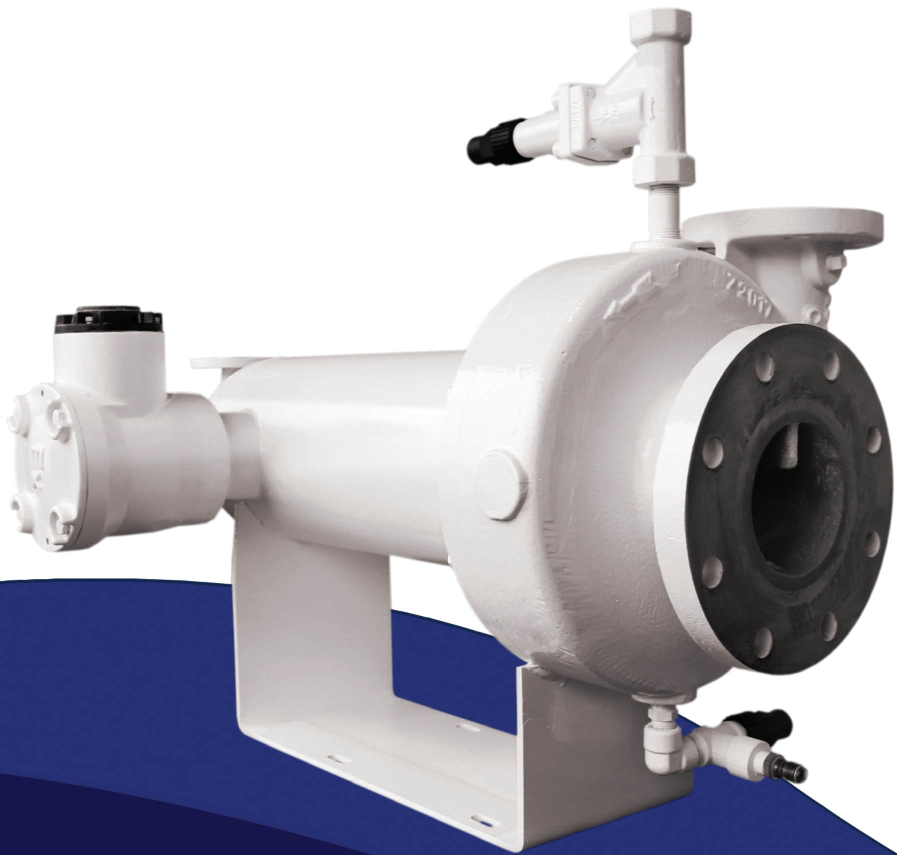
CORNELL

HERMETIC REFRIGERATION PUMPS

TECHNICAL INFORMATION AND INSTALLATION



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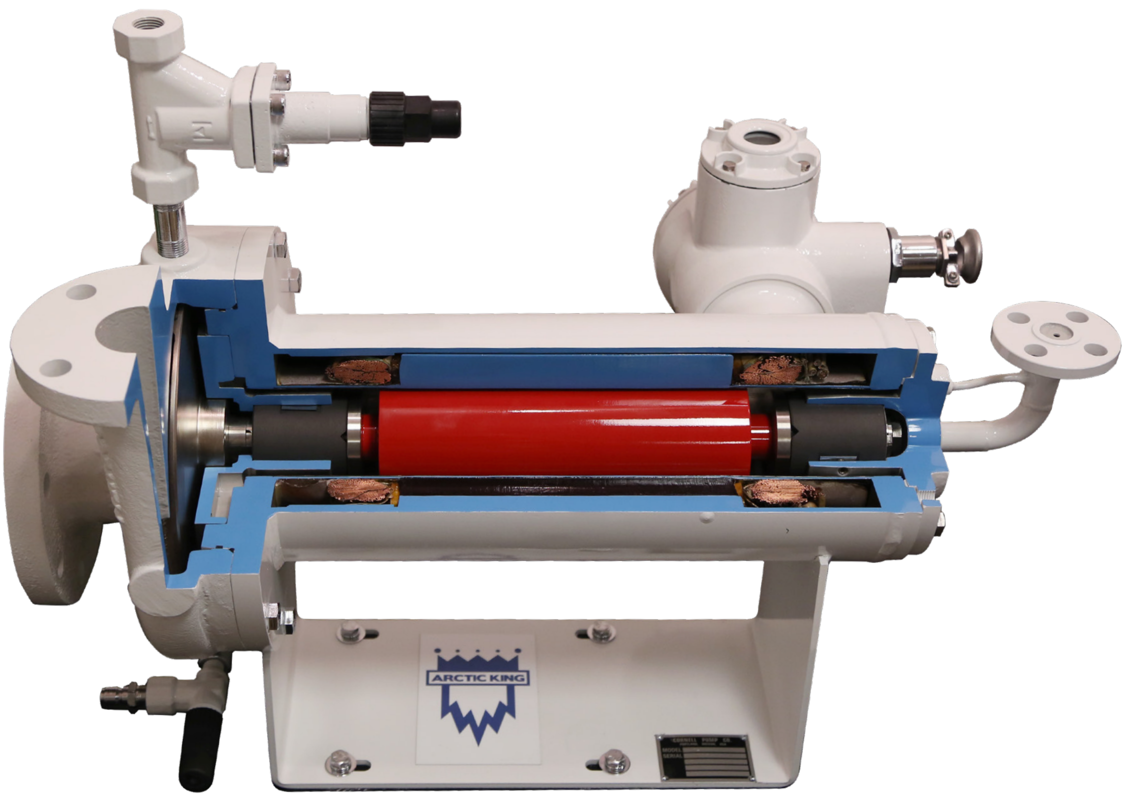


HERMETIC TECHNOLOGY

HT Design

Exceptional NPSHR characteristics are central to Cornell's liquid overfeed and transfer pump innovations. Cornell Pump Company has coupled our extensive refrigerant pump experience with an industry-leading hermetic motor technology. The hydraulic design innovations associated with our standard refrigerant pumps with Refrigerant Emission Free™ Sealing Technology, are exactly the same as the design innovations associated with our hermetic pump products.

Cornell Pump Company has been designing and manufacturing hydraulic refrigerant pumps since 1953. The Arctic King line of semi-hermetic pumps was launched in 2014, and has quickly become the flagship of Cornell's refrigeration pumps. Cornell pump company has continued to make advances in refrigeration pump technology to meet the needs of the industry and improve upon existing designs.

Cornell design enables the use of single stage impellers with large eye areas to minimize the effects of entrained vapor and four pole or six pole operating speed to enhance NPSHR characteristics throughout the entire range of performance.

Hydrodynamic Bearings

Cornell's hermetic pumps maintain a proven and extremely reliable hydrodynamic bearing design. The hydrodynamic bearings employ large grooved channels, which enhances the flow of pumpage throughout the bearing assembly and ensure a free floating non-mechanical interface on the rotating components of the motor, virtually eliminating bearing wear.

The practical and efficient hydrodynamic bearing design does not rely on complex tapered spring loaded bearings and dated design features to compensate for bearing wear. Axial thrust loads are minimized by the incorporation of balance holes during the manufacture of the single stage impeller and axial thrust bearings associated with the hermetic pump. Radial thrust loads are minimized by the incorporation of a modified concentric volute, compact shaft arrangement and minimal dimensional width associated with the single stage impeller.

Double Containment

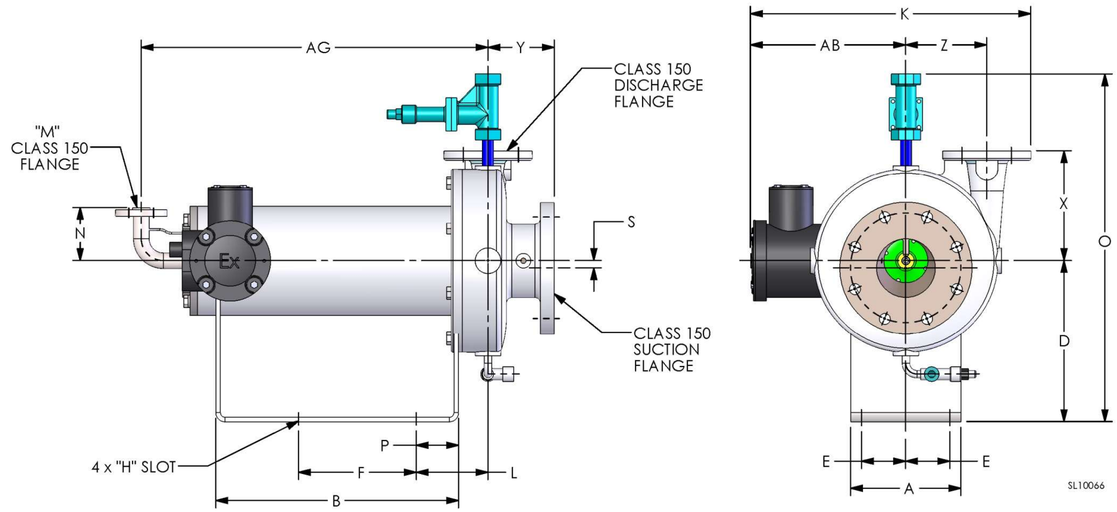
Cornell's hermetic pumps use a stainless steel, reinforced, heliarc welded stator can and hermetically sealed motor casing, providing the security of double containment to ensure a leak free unit. The conduit box is potted eliminating the requirement for condensation drain holes and potential for external leakage due to catastrophic failure of the inner can.

Interchangability

Cornell's hermetic product offering was specifically designed to be interchangeable with our standard refrigerant pumps with Refrigerant Emission Free™ Sealing Technology. Interchangeability is achievable between hermetic and close coupled Cornell refrigerant pumps counterparts as they are flange-to-flange drop in replacements (suction to discharge).

Enhanced Operating Speeds

The Arctic King operates at 1,800 RPM or lower, less than half the speed of other hermetic pumps. This lower speed allows for enhanced NPSHR requirements, longer bearing life, longer motor life, and lower energy consumption.



NOTES: 1. Flange connection dimension can vary ± .12 inch.
2. Do not use for construction unless certified.
3. Overall dimensions can vary ± .12 inch.

PUMP DIMENSIONS																					
			CONNECTION																		
MODEL	HP	RPM	DISCH.	SUCT.	A	AB	B	AG	D	E	F	H	K	L	M	N	O	P	S	X	Y	Z
1.5HT	5	1800	1.5	4	7.5	11.8	16.46	25.29	11	3	8	0.44	21.3	4.73	0.5	3.94	24.88	2.56	0.5	8	4.77	7.0
	7.5	1800	1.5	4	7.5	12.4	17.64	26.39	12.75	3	8	0.44	21.9	4.73	0.5	4.53	26.63	2.56	0.5	8	4.77	7.0
2HT/2HTS	3	1800	2	4	7.5	11.8	13.31	21.91	11	3	8	0.44	20.3	4.5	0.5	3.94	23.35	2.56	0.5	7.5	4.5	5.5
	5	1800	2	4	7.5	11.8	16.46	25.06	11	3	8	0.44	20.3	4.5	0.5	3.94	23.35	2.56	0.5	7.5	4.5	5.5
	7.5	1800	2	4	7.5	12.4	17.64	26.16	11	3	8	0.44	20.9	4.5	0.5	4.53	23.35	2.56	0.5	7.5	4.5	5.5
2.5HT	10	1800	2.5	5	9.5	12.4	17.64	26.95	12.75	4	10	0.75	23.4	5.19	0.5	4.53	26.85	3.25	0.61	9	5.5	7.5
	15	1800	2.5	5	9.5	12.8	19.61	30.55	13.75	4	10	0.75	23.8	5.19	0.75	4.72	27.85	3.25	0.61	9	5.5	7.5
	20	1800	2.5	5	9.5	13.7	21.57	32.52	13.75	4	10	0.75	24.7	5.19	0.75	4.72	27.85	3.25	0.61	9	5.5	7.5
3HT	10	1200	3	6	9.5	12.8	21.57	32.26	13.75	4	10	0.75	25.05	5.57	0.75	4.72	28.75	2.67	0.44	10	7.0	8.5
	15	1200	3	6	9.5	13.5	22.48	35.54	14.5	4	10	0.75	25.75	5.57	1	5.51	29.5	2.67	0.44	10	7.0	8.5
	15	1800	3	6	9.5	12.8	19.61	31.51	13.75	4	10	0.75	25.05	5.57	0.75	4.72	28.75	2.67	0.44	10	7.0	8.5
	20	1800	3	6	9.5	13.7	21.57	33.48	14.5	4	10	0.75	25.95	5.57	0.75	4.72	29.5	2.67	0.44	10	7.0	8.5
	25	1800	3	6	9.5	14.4	21.10	34.16	14.5	4	10	0.75	26.65	5.57	1	5.51	29.5	2.67	0.44	10	7.0	8.5
	30	1800	3	6	9.5	16.5	22.48	35.54	14.5	4	10	0.75	28.75	5.57	1	5.51	29.5	2.67	0.44	10	7.0	8.5
	40	1800	3	6	9.5	16.5	22.48	37.71	15.5	4	10	0.75	28.75	5.57	1	5.51	30.5	2.67	0.44	10	7.0	8.5

2/15/18

CORNELL PUMP COMPANY	HT CLOSE-COUPLED WITH CANNED MOTOR	DIM2233

ARCTIC KING SHIELD
WITH REMOTE BEARING MONITOR

How the Arctic King Shield Protects Your Pump

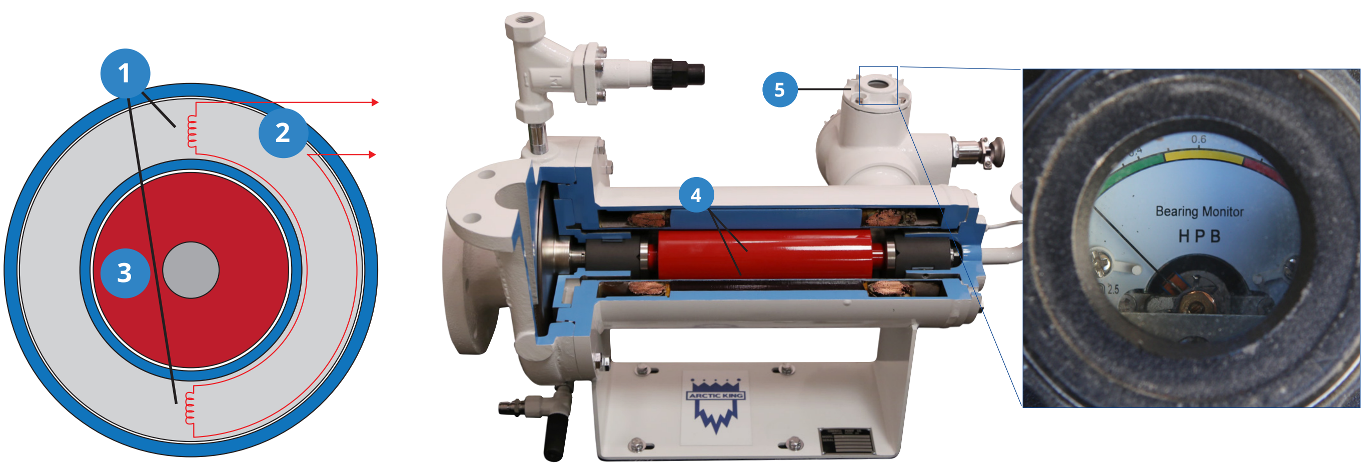
The Arctic King Shield Bearing Monitor allows you to know precisely what's occurring with your system by providing real-time wear detection, monitoring operating clearances, and indicating bearing conditions.

Real-time wear detection allows users to track current conditions and build data-driven preventive maintenance plans.

The Arctic Shield can also indicate lost phase or reverse rotation caused by incorrect wiring.

ARCTIC KING SHIELD PROTECTION	
Radial bearing wear	Identifies and specifies bearing wear during regular pump operation
Lost phase	Indicates lost phase upon start-up due to bad electrical connection or improper wiring
Reverse rotation	Indicates reverse rotation at start-up caused by incorrect wiring

SYSTEM OVERVIEW



1. Two radial sensors are located in the stator slots, at the top and bottom (180° opposing).
2. The system uses the induced voltage principle to detect bearing wear and indicate when maintenance is required.
3. When the rotor is precisely balanced, the magnetic field created by the induced voltage in the system is equal.
4. When bearings start to wear, the gap between the rotor and stator increases.
5. The resulting imbalance creates an induced voltage that is indicated by the bearing monitor.

Start-Up Indicators

Check the Arctic King Shield upon start-up to ensure proper pump installation.

ARCTIC KING SHIELD		INDICATION	ACTION
	Less than .5	Normal	No action required.
	Fluctuating between yellow and red zones	Lost phase or improper connection	Shutdown and fix connections.
	.75 or higher	Rotating wrong direction	Alternate two phases out of three.

Running Indicators

Monitor and record the status of the Arctic King Shield regularly to be aware of bearing condition and plan for maintenance as needed.

ARCTIC KING SHIELD	INDICATION	ACTION
Less than .5	Good	No action required. Continue to monitor and record.
Between .5 and .74	Caution: bearings worn	Disassembly and inspection needed; plan for maintenance.
.75 or higher	Danger: bearings must be replaced	Shutdown and replace worn parts.

Remote 4-20 mA Output

In addition to the local monitor mounted on the pump, the bearing monitor includes a 4-20 mA output that can be connected to an external DCS (distributed control system), PLC (programmable logic controller), or other process control device for monitoring. The output signal is directly related to the local monitor indicator value, and can be used to check bearing condition, improper rotation direction, and lost phase or incorrect connection.

To go along with this, the following can be used for the relationship between the output current and indicator value:

INDICATOR VALUE	OUTPUT CURRENT (MA)
0 - 0.5	4.0 - 9.6
0.5 - 0.75	9.6 - 14.8
0.75 - 1.0	14.8 - 20

INSTALLATION INSTRUCTIONS
HT SERIES REFRIGERANT PUMPS

The purpose of these instructions is to provide information about the proper installation, start-up, and maintenance of Cornell Arctic King HT Series refrigeration pumps. For more detailed instructions, please refer to the operations and maintenance manual that accompanies the pump from the factory.

PUMP INSTALLATION CHECKLIST	
1	Inspect Pump
2	Verify NPSHA is 2' above NPSHR
3	Check piping and support – Temporary Mesh Screen (at start up)
4	Install differential pressure switch (recommended)
5	Install suction vent lines (if applicable)
6	Connect volute vent line (required)
7	Connect bypass line (required) – Adjust Bypass valve (at start up)
8	Install relief valves (recommended)
9	Hook up recirculating line (required)
10	Install gauges and monitors (required)
11	Check discharge pressure (recommended) – At least 15 PSI higher than suction pressure
12	Check and compare minimum and maximum flow thresholds (recommended)

Inspect Pump

Examine pump for freight damage.

Verify NPSHA

Cavitation is a result of inadequate Net Positive Suction Head Available (NPSHA). When the total energy (pressure head and velocity) in the fluid, expressed in head or equivalent pressure, is equal to or less than the vapor pressure of the fluid, vapor is formed and moves with the liquid flow. The vapor bubbles or "cavities" collapse when they reach regions of higher pressure in the pump, which can severely damage motor bearings and pump internals.

To avoid cavitation, the pump must be located a vertical distance below the recirculation vessel's minimum liquid level, by a depth at least equal to the pump's Net Positive Suction Head Required (NPSHR), plus 2 feet. Place the pump as close to the drop leg as is practical while allowing for two to three pipe diameters between the suction stop valve and the pump suction flange. Take into consideration the access requirements for normal servicing.

NPSHA is determined for each system. NPSHR is provided per pump model by Cornell Pump and can typically be found on the pump curve.

Piping Connection and Support

The minimum pump leg diameter should be the same size as the pump suction, but should be sized for an optimum velocity of 2 feet per second. A low loss suction stop valve, such as a full port ball valve, angle valve or butterfly valve, should be located as close to the drop leg as practical and two to three pipe diameters from the pump suction flange. Piping must be lined up squarely so that the pipe flanges and pump flanges are parallel and not offset. Piping must be supported and expansion joints or bends employed, so that strain is not transmitted to the pump. The pump base should be mounted in such a way as to permit removal of the rotating element of the pump without removing the volute from the system piping. Pipe flanges connecting to the pump should be flat-faced and have the same size and rating as those of the pump.

When starting up a new system, a temporary 3/16" mesh screen should be placed at the suction of the pump to catch excess weld shot and other particulates that may be in the system. THIS SCREEN SHOULD BE USED NO LONGER THAN 24 HOURS AFTER START-UP. Operating the pump with a clogged or plugged screen will damage the pump. The screen should be sized to have at least three times the area of the suction pipe.

Differential Pressure Switch

Cavitation can severely damage motor bearings and pump internals. Therefore, it is important to set up controls that will limit cavitation when it occurs. A differential pressure switch (or equivalent control) is recommended to detect cavitation and temporarily stop the pump if cavitation is prolonged. An individual pressure switch should protect each pump.

Suction Vent Lines

Systems with widely or rapidly varying loads, and those using horizontal recirculation vessels should have pump suctions vent lines for limiting vapor entrainment into the pump. The suction vent line should be connected to the top of the suction pipe, just ahead of the pump suction flange. If the suction pipe size is reduced ahead of the pump by means of an eccentric reducer this reducer may be installed with the flat on the bottom. This provides a high point where vapor can be trapped and piped away. The suction vent line should be of at least 1.25-inch diameter and should include a valve for isolation. The suction vent must not be connected to a compressor wet suction and must be connected to the recirculation vessel above the maximum liquid level. A suction vent should not be fed into a volute vent line.

Volute Vent Lines

A 1/2-inch refrigeration duty globe valve is mounted on the top of the pump volute for connection to a vent line. The volute vent line must be connected to the recirculation vessel above the maximum liquid level and should be sloped so that no liquid can become trapped in the line. For best results, the volute vent line should not be connected to a compressor wet suction line or any other line.

Bypass Line

A bypass line is required to maintain a minimum flow through the pump during periods of reduced or zero system liquid demand. The bypass should be connected from the pump discharge, upstream of any check valve, to the recirculation vessel. It may be connected to a compressor wet suction line. The bypass should be at least 3/4-inch diameter and should include an isolation valve for service. The flow through the bypass can be controlled with a throttling valve such as a hand expansion valve, with a fixed orifice or with a constant flow regulating device. If a fixed orifice or flow regulator is to be used, consult Cornell for minimum flow requirement for the particular pump model and application.

Adjustment of bypass valve: Start with the bypass valve completely open. Close the pump discharge stop valve and volute vent valve fully. Slowly close the bypass valve until the pump discharge pressure gauge until unsteady pumping conditions are noted. Slowly open the bypass valve until conditions become stable. Observe the pump long enough to be certain pump operation is stable, then open the discharge stop valve.

Relief Valves

The pump must be protected from over-pressurization by a relief valve in the system set at no higher than 250 PSIG. The pump must not be isolated from this valve while it contains liquid or gaseous refrigerant. During normal operation the recirculation vessel relief valves may serve to protect the pump, but where the pump may be isolated from the vessel while containing refrigerant (such as during preparation for servicing) other relief devices must protect the pump. As a manufacturer of a single component of the refrigeration system Cornell cannot design or dictate the design or installation of relief systems, but as a minimum Cornell recommends adherence to ANSI/IIAR 2-1999 *Equipment, Design and Installation of Ammonia Mechanical Refrigerating Systems*, Section 5.11.1.2, except where this standard is superseded by more stringent standards or code requirements governing the particular site into which the pumps are being installed.

Motor Coolant/Recirculation Line

The back of the motor (non-drive end) has an ANSI Class 150 raised face flange to accommodate a standard flange. An orifice installed in the pump controls the flow through the motor coolant/recirculation line. This connection must be piped back to the recirculation vessel in the same fashion as the volute vent line. It should enter the recirculation vessel above the liquid level and be sloped. The piping must be made so that no liquid can become trapped in the line. The total amount of head in the motor coolant line must be great enough to overcome the friction losses in the piping plus the vapor pressure of the liquid being pumped. See below calculation. A stop valve should be present in the line for isolation when removing the pump for servicing.

$$H = .2 \text{ x } TDH$$

$$H = \text{Maximum recirculation line height(ft)} \\ \text{relative to pump C.L.}$$

$$TDH = \text{Operating head (ft) of the pump}$$

The motor coolant/recirculation line valve and bypass line should be open at all times when the pump is powered. Failure to open these valves prior to pump operation may result in damage to the motor and/or bearings, coolant leakage, and possible serious injury.

Gauges

Install gauge valves on the suction side of the pump between the suction stop valve and pump suction flange and on the discharge side between the pump discharge flange and the first valve (check or stop). When possible, locate the gauge valves at least two pipe diameters away from the pump or the nearest valve, bend or fitting.

Discharge Pressure

The pump discharge must maintain a minimum 15 PSI differential pressure over the pump suction pressure at all times while operating. Failure to maintain this differential will result in inadequate motor cooling and bearing lubrication and may result in damage to the motor and/or bearings, coolant leakage, and possible serious personal injury.

Minimum Flow Threshold

Recirculation is a phenomenon common to all centrifugal pumps, when operated at low capacity. At one half to one third of the best efficiency point (with some exceptions), a secondary flow begins within the impeller, whereby the fluid actually reverses direction and exits the eye and/or enters the discharge. This results in turbulence and small vortices. The high velocity at the core of the vortices results in low pressure, often below the vapor pressure of the fluid, and cavitation may ensue. The bypass line is an effective means to safeguard against insufficient flow. Consequently, bypass capacity should be included within the capacity requirements to enable the end user to achieve the minimum flow requirement for a given refrigeration pump.

Maximum Flow Threshold

Ensure that the maximum flow threshold of the refrigerant pump is not exceeded. The maximum flow threshold is partially influenced by the NPSHA. The pump must be located a vertical distance below the recirculation vessel's minimum liquid level an amount at least equal to the pump's NPSHR plus 2 feet. Moreover, be sure that hand expansion valves are properly set to ensure the refrigerant pump does not exceed the flow design point.

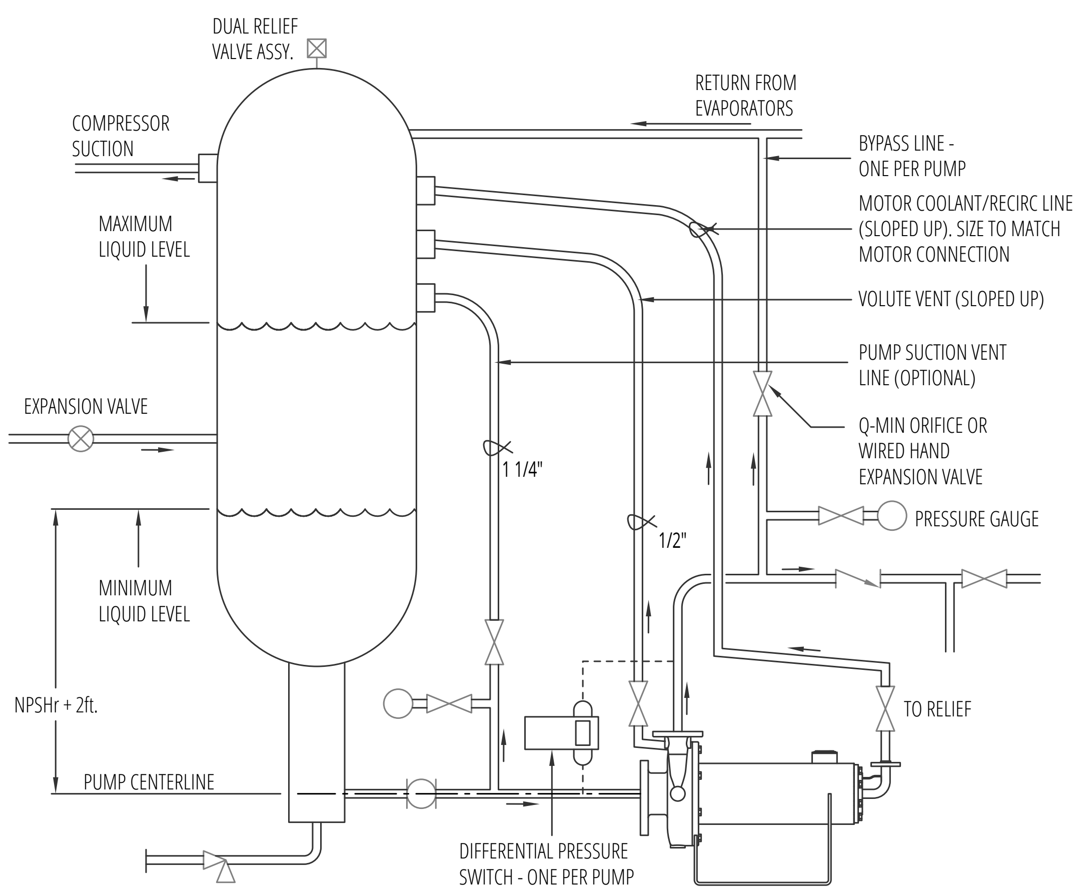
ELECTRICAL SPECIFICATIONS

PUMP MODEL	HP	VOLTAGE	RPM	FULL LOAD AMPS	LOCKED ROTOR AMPS	FRAME SIZE
1.5HT	5	460	1800	8.0	30.8	322
	5	575	1800	6.4	25.1	322
	7.5	460	1800	12.4	50.6	421
	7.5	575	1800	9.5	37.3	421
2HT/ HTS	3	460	1800	5.1	20.3	321
	3	575	1800	4.0	15.4	321
	5	460	1800	8.0	30.8	322
	5	575	1800	6.4	25.1	322
	7.5	460	1800	12.4	50.6	421
	7.5	575	1800	9.5	37.3	421
2.5HT	10	460	1800	15.6	58.6	421
	10	575	1800	12.6	47.6	421
	15	460	1800	21.2	85.4	521
	15	575	1800	16.9	65.4	521
	20	460	1800	30.3	117.8	522
	20	575	1800	22.8	91.4	522

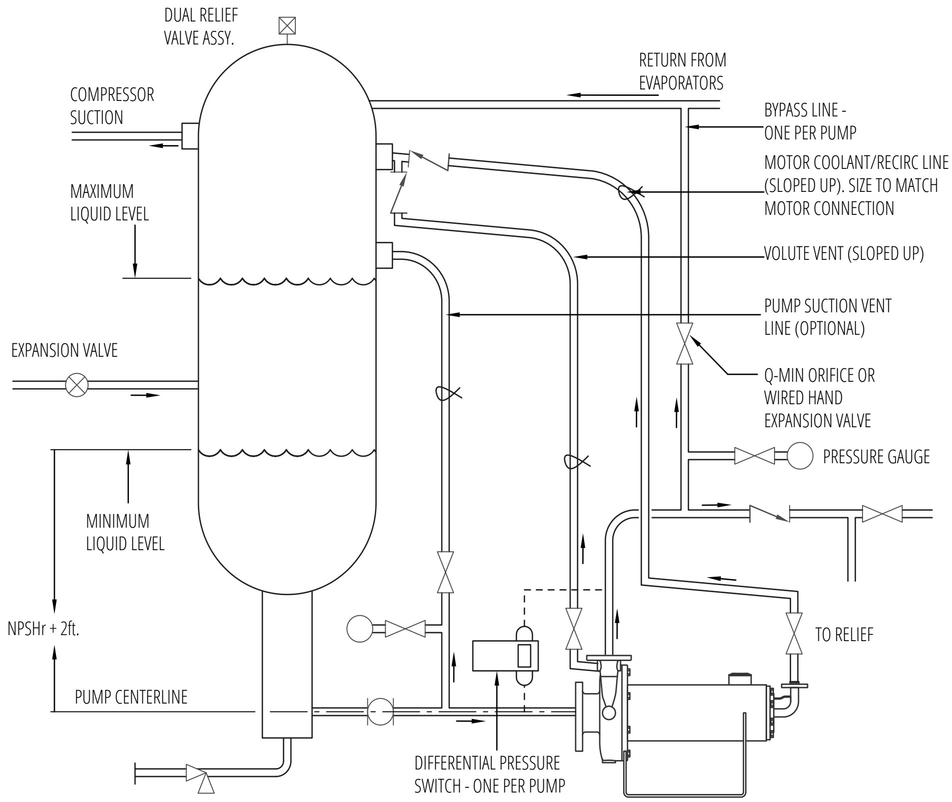
ELECTRICAL SPECIFICATIONS

PUMP MODEL	HP	VOLTAGE	RPM	FULL LOAD AMPS	LOCKED ROTOR AMPS	FRAME SIZE
3HT	10	460	1200	17.5	47.6	532
	10	575	1200	14.1	38.3	532
	15	460	1200	27.8	81.3	632
	15	575	1200	20.2	62.3	632
	15	460	1800	21.2	85.4	521
	15	575	1800	16.9	65.4	521
	20	460	1800	30.3	117.8	522
	20	575	1800	22.8	91.4	522
	25	460	1800	33.5	129.2	621
	25	575	1800	27.0	109.3	621
	30	460	1800	44.3	155.7	622
	30	575	1800	32.0	135.2	622
	40	460	1800	56.0	203.0	624
	40	575	1800	45.0	186.0	624

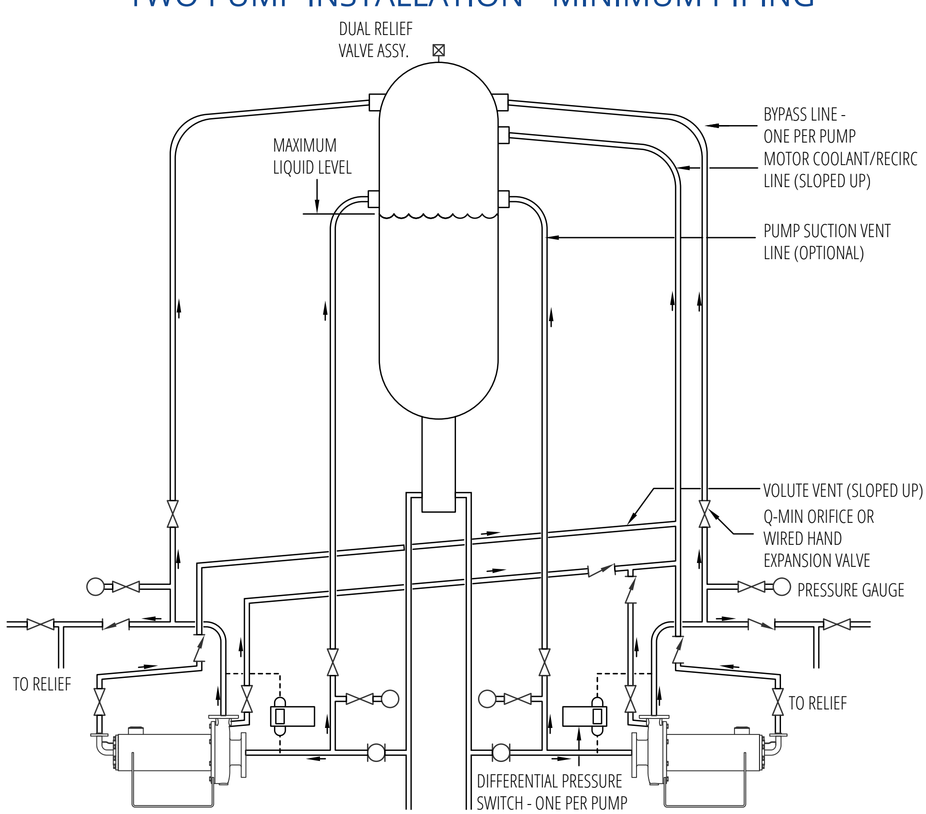
PREFERRED INSTALLATION - SINGLE STAGE PUMP



ALTERNATE INSTALLATION - SINGLE STAGE PUMP



TWO PUMP INSTALLATION - MINIMUM PIPING



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