrical distribution system to IEEE regulations and with authority having jurisdiction in accordance with Section [26 05 00 – Common Work Results for Electrical].

ARMSTRONG GUIDE NOTE: Use the following paragraph when a sensor at the most remote load condition is to be used.

* + - 1. Include wiring to most remote sensor in system where applicable.
				1. Do not run pumps dry to check rotation.
	1. FIELD QUALITY CONTROL
		1. Field Inspection: Coordinate field inspection in accordance with Section [01 45 00 - Quality Control].

ARMSTRONG GUIDE NOTE: Specify requirements if manufacturers are to provide field quality control with onsite personnel for instruction or supervision of product installation, application, erection or construction. Manufacturer field reports are included under PART 1, Action and Informational Submittals.

* + 1. Manufacturer’s Services:

ARMSTRONG GUIDE NOTE: Use the following Paragraphs only when manufacturer’s field services are provided and are required to verify the quality of the installed components. Establish the number and duration of periodic site visits required by manufacturer and specify below. Consult manufacturer for services required. Delete if field services are not required.

* + - 1. Coordinate manufacturer’s services with Section [01 45 00 - Quality Control].
				1. Have manufacturer review work involved in handling, installation, protection, and cleaning of hydronic pumps and components, and submit written reports in acceptable format to verify compliance of Work with Contract conditions.
			2. Manufacturer’s Field Services: Provide manufacturer’s field services consisting of product use recommendations and periodic site visits for product installation review in accordance with manufacturer’s instructions.
				1. Report any inconsistencies from manufacturer’s recommendations immediately to Consultant.
			3. Schedule site visits to review work at stages listed:
				1. After delivery and storage of pumps, controls and components, and when preparatory work on which Work of this Section depends is complete, but before installation begins.
				2. Upon completion of Work, after cleaning is carried out.
				3. Obtain reports within three days of review and submit immediately to Consultant.
	1. COMMISSIONING
		1. Validate alignment, rotation, motor current draw, flows and pressures in accordance with Section [23 08 00 – Commissioning of HVAC].

ARMSTRONG GUIDE NOTE: The following refers to optional On-site commissioning and should be deleted if not applicable. An Armstrong Representative shall assist in setting up pump communication to the BAS (does not include physical wiring), adjust the pump parameters to on-site conditions, and perform warranty registration of pumps. The Armstrong Representative shall set up the router and connection of multiple pumps to the network and internet.

* + 1. On-site commissioning of Design Envelope Pumps and Pump Manager [Yes] [No]
	1. CLEANING

ARMSTRONG GUIDE NOTE: For smaller projects that do not have a separate Division 01 Section for cleaning, delete the reference to Section 01 74 00 – Cleaning in the following two Paragraphs.

* + 1. Progress Cleaning: Perform cleanup as work progresses [in accordance with Section 01 74 00 - Cleaning and Waste Management].
			1. Leave work area clean end of each day.
		2. Final leaning: Upon completion, remove surplus materials, rubbish, tools, and equipment [in accordance with Section 01 74 00 – Cleaning and Waste Management].
		3. Waste Management:
			1. Co-ordinate recycling of waste materials with 01 74 19 - Construction Waste Management and Disposal.
			2. Collect recyclable waste and dispose of or recycle field generated construction waste created during construction or final cleaning related to work of this Section.
			3. Remove recycling containers and bins from site and dispose of materials at appropriate facility.
	1. PROTECTION
		1. Protect installed products and components from damage during construction.
		2. Repair damage to adjacent materials caused by hydronic pump installation.

ARMSTRONG GUIDE NOTE: The following refers to Pump Manager. A performance management service (under the industry category of automated fault detection and diagnostics) to remotely and automatically track and help manage pump performance with analytic and diagnostic Alerts, web assessible trends and automated reports available to the building end user/owner. Pump Manager helps sustain optimal performance and efficiency, minimize unexpected failures and provide predictable maintenance costs. An option for a discount on Extended Warranty for the corresponding pumps is available with a Pump Manager subscription.

* + 1. Pump Manager [building owners are to go to
		<http://armstrongfluidtechnology.com/registration> to activate].

END OF SECTION 23 21 23 – HYDRONIC PUMPS