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# Horizontal split case fire pumps

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## Installation and operating instructions

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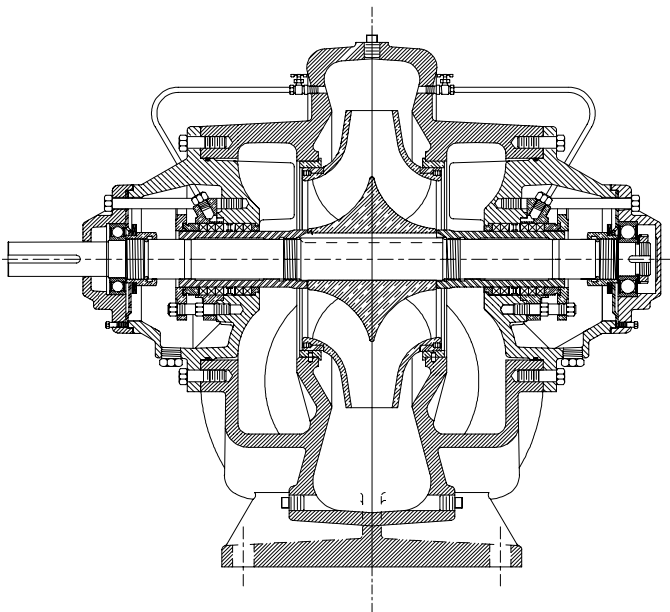
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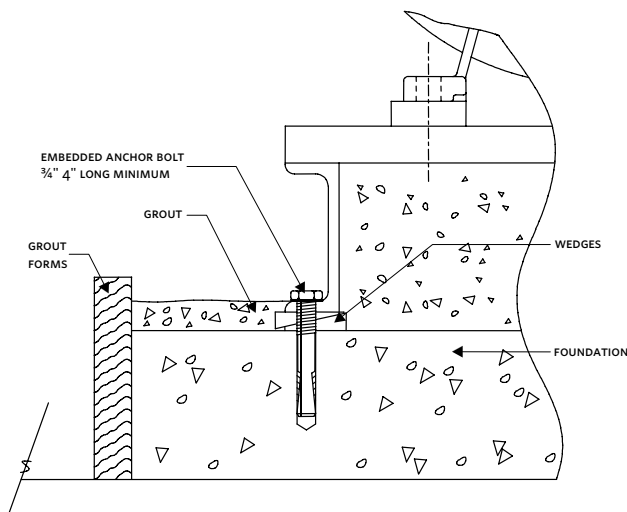
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## INSTALLATION AND OPERATING MANUAL HORIZONTAL SPLIT CASE FIRE PUMPS

The innovative Armstrong Series 4600 HSC pump is designed to allow easy maintenance. The pumps same level suction and discharge permits easy-piping layout and pump installation. Design features, such as bearing removal with no special tools, will make the reliable HSC pump a trouble-free pump for many years.

Armstrong series 4600 HSC pumps are thoroughly tested and inspected before shipping, but should be carefully examined for possible damage during transit. Contact your Armstrong representative and the transport company immediately if there is any evidence of mishandling.



- **INSTALL FOUNDATION BOLTS**
- **INSTALL GROUT FORMS**
- **FILL IN BASE WITH GROUTING**

### 1.0 INSTALLATION

#### 1.1 LOCATION AND STORAGE

- Locate the unit in a dry place as near the city water entrance as practical with a short, direct suction pipe
- Shaft should be rotated by hand 10 to 15 revolutions every one to three months depending on storage conditions

#### 1.2 FOUNDATION FOR HSC PUMP

- Foundation should be sufficiently substantial to absorb any vibration and to form a permanent, rigid support for the base plate
- Foundation bolts of suitable size should be embedded in the concrete located by a drawing or template
- Place pumping unit on foundation with wedges under base plate leaving approximately  $\frac{3}{4}$ " space for grouting
- Carefully level the unit by adjusting the wedges until shafts of pump and driver are leveled, recreating factory alignment
- Check coupling faces as well as suction and discharge flanges of pump for horizontal or vertical position with a level
- Slight misalignment at this point may be corrected by adjusting the wedges

After unit has been in operation for about a week, check alignment. Any misalignment may be corrected by placing shims between base and driver or pump feet.

#### 1.3 PUMP MOUNTING AND PIPING

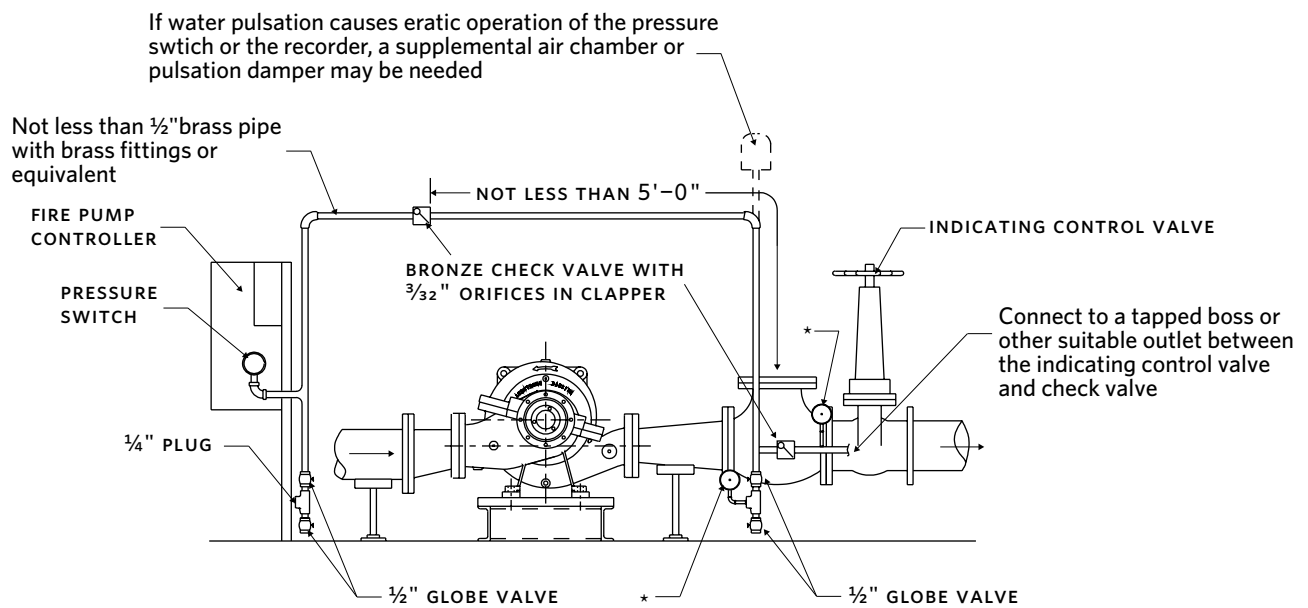
- Never connect a pump to piping, always start piping from pump
- Use as few bends as possible and preferably long radius piping
- Install good supports under suction and discharge piping with anchors near but independent of the pump
- Make sure piping exerts no strain on pump as this would throw the unit out of alignment or distort the casing
- Increase the size of both suction and discharge pipes at pump nozzle to suit pump capacity and particular conditions of installation

- Use eccentric reducers on suction
- Lay out the suction line with a continual rise towards the pump without high points, thus eliminating possibility of air pockets
- Test suction line for air leaks before starting; this becomes essential with long suction line or high static lift
- Install, at pump suction, a straight pipe of a length equivalent to 4 or 6 times its diameter
- Install gate valve close to pump in both suction and discharge lines on flooded suction application; this is used mainly to isolate the pump for inspection or repair
- Install a check valve in discharge line between pump and gate valve



**CAUTION:** Only the discharge valve must be used to reduce the flow or shutoff the pump

## PRESSURE SENSING LINE CONNECTION FOR FIRE PUMP CONTROLLERS



\* Recommended location of pressure gauges (either location)

If water is clean, ground face unions with noncorrosive diaphragms drilled for  $\frac{3}{32}$ " orifices may be used in place of the check valves.

REF.: NFPA 20, 2022 VERSION, FIG. A.4.32(A)

### 1.4 ALIGNMENT

The flexible coupling compensates for temperature changes and permits shaft end movement without interference; it will not compensate for misalignment. Faulty alignment will result in noisy pump operation, reduced bearing life, and excessive coupling wear.

- Carefully verify the alignment after the foundation bolts have been properly tightened
- Alignment should be again verified after piping is installed and unit has operated under normal conditions at operating temperature
- Use straight edge or dial indicator to check horizontal alignment on HSC.
- To verify alignment, place a straight edge across the coupling as shown; this must rest evenly on both rims at top, bottom and both sides
- With a pair of inside calipers or thickness gauge, check distance between coupling halves at points where straight edge was used; distance must be equal at all points
- Pump should be aligned and verified with misalignment data of coupling/Drive shaft, Please refer Manufacture recommendations.

### 1.5 MINIMUM FITTINGS

If minimum fittings recommended by N.F.P.A. 20 are supplied loose, they should be installed as follows:

**CIRCULATION RELIEF VALVE** (not supplied with diesel driven pumps)

- Install Circulation Relief Valve at the casing discharge (always before the check valve)
- Set pressure at the minimum suction pressure plus the pump rated pressure raised to the next higher 5 lb. increment
- Circulation relief valve and stuffing box should then be piped to drain

**AUTOMATIC AIR RELEASE VALVE**

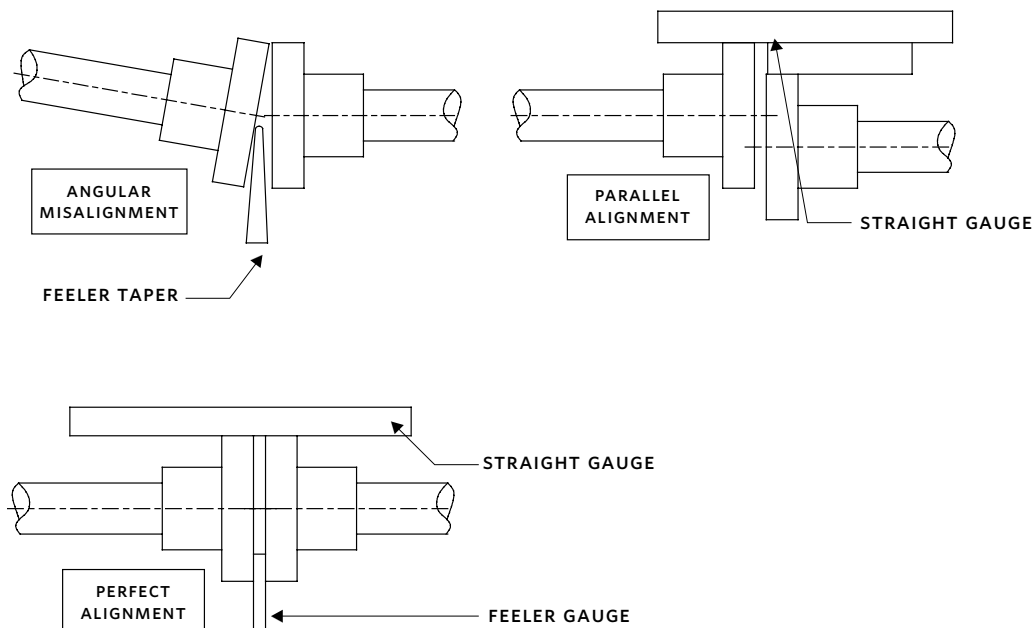
- Install automatic air release valve on top of pump casing to vent casing and suction piping of air and vapor before start-up.

**SUCTION AND DISCHARGE GAUGES**

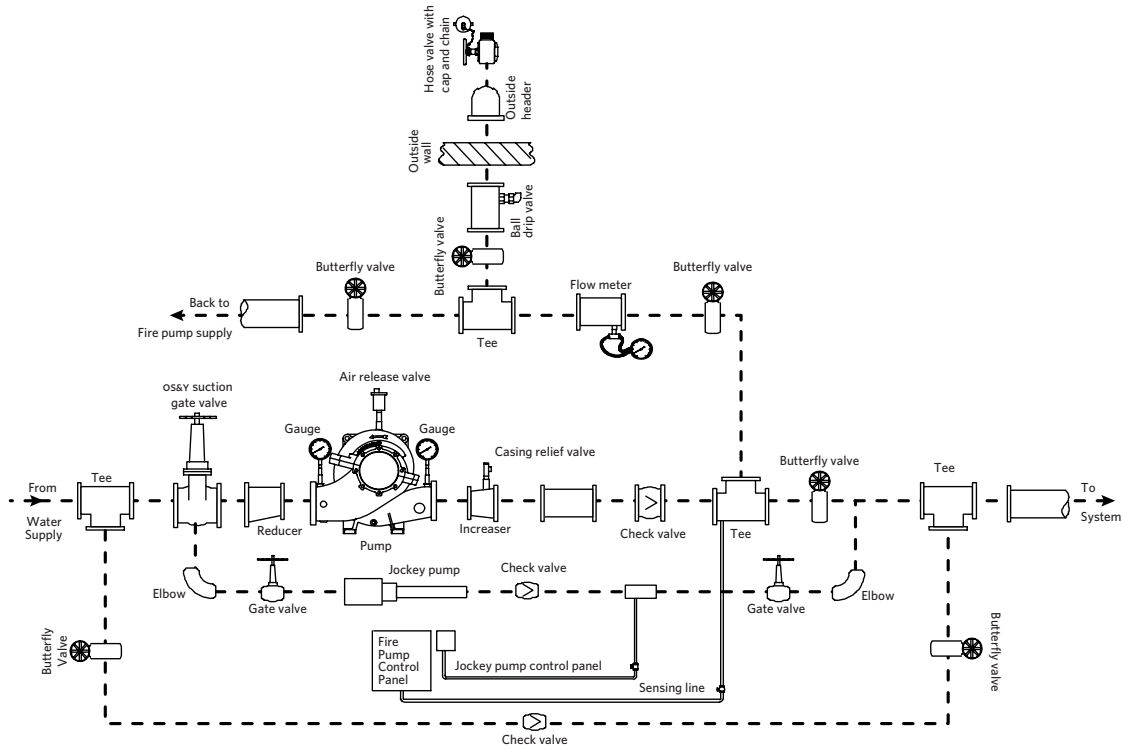
- The following gauges are required to measure both suction and discharge pressures, and must be supplied with all fire pumps to ensure close check on pump performance:

- A 3½" dial combination pressure and vacuum suction gauge
- B 3½" dial discharge pressure gauge
- C ¼" cocks with lever handle

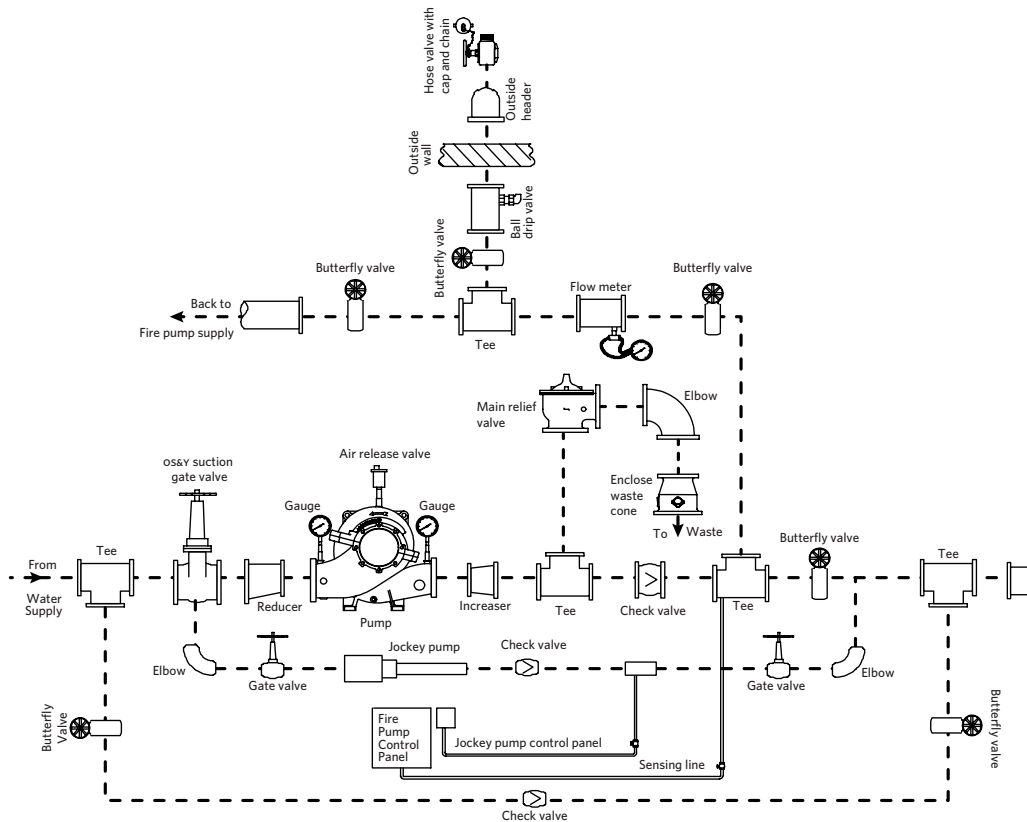
### TESTING ALIGNMENT



### TYPICAL FIRE PUMP & CONTROLLER ARRANGEMENT HORIZONTAL SPLIT CASE - ELECTRIC DRIVEN



### HORIZONTAL SPLIT CASE - DIESEL DRIVEN



**NOTE:** ALL VALVES SHALL BE LISTED FOR FIRE APPLICATION. These drawings are a suggested arrangement and are issued for information purposes only.

## 2.0 OPERATION-ELECTRIC DRIVEN

Set pressure to the following setting values:

**Example:** Rated Flow and Head = 750 USgpm and 55 psi ; Min. Suction pressure = 50 psi

<b>Fire Pump Stop Point (FSP)</b>	=	Fire Pump shutoff pressure + min. static suction pressure	=	Cut-out
	=	60 psi + 50 psi	=	110 psi
<b>Jockey Pump Stop Point (JSP)</b>	=	Fire Pump shutoff pressure + min. static suction pressure	=	Cut-out
	=	60 psi + 50 psi	=	110 psi
<b>Jockey Pump Start Point (JSTRT)</b>	=	JSP - 10 psi	=	Cut-in
	=		=	110 psi - 10 psi = 100 psi
<b>Fire Pump Start Point (FSTRT)</b>	=	JSTRT- 5 psi	=	Cut-in
	=		=	100 psi - 5 psi = 95 psi
<b>Pressure Relief Valve</b>	=	Minimum suction pressure + rated pressure + 5 psi	=	50 psi + 55 psi + 5 psi = 110 psi
<b>Resume</b>	=	<b>Fire Pump</b>	Cut-in	Cut-out
			95 psi	110 psi
		<b>Jockey Pump</b>	Cut-in	Cut-out
			100 psi	110 psi
		<b>Pressure Relief Valve</b> to open at 110 psi		

### 2.1 PRESTART-UP

Fill out PRESTART-UP CHECK LIST

### 2.2 FIRE PUMP PRESSURE SETTING

#### 2.2.1 PRESSURE SWITCH SETTING

The pressure switch to start the fire pump is normally located in the lower left-hand side of fire pump controller. Similarly the pressure switch to start the Jockey pump is located in the Jockey pump controller.

#### 2.2.2 PRESSURE TRANSDUCER SETTING

The controller shall be supplied with a solid state pressure transducer with Rated for 0-500psi working pressure (standard display at 0-300psi) and a run test solenoid valve. The wet parts shall be externally mounted and include a protective cover. The pressure sensing line connection to the transducer shall be ½" FNPT. Provisions for a redundant pressure transducer shall be provided.

Make sure pump shutoff + MAX. suction pressure does not exceed system rated pressure or its components.

### 2.3 CIRCULATION RELIEF VALVE

The circulation relief valve should be set in the field at pressure to the lowest suction pressure, plus the rated pressure of the unit raised to the next higher 5 lbs increment. When the fire pump is first running at churn, ensure an adequate water discharge through the circulation relief valve.

### 2.4 START-UP PROCEDURE



**CAUTION:** In case of electrical control circuit problem use the emergency disconnect lever to bypass control circuits

#### 2.4.1 ELECTRIC DRIVEN

- Open suction gate valves.
- Check that pump is full of water and that all air contained in pump has been allowed to escape through the air release valve.
- Compress packing evenly with gland (gland nut should be finger tight).
- Standing to side of the controller, turn disconnecting means to the on position of the Fire Pump controller.
- An initial startup menu will appear. This will only appear on the first power up or if you power down prior to completion.
- Controller will automatically check for correct voltage.
- Next it will want to check rotation, it allows you to **bump** the motor and visually check rotation. Always spins towards suction.
- For controller manufacture specific startup instruction follow direction showing on screen or found in controller IOM.
- \*(Fire controller) cut-in pressure to be set based on discharge pressure at churn (no flow). Initially use low pressure setting to ensure the fire pump will not start on pressure drop.



- Verify System control valve is in the closed position.
- Bleed the system by opening a valve on the pressure sensing line to create a pressure drop.
- As soon as fire pump starts check if full load current value is within the electric motor nameplate rating with service factor taken into account.
- Check and adjust packing glands. HSC will have one on either side, A good rule of thumb is a drip of water per second. There will be a drain plumbed for these, make sure it is unclogged and not tied in with any other drains.
- After running for one minute, stop pump with stop button.
- Bleed again until desired start-up pressure is attained.
- Allow Jockey pump to stop automatically and the **START**, **STOP** and **SYSTEM PRESSURE** shall be digitally displayed and adjustable through the user interface on Jockey pump controller.

#### START-UP PROCEDURE

##### (FLOW TEST PROCEDURE IF REQUIRED BY AUTHORITIES)

- Close system control butterfly valve.
- Open gate valve to hose outside header for flow test or flow meter discharge valve.
- Press start button to start pump.
- Adjust flow by the quantity of hose valves opened or with pump discharge valve if using flow meter.
- Perform flow test for 0% (churn), 100% (rated flow), 150% (rated flow) using approved flow testing device.
- At these 3 flows record suction pressure, discharge pressure, pump RPM, pump current and voltage.
- When test is finished, close test header and stop pump.

#### REMINDER



- Leave the disconnect switch **ON** and the circuit breaker **ON** (the **POWER ON** light must be lit)
- Bring timer setting back to required value, one minute for each 10 HP, maximum 10 minutes

#### 2.4.2 DIESEL ENGINE DRIVEN

- Open suction gate valves.
- Check that pump is full of water and that all air contained in pump has been allowed to escape through the air release valve.
- Compress packing evenly with gland (gland nut should be finger tight).
- Bring the timer setting down to one minute for automatic start test purpose.

- Start engine manually on either battery.
- Adjust main relief valve (MRV) spring to allow valve to fully open.
- Stop engine.
- Bleed the system by opening a valve on the pressure sensing line to create a pressure drop (Verify the pump start at pressure start set according to the pressure setting table 2.3 and program fire pump controller pressure setting).
- As soon as fire pump starts, verify engine RPM matches pump rated RPM.
- Check and adjust packing glands. HSC will have one on either side of the impeller A good rule of thumb is a drip of water per second. There will be a drain plumbed for these, make sure it is unclogged and not tied in with any other engine drains.
- After running for one minute, stop pump with stop button.

#### START-UP PROCEDURE

##### (FLOW TEST PROCEDURE IF REQUIRED BY AUTHORITIES)

- Close system control butterfly valve.
- Open gate valve to hose outside header for flow test or flow meter discharge valve.
- Press start button to start pump.
- Adjust flow by the quantity of hose valves opened or with pump discharge valve if using flow meter.
- Perform flow test for 0% (churn), 100% (rated flow), 150% (rated flow) using approved flow testing device.
- At these 3 flows record suction pressure, discharge pressure, engine RPM, engine water temp., engine oil pressure.
- When test is finished, close test header and stop pump.

#### 2.5 AUTOMATIC OPERATION

- Open system butterfly valve and turn all the isolating valves to the fully open position.
- Place selector switch in **AUTO** position for Fire pump, diesel pump controller (HOA).
- Switch the jockey pump to **AUTO** (the **POWER ON** light must be lit).

#### NOTE

- The settings should be established by pressures observed on test gauges
- A final adjustment may be made on any control to match the exact system requirements

**AFTER START-UP, MAKE SURE ...**

- To open system butterfly valve.
- To bring minimum run timer back to 30 minutes.
- Valve on pump suction must be fully open as throttling on suction side is harmful to the pump.
- Pump will not run dry. Most centrifugal pumps have close clearances and cannot run dry without serious damage resulting.

**3.0 MAINTENANCE**

HSC pumps are built to operate with periodic maintenance. A systematic inspection made at regular intervals, giving special attention to the following, will ensure years of trouble-free operation.

**3.1 GENERAL CARE**

- Keep unit clean.
- Provide the motor with adequate overload protection.
- Keep flying chips or other loose particles away from the ventilating openings of the motor.
- Avoid operating the unit in overheated surroundings.
- Proper ventilation should be provide in the pump room.
- Make sure all drain-lines are clear and draining properly.
- Ensure gland packing is leaking at the one drop per second while pump is running.

**3.2 BEARINGS**

- Sealed greased for life bearings are fitted on your pump.
- No particular attention is required.
- No need for greasing since the bearings are greased for the entire bearing life.
- If abnormal noises come from the bearing during normal operation, replace bearings.

**3.3 STUFFING BOX WITH PACKING**

**STUFFING BOX DISMANTLING**

- Remove flush line connection from stuffing box extension.
- Remove gland plate from stuffing box.
- Remove stuffing box extension.

**PACKING REPLACEMENT**

- When removing old packing, make sure bottom rings are completely removed (Maintain sequence of lantern ring and packing ring).

- Thoroughly clean the stuffing box and check condition of shaft sleeve (a badly worn or corroded shaft sleeve will never seal properly).
- Cut packing into lengths allowing 1/8" between ends when installed.
- Place first ring around shaft and press firmly and evenly into stuffing box.
- Continue in the same manner staggering ring joints one quarter of a turn until stuffing box is filled.
- Make certain lantern ring is in correct position under pipe connection.

**STUFFING BOX ASSEMBLY**

- Install back stuffing box extension.
- Install flush line connection on stuffing box extension.
- Install gland plate and compress evenly leaving it finger tight.
- Compress packing evenly with gland and leave gland nut finger tight.
- With pump running adjust gland with recommended leakage rate.



**CAUTION:** Packing should not be pressed too tight, as this may result in burning the packing and scoring the shaft sleeve.

**4.0 PUMP DISASSEMBLY**



**WARNING:** Whenever any disassembly work is to be done on pump, disconnect power source to driver to eliminate any possibility of starting unit.

**4.1 TO REMOVE ROTATING ASSEMBLY**

- 1 Remove coupling guard and disconnect coupling halves.
- 2 Disconnect flush line from upper half casing.
- 3 Remove pump half coupling.
- 4 Remove bolting from bearing covers and jack the (2) screws to help remove bearing covers.
- 5 Remove bearing locknut on opposite side of motor.
- 6 Remove bearing by holding shaft in place and turning nut behind bearing; bearing will slide out.
- 7 Remove gland plate and split gland.
- 8 Remove stuffing box extension.
- 9 Remove packing, lantern ring and bushing.
- 10 Remove top casing bolting.
- 11 Screw (2) jack screws down to separate upper and lower case.
- 12 Turn jack screws back after separation to prevent interference at reassembly.

- 13 Lift upper casing straight up until clear of impeller.
- 14 Place slings around shaft near the bearing housings and lift shaft assembly.
- 15 Place shaft assembly in a clean, dry work area for necessary disassembly.

#### 4.2 DISASSEMBLY OF ROTATING ELEMENT

- 1 Unscrew sleeve on right side of the pump when facing suction flange.
- 2 Slide impeller on shaft and remove.  
**NOTE DIRECTION OF VANES. IMPELLER MUST BE INSTALLED IN SAME DIRECTION.**
- 3 Remove impeller key.
- 4 Unscrew other sleeve.

#### 4.3 REMOVAL OF IMPELLER RING

It is not necessary to remove impeller from shaft to replace impeller rings

- 1 Remove rotating element.
  - 2 Slide of casing wear rings.
- If impeller rings are fitted.
- 3 Remove locking set screws from rings.
  - 4 Rings may now be pulled from impeller, cut off with a chisel, or turned off if a suitable lathe is available using original shaft centers - **do not cut into body of impeller.**
  - 5 When new rings are installed, drill and tap new holes for locking set screws - do not attempt to use old half holes in impeller hub.

#### 4.4 INSPECTION

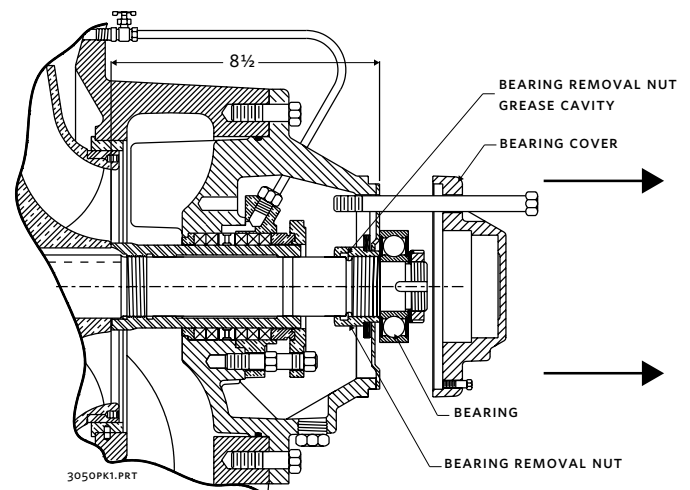
- 1 Visually inspect parts for damage affecting serviceability
- 2 Replace if defective in any way. Install new O-rings and Gasket.
- 3 Mount shaft between the lathe centers to check eccentricity throughout the entire length, runoff should not exceed 0.002".
- 4 Bearing surface should be smooth and shoulders square and free of nicks
- 5 Measure OD of impeller hub or impeller wear rings and ID of casing wear ring
- 6 Compute diametrical clearance (ID minus OD) and compare with original (0.0075" to 0.0085") radial clearance
- 7 Surfaces must be smooth and concentric
- 8 Examine impeller passages for cracks, dents or embedded material
- 9 Examine shaft sleeves for wear

#### 4.5 ASSEMBLY IS THE REVERSE OF THE DISASSEMBLY PROCEDURE

- 1 All parts, inside and out, should be clean since dirt and grit will cause excessive wear, plus needless shutdown.
- 2 Reinstall sleeve in correct position - 8½" from bearing face to sleeve face (see drawing PUMP ASSEMBLY).
- 3 The sleeve locked by impeller key must be re-install correctly. Failure to install correctly result in pump failure.
- 4 Reinstall impeller with vanes in right direction - impeller vanes slope must be opposite to pump rotation.
- 5 Install other sleeve and lock.
- 6 Some of our pumps have locking set screw in the sleeve if present ensure they are tightened.

Pump rotation is defined viewed from the driver's end

- 1 Make certain that casing rings are in proper position; the half raised ring should be on the outside and completely in the lower half casing and ensure ring is fully seated.
- 2 Install casing gasket and do not cut overlap before casing cover is in place and bolted.
- 3 Install upper half, cut gasket on each side of the stuffing box and bore after all cap screws are tightened.
- 4 Install stuffing box bracket and packing afterwards. Insure that packing does not block seal water inlet.
- 5 Install packing flush line.
- 6 Reinstall bearings and bearing covers.



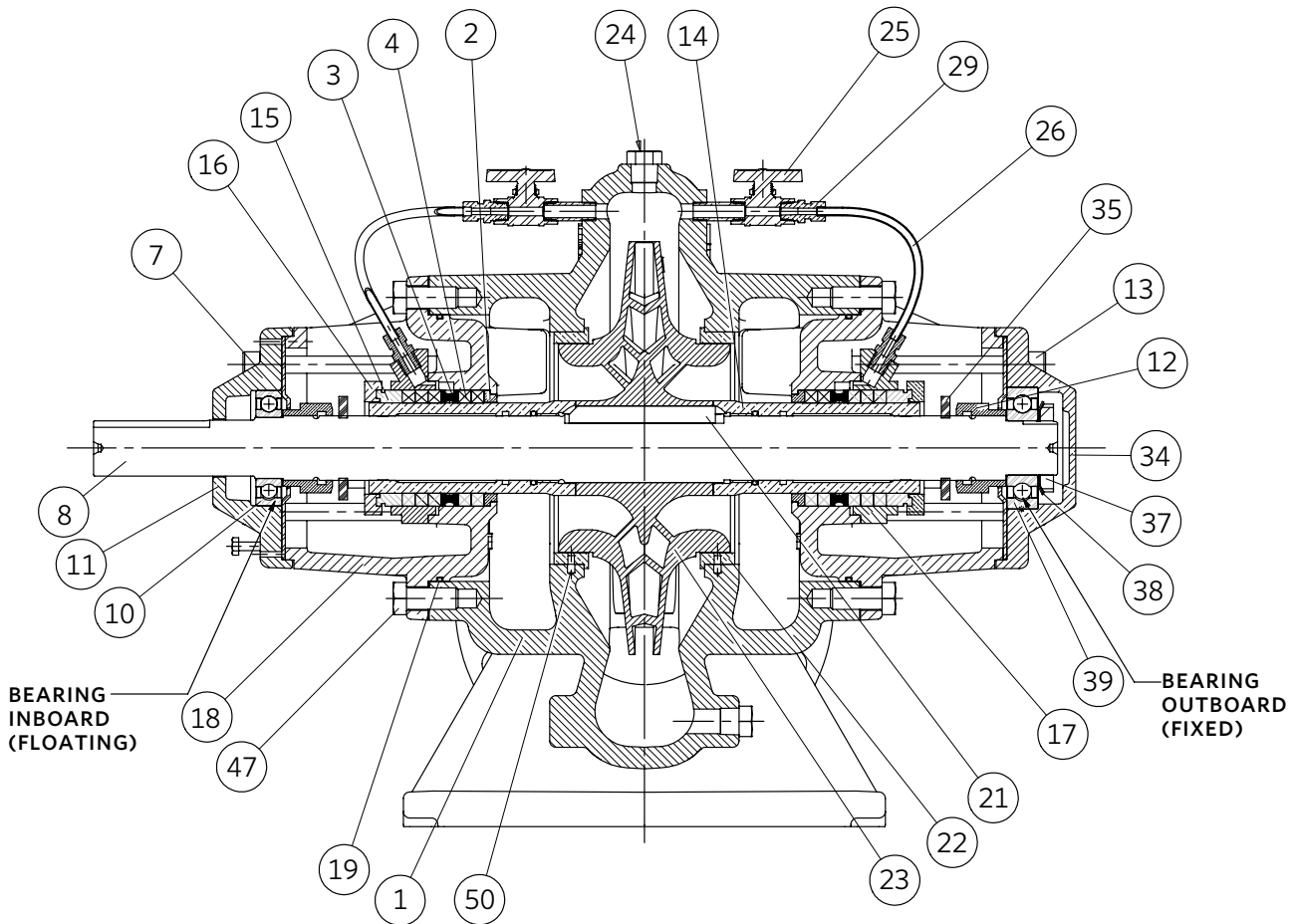
## 5.0 TROUBLE SHOOTING

CAUSES	REMEDY
<b>PUMP WILL NOT START</b>	
Faulty electrical circuit	<ul style="list-style-type: none"> <li>Make sure both circuit breaker and disconnect switch are in the <b>ON</b> position</li> <li>If the circuit breaker trips when the pump tries to start check horsepower and voltage specified on the schematic and wiring diagram inside the starter door with the pump motor nameplate</li> <li>Ensure that the pressure switch/Pressure transducer is working properly and is responding to changes in pressure.</li> </ul>
Impeller Jammed	<ul style="list-style-type: none"> <li>Remove obstruction</li> </ul>
<b>PUMP IS NOISY OR VIBRATES</b>	
Stuffing box too tight or packing improperly installed	<ul style="list-style-type: none"> <li>Loosen gland swing bolts and remove stuffing box gland halves; replace packing</li> </ul>
Impeller obstructed	<ul style="list-style-type: none"> <li>Pressures fall off rapidly when an attempt is made to draw a large amount of water, remove obstruction from impeller</li> </ul>
Excess bearing friction due to wear and dirt	<ul style="list-style-type: none"> <li>Remove bearings and clean, lubricate, or replace as necessary</li> </ul>
Foundation not rigid	<ul style="list-style-type: none"> <li>Tighten foundation bolts or replace foundation if necessary</li> </ul>
Alignment	<ul style="list-style-type: none"> <li>Correct the alignment</li> </ul>
Pump cavitation	<ul style="list-style-type: none"> <li>Ensure adequate suction pressure</li> </ul>
<b>NO WATER DISCHARGE</b>	
Air pocket or air leakage in suction line	<ul style="list-style-type: none"> <li>Uncover suction pipe and locate and re-arrange</li> </ul>
Suction connection obstructed	<ul style="list-style-type: none"> <li>Examine suction intake, screen, and suction pipe and remove obstruction</li> </ul>
Impeller obstructed	<ul style="list-style-type: none"> <li>Pressures fall off rapidly when an attempt is made to draw a large amount of water, remove obstruction from impeller</li> </ul>
Pump not primed	<ul style="list-style-type: none"> <li>First warning is a change in pitch of the sound of the driver; shut down the pump</li> </ul>
<b>DISCHARGE PRESSURE TOO LOW</b>	
Air leakage in suction line	<ul style="list-style-type: none"> <li>Uncover suction pipe and locate and re-arrange</li> </ul>
Suction connection obstructed	<ul style="list-style-type: none"> <li>Examine suction intake, screen, and suction pipe and remove obstruction</li> </ul>
Stuffing box too tight or packing improperly installed	<ul style="list-style-type: none"> <li>Loosen gland swing bolts and remove stuffing box gland halves; replace packing</li> </ul>
Water seal or pipe to seal obstructed or air leak into pump through stuffing boxes	<ul style="list-style-type: none"> <li>Loosen gland swing bolt and remove stuffing box gland halves along with the water-seal ring and packing.</li> <li>Clean the water passage to and in the water seal-ring. Replace water seal-ring, packing gland and packing in accordance with manufacturer's instructions</li> </ul>
Impeller obstructed	<ul style="list-style-type: none"> <li>Pressures fall off rapidly when an attempt is made to draw a large amount of water, remove obstruction from impeller</li> </ul>
Speed too low	<ul style="list-style-type: none"> <li>Check that rated motor speed corresponds to rated speed of pump, voltage is correct, and starting equipment is operating properly</li> </ul>
Wrong direction of rotation	<ul style="list-style-type: none"> <li>With polyphase electric motor drive two wires must be reversed; where two sources of electrical current are available, the direction of rotation produced by each should be checked</li> </ul>
Rated motor voltage different from line voltage i.e., 220 or 440 volt motor on 208 or 416 volt line	<ul style="list-style-type: none"> <li>Obtain motor of correct rated voltage or larger size motor</li> </ul>
<b>PUMP WILL NOT STOP</b>	
* Faulty electrical circuit	<ul style="list-style-type: none"> <li>Is the pressure switch inside the starter properly piped up to the water system? (system side)</li> <li>Is the stop valve in the piping to the pressure switch open?</li> <li>Check that pressure switch is working properly by disconnecting one of the pressure switch leads to simulate open contact position</li> <li>Ensure that pressure switch connection lines have been flushed to clear dirt in piping</li> <li>Make sure that pressure switch set point is correct according to suction and working pressure</li> <li>Change manual start handle to automatic</li> </ul>
Run period timer defective	<ul style="list-style-type: none"> <li>Remove jumper if applicable</li> </ul>
Pressure too low	<ul style="list-style-type: none"> <li>Verify pressure switch setting compared to system pressure</li> </ul>
Fire pump controller emergency start handle engaged or in run position.	<ul style="list-style-type: none"> <li>Return emergency start handle to off position</li> </ul>

## 6.0 WARRANTY

Refer standard warranty document.

## SERIES 4600 HORIZONTAL SPLIT CASE



### 7.0 SERIES 4600F HORIZONTAL SPLIT CASE PUMP PARTS LIST

NO.	PART LIST	MATERIAL	QTY
1	CASING	CAST IRON	1
2*	STUFFING BOX BUSHING	BRONZE	2
3	LANTERN RING	TEFLON	2
4*	PACKING	GRAPHITE	100
7	RETAINER BEARING	STAINLESS STEEL	2
8*	SHAFT	CARBON STEEL	1
10*	INBOARD BEARING	NSK	1
11	INBOARD BEARING HOUSING	CAST IRON	1
12*	BEARING REMOVAL NUT	BRONZE	2
13	BEARING HOUSING CAP SCREW	CARBON STEEL	6
14*	SHAFT SLEEVE PACKING	STAINLESS STEEL	2
15	SPLIT RING	BRONZE	2
16	PACKING GLAND	BRONZE	2
17	STUFFING BOX EXTENSION	BRONZE	2
18	STUFFING BOX	CAST IRON	2
19*	STUFFING BOX "O" RING	BUNA N 80 DURO	2

NO.	PART LIST	MATERIAL	QTY
21*	IMPELLER KEY	CARBON STEEL	1
22*	CASING RING	BRONZE	2
23*	IMPELLER	BRONZE	2
24*	DRAIN PLUG	CAST IRON	1
25	NEEDLE VALVE	COPPER	2
26	FLUSH LINE	BRASS	2
29	TUBE CONNECTOR	BRASS	2
34	OUTBOARD BEARING HOUSING	CAST IRON	1
35*	DEFLECTOR	NEOPRENE	2
37	BEARING LOCK NUT	CARBON STEEL	1
38	BEARING LOCK WASHER	CARBON STEEL	1
39*	OUTBOARD BEARING	NSK	1
47	CAP SCREW	CARBON STEEL	16
50	LOCKING PIN	STAINLESS STEEL	2
	CASING GASKET* (NOT SHOWN)	VELOTHERM	1

\*RECOMMENDED SPARES

## 8.0 PRE START-UP / POST START-UP CHECK LIST

Refer Armstrong pre-startup check list.

**TORONTO**

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**LYON**

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**DUBAI**

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