**Design Envelope Tango 4322 & 4372**

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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, vertical inline 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 ½ 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- [2001 (R2010)], 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.
	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.
			3. Include product names, types and series numbers.
			4. Include contact information for manufacturer and their representative for this Project.
				1. 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. Sustainable Design (LEED).
			1. LEED Submittals: In accordance with Section [01 35 21 – LEED Requirements].
		6. 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 and controls shall be integrated by the manufacturer in the factory, including assembly, wiring, programming and testing. Sensorless data, for all suitable pumping unit, shall be mapped in the integrated controls using tested performance measurements for each specific pump. Actual flow reading on site is to be available digitally for the BMS and on the controls local touchscreen. The use of catalog data for Sensorless data mapping will not be acceptable.
		2. The complete pump and control package shall be Underwriter’s Laboratories listed and carry UL778 approval
		3. Sustainability Standards Certification (LEED).
			1. LEED NC Version 2.2 submittals: In accordance with Section [01 35 21 ‑ LEED Requirements].
		4. 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 the temperature rating of the controls unit when installed at sea level. Operating in higher ambient temperatures will require derating of the controls unit. Verify maximum temperatures with manufacturer for elevations other than sea level.

* + 1. Ambient Temperature: [113 °F] [45°C] maximum at [sea level] [up to [3,300 feet] above sea level]. Refer to I&O Manual for specific temperature rating by frame size.
		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. 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 Tango units, which allows [2] pumps in a common casing to be operated for parallel operation or duty / standby applications, with a single pipe connection. The 4322 series describes a split-coupled shaft design which allows mechanical seals to be removed without disturbing the pump, motor or controls. (Recommended for above 5hp motors) The 4372 series contain close-coupled pumps where the mechanical seal can be serviced without disturbing the in-line casing (Recommended for 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, Tango vertical inline design pump with integrated intelligent controls. The cast casing with equal size suction and discharge flanges, each having separate tapped flush line and pressure gauge connections, shall incorporate two radially split, single stage centrifugal pumps.
			1. The inlet and outlet ports on the casing shall be a common size, so that both units may operate in parallel or individually in duty / standby operation
			2. The discharge port shall be fitted with a component that allows each unit to operate independently, without bypassing fluid through the idle pump and for duty / standby operation
			3. Mechanical Seals: [Split-coupled] [close-coupled] serviceable without disturbing [motor, controls or piping connections] [piping connections]
			4. Include casing drain plug at the lowest point in the casing
		2. Acceptable Material: ARMSTRONG, [Design Envelope 4322] [Design Envelope 4372]
	3. DESIGN CRITERIA
		1. Design pump for variable flow applications and selected for hydraulic design conditions and minimum system pressure with [sensorless load Demand Based control] [pressure sensor across most remote load] [IPS control panel / BMS control].

ARMSTRONG GUIDE NOTE: Use the following paragraph for variable flow applications Sensorless or IPS control panel / BMS control. (Note that constant flow applications can also be served by intelligent controls operating at reduced speed to match actual system head)

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] [constant pressure] [not operative to allow BMS or IPS control panel operation]
		1. Meet or exceed energy saving requirements of ASHRAE 90.1 [2010] [2013] by pump selection, based on optimum performance at part load, to save 70% of design flow energy at 50% part-load
		2. Design pumping units to UL STD 778 & CSA STD C22.2 No.108
		3. Pump Operating Conditions:
			1. Pump head: [\_\_\_\_\_\_] minimum [\_\_\_\_\_\_] maximum capability.
			2. Pump capacity: [\_\_\_\_\_\_] minimum [\_\_\_\_\_\_] maximum capability.

ARMSTRONG GUIDE NOTE: Use 175 psig at ≤150°F and 140 psig at 250°] for ANSI/ASME Class 150 flanged piping systems

[175 psig at 150°F] for lower temperatures and [140 psig at 250°F] maximum for fluid temperatures higher than 150°F

ARMSTRONG GUIDE NOTE: Use 250 psig at ≤150°F and 250 psig at 250°F for ANSI/ASME Class 300 flanged piping systems.

[250 psig at 150°F] for lower temperatures and [250 psig at 250°F] maximum for fluid temperatures higher than 150°F

* 1. MATERIALS

ARMSTRONG GUIDE NOTE: Use Ductile iron grade 65-45-12, e-coated casing for Class 150 flanged piping systems and ductile iron grade 120-90-2 e-coated casing for Class 300 flanged piping systems.

* + 1. Casing: [Ductile iron ASTM A536 Grade 65-45-12, e-coated] [Ductile iron ASTM A536 Grade 120-90-2, e-coated].
			1. Test casing to 150 % maximum working pressure.
			2. Ensure casing is radially split to allow for removal of rotating element without disturbing pipe connections.
			3. Casing wetted surfaces shall be e-coated to prevent seizing of impeller to casing after periods of inactivity
			4. Drill and tap casing for gauge ports on both suction and discharge connections.
			5. Drill and tap casing at lowest point for drain port.
		2. Impeller: To ASTM A743 CF8M, stainless steel 316, 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. [4322] Split-coupled: Stainless steel to ASTM A582/A582M, Grade 416.
			2. [4372] Close-coupled: Steel motor shaft with shaft Sleeve: Stainless steel to ASTM A276, Type 316

ARMSTRONG GUIDE NOTE: Use the following paragraph for DE 4322 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 4322 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, controls or motor.
			2. Include an OSHA compliant coupling guard.
			3. Include lower 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.

* + - 1. Include sight flow indicator in flush line to mechanical seal and [50-micron cartridge filter to suit system working pressure] [maintenance- free sediment separator for pump differential pressures greater than 30 psig].

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

* + 1. Flanges: To ANSI/ASME B16.5, Class [125] [250].
		2. Flush Line: 3/8 inch braided stainless steel complete with vent.
		3. Casing O-ring: EPDM.

ARMSTRONG GUIDE NOTE: Select split-coupled seal options for DE 4322 and close coupled seal options for DE 4372

ARMSTRONG GUIDE NOTE: For split-coupled pumps in most HVAC applications specify Type AB2, outside balanced seals visit <http://www.armstrongpumps.com/Data/submitaldatas/Links/01_01_001/43.50> Mechanical Seal Data.pdf

ARMSTRONG GUIDE NOTE: Specify AB2 type seal with resin bonded carbon rotating face for potable and general non-potable water systems to 200°F. Specify AT-70 type seal with Antimony loaded carbon rotating face for non-potable systems with a temperature >200°F to 300°F. For low or high temperature applications for all glycols above 30% concentration by weight and / or abrasives above 2000ppm specify AT-70 type seal with Sintered Silicon Carbide rotating face

ARMSTRONG GUIDE NOTE: Specify Viton® secondary seal for [AB2] potable and general non-potable water systems to 200°F. For non-potable higher temperature to 300°F specify [AT-70] with Aflas® secondary seal elastomer

* + 1. Mechanical Seal: [Potable] [Non-potable], Type [AB2] [AT-70] outside balanced seal design and rated to [200°F] [300°F] maximum
			1. Rotating face: [Resin bonded carbon] [Antimony loaded carbon] [Sintered Silicon Carbide]
			2. Stationary face: Sintered Silicon Carbide
			3. Seal rotating hardware: Stainless Steel
			4. Secondary / shaft seal elastomer: [Viton®] [Aflas®]

ARMSTRONG GUIDE NOTE: For close coupled pumps specify Type 2A single spring inside seals with Sintered Silicon Carbide stationary seats

ARMSTRONG GUIDE NOTE: Specify 2A type seal with resin bonded carbon rotating face for potable and general non-potable water systems to 200°F. Specify 2A type seal with Antimony loaded carbon rotating face for non-potable systems with a temperature >200°F to 250°F. For low or high temperature applications for all glycols above 30% concentration by weight and / or abrasives above 2000ppm specify 2A type seal with Sintered Silicon Carbide rotating face

* + 1. Mechanical Seal: [Potable] [Non-potable], Type 2A inside single spring seal design and rated to [200°F] [250°F] maximum
			1. Rotating face: [Resin bonded carbon] [Antimony loaded carbon] [Sintered Silicon Carbide]
			2. Stationary face: Sintered Silicon Carbide
			3. Seal rotating hardware: Stainless Steel
			4. Secondary / shaft seal elastomer: EPDM
	1. MOTOR

ARMSTRONG GUIDE NOTE: Specify Design Envelope Permanent Magnet Motors with IE5 efficiency for up to 20% operating cost savings over NEMA Premium® Efficiency Table 12.12.

* + 1. Permanent Magnet Motor: To IE5 efficiency
			1. Horsepower: [\_\_\_\_\_\_] HP.
			2. Enclosure: TEFC.
			3. Efficiency: IE5 efficiency To IEC 60034-30-1
			4. Power supply: [200 – 240] [380 -480] [575 - 600] V, [50/60] Hertz
	1. PUMP CONTROLS

ARMSTRONG GUIDE NOTE: All integrated controls need a minimum of UL Type 12 (IP54/55) enclosure as water splashes may occur. For outdoor or perhaps sprinklered space service UL Type 4X (IP66) enclosure is available. UL Type 4X units are supplied with a touchscreen cover to protect the interface from UV degradation, and a weather shield to protect the motor fan from freezing rain or snow.

* + 1. Control: Integrated with UL type 12 minimum enclosure rating, [sensorless] controls complete with [fused disconnect switch] and menu-driven graphical touchscreen interface.
			1. Provide near unity displacement power factor (cos Ø) 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. 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: Minimum maintained pressure for speed control from a remote sensor placement would be the value of the sensor setting. Sensorless control would use that same setting value for the control curve pressure at zero flow. If minimum maintained system pressure is not known, default to 40% of design head.

* + - 1. Minimum system pressure to be maintained: [\_\_\_\_\_\_] [feet] [psig] head

ARMSTRONG GUIDE NOTE: The default for orientation is typically with controls mounted N at discharge flange on plan view. If not convenient for other equipment, motor and controls may be rotated at installation site at any 360˚ orientation provided there are no physical clashes with other equipment – note that the seal flush line may need to be replaced to fit the new orientation.

* + - 1. Orientation: Controls face pump discharge.

ARMSTRONG GUIDE NOTE: Armstrong pump controls support Modbus RTU, BACnet™ MS/TP, and BACnet™ TCP/IP. Contact Armstrong Fluid Technology at info@armlink.com for further information.

* + - 1. Protocol: [BACnet™ MS/TP] [BACnet™ TCP/IP] [Modbus RTU]
			2. Sensorless override for BAS/BMS control signal.
			3. [Manual pump control] [Closed loop PID control]
			4. Enclosure: UL Type [12] [4X]
			5. EMI/RFI Control: Integrated filter designed to DIN EN61800-3.

ARMSTRONG GUIDE NOTE: The Permanent Magnet motor intelligent variable speed drive is a low harmonic drive. This does not guarantee 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 suppression: Equivalent: 5% impedance AC line reactor to mitigate harmonics to support IEEE 519 system requirements.
			2. Cooling: Fan cooled, surface cooling.
			3. Ambient working conditions: [14°F to +113°F], up to [3300] feet above sea level. Refer to I&O Manual for specific temperature rating by frame size.
			4. Analog I/O: 2 inputs minimum, 1 output minimum. Output can be configured for voltage or current.
			5. Digital I/O: 2 inputs minimum, 2 outputs minimum. Outputs can be configured as inputs.
			6. Pulse inputs: 2 programmable minimum.
			7. Relay outputs: 2 programmable minimum.
			8. Communications ports: 1- RS485.
			9. One volt free contact.
			10. Auto alarm reset.
		1. Software: Ensure software for sensorless control includes 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 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.
			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 integrated control software is capable of flow rate display and data output of ± 5% accuracy to BAS/BMS.
			6. Ensure the controls can display and digitally transmit real-time flow & head 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 multiple pump configuration ensure [parallel Sensorless pump control with best efficiency staging] [duty/standby] is applied

ARMSTRONG GUIDE NOTE: The following refers to Parallel Sensorless Pump Control and should be deleted if not applicable. Note that DE 4322 & DE 4372 double pump units may be operated in 2\*50%, 60%, 70%, 80%, 90%, 100% parallel operation. Typically, 2\*50…90% consumes less energy than 2\*100% pumps and provides approximately 80% flow redundancy and higher. 2\*100% is superior over duty/standby operation as it provides 100% redundancy and will operate 2 pumps when advantageous for less energy being consumed.

* + 1. Parallel pump staging will be provided without the use of BAS / BMS. Min / max speed / frequency based staging shall not be acceptable and a locally mounted logic controller shall be used for best efficiency staging.
		2. Parallel pump speed control shall be achieved without the need for differential pressure sensors either in the mechanical room or remotely installed in the system.
		3. The parallel sensorless pump control will have in-built redundancy features including:
			1. Factory installed power connection to each pump controller
			2. 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. Ensure controls run automatic motor adaptation (AMA) for superior motor protection and control.
	2. FABRICATION
		1. Install integrated controls on each pump for use with BAS/BMS for energy logging to ASHRAE 189.1P.

ARMSTRONG GUIDE NOTE: Split-coupled [DE 4322] and close-coupled [DE 4372] are supplied with flush lines. DE 4322 seals are installed in isolated seal chambers and lubricated and cooled by a flush line piped in from the pump discharge. This allows for a clean-up of the flush fluid (See item 2.4.4.4). A vent is necessary on this design to eliminate air blockage of the flush line. Close-coupled [DE 4372] seal flush line evacuates air from the seal area automatically, by being piped to the (Lower pressure) suction area

* + 1. Pre-program integrated intelligent controls for each pump before pump leaves factory.
			1. Install flush / vent line in factory.
				1. Ensure flush / vent line runs from seal chamber to [pump discharge] [pump suction].
			2. Mark pumps and controls with coordinated identification.
	1. 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. Armstrong Fluid Technology 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 paragraphs 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 Class 150 pipe flange and ANSI 125 pump flange] [grooved pipe and ANSI 125 pump flange] [ANSI Class 300 pipe 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 FTV combination / triple duty valves 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 is required. Use the Flo-Trex valve generally only with constant speed pump applications in accordance with ASHRAE 90.1 standards. Specify cast iron for ANSI Class 150 pipe flanges and ductile iron for ANSI Class 300 pipe flanges.

* + 1. Triple Duty Valve: [Cast iron] [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.
		2. Pressure Gauges: 4½inch 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: View DE 4322 & DE 4372 installation and operating instructions (I&O) at: <http://armstrongfluidtechnology.com/en/resources-and-tools/installation-and-maintenance-and-parts/installation-and-operating-instructions>

* + 1. Install pumps level in accordance with pump manufacturer’s written recommendations.
		2. Ensure that pump is pipe-mounted and free to float with any movement, expansion and contraction of piping system.
			1. Support pump using floor mounted saddle as required.
			2. For vertical in-line pumps supported from structure, ensure no pipe strain is imposed on pump flanges.

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

* + - 1. Use vibration isolators, neoprene isolation pads to meet project conditions in accordance with Section [23 05 48 – Vibration and Seismic Controls for HVAC].

ARMSTRONG GUIDE NOTE: Use the following paragraphs 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].
			2. Where pumps are supported entirely by piping system ensure hangers are sized for extra load of pump weight.
		1. Install Flo-Trex valve [after recommended length of spool piece on discharge connection from pump] [vertically after long radius elbow off pump discharge valve]
		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 labour 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 IEE 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