HM, CWR & CWX Pumps Installation, Operation and Maintenance Manual

SAMengineering

Customised Pump Solutions

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SABS ISO 9001

Alloys to suit all applications

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Contents

NOTE:
The information contained in this book is intended to assist operating personnel by providing information on the characteristics of the purchased equipment.

It does not relieve the user of the responsibility of using accepted engineering practices in the installation, operation and maintenance of this equipment.

INTRODUCTION

This manual is furnished to acquaint you with the easiest and most practical way to install, operate, and maintain this pump. Keep it handy for future reference. Additional information can be obtained from the nearest SAM Engineering. The Standards of the Hydraulic Institute are an excellent source for more detailed advice on the subject of installation, operation and maintenance.

Equipment cannot operate well without proper care. To keep the unit at top efficiency, correct procedures for installing and maintenance must be followed. SAM Engineering can help install this equipment correctly, so that maximum machine life can be attained with a minimum of downtime.

SAM Engineering Servicemen are experienced, factory trained assembly superintendents, and offer prompt, efficient service at reasonable rates. Costly errors such as poor grouting, incorrect alignment, pipe stresses transmitted to the casings, and improperly cleaned piping are frequently found and corrected by these servicemen, thus saving costly repair and additional delays. The serviceman can be obtained through the nearest SAM Engineering Sales Office. This office will also help with spare parts orders and problems requiring special attention.

PUMP IDENTIFICATION

a. The new HM Pump Standard is designated style C-011. It combines the best features of both the HM-II & HM-12 designs.

b. The C-011 Pump has internal pressure relief vanes cast integral in the impeller to reduce stuffing box pressure. Flush water is piped to the centre of the stuffing box. A split seal cage delivers the water, sealing the packing from entrance of abrasive particles. Lower stuffing box pressure results in longer shaft sleeve and packing life.

c. The new CWR pump standard designation is style C-011. It is the same design as the HM except the impeller is radially ribbed on both the front and back shroud wall. This is recommended for highly abrasive slurries. The impeller ribs cut down on recirculation of slurry through the wear plate clearance, reducing wear.

d. The dynamic seal, style C-022, is used when seal water dilution of the product cannot be permitted. This design employs a combination static seal and second impeller to eliminate the conventional stuffing box. Seal water in the amount of 1/4-1/2 GPM is all that is required.

The HM and CWR Pumps are designated by Model Numbers, Serial Numbers, Size, and Style. This information is stamped on an identification plate and affixed to the pump casing. A second plate, attached to the pump frame, contains the inboard and outboard bearing part numbers.

a. Permanent records for this pump are kept by the serial number; therefore, the serial number must be used with all correspondence and spare-parts orders.

b. Maintenance instructions in this manual are based upon the Model F6 frame.

SAMCO PUMPS

MODEL (1.)	SER. NO. (2.)
FLOW (m^3/hr) (3.)	HEAD (m) (4.)
MAX.DES.PRS (kPa) (5.)	IMP. DIA. (mm) (6.)
MOC (7.)	RPM (8.)

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These pumps are designated by serial number, model, size, and M.O.C. This information is stamped on an identification plate and affixed to the pump frame or casing.

Permanent records are kept by the factory and filed by serial number.

The pump nameplate contains the following information:

1. SERIAL NUMBER – Composed of certain groups of numbers. All groups are necessary for identification. TYPICAL EXAMPLE: P 2081 / 98

2. MODEL - HM, followed by SIZE – Composed of three (3) groups of numbers.
EXAMPLE: 4 x 3 x 11 – First number (4) is the ASA suction flange size in inches, second number (3) is the ASA discharge flange size in inches, the third number (11) is the nominal maximum impeller diameter in inches.

3. IMPELLER DIAMETER – This number is the impeller diameter in millimetres as supplied by the factory. EXAMPLE: 265

4. FLOW – Design flow rate in cubic metres per hour.

5. HEAD – Design head in metres.

6. MAX. DESIGN PRESSURE – This refers to factory standard hydrostatic test pressure for hydraulic end of pump.

7. M.O.C. – Material of construction of pump shown in abbreviated form and in four parts. EXAMPLE: CI/SS/CI/EN8 – where casing, stuff box and wear plate (if fitted) are in Cast Iron / impeller in Stainless Steel / frame is in Cast Iron / shaft is in EN8

8. RPM – Design speed of pump to achieve design flow and head.

TEMPORARY STORAGE

If the pump is not to be installed and operated soon after arrival, store it in a clean, dry place having slow, moderate change in ambient temperature. Rotate the shaft periodically to coat the bearings with lubricant and to retard oxidation and corrosion.

PUMP INSTALLATION
SUCTION AND DISCHARGE PIPING

General: When installing the pump piping, be sure to observe the following precautions:

a. Both the suction and discharge piping should be independently supported near the pump and properly aligned so that no strain is transmitted to the pump when the flange bolts are tightened. Use pipe hangers or other supports at necessary intervals to provide supports.

b. It is usually advisable to increase the size of both suction and discharge pipes at the pump connections to decrease the loss of head from friction.

c. Install piping as straight as possible, avoiding unnecessary bends. Where necessary, use long radius or 90° fittings to decrease friction losses.

d. Make sure that all piping joints are airtight.

e. Where flanged joints are used, assure that inside diameters match properly.

f. Remove burrs and sharp edges when making up joints.

g. Do not "spring" piping when making any connections.

h. Provide for pipe expansion when hot fluids are to be pumped. The use of expansion joints is not recommended.

CAUTION: Bolt torque must not exceed 12S ft. lbs. on flanges. Hard iron is brittle and an over-torque could crack casing.

SUCTION PIPING

When installing the suction piping, observe the following precautions:

a. The sizing and installation of the suction piping is extremely important. It must be selected and installed so that pressure losses are minimised and sufficient liquid will flow into the pump when started and operated. Many NPSH (Net Positive Suction Head) problems can be directly attributed to improper suction piping systems.

b. Suction piping should be short in length, as direct as possible, and never smaller in diameter than the pump suction opening. If the suction pipe is short, the pipe diameter can be the same size as the suction opening. If longer suction pipe is required, pipes should be one or two sizes larger than the opening depending on piping length.

c. The suction pipe should slope upward to the pump nozzle. A horizontal suction line must have a gradual rise to the pump. Any high point in the pipe will become filled with air and thus prevent proper operation of the pump. When reducing the piping to the suction opening diameter use an eccentric reducer with the eccentric side down to avoid air pockets.

NOTE: Never use a straight taper reducer in a horizontal suction line, as it tends to form an air pocket in the top of the reducer and the pipe.

DISCHARGE PIPING

For plain liquid service, if the discharge piping is short, the pipe diameter can be the same as the discharge opening. If the piping is long, pipe diameter should be one or two sizes larger than the discharge opening. On long horizontal runs it is desirable to maintain as even a grade as possible. Avoid high spots, such as loops, which will collect air and throttle the system or lead to erratic pumping. For slurries, it is suggested to consult technical advice on correct pipe sizing. Each application may require consideration to provide proper line velocity to prevent settling out. Selection of size of discharge line is important in order to keep velocities up to prevent slurries from settling out.

VALVES IN DISCHARGE PIPING

A check valve and gate valve should be installed in the discharge. The check valve, placed between pump and gate valve, protects the pump from excessive pressure, and prevents liquid from running back through the pump in case of power failure.

The gate valve is used in priming and starting, and when shutting the pump down.

PRESSURE GAUGES

Properly sized pressure gauges can be installed in both the suction and discharge pipe sections adjacent to the pump. The gauges will enable the operator to easily observe the operation of the pump, and also determine if the pump is operating in conformance with the performance curve. For slurry service gauges should be of the protected type. If cavitation, vapour binding or other unstable operation should occur, widely fluctuating discharge pressure will be noted.

NOTE: The standard pump has no drain or vent taps.

OPERATION

PRE-START CHECKS

Before initial start of the pump, make the following inspections:

a. Check alignment between pump and motor.

b. Check Rotation. Be sure that the pump operates in the direction indicated by the arrow on the pump casing, as serious damage can result if the pump is operated with incorrect rotation. Check rotation each time the motor leads have been disconnected.

NOTE: If motor cannot be carefully "bumped" it is suggested that couplings be disconnected for rotation check.

c. Check all connections to motor and starting device with wiring diagram. Check voltage, phase and frequency on motor nameplate with line circuit.

d. Check suction and discharge piping and pressure gages for proper operation.

e. Turn rotating element by hand to assure that it rotates freely.

f. Check impeller adjustment.

g. Check stuffing box adjustment, lubrication and piping.

h. Assure that bearings are properly lubricated.

i. Assure that pump is full of liquid.

PRIMING

a. If the pump is installed with a positive head on the suction, it can be primed by opening the suction valve and allowing the liquid to enter the casing.

b. If the pump is installed with a suction lift, priming must be done by other methods such as foot valves, ejectors, or by manually filling the casing and suction line.

CAUTION: Under either condition, the pump must be completely filled with liquid before starting. The pump must not be run dry in the hope it will prime itself. Serious damage to the pump may result if it is started dry.

STARTING

a. Close valve in discharge line and drain valves.

b. Fully open all valves in the suction line.

c. Turn on external flushing water to the stuffing box and adjust pressure if necessary. (If pumped liquid is dirty or if leakage of air is to be prevented, these lines should always be left on.)

d. Prime the pump.

NOTE: If the pump does not prime properly, or loses prime during start-up, it should be shut down and the condition corrected before the procedure is repeated.

e. (Pumps moving high temperature liquids.) Open the warm-up valve to circulate liquid for preheating. Close the valve after the pump is warmed up.

f. Start the pump driver (turbines and engines require warming up, consult the manufacturer's instructions).

g. When pump is operating at full speed, open the discharge valve slowly. (Note: Pump should not operate against a closed discharge for any length of time. In some cases this should not be more than a few minutes.)

h. Adjust the liquid seal valves to proper pressure according to instructions.

CAUTION: The gate valve in the discharge line should always be closed when the pump is started. The excessive current required by the motor to start under full load will in time cause motor trouble. A centrifugal pump, primed and operated at full speed with the discharge gate valve closed, usually requires much less power than when it is operating at its rated capacity and head with the discharge gate valve open.

OPERATING CHECKS

a. Check the pump and piping to assure that there are no leaks.

b. Check and record pressure gauge readings for future reference.

c. Check and record voltage, amperage per phase, and kW if an indicating wattmeter is available.

d. Check bearings for lubrication and temperature.

e. Check and adjust stuffing box for correct operation. Check sealing water lines and valves.

CAUTION: If heat is used to keep the pump from freezing, do not let the temperature rise above 37.8°C – 65.6°C.

SHUTDOWN

The following steps of procedure will take care of most normal shutdowns of the pump. Make any further adjustments of process piping, valves, etc., as required. If the pump is to be removed from service for an extended period of time, consult storing procedures, and protection from freezing.

a. Close the discharge valve slowly.

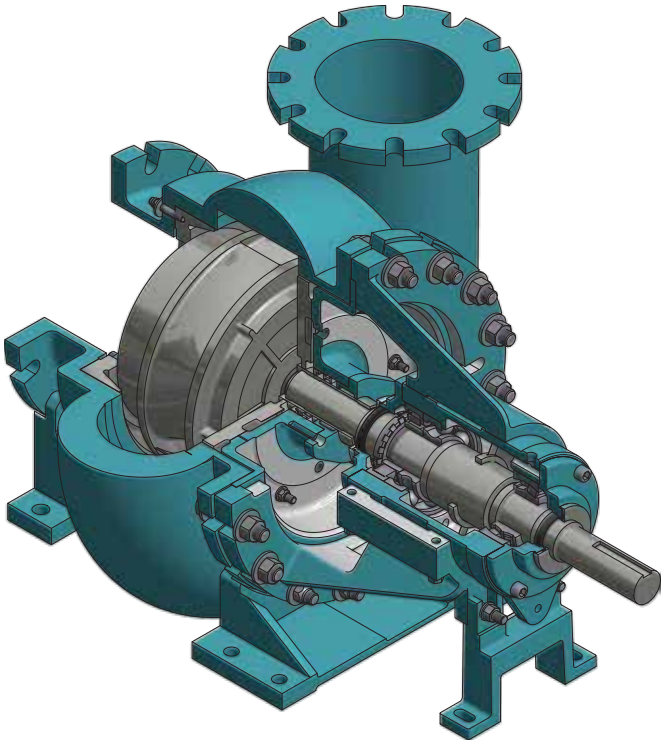
NOTE: When stopping pump, always close discharge valve first.

b. Shut down the driver (consult manufacturer's instructions for special operations).

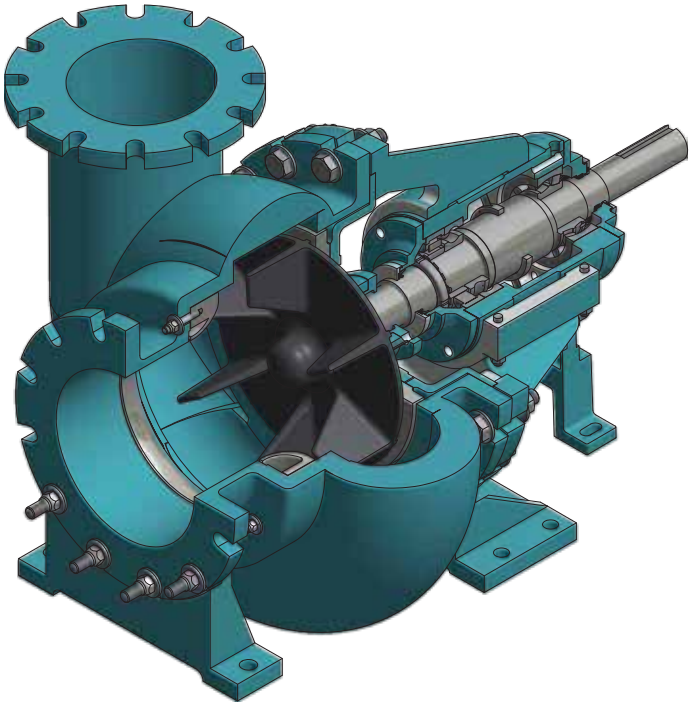
c. Close seal liquid valves. (If pumped liquid is dirty or if in-leakage is to be prevented, these lines should always be left open.)

d. Open drain valves as required.

HM SERIES



CWX SERIES



Between regular maintenance inspections, be alert for signs of motor or pump trouble. Common symptoms are listed below. Correct any trouble immediately to AVOID COSTLY REPAIR AND SHUTDOWN.

CAUSES	CURES
No liquid delivered	
1. Lack of prime	Fill pump and suction pipe completely with liquid.
2. Loss of prime	Check for leaks in suction pipe joints and fittings; vent casing to remove accumulated air.
3. Suction lift too high	If no obstruction at inlet, check for pipe friction losses. However, static lift may be too great. Measure with mercury column or vacuum gauge while pump operates. If static lift is too high, liquid to be pumped must be raised or pump lowered.
4. Discharge system head too high	Check pipe friction losses. Larger discharge piping may correct condition. Check that valves are wide open.
5. Speed too low	Check whether motor is directly across-the-line and receiving full voltage. Alternatively, frequency may be too low; motor may have an open phase.
6. Wrong direction of rotation	Check motor rotation with directional arrow on pump casing. Wrong rotation will cause pump damage.
7. Impeller completely plugged	Dismantle pump or use piping hand hole to clean impeller.
Not enough liquid delivered	
8. Air leaks in suction piping	If liquid pumped is water or other non-explosive material, and explosive gas or dust is not present, test flanges for leakage with a flame or match. For such liquids as gasoline, suction line can be tested by shutting off or plugging inlet and putting line under pressure. A gauge will indicate a leak with a drop of pressure.
9. Air leaks in stuffing box	Increase seal lubricant pressure to above atmosphere.
10. Speed too low	See item 5.
11. Discharge system head too high	See item 4.
12. Suction lift too high	See item 3.
13. Impeller partially plugged	See item 7.
14. Cavitation; insufficient NPSH (depending on installation)	a. Increase positive suction head on pump by lowering pump or increasing suction pipe size or raising fluid level. b. Sub-cool suction piping at inlet to lower entering liquid temperature. c. Pressurise suction vessel.
15. Defective impeller	Inspect impeller. Replace if damaged or vane sections badly eroded.
16. Defective packing	Replace packing and sleeves if badly worn.

Not enough liquid delivered	
CAUSES	**CURES**
17. Foot valve too small or partially obstructed	Area through ports of valve should be at least as large as area of suction pipe, preferably 1½ times. If strainer is used, net clear area should be 3 to 4 times area of suction pipe.
18. Suction inlet not immersed deep enough	If inlet cannot be lowered, or if eddies through which air is sucked persist when it is lowered, chain a board to suction pipe. It will be drawn into eddies, smothering the vortex.
19. Wrong direction of rotation	Compare rotation of motor with directional arrow on pump casing. Wrong rotation will cause pump damage.
20. Too small impeller diameter (probable cause if none of the above)	Check with factory to see if a larger impeller can be used; otherwise, cut pipe losses or increase speed, or both, as needed. Be careful not to seriously overload drive.
Not enough pressure	
21. Speed too low	See item 5.
22. Air leaks in suction piping	See item 8.
23. Mechanical defects	See items 15, 16, and 17.
24. Obstruction in liquid passages	Dismantle pump and inspect passages of impeller and casing. Remove obstruction.
25. Air or gases in liquid (Test in laboratory, reducing pressure on liquid to pressure in suction line. Watch for bubble formation.)	May be possible to overrate pump to the point where it will provide adequate pressure despite condition. It is better to provide gas separation chamber on suction line near pump, and periodically exhaust accumulated gas. See item 14.
26. Excessive impeller clearance	Adjust impeller clearance.
27. Too small impeller diameter (probable cause if none of the above.)	See item 20.
Pump operates for a short time, then stops	
28. Incomplete priming	Free pump, piping and valves of all air. If high points in suction line prevent this, they need correcting.
29. Suction lift too high	See item 3.
30. Air leaks in suction piping	See item 8.
31. Air leaks in stuffing box	See item 9.
32. Air or gases in liquid	See item 25.

Pump takes too much power	
CAUSES	**CURES**
33. Head lower than rating; thereby pumping too much liquid	Machine impeller's OD to size advised by factory.
34. Cavitation	See item 14.
35. Mechanical defects	See items 15, 16, and 17.
36. Suction inlet not immersed enough	See item 18.
37. Liquid heavier (in either viscosity or specific gravity) than allowed for	Use larger driver. Consult factory for recommended size. Test liquid for viscosity and specific gravity. See item 6.
38. Wrong direction of rotation	Release gland pressure. Tighten reasonably. If sealing liquid does not flow while pump operates, replace packing. If packing is wearing too quickly, replace scored shaft sleeves and keep liquid seeping for lubrication.
39. Stuffing box too tight (Packing)	Check alignment. Examine pump for friction between impeller and casing. Replace damaged parts. Check for pipe strain.
40. Casing distorted by excessive strains from suction or discharge piping	Check alignment. Examine pump for friction between impeller and casing. Replace damaged parts. Check for pipe strain.
41. Shaft bent due to damage - through shipment, operation, or overhaul	Dismantle pump and inspect shaft.
42. Mechanical failure of critical pump parts	Check bearings and impeller for damage. Any irregularities in these parts will cause a drag on the shaft.
43. Misalignment	Realign pump and driver.
44. Speed may be too high (brake hp of pump varies as the cube of the speed; therefore any increase in speed means considerable increase in power demand)	Check voltage on motor.
45. Electrical defects	The voltage and frequency of the electrical current may be lower than that for which the motor was built: or there may be defects in the motor. The motor may not be ventilated properly due to a poor location.
46. Mechanical defects in turbine, engine, or other type of drive exclusive of motor	If trouble cannot be located, consult factory.

NOTE: If unable to correct troubles with cures outlined above, or if other difficulties develop, contact nearest SAM Engineering representative. Describe completely the operating conditions of pump at time of failure along with other pertinent data.

LUBRICATION

Proper lubrication of the pump bearings is essential in obtaining maximum trouble-free operation. The quantity of lubricant used is as important as the right type. The lubricant for anti-friction bearings protects the bearing parts from corrosion, and helps dissipate heat that is generated by use.

Oil Lubrication

a. The oil-lubricated pumps have splash oiling in which the oil is picked up from the reservoir by a rotating slinger arid deposited as fine droplets on the shaft bearings and entire interior of the bearing housing.

b. After the pump has been installed, flush the bearing housing to remove dirt, grit and other impurities that may have entered the bearing housing during shipment or assembly. Then refill the bearing housing with proper lubricant. The oil level to be maintained is shown by a line in the sight glass or oil level indicator.

c. Experience shows that oils meeting the following specifications will provide satisfactory lubrication. These oils can be furnished by all major oil companies. It is the responsibility of the oil vendor to supply a suitable lubricant.

1	Saybolt viscosity at 100°F	150 - 200 SSU
2.	Saybolt viscosity at 210°F	43 SSU
3.	Viscosity index, minimum	95
4.	API gravity	28-33
5.	Pour point, maximum	-30°C
6.	Flash point, minimum	200°C
7.	Additives	Rust and Oxidation Inhibitors

d. The oil should be well-refined, good grade, straight cut, filtered mineral oil. It must be free from water, sediment, resin, soaps, acid and fillers of any kind, and should also be non-foaming.

NOTE: Oils from different suppliers should not be mixed.

e. In installations with moderate temperature changes, humidity, and dirt, the oil should be changed after approximately 160 hours of operation. The oil should be inspected this time to determine the operating period before the next oil change. Oil change periods may be increased up to 2000-4000 hours based on an 8000 hour year. Check the oil frequently for moisture, dirt or signs of "breakdown."

CAUTION: DO NOT OVER OIL: this causes the bearings to run hot. The maximum desirable operating temperature for ball bearings is 82.2°C. Should the temperature of the bearing frame exceed 82.2°C (measured by thermometer) shut down pump to determine the cause.

Oil Reservoir

The capacity of the oil reservoir is as follows:

FRAME SIZE	QUANTITY PINTS F6 Frame
I	3/4
II	1
III	2

Grease Lubrication

a. The lubricating grease should be a mixture of highly refined mineral oil and a soap base. The most commonly used soap bases are sodium, calcium, lithium, barium, aluminium, and strontium.

b. Sodium soap greases can be used at bearing temperatures up to 121°C. Under ordinary temperatures, this grease is comparatively stiff. The emulsifying properties of the grease permit absorption of a certain amount of water. The lubricant manufacturer should be consulted for recommendations, temperature limits, and length of lubricant life. All recommendations here are based on standard greases. A good bearing grease should have the following properties:

   1. Freedom from chemically or mechanically active ingredients such as free lime, iron oxide, and similar material or solid substances.

   2. Be free from possible tendency to change in composition or consistency such as thickening, separation of oils, acid formation or hardening ("milling down").

   3. A melting point considerably higher than the operating temperature to assure adequate film strength.

   4. Ability to protect metal surfaces from rust.

NOTE: Since lubricant qualities are not assured solely on these points, it is advisable to secure lubricants from a reputable manufacturer who assumes responsibility for his products.

c. Mineral oil from which grease is compounded should conform to the following tests:

1.	Flash	Minimum 171°C
2.	Fire	193°C
3.	Viscosity at 37.8°C	200 SSU Minimum
4.	Cold test (POST) maximum	-1.1°C

NOTE: The grease used in this pump should conform to NGLI Grade 2 standards.

Bearing Lubrication Notes

a. Bearings in the pump are anti-friction (ball bearings). Since bearings are lubricated to reduce friction, remove heat and prevent corrosion, it is important to add the proper amount of the right lubricant at the right time and to flush as often as necessary.

b. Bearings are normally lubricated every 3 to 6 months and flushed yearly. When applying this schedule, take into consideration the number of hours of operation, starting and stopping cycles, dirt, dust and moisture (from rain or condensation).

c. The condition of the lubricant - discolouration and contamination - will determine the proper maintenance schedule. The bearings should be inspected when the pump is dismantled for other repairs. If the bearing shows signs of galling, it may be suspected that too much grease has been "packed" into the bearings, thus causing the balls to slide rather than roll. If the bearing is pitted, the grease or oil is not preventing corrosion; or dirt and dust maybe entering the bearing housing.

d. After grease has been added to the pump (for grease lubricated pump) the drain plug on the bottom of the bearing housing should be removed for half an hour while the pump is running.

Bearing Seal Lubrication

Inboard and outboard bearings are protected from entrance of moisture and dirt by a grease seal which is independent from bearing lubrication. The seal consists of a metal backed rubber slinger which fits over the shaft and is pressed up close to the bearing cover. The bearing cover has an annular labyrinth groove and grease cavity to trap any foreign material protecting the bearing.

Grease fittings are located on the bearing cover. Grease should be applied every three months. A relief hole will discharge the excess grease and prevent overloading.

MAINTENANCE

GENERAL

NOTE: A pump properly installed and operated will require minimum maintenance. For the best overall performance, be sure to adhere to the instruction in this manual.

a. Operating conditions vary so widely that to recommend one schedule of preventive maintenance for all centrifugal pumps is not possible. It is suggested that a permanent record be kept of the periodic inspections and maintenance performed on the pump. This recognition of maintenance procedure will keep the pump in good working condition and prevent costly breakdowns.

b. One of the best rules to follow in proper maintenance is to keep a record of actual operating data and hours of operation. The length of this operation period will vary with different applications and can only be determined from experience. The next inspection period can be scheduled based on the condition of the components at this first inspection. This system can be followed until a maximum period of operation is reached, which should be considered the operation schedule between inspections.

PERIODIC INSPECTION

The following table is provided as a guide for performing periodic inspections on the pump:

PERIOD	INSPECTION
Every month	Check bearing temperature with a thermometer, not by hand. If bearings are running hot, it may be the result of too much lubricant. If changing the lubricant does not correct the condition, disassemble and inspect the bearings. Adjust impeller clearance to retain operating efficiencies.
Every 3 months	Check grease lubricated bearings for saponification. This condition is usually incurred by the infiltration of water or other fluid past the bearing shaft seals, and can be noticed immediately upon inspection, since it gives the grease a whitish colour. Wash out the bearings with kerosene and replace the grease with the proper type as recommended.
Every 6 months	Check the packing and replace if necessary. Use the grade recommended. Be sure the seal cages are centred in the stuffing box at the entrance of the stuffing box piping connection. Check shaft or shaft sleeve for scoring. Scoring accelerates packing wear. Check alignment of pump and motor. Shim up units if necessary. If misalignment recurs frequently, inspect the entire piping system. Unbolt piping at suction and discharge flanges to see if it springs away, thereby indicating strain on the casing. Inspect all piping supports for soundness and effective support of load.
Every year	Remove the rotating element. Inspect thoroughly for wear, and order replacement parts if necessary. Remove any deposit or scaling. Clean out stuffing box piping. Measure total dynamic suction and discharge head as a test of pipe connection. Record the figures and compare them with the figures of the next test. This is important especially where the fluid being pumped tends to form a deposit on internal surfaces. Inspect foot valves and check valves, especially the check valve which safeguards against water hammer when the pump stops. A faulty foot or check valve will also reflect in poor performance of the pump while in operation.

MAINTENANCE AFTER FLOODED CONDITION

The servicing of centrifugal pumps after a flooded condition is a comparatively simple matter under normal conditions. Any pump that is properly sealed at all joints and connected to both the suction and discharge should exclude outside liquid. Therefore, it should not be necessary to go beyond the bearings, stuffing box and coupling when servicing the pump. However, in the event that flood liquid or other foreign matter enters the pump, it may be necessary to flush the pump, and inspect and clean wearing surfaces.

a. Bearings are a primary concern on horizontal pumping units. First, dismantle the bearings, clean and inspect them for any rusted or badly worn surfaces. If bearings are free from rust and wear, reassemble and re-lubricate them with one of the recommended pump lubricants. Depending on the length of time the pump has remained in the flooded area, it is unlikely that bearing replacement is necessary, however, in the event that rust or worn surfaces appear, it may be necessary to replace the bearings.

b. Inspect the stuffing box, and clean out any foreign matter that might clog the box. Packing that appears to be worn, or no longer regulates leakage properly should be replaced.

c. Couplings should be dismantled and thoroughly cleaned. Lubricate the coupling with one of the coupling manufacturer's recommended lubricants where required.

DISASSEMBLY

Pump Style C-011

a. Close suction and discharge valves or otherwise isolate pump from liquid system.

b. Disconnect power source to driver.

c. Turn off water supply to stuffing box and disconnect piping.

d. Disconnect drive.

   1. Spacer type coupling - Universal type
      Remove four cap screws from flanges of both the drive and driven ends of the spacer coupling. Remove spacer section to permit disassembly of rotating element from pump.

   2. V -Belt Drive
      Loosen bolts on motor slide base and move motor base toward pump to relax tension on belts. Remove belts from driven sheave.

e. Support frame assembly with a hook and sling under the top web of the frame. Loosen and remove cap screws, washers and nuts holding frame to casing.

f. Using sling, slide frame from casing, out and away from pump. Strip off gasket.

NOTE: If desired, the complete rotating element may now be removed as a unit and taken to the shop for further disassembly. The casing is left in place, bolted to suction and discharge piping.

g. To remove suction wear plate, remove cap screws and washers holding suction wear plate to casing. Take suction wear plate out of casing. Strip off gasket.

Rotating Element

a. Remove oil drain cap from nipple on underside of frame and drain oil from bearing housing.

b. Remove sheave or coupling fitting yoke from pump shaft.

c. Hold drive end of pump shaft with padded wrench, or insert rod through hole in shaft and turn impeller counter clockwise to remove. If impeller is tight and will not loosen readily, use the following procedure:

    1. Place a block of hardwood against edge of impeller vane and strike with mallet to loosen.

or

    2. Place large block of hardwood upright on ground so that when the rotating assembly is turned 180° with wrench or rod attached to shaft, the end of the wrench strikes the block. This method imparts considerable force to loosen the impeller.

NOTE: Impeller will unscrew counter clockwise (from impeller end), so wrench must strike the block in this same direction.

    3. It is sometimes helpful to apply heat with a torch to the impeller hub to assist in loosening the threads.

d. Remove cap screws holding wear plate to stuffing box. Strip off gasket.

e. Remove two nuts from studs holding stuffing box cover to frame. Loosen gland bolts and remove split gland pieces. Pull stuffing box from frame and remove packing.

f. Remove shaft sleeve from shaft using bearing puller. Apply heat from torch if necessary. If this fails it may be necessary to cut the sleeve by splitting it lengthwise on one side with a chisel.

Frame

NOTE: Study Figure 8 showing recommended method of handling frame assembly during the dismantling and assembly operations. Using the impeller as a stand, the frame with frame liner maybe lifted vertically with hooks as shown.

a. First remove deflectors from shaft and remove outboard bearing cap.

b. Screw impeller onto shaft far enough to provide a rigid mounting and stand the assembly on end.

c. Remove screws from inboard bearing cap and drop cap from frame liner.

d. Assemble lifting hooks into upper end of frame liner and slowly raise frame with liner off of the shaft and bearings assembly.

e. Unscrew shaft from impeller, remove inboard bearing cap and proceed with pressing bearings from shaft.

f. Remove oil slingers and collar from shaft to prevent its damage while handling the shaft.

NOTE: It is suggested that the parts frame linear and frame, be kept assembled with adjusting screw unless replacements are needed.

CLEANING

Clean all parts in a suitable cleaning solvent. Pay particular attention to all machined surfaces and gasket joints. At the frame, check and clean the oil level indicator. Be sure to clean stuffing box cavity and sealing liquid inlet.

INSPECTION

Inspect all parts for excessive wear or damage. Pay particular attention to the following items:

a. Casing. Check for evidence of extreme wear or corrosion, especially at threaded taps. Examine casing joint for rust, burrs or raised surfaces.

b. Front Wear Plate. See that wear face fits closely to impeller. Replace wear plate if wear is excessive.

c. Impeller. Check impeller vanes for signs of wear, cracks or corrosion.

d. Stuffing Box Details. Check gland and seal cage for nicks or burrs. Replace all packing.

e. Shaft Sleeve. Examine shaft surface to see that it is smooth and free from grooves or scoring. Check to see that sleeve is round without any appreciable eccentricity.

f. Shaft. Inspect all rotating, close-clearance surfaces for wear. Check for straightness by mounting in a lathe. (If lathe not available, use suitable Vee blocks.)

g. Bearings. After cleaning, rotate bearings very slowly under hand pressure to feel for smooth and even action. Never spin a dry bearing. Examining carefully for "dull" spots indicating hollows; for "shiny" spots indicating concentrated wear; for pitting, "galling," or other damage to races, ball, or rollers. Check for cracks, for burrs on outside or inside diameters, or other structural damage. Replace the bearing if there is any doubt as to complete serviceability.

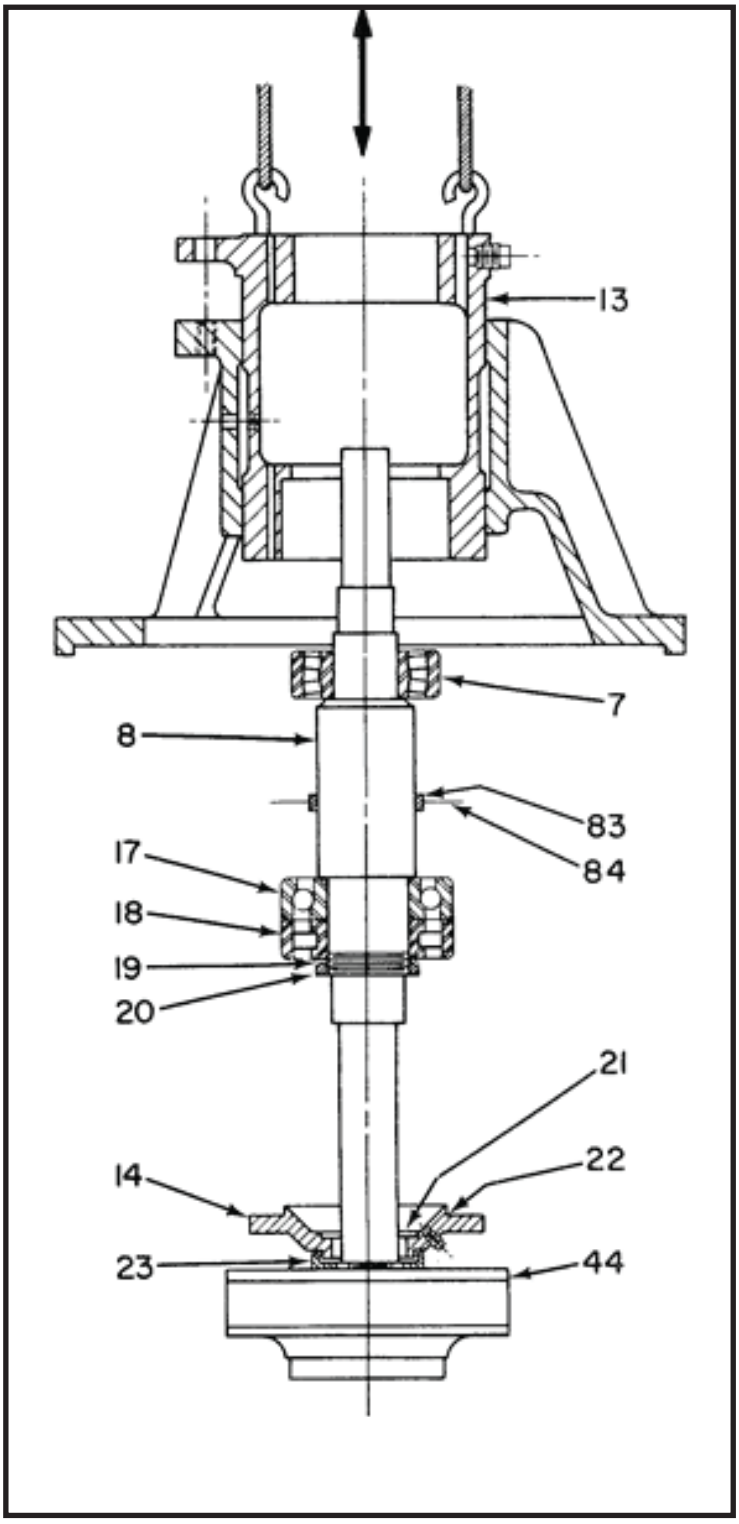


Figure 8. Front Liner Assembly

REPAIR AND REPLACEMENT

a. General Replacement. Replace all parts that are excessively damaged or worn.

b. Casing. If necessary, use a fine stone to remove rust, burrs, raised surfaces, dirt, paint, etc. from casing joint.

c. Shaft Sleeve. If shaft sleeve surface is grooved, polish to remove grooves. If grooves are too deep to polish, replace shaft sleeve.

d. Fibre Packing. The standard packing is a soft, square asbestos, impregnated with oil and graphite. A soft well-lubricated packing reduces stuffing box resistance and prevents excessive wear on the shaft, or shaft sleeve. Many brands of packing have the desired qualities. Those listed below should be regarded as typical rather than specific recommendations for replacements:

1.	No. 317	Anchor Packing Company
2.	Centripack Style C-7	Johns-Manville Co.
3.	Garlock No. 234	Garlock Packing Co.
4.	Monarch Style No. 454	Monarch Packing Co.
5.	No.193	U.S.RubberCo.
6.	Regal No. 49	Quaker Rubber Co.
7.	Semi-Metallic	Bausman Packing Co.
8.	Ace-O-Pak	Packing Engineering Co.

REASSEMBLY

In general, reassemble in the reverse order of disassembly. Always replace all gaskets, packing, or a-rings at each disassembly of the pump.

Frame

NOTE: Study Figure 8 showing recommended method of handling frame assembly during the assembly operation.

a. Inboard Bearings. Heat bearings in a clean hot-air oven at 200° - 225°F. Install heated bearing over threaded half of shaft. Assemble lock washer and nut. Tighten with a spanner wrench. Nut should be tight, a few sharp blows on the spanner wrench will assure this. Meter bearings cool, tighten nut again and bend lock tab of lock washer into place.

b. Slip oil slinger over centre portion of shaft. Adjust spacing "A" and "B". Tighten slinger locking screws. Take care in handling the shaft from this point on as these slingers are easily bent or broken.

c. Outboard Bearings: Heat bearing in a clean hot-air oven at 93-107°C. Install heated bearings on the shaft, against the shaft shoulder and allow to cool in place.

d. Place inboard bearing cap shaft. Screw the shaft into the impeller and stand the assembly on end.

NOTE: The adjusting screw group and liner constitute a matched, drilled set that should not be disassembled. If they were disassembled, be sure that all parts are from the same set. If liner has been replaced, install a new nut and screw. Drill and pin nut in place with spring. Washer should be fully compressed to eliminate end play.

e. Inspect slingers to make sure they have not been bent or broken. Since your unit has spherical roller bearings, tap the outer race square to shaft, as it must enter the frame liner perfectly straight to avoid serious damage.

f. Lower frame and liner over shaft and bearings per Figure 8. Proceed slowly and notice that as slingers enter the frame liner they must deflect and spring back into place when they reach the centre of the bearing cavity. With a spherical roller bearing, it may be necessary to guide it into the fit in the liner. Note the outer race from an old bearing serves as an ideal tool if placed into the liner at this time. You may slide it down in the fit until it contacts the upper shaft bearing. By tapping lightly on this "tool" you can square up the bearing race and it will enter to fit easily. Continue to lower frame and liner until the liner rests solidly against the lower bearing outer race.

g. Remove lifting hooks and allow unit to stand vertically.

h. Position end caps with gaskets and bolt into place.

i. Assemble deflectors on both ends.

j. Remove impeller and place unit in a horizontal position. Adjust liner to set dimensions.

k. Replace all plugs and special oil fittings that may have been removed in cleaning.

Stuffing Box

a. Place wear plate on the table with bolt holes up and cement gasket in place.

b. Place stuffing box cover on wear plate, line up holes and assemble cap screws but do not tighten until later. Insert shaft sleeve in centre of stuffing box cavity to act as a guide when installing packing. Insert packing base ring in bottom of cavity.

c. Assemble studs into flange of cover plate.

d. If moulded fibre packing is used, open packing ring sideways and push joint into stuffing box first. Install two rings, one at a time, seating each ring firmly. Stagger the ring joints at least 90°. Install seal cage, being sure that it will line up with the seal liquid inlet in cover when packing is compressed. Install remaining two or three packing rings. Refer to the Stuffing Box Dimensions below for the particular pump being assembled for the correct quantity and size of packing to install.

STUFFING BOX DATA HM and CWR (Dimensions in Inches)*

Pump Size and Max. Imp.	Frame Size	Stuffing Box		Shaft Sleeve Diameter in Box	Seal Cage Width	Size of Flushing Connections to Box	Packing	
		Length	Bore				Number of Rings	Size (Square)
4 x 3 x 11-1/2	F-6D2	3	3-5/16	2-1/4	3/4	1/4	4	1/2
5 x 4 x 11-1/2	F-6D2	3	3-5/16	2-1/4	3/4	1/4	4	1/2
5 x 4 x17	F-6E2	3-1/8	4-5/16	3-1/4	11/16	1/2	4	1/2
6 x 5 x17	F-6E2	3-1/8	4-5/16	3-1/4	11/16	1/2	4	1/2
8 x 6 x17	F -6E2	3-1/8	4-5/16	3-1/4	11/16	1/2	4	1/2
10x 8 x17	F -6E2	3-1/8	4-5/16	3-1/4	11/16	1/2	4	1/2
12x10x17	F-6E2	3-1/8	4-5/16	3-1/4	11/16	1/2	4	1/2
8 x 6 x21	F-6F2	6	6-3/4	5-1/4	1-1/4	1/2	5	3/4
10x 8 x21	F-6F2	6	6-3/4	5-1/4	1-1/4	1/2	5	3/4
14x12x21	F-6F2	6	6-3/4	5-1/4	1-1/4	1/2	5	3/4
16x14x21	F-6F2	6	6-3/4	5-1/4	1-1/4	1/2	5	3/4

*Refer to factory for stuffing box data on other styles.

Rotating Element

a. Remove shaft sleeve from the stuffing box, and slide sleeve onto shaft.

b. Install stuffing box cover group onto shaft and frame group carefully to keep the packing in position within stuffing box. Attach cover to frame with nuts and washers.

c. Install packing gland and secure with attaching parts. If fibre packing is used, tighten nuts firmly but not too tight. If metallic packing is used, tighten nuts tightly. Final adjusting of nuts will be made during the pump run-in.

d. Tighten cap screws holding wear plate to stuffing box cover. If wear plate tends to drop and rub on sleeve it may be supported temporarily with a shim against the sleeve.

e. Apply a thin coat of "white lead" or a similar anti-seize thread compound to threads of shaft. Install impeller on shaft, and tighten securely while holding shaft.

CAUTION: Torque casing bolts to 125 ft. lbs. maximum.

Pump

a. Assemble suction wear plate with new gasket and secure in casing with attaching parts.

b. Before installing rotating element into pump casing, the total clearance of impeller in casing must be established. Proceed as follows:

IMPELLER ADJUSTMENT

After assembling pump, set impeller clearance according to the following: Check that the two clamping screws on side of frame are loose, to allow liner to move freely. Turn adjusting screw (at lower frame) clockwise until impeller contacts suction wear plate. Now turn adjusting screw counter clockwise just enough to allow impeller to rotate freely. Normal clearance is 0.38mm-0.64mm. Tighten clamp screws.

REPLACEMENT PARTS

a. The pumps covered by this manual have been designed and built with all wearing parts replaceable. A recommended inventory of spare parts is dependent upon the installation and the importance of continued operation.

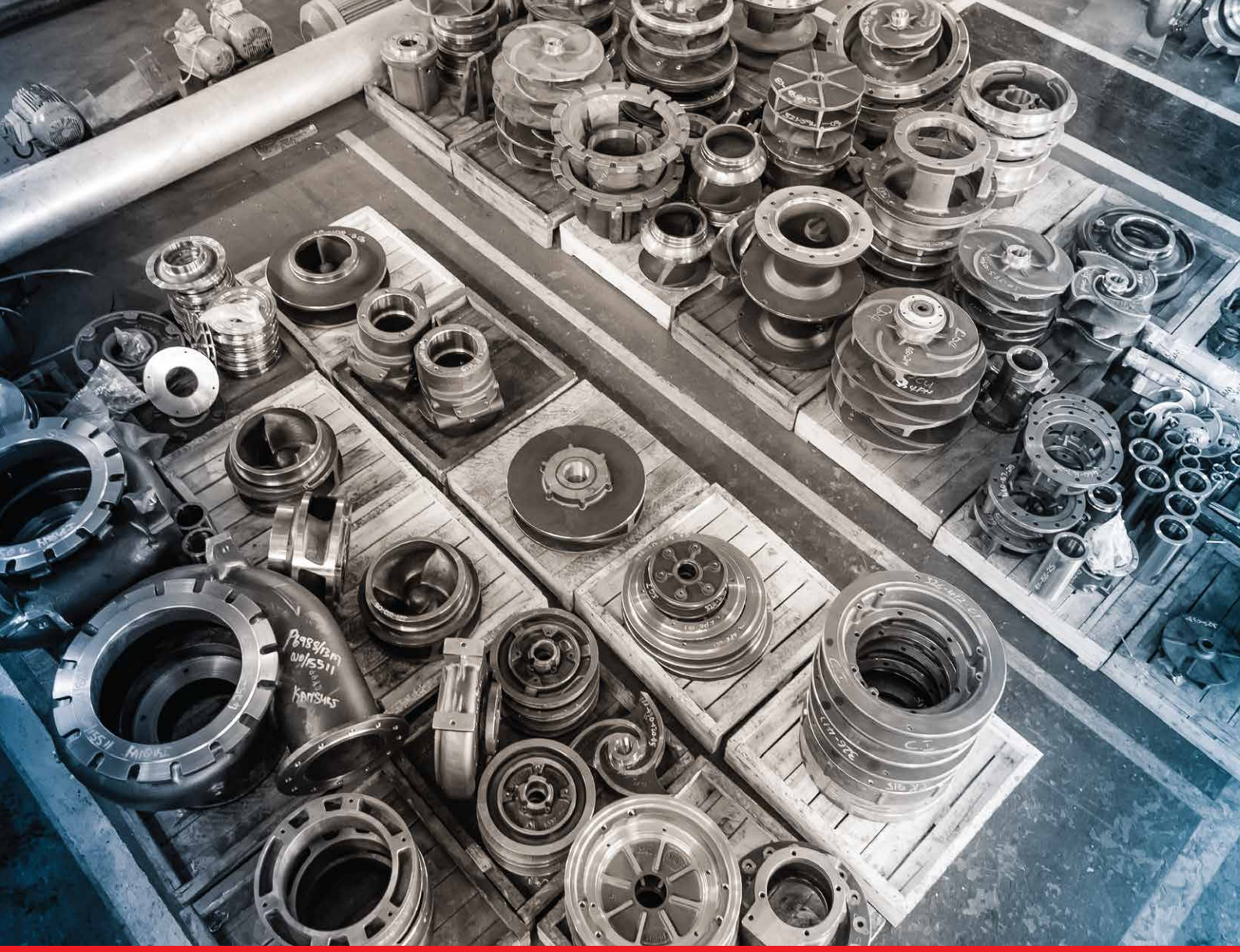
b. For critical service requiring a minimum of down time, a complete rotating element is recommended.

c. For normal service, all items in the parts list that are coded with "*" are recommended for each pump in service.

d. Parts should be ordered as far in advance of their use as possible since circumstances beyond the control of the Company may reduce existing stock. Not all parts are stocked; some must be manufactured for each order.

e. When ordering spare parts, always include the following information:

1. Pump Serial Number
2. Pump Model Number
3. Pump Size and Type Number
4. Catalogue Number of part
5. Name of part
6. Quantity of each part
7. Material desired (if different than original material). (Parts will be furnished in original materials unless specified as a material change. All material substitutions should be discussed with the factory.)



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