FLOW CENTER AND PUMP TROUBLESHOOTING

GEO-FLO

Rev: May 6, 2019

TOPICS

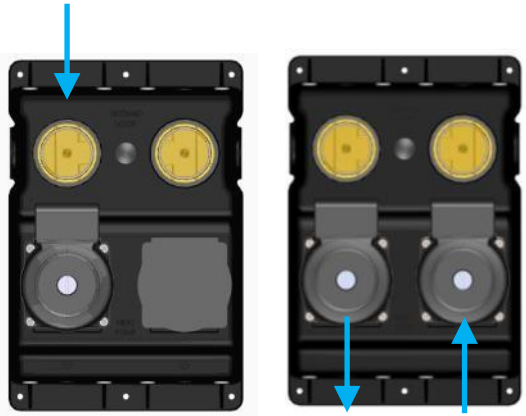
- Goals
- Flow Center Construction Overview
    - Discussion of potential leak points
    - Production and return product testing
- Installation Checks
    - Common start-up issues
- Reported Failures, Causes, and Solutions
    - Flow center leaks
    - Pump Failures

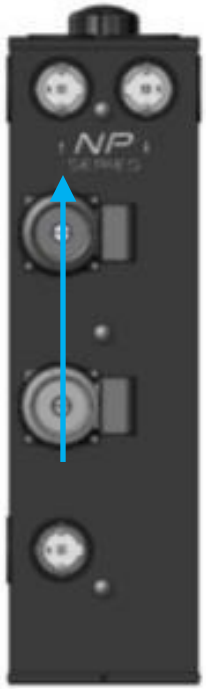
GOALS OF TRAINING

- Understand flow center construction
- Understand potential failure modes of flow centers and pumps
- Help technicians determine the most cost effective solutions
- Lower warranty returns of “no-fault found” components
- Keep geothermal technology cost effective

PUMP CONFIGURATION

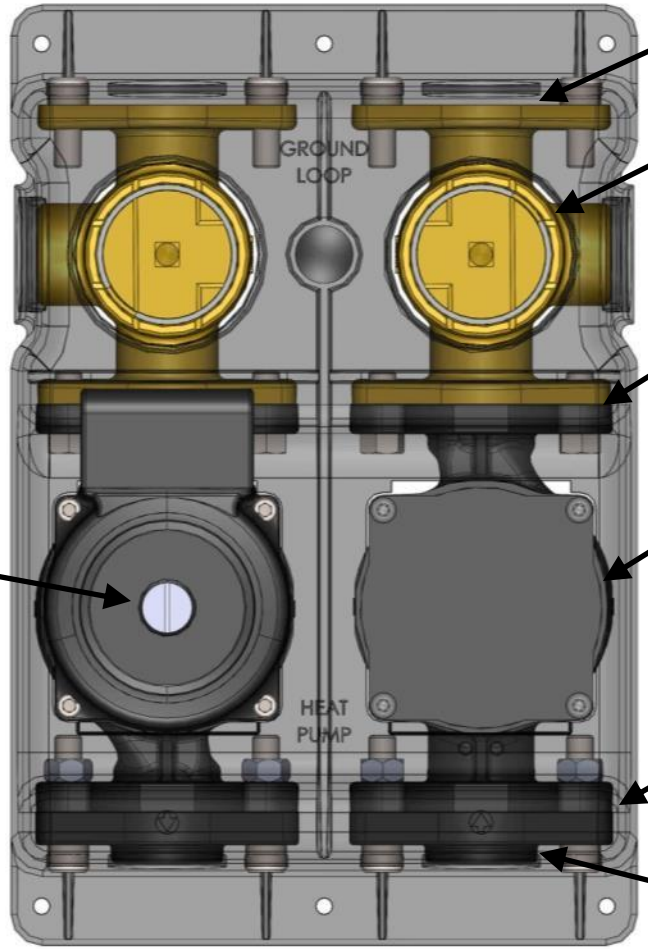
- Single pump pressurized flow center
  - Pump on ground loop return side for most flow centers
  - Right side for some flow centers
  - Pump receives most moderate fluid temps on LH side
- Double pump pressurized flow center
  - Push/pull configuration
- Non-pressurized flow center
  - In-line configuration





FPT / FLANGE TYPE FLOW CENTER

- Potential leak points



FPT connection

Valve; (2) O-ring seals

Valve to volute; (1) O-ring seal

Blank plate or power head to volute; (1) gasket seal

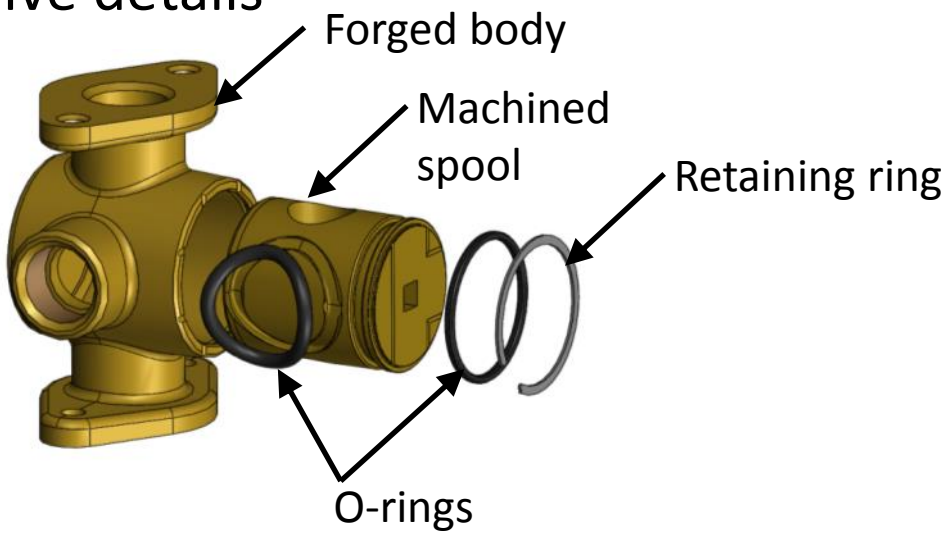
Volute to flange; (1) O-ring seal

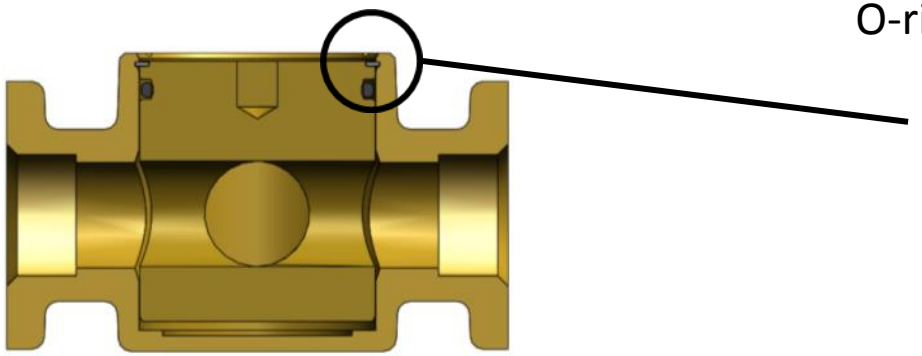
FPT connection

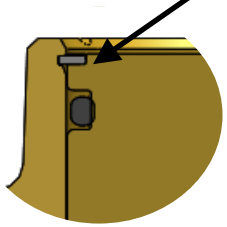
Vent Screw; (1) O-ring seal

VALVE CONSTRUCTION

- Look for 3-way valves that are designed for low temperature applications and allow field repair.
- Most heat pump manufacturers use a 3-way valve similar to the one below.
- Flanged, FPT valve details



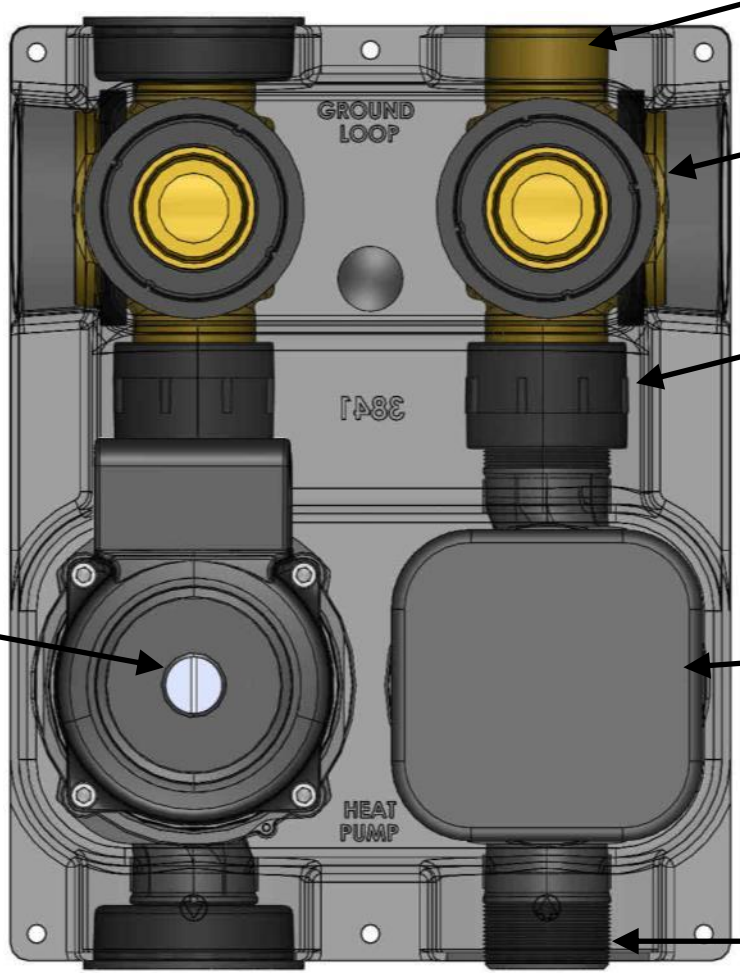




Shoulder on spool prevents retaining ring removal while valve is under pressure

DOUBLE O-RING FLOW CENTER

- Potential leak points



Double O-ring connection (ID Seal)

Valve; (3) O-ring seals

Valve to volute; (4) O-ring seals; ID seals (2) per side

Vent Screw; (1) O-ring seal

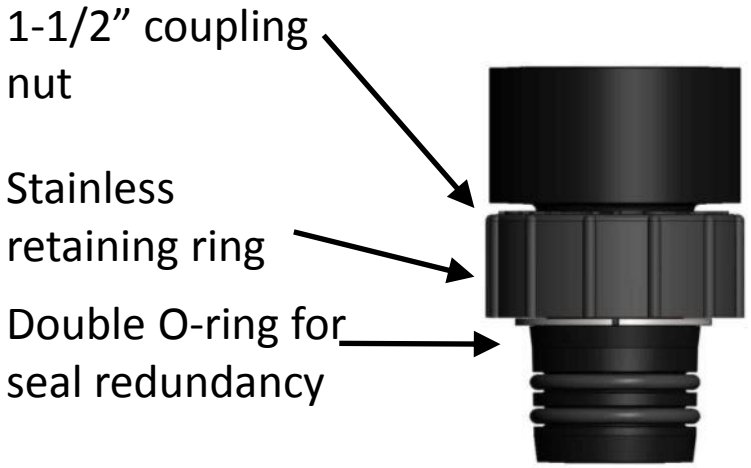
Blank plate or power head to volute; (1) gasket seal

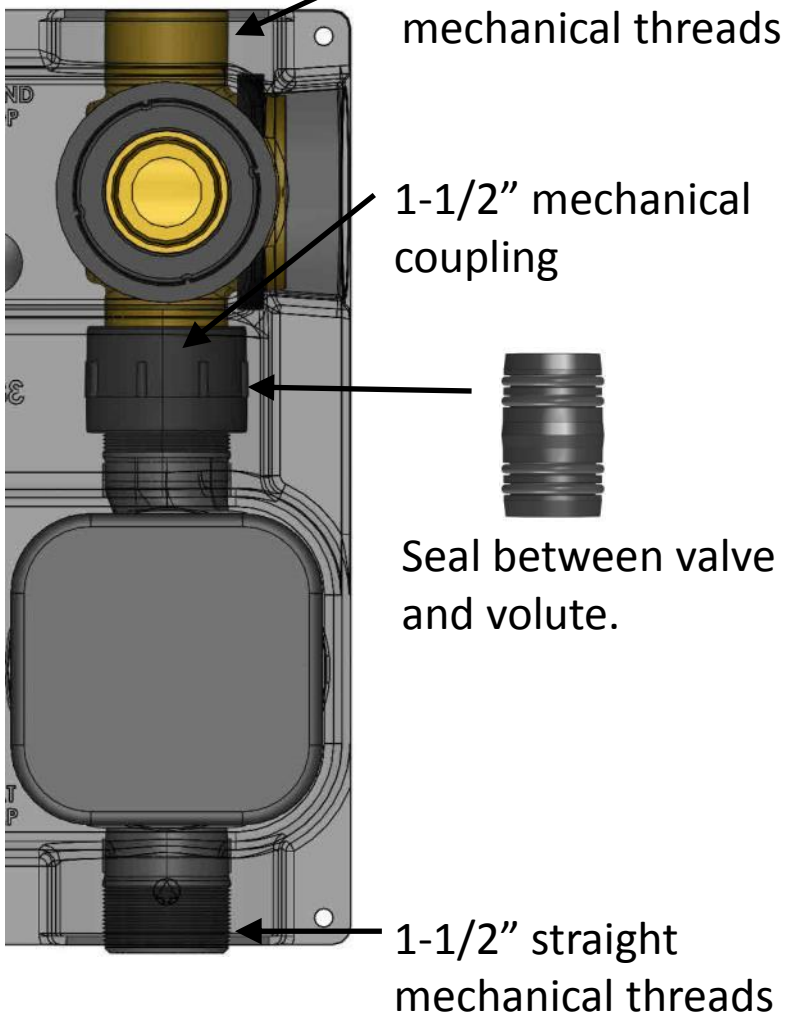
Double O-ring connection (ID Seal)

Double O-ring flow centers use union style pump volutes

DOUBLE O-RING FITTINGS AND SEAL

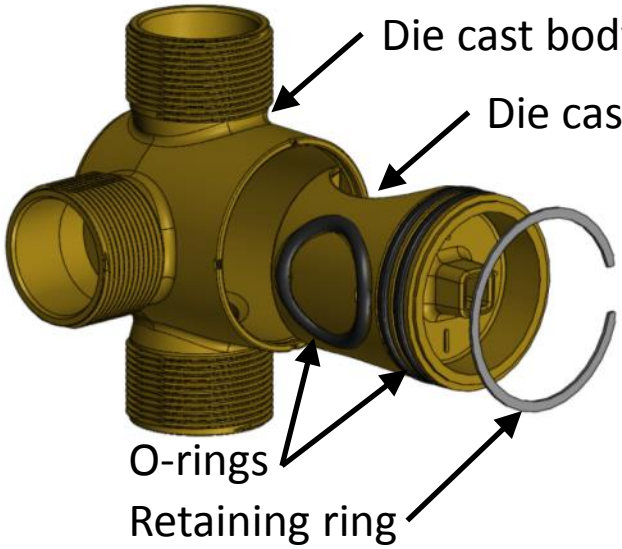
- NBR (Nitrile) O-rings
  - Not affected by petroleum jelly
  - NBR = Nitrile Butadiene Rubber, Temp rate = -40° to 226° F
- Straight mechanical threads will not seal with NPT fitting

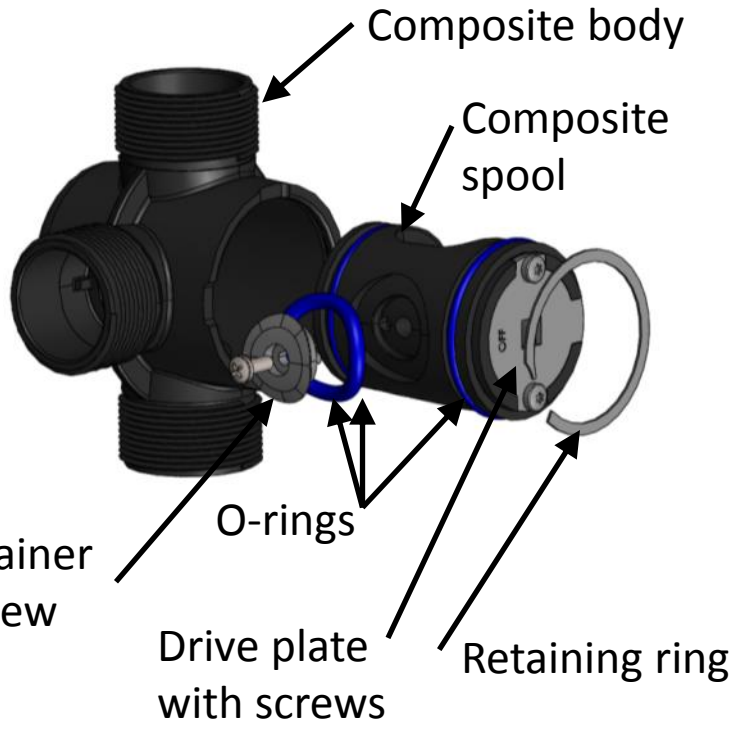


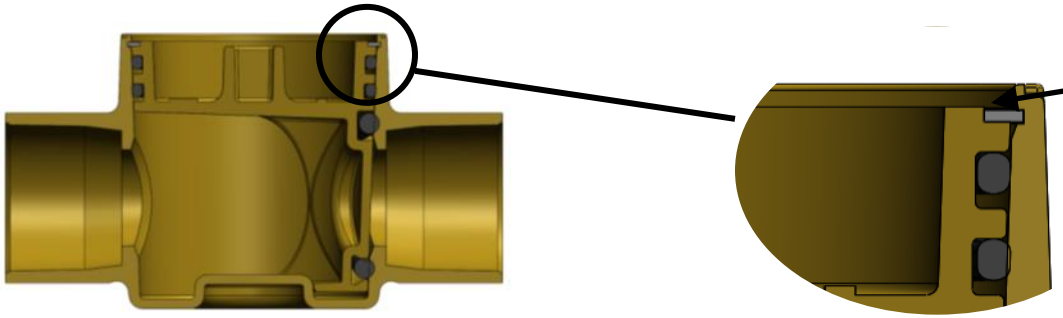


VALVE CONSTRUCTION

- Double O-ring brass and composite valve details

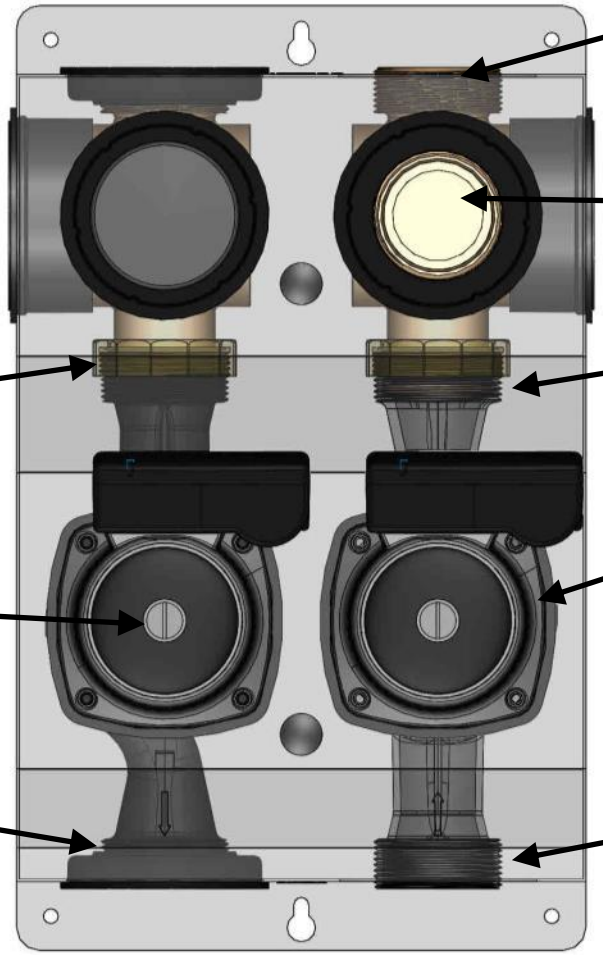






2” DOUBLE O-RING FLOW CENTER (2-PUMP)

- Potential leak points and construction details



Double O-ring connection (ID Seal)

Valve; (3) O-ring seals

Valve to volute; (2) O-ring seals

Power head to volute; (1) O-ring seal

Double O-ring connection (ID Seal)

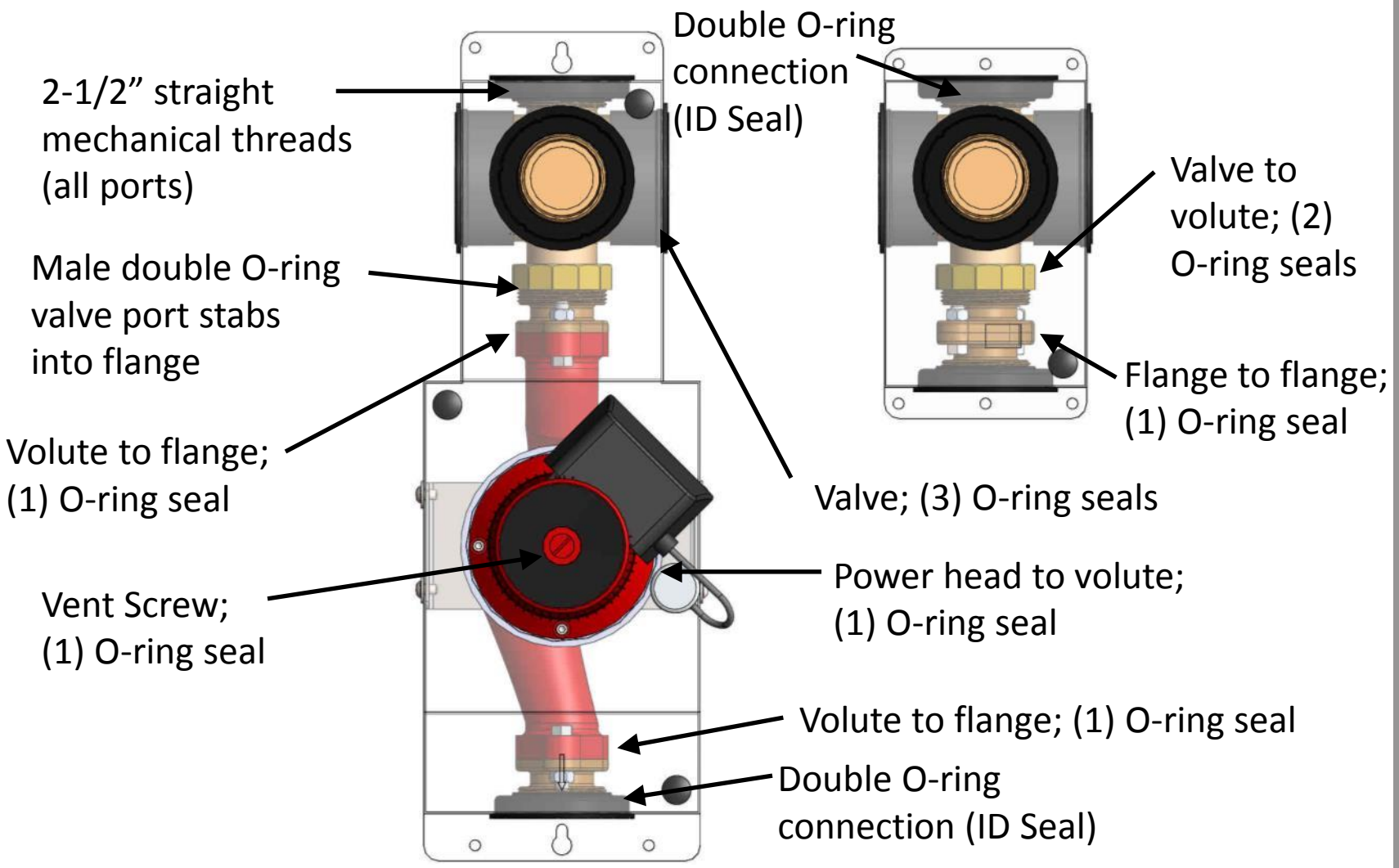
Male double O-ring valve port stabs into volute

Vent Screw; (1) O-ring seal

2-1/2” straight mechanical threads (all ports)

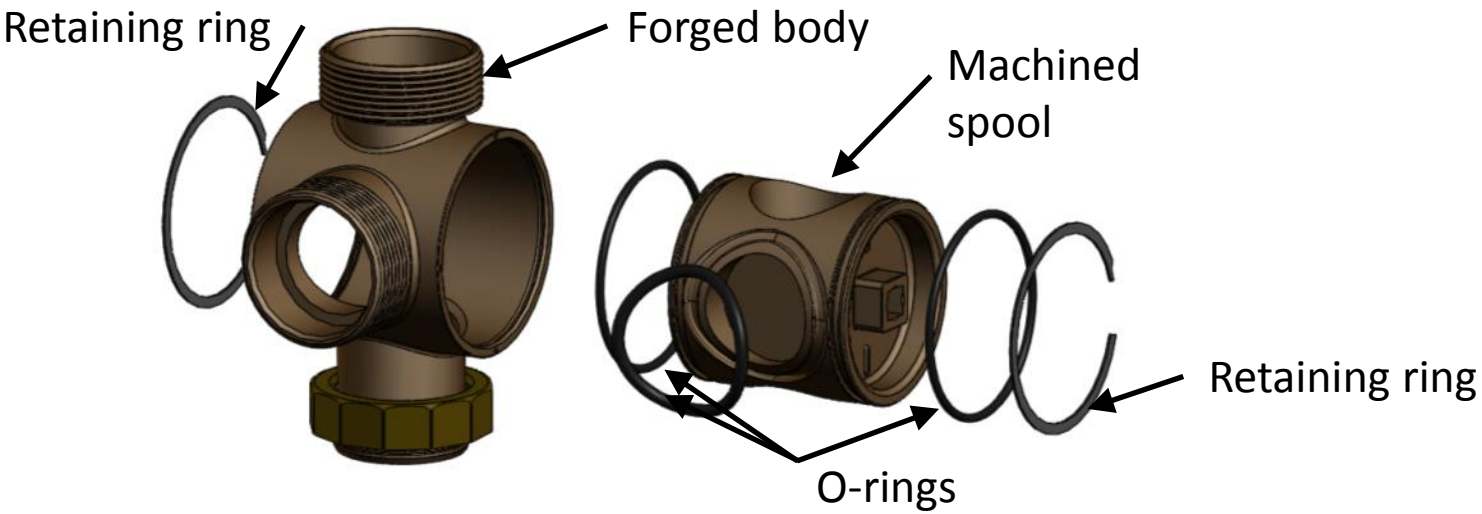
2” DOUBLE O-RING FLOW CENTER (LARGER PUMPS)

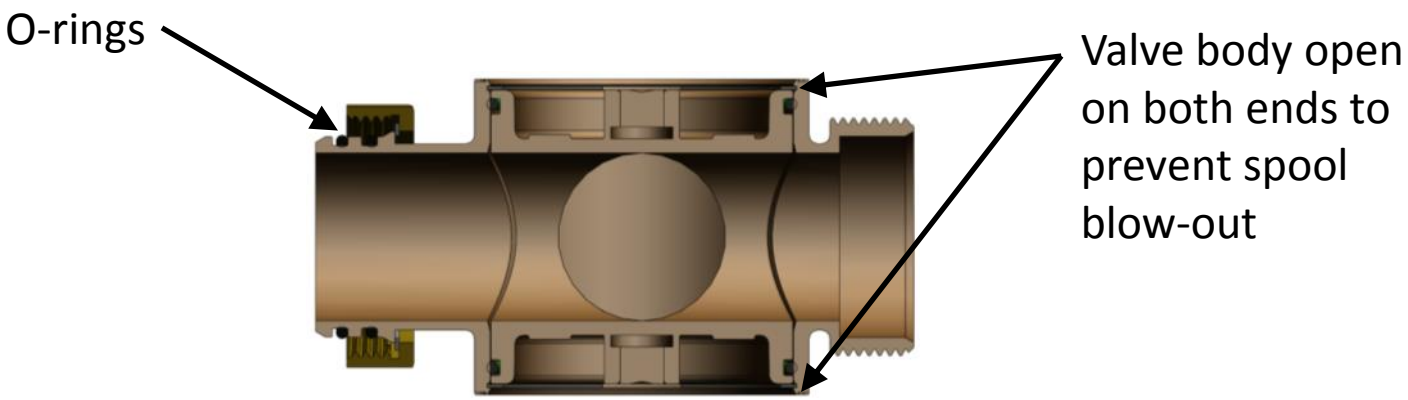
- Potential leak points and construction details



VALVE CONSTRUCTION

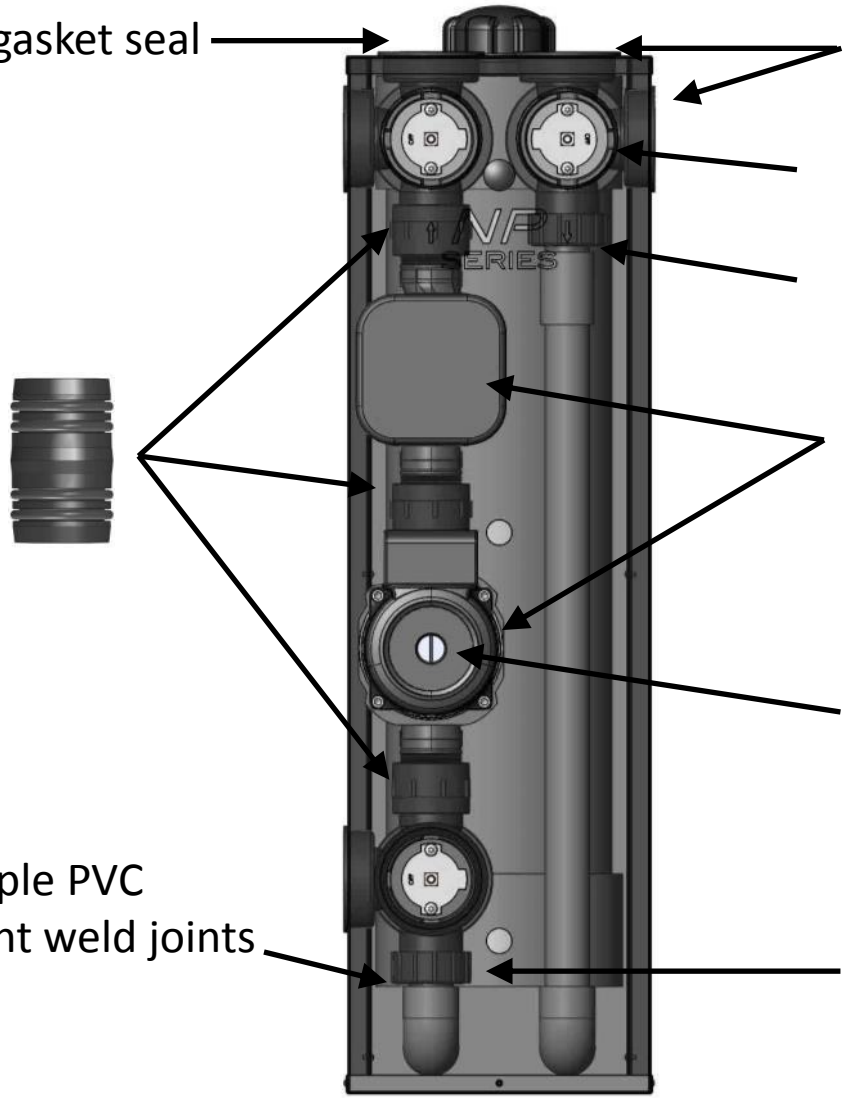
- 2” valve details





NON-PRESSURIZED FLOW CENTER

- Potential leak points



PUMP SELECTION

- Not all pumps are designed for geothermal operation
  - Condensate weep/drain hole(s)
  - Pumps for chilled water have coated windings
- Even similar circulators may not be approved for geo.
- Some are only designed for hot water (boiler) operation
- Very important when selecting a flow center (examples in next slides)
- Very important when considering replacement pumps or troubleshooting a failed pump

WHICH PUMP IS APPROVED FOR GEO?

Weep holes

There are 3 total…

3’o-clock (this one)

6’o-clock (bottom)

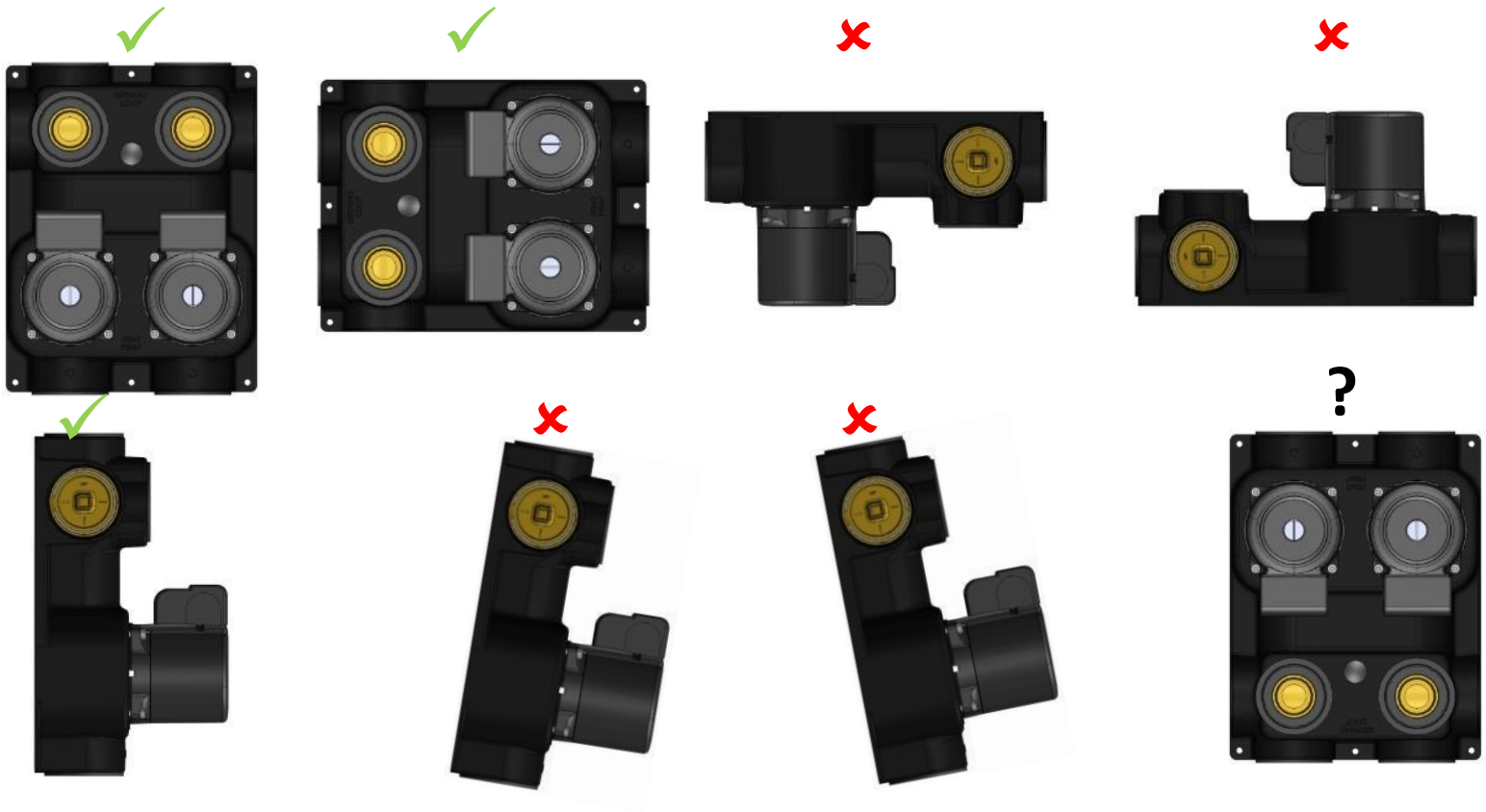
9’o-clock (left side)

Approved Grundfos Circulators:

UP26-99	UPS26-99 (3 spd.)
UP26-116	UPS32-140 (var. spd.)
UPS32-160	UPS40-160
UPS40-240	UPS60-150
Magna GEO	

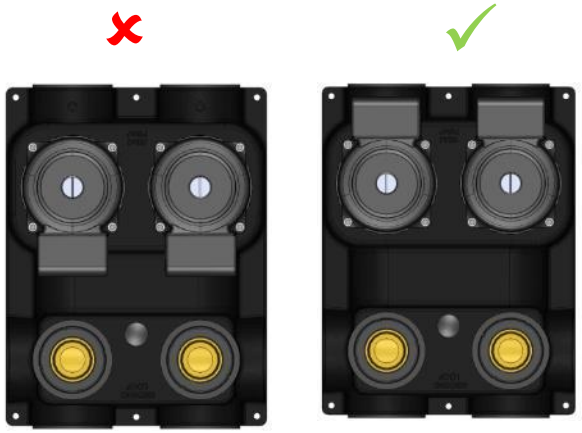
ORIENTATION

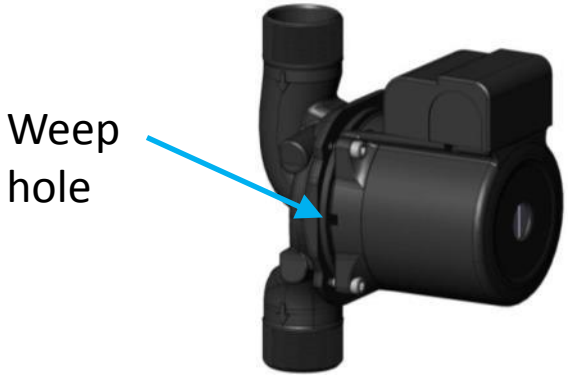
- Flow center oriented correctly?
  - Must be oriented vertical or horizontal
  - Pump shaft must be parallel to ground (true of all wet rotor circulators)

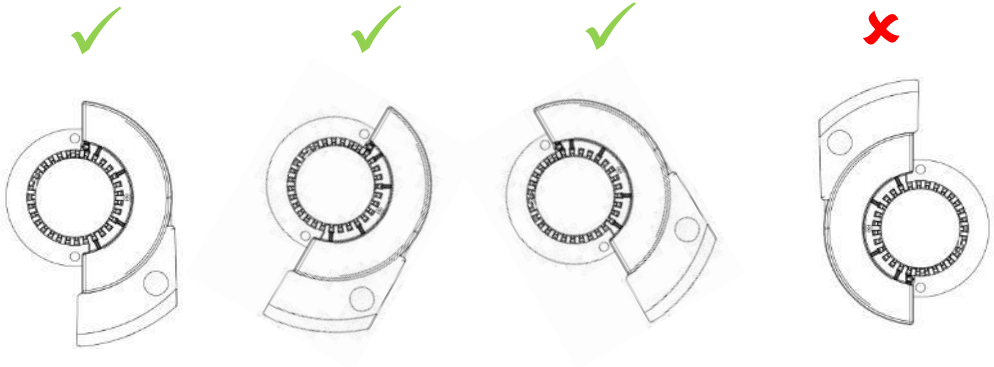


ORIENTATION

- Proper terminal box orientation?
  - Condensate weep/drain hole(s) down
  - Pumps for chilled water have coated windings
  - Most pumps have three; 3-,6-, and 9-o'clock position
  - Exception is Magna GEO VS pump; weep holes at 5-, 6, and 7-o'clock with term box down







MISCELLANEOUS

- Have proper fittings been utilized?

- Has pump been vented?

- Has system been properly flushed (including filtering)?

- Has system been pressurized properly (if necessary)?

CATEGORIES OF REPORTED FAILURES

- Three general categories of issues with flow centers
  - Noise
  - Leaks
  - Performance

- About 30-35% of all returned flow centers are classified as "No Fault"
  - This number does not include units that could easily have been field repaired
  - Does not include field induced leaks due to debris, water quality, or improper installation.

NOISE

- Reported Issue: Noise
  - Generally does not result in flow center returns

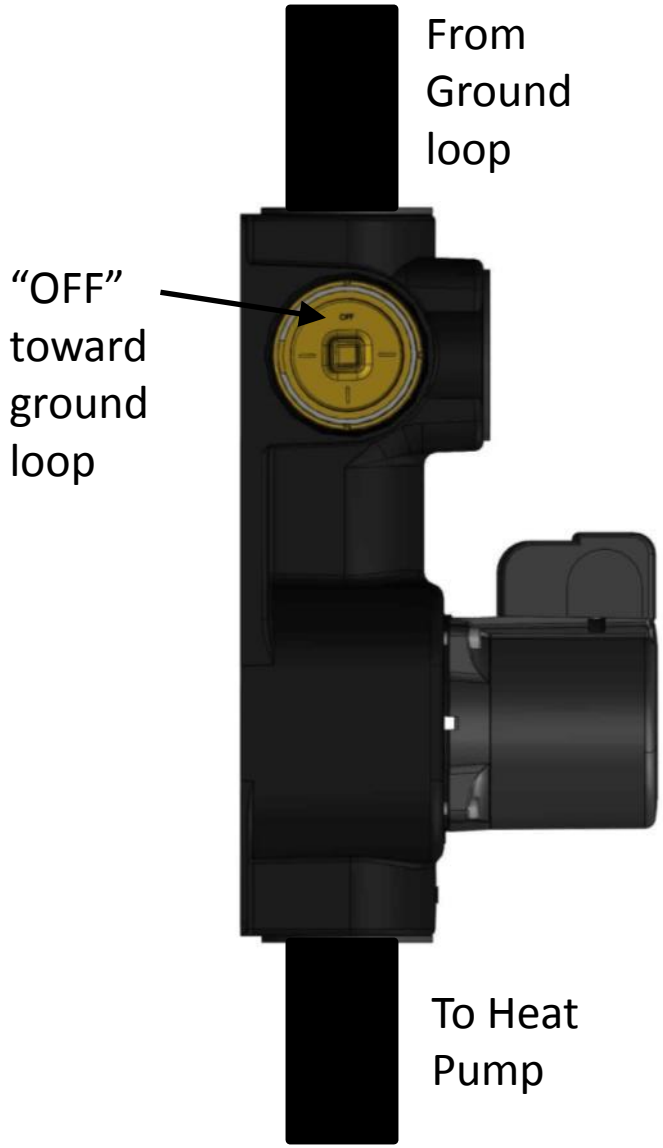
POSSIBLE CAUSE	SOLUTION
Mechanical vibration due to pump motor resonance	Provide vibration isolation between: 1) piping and flow center 2) flow center and unit 3) flow center and mounting location (wall, heat pump, etc.)
Air/debris in system	Flush loop
High velocity water: pump oversized or piping undersized	1) Use smaller pump 2) Turn pump speed down 3) Remove one of two pumps 4) Add flow restriction (ball valve) 5) Increase pipe size
Pump cavitation	Increase pump suction pressure
Pump motor noise-squealing	1) Vent pump; ensure not dry running 2) Bearing failure: replace pump

LEAKS

- Reported Issue: Leaks
  - Presence of water alone is not sufficient to claim the flow center is defective
  - Many confuse condensation with leaks
  - Look for signs of fluid running down flow center or plumbing
  - How is flow center mounted? (valves up or valves down)
  - Flat loop does not guarantee a leak; air in loop along with pipe relaxation can cause a flat loop

LEAKS

- Leak at flow center fitting much more likely than flow center leak
  - Ensure properly installed, high quality threaded fittings (FPT flow centers)
  - Double O-ring fittings: ensure proper pipe alignment
    - Recall that double O-ring fittings can be rotated under pressure without leaking
  - Rotate 3-way valve to isolate flow center from ground loop fittings and pressurize through PT at unit



LEAKS

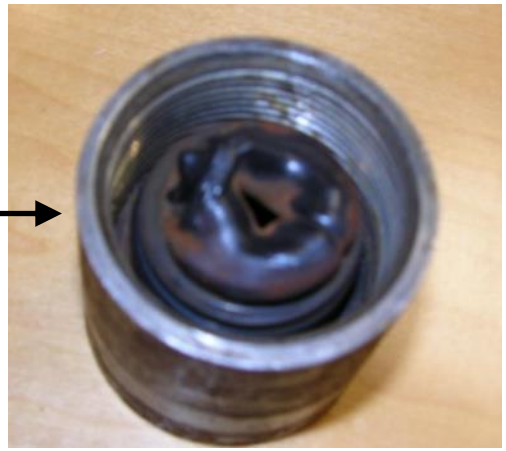
REPORTED PROBLEM	POSSIBLE CAUSE	SOLUTION
Fluid leaks out of cabinet (out back, around valve, around pump, etc.)	Leak from above dripping down through flow center and out path of least resistance	Investigate further
Fluid leaks out “Heat Pump” connections	Cracked flange: over tightening MPT fitting (flanged flow center)	Replace flow center
	Leak from above dripping down through flow center and out bottom holes	Investigate further
	Condensation	Insulate piping/fittings

LEAKS

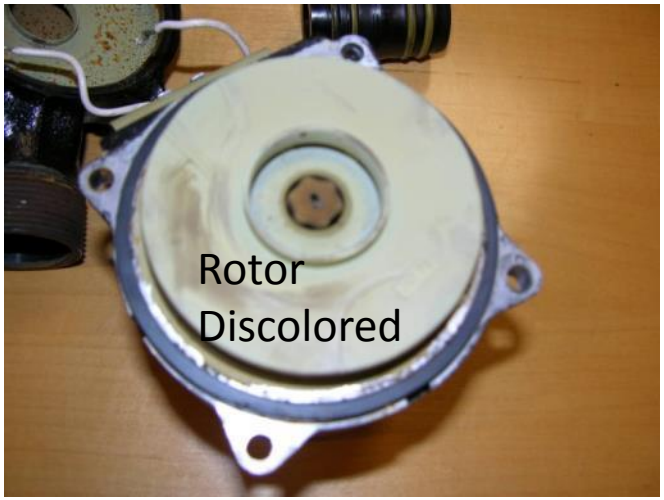
REPORTED PROBLEM	POSSIBLE CAUSE	SOLUTION
Fluid leaks out “Heat Pump” connections, cont.	Pipe misalignment; side-loading double O-ring fittings	Remove fittings; check O-rings and replace if necessary; align piping
	O-ring seal failure	Remove fitting; clean valve port and fittings; replace O-rings if necessary
	Internal leak-volute corrosion/erosion due to poor water quality	Replace flow center
	Internal leak-seal failure due to high temperature	Replace flow center; check wiring to be sure pump is not powered continuously
Fluid leaks out “Ground Loop” connections	See above (except cracked flange)	See above

LEAKS

- Example: internal leak caused by pump overheating
- Flow center returned with cause “leaks”



Softening point of this material is 259 deg. F



LEAKS

REPORTED PROBLEM	POSSIBLE CAUSE	SOLUTION
Valve Leak	Debris in valve	Rotate valve 360 degrees to dislodge debris
	Side loading valve when actuating	Turn valve axially only
	Pinched/twisted O-ring	Rotate valve 360 degrees to reseat O-ring
Valve Leak-fluid leaks out valve face	Cut O-ring	Replace O-ring; kits and instructions are available

SEAL REPLACEMENT EXAMPLE

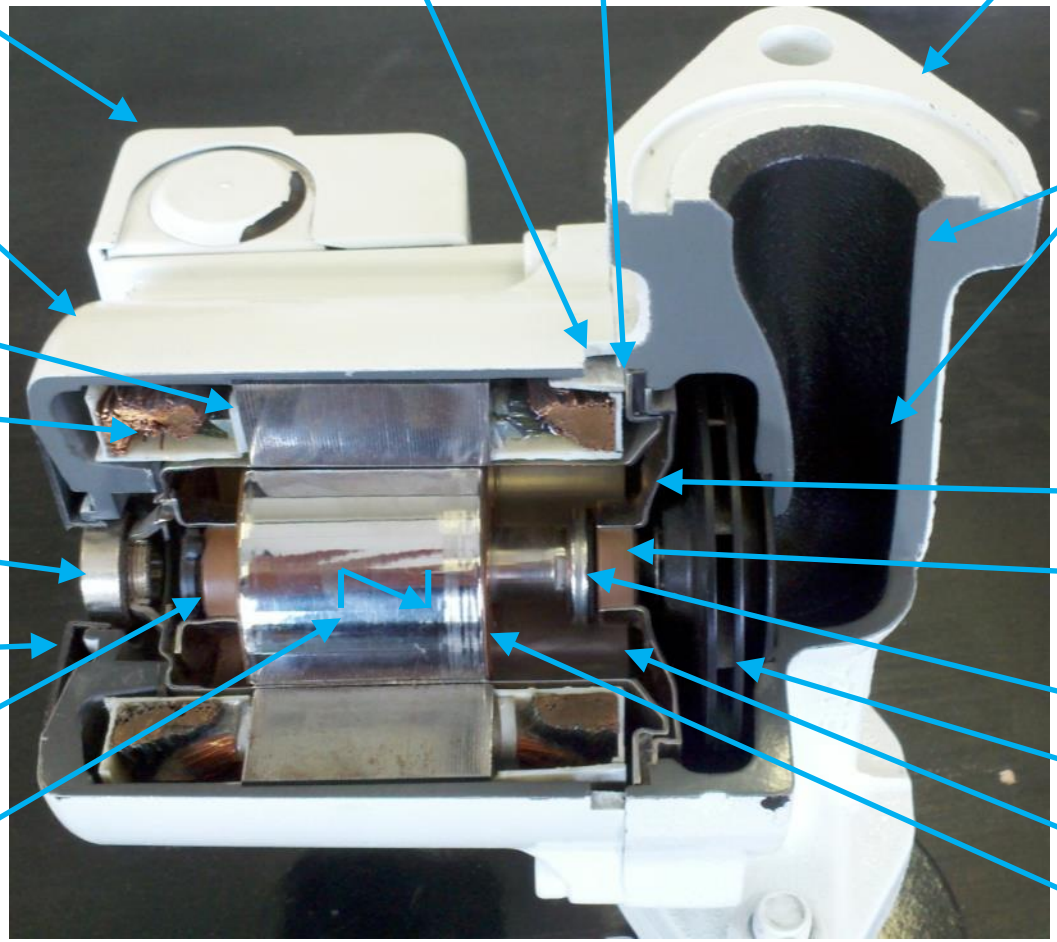
EXAMPLE FLOW CENTER RETURNS

EXAMPLE FLOW CENTER RETURNS

EXAMPLE FLOW CENTER RETURNS

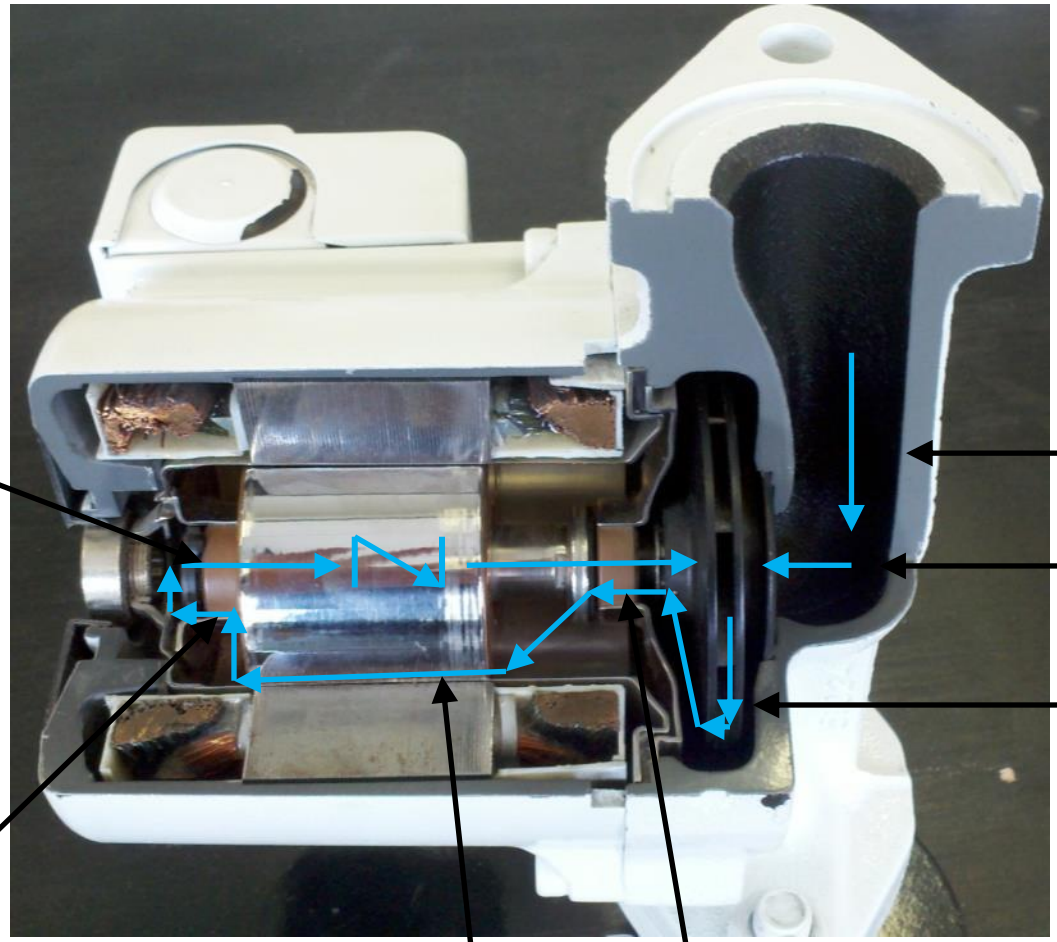
PUMP CONSTRUCTION

- Typical wet rotor circulator



PUMP CONSTRUCTION

- Simplified fluid path inside pump



PUMPS AND PERFORMANCE

- Performance issue include
  - No flow
  - Lack of sufficient flow
- How can we tell if the pump is running?
  - “Feel”
    - Not reliable since pumps are generally quiet with little vibration
  - AC Indicator
    - Only indicates presence of AC field
    - Does not prove flow; could have broken shaft

PUMPS AND PERFORMANCE

- How can we tell if the pump is running?
  - Rotating shaft-remove vent screw
    - Does not prove flow; could have broken shaft
  - Measure voltage/amp draw
    - Does not prove flow; could have broken shaft
  - Pressure drop across coax, or flow meter
    - Provides proof and magnitude of flow
    - This is the only reliable method of checking for flow.

PUMPS AND PERFORMANCE

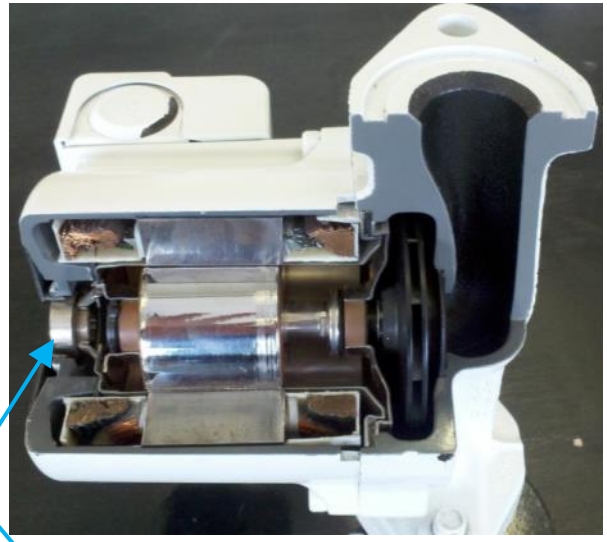
- Lack of sufficient flow reported
  - Startup/new installation or existing?
    - If existing, check pump(s) for operation
    - Is there a documented record of past performance in which to compare?
  - Higher head than design
    - Restriction
    - Incorrect pressure drop calculation
    - Plumbing different than design
- No flow reported
  - Pump checks
    - Wiring correct?
    - Power correct?
    - Pump vented?
    - Sufficient suction pressure?

PUMPS AND PERFORMANCE

- No flow reported
  - Flow center assembly checks
    - Valves open?
    - Volutes plumbed correctly from factory?
    - Check valves installed (improperly)?
- Multiple pump failures on same system
  - Power issue; be sure pumps are not running constantly
    - Voltage tolerance +/- 10%
  - Debris
  - Dry run/air

PUMP CHECKS

- Before removing a pump motor/power head, remove the vent plug and check for shaft rotation
  - If there is no rotation, use a small screwdriver to rotate the shaft. If it rotates, power the pump and check for flow. If no flow, possible mechanical blockage or broken shaft.
  - Fine debris buildup between rotor and rotor can could prevent the pump from starting. ***Breaking the rotor free with a screwdriver could extend the life of the pump.***



Remove vent screw to access shaft

PUMP CHECKS

- Only after all checks have been completed should the power head be removed
- Proper procedures for isolating loop and re-flushing system should be completed when replacing power head
- Pump should be checked for indications of failure mode prior to replacement
  - Analyzing and correcting the mode of failure will prevent future failures
- Recent (2013) analysis conducted jointly with Grundfos showed that about 50% of returns were water quality related, about 10 % were installation, and about 30% were no faults returns.

PUMP ANALYSIS

FAILURE MODE	POSSIBLE CAUSE	SOLUTION
Locked rotor	Debris in rotor can	Re-flush system with appropriate filter
	Air lock/dry run	Re-flush system

- Checking for locked rotor
  - Amp draw (check nameplate for max amp)
    - Not conclusive
  - Turning shaft by removing vent screw
    - Not conclusive
  - Removing pump motor (power head)

PUMP ANALYSIS

FAILURE MODE	POSSIBLE CAUSE	SOLUTION
Locked rotor	Debris in rotor can	Re-flush system with appropriate filter
	Air lock/dry run	Re-flush system

- Checking for dry run
  - Remove rotor/bearing plate assembly from rotor can using flat head screwdriver.
    - Is rotor can dry?
    - Is there a coating inside can?
    - Is there a distinct water line inside can?
- Look for debris in impeller vanes

PUMP ANALYSIS

- Why is debris mentioned repeatedly?
  - Consider particle size in table below.
  - Can flush cart filter catch fine sand/clay?
- Consider finer filtration if debris seems to be prevalent in some regions/with some customers

Soil Type	Grain Size*
Gravel	2,000 to 75,000 microns
Course Sand	425 to 2,000 microns
Fine Sand	75 to 425 microns
Silt-Clay	< 75 microns*
Clay	< 2 microns*

* Grain size is defined by the AASHTO soil classification system for the U.S. Bureau of Public Roads (now the Federal Highway Administration). Silt-Clay is the smallest grain size considered in the AASHTO system. ISO 14688-1 includes clay particles in the 2 micron and smaller range.

PUMP ANALYSIS

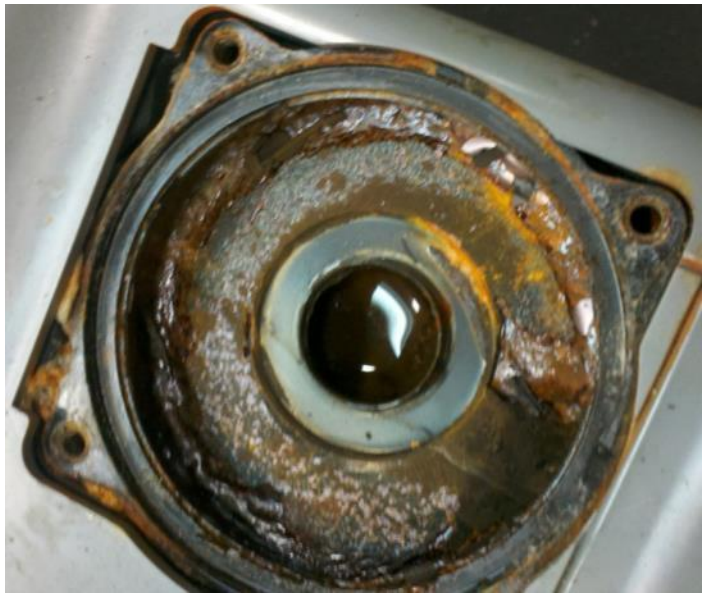
FAILURE MODE/INDICATOR	POSSIBLE CAUSE	SOLUTION
Broken shaft	Thermal shock	Prevent temperature extremes
	Mechanical shock	Prevent water hammer or debris from impacting impeller
	Manufacturing defect	Contact manufacturer
Bearing plate seized	Debris in bearing	Re-flush system with appropriate filter
Bearing plate “loose”	Worn bearing due to abrasive debris	Re-flush system with appropriate filter
Excess axial “play” in bearing play	Worn axial (thrust) bearing due to abrasive debris	Re-flush system with appropriate filter

PUMP ANALYSIS

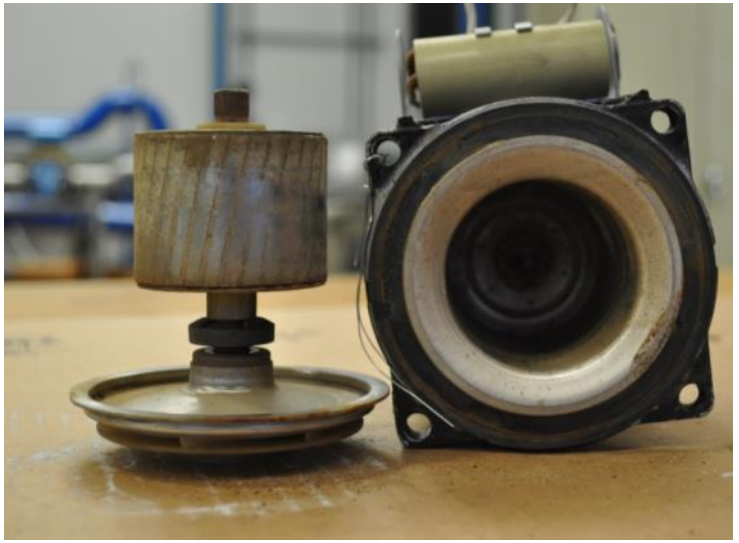
FAILURE MODE/INDICATOR	POSSIBLE CAUSE	SOLUTION
Impeller eye damage (worn or broken)	Larger debris such as rocks impacting impeller	Re-flush system with appropriate filter
Balance hole in rotor corroded	Poor water quality	Test and correct water quality issues
Electrical short (burnt terminal strip)	Condensation in stator housing/improper power head orientation (i.e. terminal box down with UP26-99 or -116)	Install pump power head with terminal box in proper orientation.
Pump runs hot	Locked rotor	Replace pump
	No issue	Pumps have internal thermal overload protection via a Thermik on pump windings (170° C or 338° F)

PUMP ANALYSIS

FAILURE MODE/INDICATOR	POSSIBLE CAUSE	SOLUTION
Leaking volute	Corrosion due to poor water quality	Test and correct water quality issues
	Erosion due to abrasive debris.	Re-flush system with appropriate filter



PUMP RETURNS



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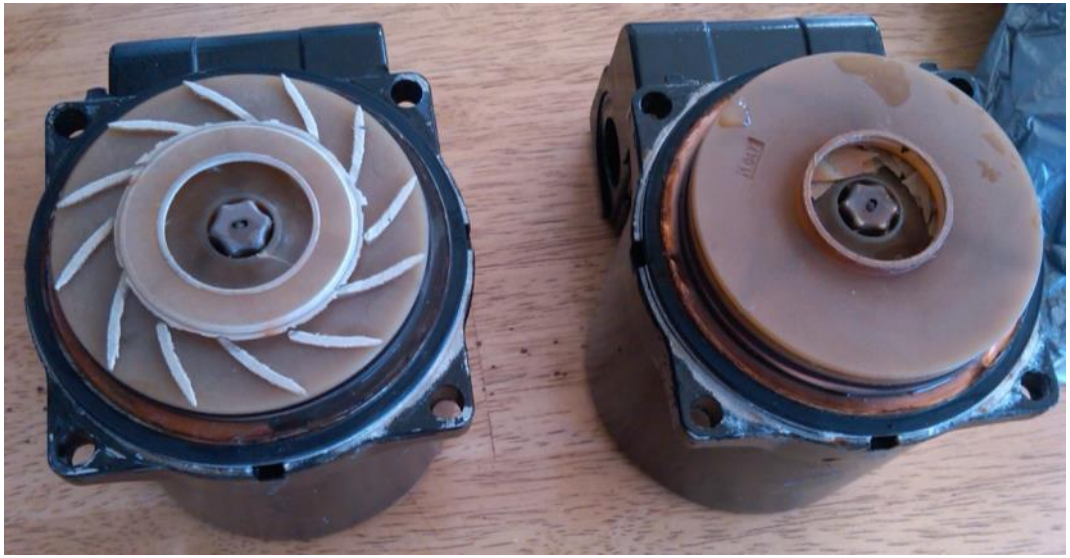

TWO RECURRING THEMES

- Air in the loop and/or loop pressurization issues
  - Potential for pump to run dry

- Debris in the loop fluid
  - Premature pump failure due to excessive wear and/or blocked flow path

PRESSURIZATION SOLUTIONS

- Pressurized system with the right components
- AND: Air purged from the piping system

Flow center

Expansion tank

Air/dirt eliminator

OR:

PRESSURIZATION SOLUTIONS

- Pressurized system with the right components
- AND: Air purged from the piping system

Flow center

Active pressurization/
antifreeze makeup system

Air/dirt eliminator

OR:

PRESSURIZATION SOLUTIONS

- Non-pressurized system with the right components
- AND: Air purged from the piping system

DEBRIS ELIMINATION SOLUTIONS

- Filter while flushing (100 micron filter)
- AND: Once air is purged from system, filter with finer (1 micron) filter

Clay can be < 2 microns

CONCLUSION

- Majority of flow center and pump returns are preventable
- Using basic installation and flushing guidelines will result in a long product life
- Decreased issues will result in more satisfied customers and a more robust industry

Thank You!

QUESTIONS?

GEO-FLO