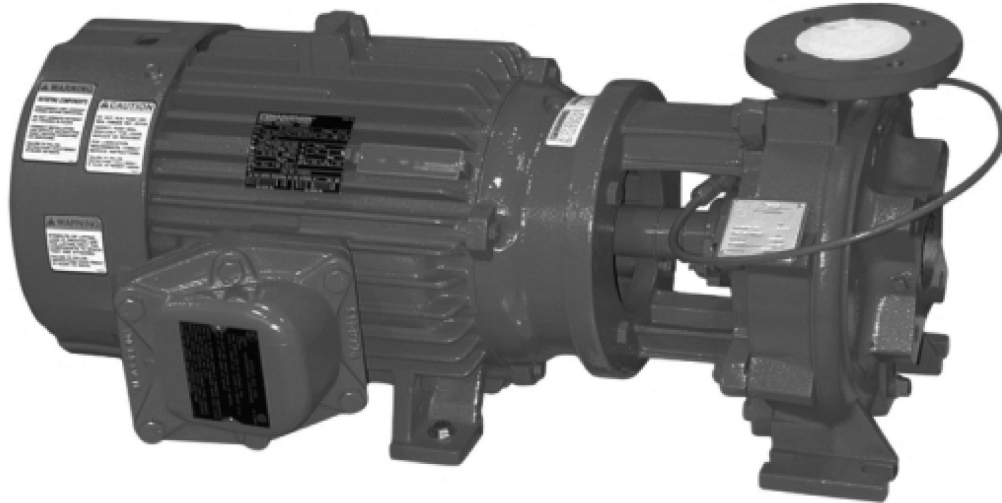


INSTRUCTION MANUAL

P2002569

REVISION B



Series A-C 2000

CLOSED-COUPLED PUMPS

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.

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Specific Series A-C 2000

Instruction for Close-Coupled Pumps

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Introduction and safety

Introduction

Purpose of this manual

The purpose of this manual is to provide necessary information for:

- Installation
- Operation
- Maintenance

**CAUTION:**

Read this manual carefully before installing and using the product. Improper use of the product can cause personal injury and damage to property, and may void the warranty.

NOTICE:

Save this manual for future reference, and keep it readily available at the location of the unit.

Requesting other information

Special versions can be supplied with supplementary instruction leaflets. See the sales contract for any modifications or special version characteristics. For instructions, situations, or events that are not considered in this manual or in the sales documents, please contact the nearest Xylem representative.

Always specify the exact product type and identification code when requesting technical information or spare parts.

Safety

**WARNING:**

- The operator must be aware of safety precautions to prevent physical injury.
 - Any pressure-containing device can explode, rupture, or discharge its contents if it is over-pressurized. Take all necessary measures to avoid over-pressurization.
 - Operating, installing, or maintaining the unit in any way that is not covered in this manual could cause death, serious personal injury, or damage to the equipment. This includes any modification to the equipment or use of parts not provided by Xylem. If there is a question regarding the intended use of the equipment, please contact a Xylem representative before proceeding.
 - Do not change the service application without the approval of an authorized Xylem representative.
-

**CAUTION:**

You must observe the instructions contained in this manual. Failure to do so could result in physical injury, damage, or delays.




Safety terminology and symbols

About safety messages

It is extremely important that you read, understand, and follow the safety messages and regulations carefully before handling the product. They are published to help prevent these hazards:

- Personal accidents and health problems
- Damage to the product
- Product malfunction

Hazard levels

Hazard level	Indication
 DANGER:	A hazardous situation which, if not avoided, will result in death or serious injury.
 WARNING:	A hazardous situation which, if not avoided, could result in death or serious injury.
 CAUTION:	A hazardous situation which, if not avoided, could result in minor or moderate injury.
NOTICE:	<ul style="list-style-type: none">• A potential situation which, if not avoided, could result in undesirable conditions• A practice not related to personal injury

Hazard categories

Hazard categories can either fall under hazard levels or let specific symbols replace the ordinary hazard level symbols.

Electrical hazards are indicated by the following specific symbol:



ELECTRICAL HAZARD:

These are examples of other categories that can occur. They fall under the ordinary hazard levels and may use complementing symbols:

- Crush hazard
 - Cutting hazard
 - Arc flash hazard
-

Safety instruction decals



WARNING:

The maximum working pressure of the pump is listed on the nameplate. Do not exceed this pressure. Failure to follow these instructions can result in serious personal injury, death, and/or property damage.

Alert symbol

	<p>This safety alert symbol is used in manuals and on the safety instruction decals on the pump to draw attention to safety-related instructions.</p> <p>When used, the safety alert symbol means that failure to follow the instructions may result in a safety hazard.</p>
--	--

Decals

Make sure your pump has these safety instruction decals and that they are located as this figure shows. If the decals are missing or illegible, contact your local sales and service representative for a replacement.

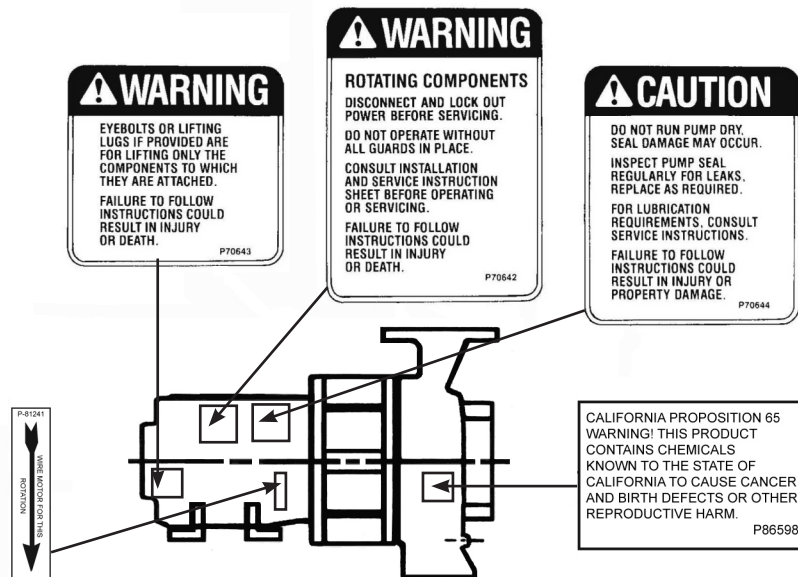


Figure 1: Safety Instruction Decals

Make sure that all safety instruction decals are always clearly visible and readable.

User safety

General safety rules

These safety rules apply:

- Always keep the work area clean.
- Pay attention to the risks presented by gas and vapors in the work area.
- Avoid all electrical dangers. Pay attention to the risks of electric shock or arc flash hazards.
- Always bear in mind the risk of drowning, electrical accidents, and burn injuries.

Safety equipment

Use safety equipment according to the company regulations. Use this safety equipment within the work area:

- Hard hat
- Safety goggles, preferably with side shields
- Protective shoes
- Protective gloves
- Gas mask
- Hearing protection
- First-aid kit
- Safety devices

NOTICE:

Never operate a unit unless safety devices are installed. Also see specific information about safety devices in other chapters of this manual.

Electrical connections

Electrical connections must be made by certified electricians in compliance with all international, national, state, and local regulations. For more information about requirements, see sections dealing specifically with electrical connections.

Precautions before work

Observe these safety precautions before you work with the product or are in connection with the product:

- Provide a suitable barrier around the work area, for example, a guard rail.
- Make sure that all safety guards are in place and secure.
- Make sure that you have a clear path of retreat.
- Make sure that the product cannot roll or fall over and injure people or damage property.
- Make sure that the lifting equipment is in good condition.
- Use a lifting harness, a safety line, and a breathing device as required.
- Allow all system and pump components to cool before you handle them.
- Make sure that the product has been thoroughly cleaned.
- Disconnect and lock out power before you service the pump.
- Check the explosion risk before you weld or use electric hand tools.

Wash the skin and eyes

Follow these procedures for chemicals or hazardous fluids that have come into contact with your eyes or your skin:

Condition	Action
Chemicals or hazardous fluids in eyes	<ol style="list-style-type: none">1. Hold your eyelids apart forcibly with your fingers.2. Rinse the eyes with eyewash or running water for at least 15 minutes.3. Seek medical attention.
Chemicals or hazardous fluids on skin	<ol style="list-style-type: none">1. Remove contaminated clothing.2. Wash the skin with soap and water for at least 1 minute.3. Seek medical attention, if necessary.

Environmental safety

The work area

Always keep the station clean.

Waste and emissions regulations

Observe these safety regulations regarding waste and emissions:

- Appropriately dispose of all waste.
- Handle and dispose of the processed liquid in compliance with applicable environmental regulations.
- Clean up all spills in accordance with safety and environmental procedures.
- Report all environmental emissions to the appropriate authorities.



WARNING:

Radiation Hazard. Do NOT send the product to Xylem if it has been exposed to any nuclear radiation.

Electrical installation

For electrical installation recycling requirements, consult your local electric utility.

Recycling guidelines

Always follow local laws and regulations regarding recycling.

Product warranty

Coverage

Xylem undertakes to remedy defects in products from Xylem under these conditions:

- The faults are due to defects in design, materials, or workmanship.
- The faults are reported to a local sales and service representative within the warranty period.
- The product is used only under the conditions described in this manual.
- The monitoring equipment incorporated in the product is correctly connected and in use.
- All service and repair work is done by Xylem authorized personnel.
- Genuine Xylem parts are used.
- Only Ex-approved spare parts and accessories authorized by an Ex-approved Xylem Inc. representative are used in Ex-approved products.

Limitations

The warranty does not cover defects caused by these situations:

- Deficient maintenance
- Improper installation
- Modifications or changes to the product and installation made without consulting a Xylem authorized representative
- Incorrectly executed repair work
- Normal wear and tear

Xylem assumes no liability for these situations:

- Bodily injuries
- Material damages
- Economic losses

Warranty claim

Xylem products are high-quality products with expected reliable operation and long life.

However, should the need arise for a warranty claim, then contact your local sales and service representative.

Transportation and storage

Inspect the delivery

Inspect the package

1. Inspect the package for damaged or missing items upon delivery.
2. Note any damaged or missing items on the receipt and freight bill.
3. File a claim with the shipping company if anything is out of order.
If the product has been picked up at a distributor, make a claim directly to the distributor.

Inspect the unit

1. Remove packing materials from the product.
Dispose of all packing materials in accordance with local regulations.
2. Inspect the product to determine if any parts have been damaged or are missing.
3. If applicable, unfasten the product by removing any screws, bolts, or straps.
For your personal safety, be careful when you handle nails and straps.
4. Contact the local sales representative if there is any issue.

Pump lifting



WARNING:

- Assembled units and their components are heavy. Failure to properly lift and support this equipment can result in serious physical injury and/or equipment damage. Lift equipment only at the specifically identified lifting points. Lifting devices such as eyebolts, slings, and spreaders must be rated, selected, and used for the entire load being lifted.
- Crush hazard. The unit and the components can be heavy. Use proper lifting methods and wear steel-toed shoes at all times.

In order to lift the entire pump, use slings placed around the unit as shown.

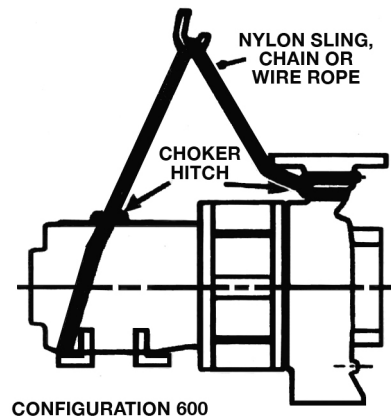


Figure 2: Proper lifting method

Long-term storage

If the unit is stored for more than 6 months, these requirements apply:

- Store in a covered and dry location.
- Store the unit free from heat, dirt, and vibrations.
- Rotate the shaft by hand several times at least every three months.

Treat bearing and machined surfaces so that they are well preserved. Refer to the drive unit and coupling manufacturers for their long-term storage procedures.

For questions about possible long-term storage treatment services, please contact your local sales and service representative.

Product description

General description

The Series A-C 2000 pump is a centrifugal, close-coupled pump. These features make the pump easy to install, operate, and service:

- High efficiency
- Rugged bronze-fitted construction
- Foot-mounted motor

Intended applications



WARNING:

This product can expose you to chemicals including Lead, which is known to the State of California to cause cancer or birth defects or other reproductive harm.
For more information go to: www.P65Warnings.ca.gov.

NOTICE:

This product is not intended for potable water applications.

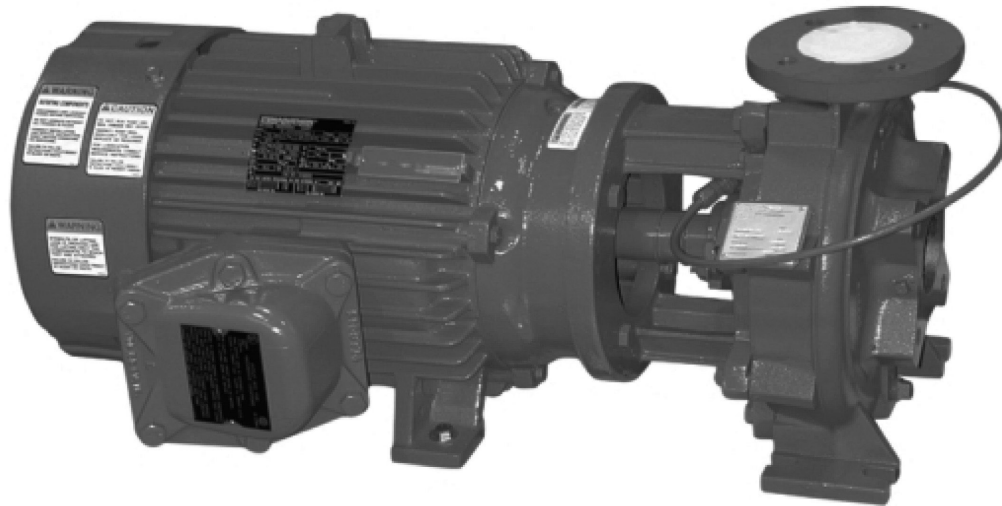
The pump is intended for use with these pumped fluids:

- Unheated domestic and fresh water
- Boiler feed water
- Condensate
- General liquid transfer

Rotation

Pump rotation is clockwise when viewed from the back of the motor. An arrow is also located on the pump to show the direction of rotation.

Specific Series A-C 2000 close-coupled pumps instruction



Pump identification

There are two identification plates on each pump. The pump rating plate gives identification and rating information. **Figure 3** shows an example of a typical Rating Plate.

Permanent records for this pump are kept by the Serial Number and it must, therefore, be used with all correspondence and spare parts orders. The last digit indicates the specific pump on orders for more than one pump. For example, if an order called for six pumps, all pumps would have the same first three sets of digits and the last digit will change to identify each of the six. (e.g. 1-21938-1-1, 1-21938-1-2, etc.)

The identification number is a number which the end user of the pump requests to be put on the rating plate to identify the pump in his operation. (e.g. CWP-11 stands for Chilled Water Pump No. 11.)

The frame plate, **Figure 4**, gives information concerning the bearing and their lubrication. The inboard and outboard bearing numbers refer to the bearing manufacturer's numbers.


		
Size	Type	
Serial Number		
GPM	Head (ft.)	RPM
Model Number	Imp. Dia.	
Max. Field Hydrotest Pressure	PSI	
Identification No.	Year	
MORTON GROVE, IL USA		AC0686

Figure 3 - Rating Plate

Frame	Inb. Brg.
Lubrication	Out. Brg.
Part No.	AC0685

Figure 4 - Frame Plate

Disassembly and reassembly procedures

The procedures outlined in this section cover the dismantling and reassembly of different types of Series A-C 2000 close-coupled pumps.

When working on the pumps, use accepted mechanical practices to avoid unnecessary damage to parts. Check the condition of all pump parts when the pump is dismantled and replace if necessary.

General dismantling instructions

1. Disconnect the power source to the driver.
2. Close the suction and discharge valves to isolate the pump from the system. Turn off liquid supply and disconnect any piping to the stuffing box.
3. Remove all bolts holding the motor to the foundation.

Dismantling procedure

Initial disassembly

1. Drain the pump by opening the discharge gauge tap located directly below the discharge flange and removing the drain plug (1-910-0) at the bottom of the casing.
2. Unbolt the motor adapter from the casing by removing capscrews (1-904-0) and where applicable clamping lugs (1-937-0). Pull the entire rotating assembly and motor from the casing leaving the casing connected to the piping unless it is to be repaired, replaced, or if applicable, to have new wear rings installed.
3. Remove the "O" ring (2-914-0) from the stuffing box cover and inspect for damage. Replace if necessary.

Impeller removal

1. Hold impeller by the outside diameter.
2. Remove the impeller nut (4-023-0). To do this, turn the impeller nut counterclockwise as viewed from the suction inlet.
3. Pull the impeller (4-002-0) from the shaft and remove the impeller key (4-911-0). (**Figure 5** Impeller Removal)

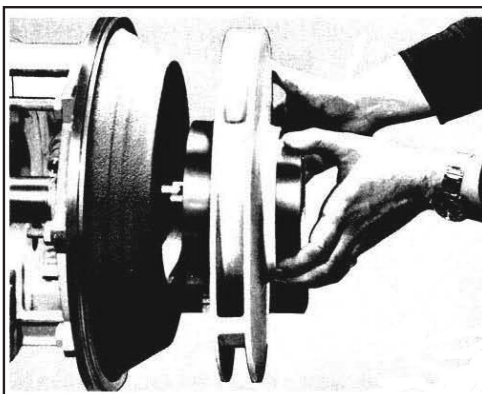


Figure 5 - Impeller Removal

Dismantling the stuffing box

- A. Pumps with mechanical seals
1. Remove spacer sleeve (1-154-0).
 2. Remove the two nuts holding the gland (6-014-0) to the stuffing box (2-036-0).
 3. Pull the stuffing box cover off the shaft assembly.

NOTE: On the larger Series A-C 2000 pumps, it will be necessary to remove the capscrews holding the stuffing box cover to the motor adapter.

NOTE: The mechanical seal (6-400-0) should now be exposed on the shaft sleeve. (In some cases, the shaft sleeve may come off the shaft with the stuffing box cover. If this happens, gently press or pull the shaft sleeve and mechanical seal from the stuffing box toward motor side of the stuffing box cover.) This will expose the mechanical seal as above.

4. Remove the seal from the shaft sleeve, examine for damage, and if necessary replace.
 5. Remove the gland (6-014-0), shaft sleeve (1-009-0), and the deflector (1-136-0) from the motor shaft. A puller may be used to remove the shaft sleeve if it does not slide off the motor shaft easily.
- B. Pumps with packed stuffing box
1. Loosen packing gland (6-014-0) by loosening the two gland retaining nuts.
 2. Pull the stuffing box cover, gland, and packing from the motor shaft.
 3. Remove the two gland retaining nuts and the gland (6-014-0). Remove the packing rings (6-924-0) and, where applicable, the seal cage (6-013-0) from the stuffing box. A standard packing hook is recommended for removing the packing and seal cage.
 4. Remove the packing base ring.

Motor adapter removal

NOTE: Do not remove the adapter from the motor unless the motor is to be repaired or replaced. If the adapter is removed, it will necessitate repositioning of motor adapter to the motor shaft.

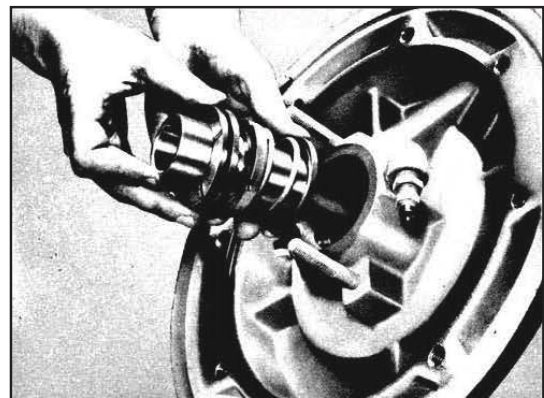


Figure 6 - Removing Mechanical Seal

Suction and stuffing box wear ring removal (optional)

The optional wear rings are removed from the casing and stuffing box cover by the following method:

1. Drill two axial holes in each wear ring approximately 180 degrees apart being careful not to drill into the casing or stuffing box cover.
2. Split the wearing rings using a chisel.
3. Remove the pieces.

This completes the disassembly of the Series A-C 2000 close-coupled pump.

Assembly procedures

Motor adapter assembly

If necessary, mount the motor adapter (1-534-0) to the motor using four capscrews (1-904-0). Be certain the adapter is mounted such that the drain hole is on the bottom. Tighten the capscrews.

Stuffing box assembly

NOTE: There are two pipe taps on the stuffing box; one closer to the gland, and one farther away from the gland.

If the pump is equipped with a mechanical seal, the small box cover should be positioned with the pipe tap closer to the gland in the most accessible position.

If the pump is equipped with packing, the stuff box cover should be positioned so the pipe tap farthest from the gland is in the most accessible position.

For ease of assembly, install pipe fittings in the stuffing box pipe taps before assembling stuffing box on the motor adapter.

A. General assembly

1. Install the two gland retaining studs (6-908-0) into the stuffing box cover.
2. Screw the impeller stud (4-908-0) into the end of the motor shaft using a locking compound on the stud.

B. Pumps with mechanical seals

1. Install the rotating and stationary elements of the mechanical seal (6-400-0) on the shaft sleeve (1-009-0) being certain that the two wearing surfaces face each other. Position the seal on the sleeve according to the "G" dimension found in **Figure 7A**.

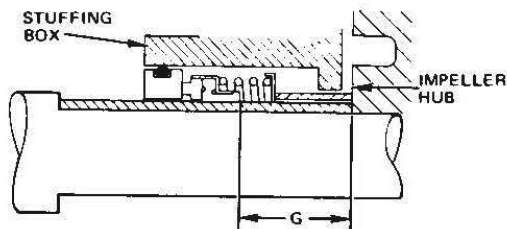


Figure 7A

"G" SETTING DIMENSIONS				
PUMP SIZE	143JP-184JP	213JP-256JP	284JP-326JP	364JP-365JP
2 x 1 1/2 x 6	1.22	—	—	—
2 1/2 x 2 x 6 1/2 S		1.31	—	—
2 1/2 x 2 x 6 1/2 L			—	—
3 x 2 x 6 1/2 S				—
3 x 2 x 6 1/2 L			1.31	—
1 1/2 x 1 1/2 x 9			—	—
2 x 1 1/2 x 9			1.31	—
2 1/2 x 2 x 9 S			—	—
2 1/2 x 2 x 9 L			1.31	—
3 x 2 x 9			▼	—
3 x 2 x 10			—	—
3 x 2 x 11			—	—
3 x 2 1/2 x 11	▼		—	—
4 x 3 x 6 1/2	1.38		1.31	—
3 x 2 1/2 x 9			▼	1.38
4 x 3 x 9	▼		—	▼
6 x 4 x 9	—		—	—
6 x 6 x 9	—		1.31	—
6 x 6 x 9 1/2	—		▼	—
8 x 6 x 9	—		▼	—
8 x 6 x 9 1/2	—		▼	—
4 x 3 x 11	2.00		—	—
4 x 4 x 11	—		1.31	—
6 x 6 x 11	—		▼	—
8 x 6 x 11	—		▼	—
3 x 2 1/2 x 13	2.00		—	—
4 x 3 x 13	—		—	—
6 x 4 x 13	—		—	—
6 x 6 x 13 S	—		—	1.38
6 x 6 x 13 L	—	▼	▼	▼
8 x 6 x 13	—	—	—	—
10 x 8 x 13	—	—	—	—

Figure 7B - "G" Setting dimensions

2. Place the seal spring retainer into stuffing box.
3. Place seal spring into stuffing box.
4. Place sleeve and seal assembly into stuffing box with rotating half of seal installed closest to the impeller.
5. Install the seal gland (6-014-0) (flat side toward stuffing box) on the stuffing box using the gland studs (6-908-0) and gland nuts (6-903-0). Tighten gland nuts evenly until the gland is approximately 1/8" from the stuffing box.
6. Slide the deflector ring (1-136-0) onto the motor shaft.
7. Slide the stuffing box cover, seal, and sleeve assembly onto the motor shaft being certain the stuffing box is closest to the motor adapter. To prevent any leakage, use Dow Corning Silicone Rubber #732 or equal sealant between the shaft and shaft sleeve.
8. If applicable, bolt the motor adapter to the stuffing box using capscrews (1-904-0).

C. Pumps with packed stuffing boxes

1. Slide deflector (1-136-0) onto the motor shaft.
2. Slide the packing gland (6-014-0) onto the motor shaft (flat side toward motor).
3. Slide the shaft sleeve (1-009-0) onto the motor shaft. To prevent leakage, use Dow Corning Silicone Rubber #732 or equal lubricating sealant between the shaft and shaft sleeve.

4. Place the packing base ring (6-152-0) into the stuffing box. Slide the stuffing box cover over the pump shaft, and, if applicable, bolt the stuffing box to the motor adapter using capscrews (1-904-0).
5. Install the packing (6-924-0) and, if applicable, the seal cage (6-013-0) into the stuffing box being sure to stagger the joints as per the instructions found in the general pump instruction section of this book.

Impeller installation

1. If the pump is equipped with mechanical seals, slide the spacer sleeve (1-154-0) over the shaft sleeve and into the stuffing box.
2. Install the impeller key into the keyway on the impeller side of the motor shaft.
3. Slide the pump impeller (4-002-0) onto the motor shaft.
4. Screw the impeller nut (4-023-0) onto the pump shaft until finger tight. Hold the outside diameter of the impeller and tighten (clockwise as viewed from the suction inlet) the impeller nut to 25-30 ft. lbs.
5. For pumps with mechanical seals, tighten gland evenly against the stuffing box.

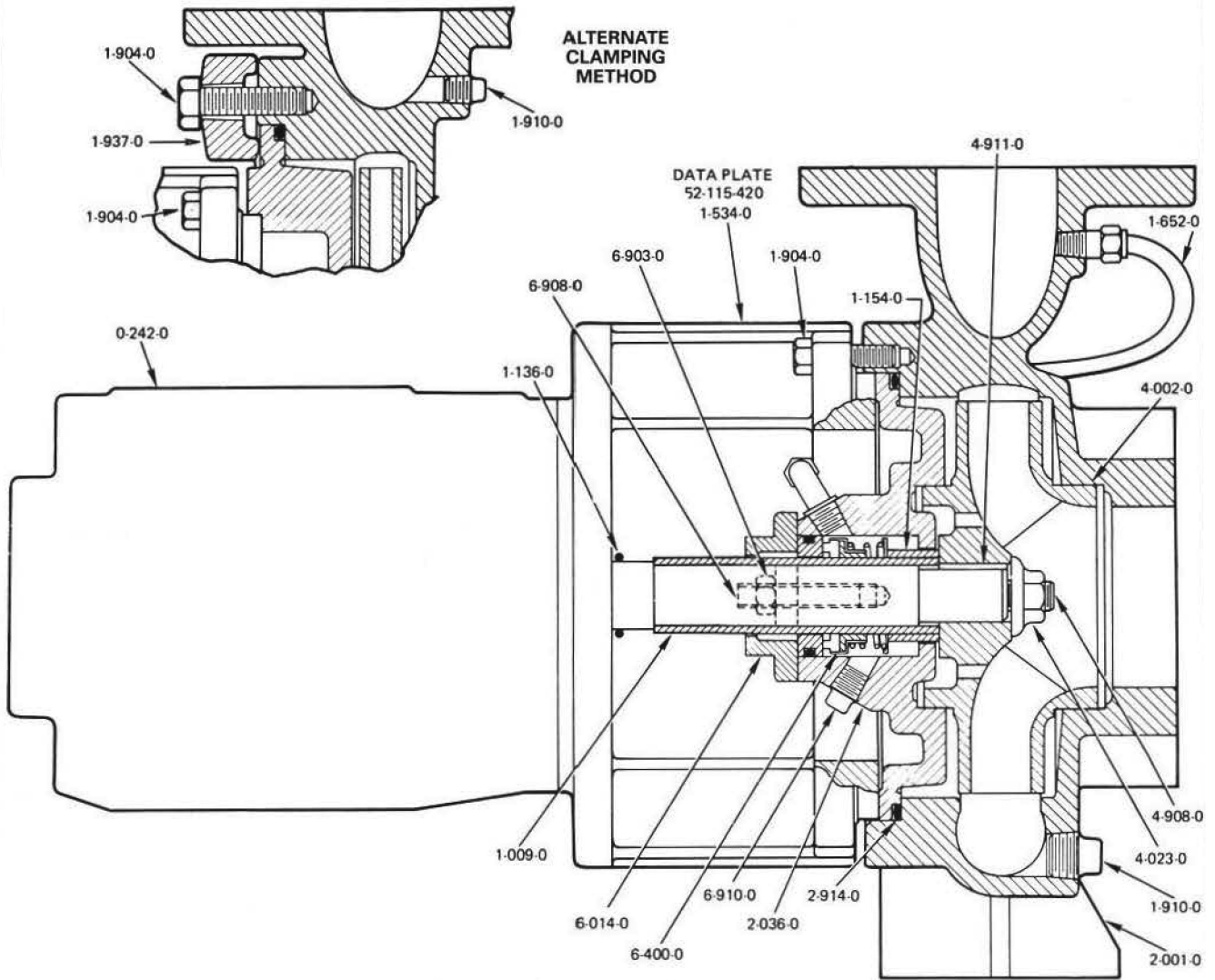
Final assembly

NOTE: When assembling the rotating assembly to the casing, be certain that the pump feet are parallel to the motor feet.

1. Place the "0" ring casing seal (2-914-0) around the "0" ring seat on the stuffing box cover.
2. Carefully slide the motor, motor adapter, stuffing box assembly into the casing being sure not to pinch the "0" ring. Insert the capscrews (1-904-0) through the frame and into the casing (the large Series A-C 2000 pumps use capscrews and clamping lugs (1-937-0) to hold the motor adapter to the casing. Tighten opposite capscrews evenly around the adapter until the stuffing box has been drawn evenly into the casing). Then, alternately torque each capscrew to 25 ft. lbs.
3. If necessary, connect the suction and discharge piping to the pump.
4. Secure the motor foot.
5. Connect the flushing water system to the stuffing box.
6. If the pump is to be started, be sure flushing is provided to the stuffing box.
7. Connect the power to the motor. CHECK THE MOTOR ROTATION.

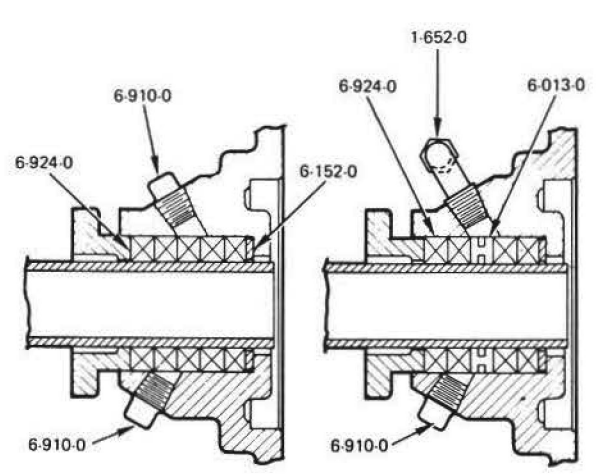
This completes the assembly of the Series A-C 2000 close-coupled pump.

Sectional view drawing



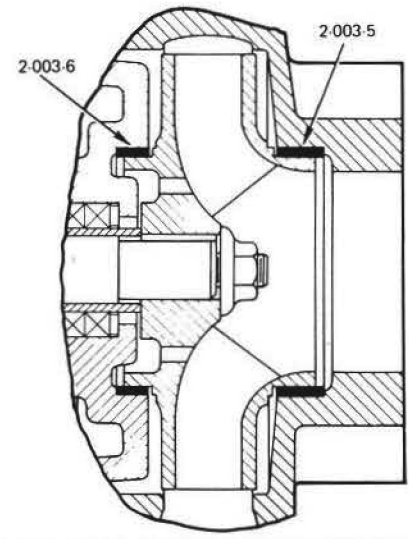
ALTERNATE CLAMPING METHOD

INTERNAL OR EXTERNAL FLUSH



PUMP WITH PACKING (PLUGGED)

PUMP WITH PACKING OPTIONAL SEAL CAGE (INTERNAL OR EXTERNAL)



PUMP WITH OPTIONAL CASING WEAR RINGS

PARTS LIST

Cat. No.	Part Name	Qty.
0-242-0	Motor	1
1-009-0	Shaft Sleeve	1
1-136-0	Deflector	1
1-154-0	Spacer Sleeve	1
1-534-0	Motor Adapter	1
1-652-0	By-Pass Piping Kit	1
1-904-0	Bolts – Miscellaneous	8
	With Lugs	16
1-910-0	Pipe Plugs	2
	Without By-Pass	3
1-937-0	Clamping Lug	8
2-001-0	Casing	1
2-036-0	Stuffing Box Cover	1
2-914-0	“O” Ring, Casing Seal	1
4-002-0	Impeller	1
4-023-0	Impeller Nut	1
4-908-0	Shaft Stud	1

Cat. No.	Part Name	Qty.
4-911-0	Key, Impeller	1
6-014-0	Gland	1
6-152-0	Ring Packing Base	1
6-400-0	Mechanical Seal	1
6-903-0	Gland Nut	2
6-908-0	Gland Stud	2
6-910-0	Pipe Plug	1
	Without By-Pass	2
6-924-0	Packing	5
	With Seal Cage	4
OPTIONAL COMPONENTS		
1-652-0	By-Pass Piping Kit, Seal Cage	1
2-003-5	Wear Ring, Suction	1
2-003-6	Wear Ring, Stuffing Box	1
6-013-0	Seal Cage	1

Ordering parts

The pumps covered by this manual have been designed and built with certain replaceable wearing parts. The recommended inventory of spare parts depends upon the installation and the importance of continued operation.

For critical service requiring a minimum of "down time" a complete or "quick change" rotating element is recommended.

For normal service, with repairs to be made in the field, the following parts are recommended for stock.

- 1 set of bearings
- 2 sets of wearing rings
- 1 set of gaskets and "O" rings
- 2 mechanical seals (complete)

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 and must be manufactured for each order.

To facilitate rapid handling of your order for spare parts, be sure to include the following information:

1. Serial number of the pump.
2. Quantity of each part.
3. Catalog number of the part.
4. Name of the part.
5. Material desired. (Parts will be furnished in original materials unless specified as a material change. All material substitutions should be discussed with the factory.)

General pump instruction

Introduction

Purpose of manual

This manual is furnished to acquaint you with some of the practical ways to install, operate, and maintain this pump. Read it completely before doing any work on your unit and keep it handy for future reference.

Equipment cannot operate well without proper care. To keep this unit at top efficiency, follow the recommended installation and servicing procedures outlined in this manual. The Industrial Pump Division's Customer Service Department is available to expertly guide the installation of the pump for maximum operating life and minimum downtime.

Goulds Water Technology service organization

Experienced, factory-trained servicemen offer prompt, efficient service at reasonable rates. These servicemen can find and correct costly errors such as poor grouting, misalignment, pipe stresses transmitted to the pump casing, or improperly cleaned piping. A serviceman may be requested through your nearest Goulds Water Technology Sales Representative.

Replacement and spare parts, including special attention to your individual problems, may also be obtained through the same Sales Representative.

Warranty

Refer to your sales contract for coverages.

Pump identification

All pumps are designated by Serial Number, Model Number, Size and Type. This information is stamped on an identification plate which is mounted on the pump. Refer to pump identification in the specific instruction section of this manual for detailed information (page 11).

Installation

Receiving pump

Check pump for shortages and damage immediately upon arrival. (An absolute must). Prompt reporting to the carrier's agent with notations made on the freight bill, will expedite satisfactory adjustment by the carrier.

WARNING: WHEN UNLOADING HORIZONTAL PUMPS, LIFT EQUALLY AT FOUR OR MORE POINTS ON THE BASEPLATE. DO NOT LIFT ON THE DRIVER OR PUMP. FOR VERTICAL PUMPS, USE THE LIFTING LUGS OR EYEBOLTS FOUND ON THE PUMP. DO NOT LIFT BY

FLANGES OR BY THE EYEBOLTS FOUND ON THE MOTOR. BE VERY CAREFUL NOT TO DAMAGE ANY AUXILIARY PIPING OR CONTROLS WHEN MOVING PUMPS.

Horizontal pumps and drivers are normally shipped from the factory mounted on a baseplate and painted with primer and one finish coat. Couplings may either be completely assembled or have the coupling hubs mounted on the shafts and the connecting members removed. When the connecting members are removed, they will be packaged in a separate container and shipped with the pump or attached to the baseplate.

Shafts are in alignment when unit is shipped; however, due to shipping, the pumps may arrive misaligned and, therefore, *alignment must be established during installation*. Series A-C 2000 pump has determined that proper and correct alignment can only be made by accepted erection practices. Refer to the following paragraphs on "Foundation", "Baseplate Setting", and "Grouting Procedure".

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 changes in ambient temperature. Rotate the shaft periodically to coat the bearings with lubricant and to retard oxidation, corrosion, and to reduce the possibility of false brinelling of the bearings.

Location

The pump should be installed as near the suction supply as possible, with the shortest and most direct suction pipe practical. The total dynamic suction lift (static lift plus friction losses in suction line) should not exceed the limits for which the pump was sold.

The pump must be primed before starting. Whenever possible, the pump should be located below the fluid level to facilitate priming and assure a steady flow of liquid. This condition provides a positive suction head on the pump. It is also possible to prime the pump by pressurizing the suction vessel.

When installing the pump, consider its location in relation to the system to assure that sufficient Net Positive Suction Head (NPSH) at pump suction is provided. Available NPSH must always equal or exceed the required NPSH of the pump.

The pump should be installed with sufficient accessibility for inspection and maintenance. A clear space with ample head room should be allowed for the use of an overhead crane or hoist sufficiently strong to lift the unit.

NOTE: Allow sufficient space to be able to dismantle pump without disturbing the pump inlet and discharge piping.

Select a dry place above the floor level wherever possible. Take care to prevent pump from freezing during cold weather when not in operation. Should the possibility of freezing exist during a shut-down period, the pump should be completely drained, and all passages and pockets where liquid might collect should be blown out with compressed air.

Make sure there is a suitable power source available for the pump driver. If motor driven, electrical characteristics should be identical to those shown on motor data plate.

Foundation

A substantial foundation and footing should be built to suit local conditions. It should form a rigid support to maintain alignment.

Vertical Pumps - Foundation bolts should be sized and accurately located. Each foundation bolt should be located in a bushing two diameters larger than the bolt to allow free movement of the bolt in conforming to the mounting holes in the pedestal. When vertical pumps are used with intermediate shafting, the motor mount baseplate should be securely attached to the floor or support structure.

Horizontal Pumps - The foundation should be poured without interruption to within 1/2 to 1-1/2 inches of the finished height. The top surface of the foundation should be well scored and grooved before the concrete sets; this provides a bonding surface for the grout. Foundation bolts should be set in concrete as shown in **Figure 8**. A 4-inch long tube around the bolts at the top of the concrete will allow some flexibility in bolt alignment to match the holes in the baseplate. Allow enough bolt length for grout, shims, lower baseplate flange, nuts and washers. The foundation should be allowed to cure for several days before the baseplate is shimmed and grouted.

Baseplate setting: (before piping)

NOTE: This procedure assumes that a concrete foundation has been prepared with anchor or hold down bolts extending up ready to receive unit. It must be understood that pump and motor have been mounted and rough aligned at the factory. If motor is to be field mounted, consult factory for recommendations. Goulds Water Technology cannot assume responsibility for final alignment.

1. Use blocks and shims under base for support at anchor bolts and midway between bolts, to position base approximately 1" above the concrete foundation with studs extending through holes in the baseplate.

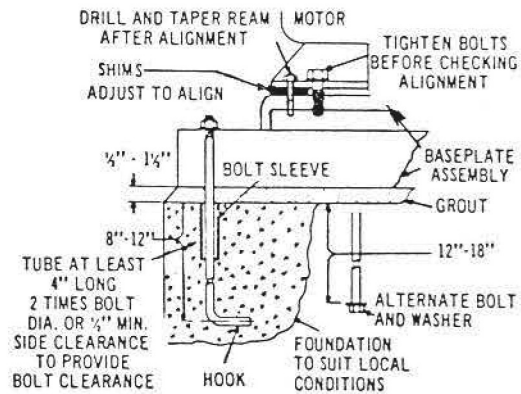


Figure 8 - Foundation

2. By adding or removing shims under the base, level and plumb the pump shaft and flanges. The base plate does not have to be level.
3. Draw anchor nuts tight against base, and observe pump and motor shafts or coupling hubs for alignment. (Temporarily remove coupling guard for checking alignment.)
4. If alignment needs improvement, add shims or wedges at appropriate positions under base so that retightening of anchor nuts will shift shafts into closer alignment. Repeat this procedure until a reasonable alignment is reached.

NOTE: Reasonable alignment is defined as that which pump contractor and the accepting facility (final operator) mutually agree upon.

5. Check to make sure the piping can be aligned to the pump flanges without placing pipe strain on either flange.
6. Grout baseplate in completely (See "Grouting Procedure") and allow grout to dry thoroughly before attaching piping to pump. (24 hours is sufficient time with approved grouting procedure.)

Grouting procedure

Grout compensates for uneven foundation, distributes weight of unit, and prevents shifting. Use an approved, non-shrinking grout (such as Embecco 636 by Master Builders, Cleveland, Ohio or equivalent), as follows, after setting and leveling unit. (See **Figure 9**)

1. Build strong form around the foundation to contain grout.
2. Soak top of concrete foundation thoroughly, then remove surface water.
3. Baseplate should be completely filled with grout and if necessary, temporarily use air relief tubing or drill vent holes to remove trapped air.
4. After the grout has thoroughly hardened, check the foundation bolts and tighten if necessary.

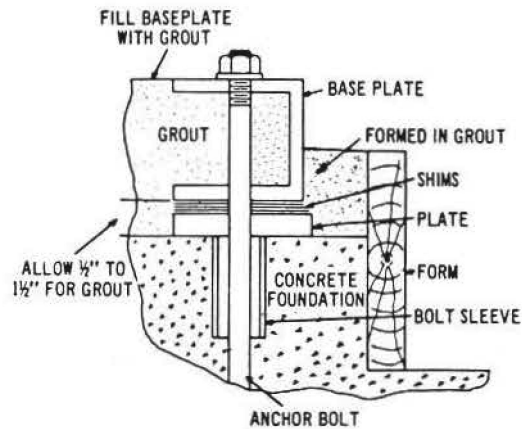


Figure 9- Setting baseplate and grouting

5. Check the alignment after the foundation bolts are tightened.
6. Approximately 14 days after the grout has been poured or when the grout has thoroughly dried, apply an oil base paint to the exposed edges of the grout to prevent air and moisture from coming in contact with the grout.

Suction and discharge piping

General

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

Piping should always be run to the pump.

Do not move pump to pipe. This could make final alignment impossible.

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 support. When expansion joints are used in

the piping system they must be installed beyond the piping supports closest to the pump. Tie bolts should be used with expansion joints to prevent pipe strain. Do not install expansion joints next to the pump or in any way that would cause a strain on the pump resulting from system pressure changes. 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.

Install piping as straight as possible, avoiding unnecessary bends. Where necessary, use 45-degree or long sweep 90-degree fitting to decrease friction losses.

Make sure that all piping joints are air-tight. Where flanged joints are used, assure that inside diameters match properly.

Remove burrs and sharp edges when making up joints.

Do not "spring" piping when making any connections.

Provide for pipe expansion when hot fluids are to be pumped.

Suction piping

When installing the suction piping, observe the following precautions (See Figure 10).

The sizing and installation of the suction piping is extremely important. It must be selected and installed so that pressure losses are minimized 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. 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.

Suction piping for horizontal double suction pumps should not be installed with an elbow close to the suction flange of the pump except when the suction elbow is in the vertical plane. A suction pipe of the same size as the suction nozzle approaching at any angle other than straight up or straight down must have the elbow located 10 pipe diameters from the suction flange of the pump. Vertical mounted pumps and other space limitations require special piping.

There is always an uneven turbulent flow around an elbow and when it is in a position other than the vertical it causes more liquid to enter one side of the impeller than the other. (See Figure 11) This results in high unequalized thrust loads that will overheat the bearings and cause rapid wear in addition to affecting hydraulic performance.

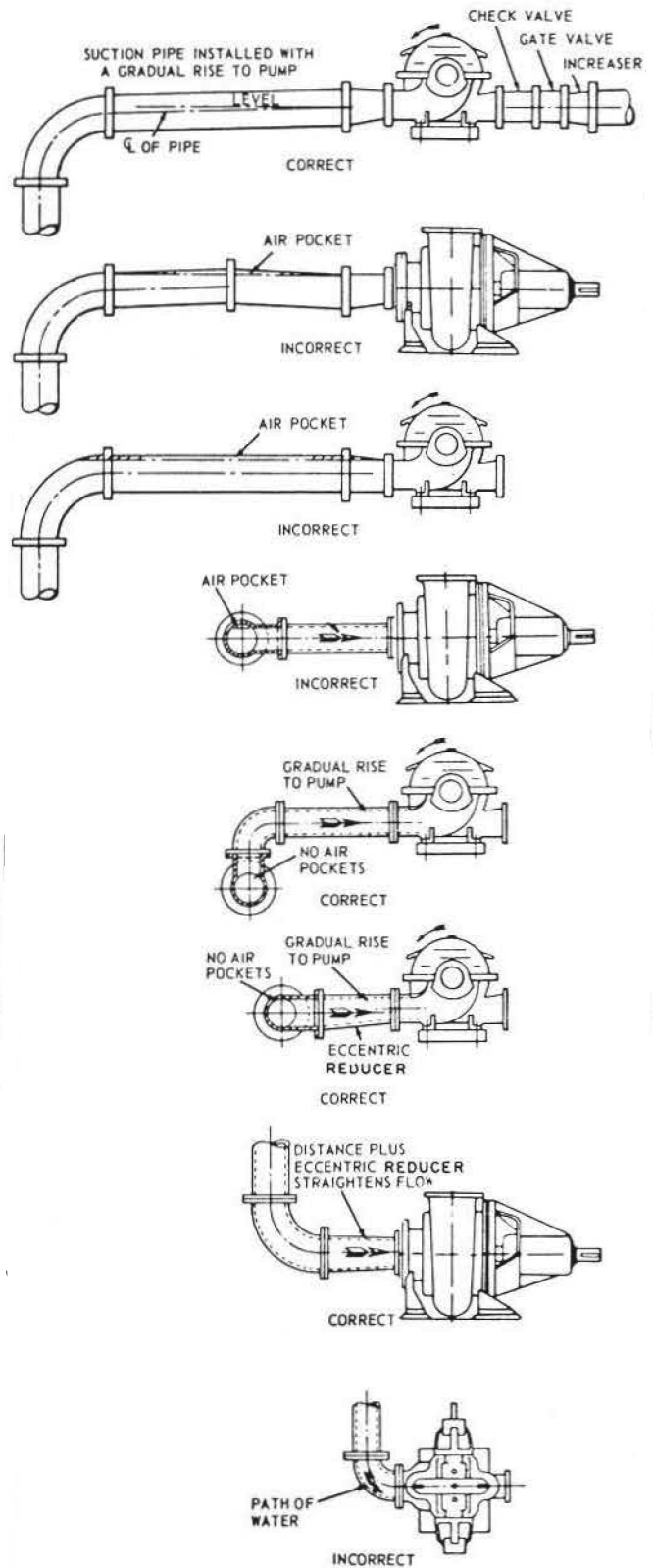


Figure 10 - Suction pipe installation
(Piping supports not shown)

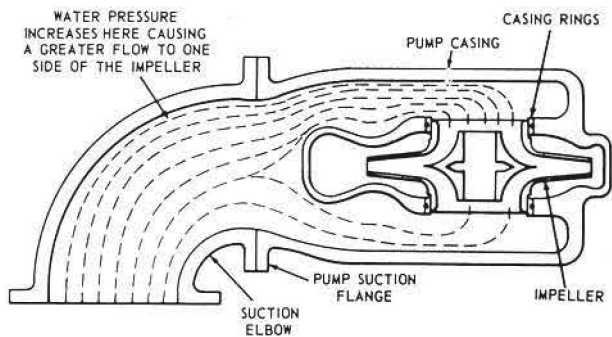


Figure 11 - Unbalanced loading of a double suction impeller due to uneven flow around an elbow adjacent to the pump.

When operating on a suction lift, 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: When operating on suction lift 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.

To facilitate cleaning pump liquid passage without dismantling pump, an increasing suction nozzle or suction diffuser should be bolted to the suction flange. If this is not done, a short section of pipe (Dutchman or spool piece) so designed that it can be readily dropped out of the line can be installed adjacent to the suction flange. With this arrangement, any matter clogging the impeller is accessible by removing the nozzle (or pipe section).

Valves in suction piping

When installing valves in the suction piping, observe the following precautions:

1. If the pump is operating under static suction lift conditions, a foot valve may be installed in the suction line to avoid the necessity of priming each time the pump is started. This valve should be of the flapper type, rather than the multiple spring type, sized to avoid excessive friction in the suction line. (Under all other conditions, a check valve, if used, should be installed in the discharge line.

See Figure 12.)

2. When foot valves are used, or where there are other possibilities of "water hammer," close the discharge valve slowly before shutting down the pump.

3. Where two or more pumps are connected to the same suction line, install gate valves so that any pump can be isolated from the line. Gate valves should be installed on the suction side of all pumps with a positive pressure for maintenance purposes. Install gate valves with stems horizontal to avoid air pockets. Globe valves should not be used, particularly where NPSH is critical.
4. The pump must never be throttled by the use of a valve on the suction side of the pump. Suction valves should be used only to isolate the pump for maintenance purposes, and should always be installed in positions to avoid air pockets.

Discharge piping

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.

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 back 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 should be installed in both the suction and discharge nozzles in the gauge taps (which are provided on request). 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. If cavitation, vapor binding, or other unstable operation should occur, widely fluctuating discharge pressure will be noted.

Stuffing box

Contaminants in the pumped liquid must not enter the packing space. These contaminants may cause severe abrasion or corrosion of the shaft, or shaft sleeve, and rapid packing deterioration; they can even plug the stuffing box flushing and lubrication system. The stuffing box must be supplied at all times with a source of clean, clear liquid to flush and lubricate the packing. The most important consideration is to establish the optimum flushing pressure that will eliminate contaminants from the packing. If this pressure is too low, fluid being pumped may enter the stuffing box. If the pressure is too high, excessive packing wear will result; and extreme heat may develop in the shaft causing higher bearing temperatures. The most desirable condition,

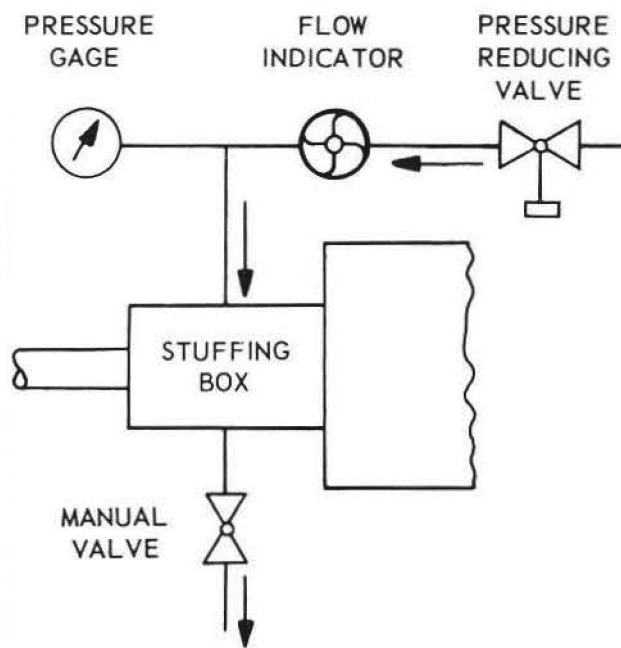


Figure 12 - Controlled pressure system for stuffing box

therefore, is to use the lowest possible flushing pressure which the operating conditions will permit. If the pump system pressure conditions vary during the day, the packing problem becomes difficult. Consideration should be given to using a mechanical seal. (See "Mechanical Seals".)

One recommended method to minimize error in regulating flushing water is a "Controlled Pressure System" (**Figure 12**). Most important is the pressure reducing valve adjusted to a value slightly exceeding the maximum stuffing box operating pressure (assuming it is reasonably constant). A flow indicating device will serve to indicate a failing of the bottom packing rings allowing leakage into the pump. With this arrangement, the packing gland need be tightened only against the lowest necessary pressure. Longer packing life and less frequent adjustments are possible with the "Controlled Pressure System" if properly installed and operated. (See "Stuffing Box Operating Pressure".)

Packing

Standard pumps are normally packed before shipment. If the pump is installed within 60 days after shipment, the packing will be in good condition with a sufficient supply of lubrication. If the pump is stored for a longer period, it may be necessary to repack the stuffing box. In all cases, however, inspect the packing before the pump is started.

NOTE: Packing adjustment is covered on page 31.

Packing lubrication

Internal liquid lubricant

Pumped liquid may be used to lubricate the packing when the following conditions prevail:

1. Liquid is clean, free from sediment and chemical precipitation and is compatible with seal materials.
2. Temperature is above 32°F and below 160°F.
3. Suction pressure is below 75 psig.
4. Liquid has lubricating qualities.
5. Liquid is non-toxic and non-volatile.

External liquid lubricant

When the liquid being pumped contains solids or is otherwise not compatible with packing materials, an outside supply of seal liquid should be furnished. In general, external-injection liquid (from an outside source) is required when the following conditions prevail:

1. Liquid being pumped contains dirt, grit, or other impurities.
2. Temperature of the pumped liquid is below 32°F or above 160°F.
3. Liquid being pumped has non-lubricating properties.
4. Liquid is toxic or volatile.
5. Suction pressure is above 75 psig, vacuum, or high lift.

Stuffing box operating pressure

The actual stuffing box operating pressure may be obtained by installing a pressure gauge on the box. This is done with an extra seal cage temporarily replacing the two rings of packing in the bottom of the box to obtain accurate gauge readings. Take gauge readings with the pump running under various head and capacity conditions. Then set the pressure of flushing or lubrication liquid at a value 5 to 10 psi above the maximum expected stuffing box operating pressure.

Even under the best conditions, a properly packed stuffing box should be watched closely. If pressure conditions change slightly, there will be a resultant change in packing "seating" which should be compensated by a change in gland adjustment. Consideration should also be given to the lubrication pressure. A wide variation indicates a need to use a mechanical seal.

Mechanical seals

Mechanical seals are preferred over packing on some applications because of better sealing qualities and longer serviceability. Leakage is eliminated when a seal is properly installed, and normal life is much greater than that of packing on similar applications.

A mechanical shaft seal is supplied in place of a packed stuffing box when specifically requested. The change from packing to an alternate arrangement may be made in the field by competent service personnel. Conversion kits may be ordered from your Goulds Water Technology Sales Representative.

Single mechanical seal

Pumps containing single mechanical seals normally utilize the pumped liquid to lubricate the seal faces. This method is preferred when the pumped liquid is neither abrasive nor corrosive. If the liquid being pumped is not suitable, an external flush should be provided. (See "External Liquid Lubricant" page 22.)

Double mechanical seal

A double mechanical seal consists of two single seals mounted back-to-back and a suitable sealing liquid which is introduced into the seal chamber. The sealing liquid (preferably clear water) is injected into the box at a higher pressure than that which exists at the entrance to the seal cavity on the pump side. The pressure differential isolates the sealing faces from the pumped liquid. Double mechanical seals are normally preferred in pumps handling sewage, slurries, or any other solids suspended in the pumped liquid.

Lubrication for the double seal is provided by the sealing liquid which is introduced through the tap in the seal cavity. The sealing liquid pressure must always be higher than the pressure on the seal closer to the suction side. If sufficient sealing pressure is not maintained, the pressure within the pump can force open the lower seal and allow the pumped liquid to enter the box which can damage the seals.

Two methods are used to provide sealing liquid to the stuffing box:

1. A common method utilizes a pressure line which is installed from a tap on the discharge nozzle to the tap in the stuffing box cartridge. A filter is installed in the line to trap the solid particles. The filter must be capable of screening out all particles above 25 microns in size.

Since the liquid is bypassed from the high pressure (discharge) side of the pump, and dead-ended in the stuffing box cartridge, there are no problems in maintaining a sufficient pressure differential provided the filter is not clogged.

2. Clear, clean water can be supplied from an external source in some installations. City water can be used if there is an air break between the water supply and the water being provided to the pump. Various municipal ordinances require this break to prevent contamination of the city water supply.

Operation

Pre-start checks

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

1. Check alignment between pump and motor
2. Check all connections to motor and starting device with wiring diagram. Check voltage, phase, and frequency on motor nameplate with line circuit.
3. Check suction and discharge piping and pressure gauges for proper operation.
4. Check impeller adjustment, see specific section for proper adjustment.
5. Turn rotating element by hand to assure that it rotates freely.
6. Check stuffing box adjustment, lubrication, and piping.
7. Check driver lubrication.
8. Assure that pump bearings are properly lubricated.
9. Assure that coupling is properly lubricated, if required.
10. Assure that pump is full of liquid, (See "Priming" below) and all valves are properly set and operational, with the discharge valve closed, and the suction valve open.
11. Check rotation. Be sure that the driver 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.

CAUTION: ROTATION SHOULD BE CHECKED WITH COUPLING DISCONNECTED ON COUPLED UNITS.

Priming

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

1. Close drain valves and valve in discharge line.
2. Open fully all valves in the suction line.
3. Turn on seal water to the stuffing box. (If pumped fluid is dirty or if leakage of air is to be prevented, these lines should be always left open.)
4. Prime the pump.

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

5. (Pumps moving high temperature liquids.) Open the warm-up valve to circulate liquid for preheating. Consult the instructions that cover such specially designed heating system.
6. Start the pump driver (turbines and engines may require warming up; consult the manufacturer's instructions).
7. When the pump is operating at full speed, open the discharge valve slowly. This should be done promptly after start-up to prevent damage to pump by operating at zero flow.
8. Adjust the liquid seal valves to produce the recommended pressure for either the mechanical seal or packed stuffing box.

Operating checks

1. Check the pump and piping to assure that there are no leaks.
2. Check and record pressure gauge readings for future reference.
3. Check and record voltage, amperage per phase, and kW if an indicating wattmeter is available.
4. Check bearings for lubrication and temperature. Normal temperature is 180°F maximum.
5. Check and adjust stuffing box for correct operation. (See page 31).
6. Check sealing water lines and valves.

CAUTION: MAKE ALL PUMP OUTPUT ADJUSTMENTS WITH THE DISCHARGE VALVE. DO NOT THROTTLE THE SUCTION LINE TO ADJUST THE PUMP OUTPUT.

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, refer to "Temporary Storage" and "Freezing Protection" (See page 17).

1. Close the discharge valve slowly.

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

2. Shut down the driver (Consult manufacturer's instructions for special operations.)
3. Close seal liquid valves. (If pumped liquid is dirty or if leakage is to be prevented, these lines should always be left open.)
4. Open drain valves as required.

Freezing protection

Pumps that are shut down during freezing conditions should be protected by one of the following methods.

1. Drain the pump; remove all liquids from the casing.
2. Keep fluid moving in the pump and insulate or heat the pump to prevent freezing.

CAUTION: IF HEAT IS USED TO KEEP THE PUMP FROM FREEZING, DO NOT LET THE TEMPERATURE RISE ABOVE 150°F.

Field tests

Performance curve

A typical performance curve for a specific pump can be obtained from Goulds Water Technology. This can be used in conjunction with a field test, if one is required. All Goulds Water Technology pump tests and curves are based on the "Hydraulic Institute Standards." Any field test must be conducted according to these Standards.

Unless otherwise specifically agreed, all capacity, head, and efficiencies are based on shop tests when handling clear, cold, fresh water at a temperature not over 85°F and under suction conditions as specified in the contract.

To aid in calculating pump performance, the following test information and definitions are included for reference.

NOTE: Complete procedure for testing pumps is given in the "Hydraulic Institute Standards" Centrifugal Pump Section.

Gauge datum

The datum for all gauge readings is taken as the centerline of the pump shaft for all horizontal shaft pumps and as the eye of the impeller for vertical pumps.

Head measurement

The unit for measuring head should be feet; therefore, all pressure readings of the pumped liquid should be converted to feet. The relationship between a pressure expressed in pounds per square inch (psi) and that expressed in feet of head is:

$$\text{Head in feet} = \frac{\text{psi} \times 2.3}{\text{sg}}$$

Where sg = specific gravity of the liquid pumped
Where sg = 1.0 for water at 60°F

Total head

Total head is the algebraic difference between the total suction and the total discharge heads.

1. Where suction lift exists, total head is the sum of the total discharge head and the suction lift.
2. Where positive suction head exists, the total head is the total discharge head minus the total suction head.

Suction lift

Suction lift exists where the total suction head is below atmospheric pressure. Total suction lift is the reading of a liquid monometer at the suction nozzle of the pump, converted to feet of liquid, and referred to the datum minus the velocity head at the point of gauge attachment.

Positive suction head

Suction head exists when the total suction head is above atmospheric pressure. Total suction head is the reading of a gauge at the suction of the pump, converted to feet of liquid, and referred to datum plus the velocity head at the point of gauge attachment.

Velocity head

Velocity head is figured from the average velocity obtained by dividing the discharge flow (in cubic feet per second) by the actual area of the pipe cross-section (in square feet), and is determined at the point of gauge connection. It is expressed by the formula:

$$h_v = \frac{V^2}{2g}$$

Where g = the acceleration due to gravity, and is 32.17 feet per second squared at sea level and 45 degrees latitude.

V = velocity in the pipe in feet per second.

Volume measurement

The method of volume measurement should be made by some accurate and accepted method and converted to gallons per minute. For easy reference, refer to the following:

1. The standard U.S. gallon contains 231 cubic inches.
2. One cubic foot equals 7.4805 gallons.
3. The specific weight of water at a temperature of 60°F shall be taken as 62.34 pounds per cubic foot.

Horsepower

1. The formula for horsepower required at the pump shaft is:

$$\text{Bhp} = \frac{\text{Total head} \times \text{GPM}}{3960 \times \text{Eff.}} \times \text{specific gravity}$$

2. The true motor brake horsepower, once the efficiency is determined from dynamometer tests, can also be calculated from the following formula:

$$\text{Bhp} = \frac{\text{kW input} \times \text{Eff.}}{0.746}$$

Where Bhp = Brake horsepower delivered
kW input = Real input power (kW)
Eff. = Motor efficiency

Pump efficiency

Pump efficiency can be calculated by the formula:

$$\text{Pump efficiency} = \frac{\text{Total head} \times \text{GPM}}{3960 \times \text{Bhp}} \times \text{specific gravity}$$

Vibration

The acceptable vibration level of a centrifugal pump depends on the rigidity of the pump and the supporting structure. Recommended values for vibration can vary between .20 ips velocity to .60 ips velocity depending on the operating characteristics and the structure. Refer to the standards of the "Hydraulic Institute" for the complete description and charts on various structures.

Electrical requirements

Motor (also see separate motor instructions)

If the motor is sized to operate near full load at the rated head and capacity of the pump, a watt-meter should be installed to record input power to the motor. If motor efficiency is known, the shaft horsepower may be calculated and checked against the motor rating. A motor operating outside its service factor will overheat and could possibly burn out. Motors are usually rated with normal temperature requirements stamped on the data plate.

NOTE: A motor which feels hot to the touch of the hand is not necessarily running hot. Check with an accurate temperature measuring device to be sure. A motor operating outside its service factor will overheat and could possibly burn out. Motors are usually rated with normal temperature requirements stamped on the data plate.

Conduit box

Conduit boxes are mounted on the motors at lead access openings. Conduit boxes are normally provided for main power leads and other special accessories, such as space heaters, temperature alarms and control features.

The conduit box openings are sized as shown on the motor dimension drawing, and threaded for using standard rigid or flexible conduit. They may be assembled with conduit openings at any of four (4) 90° positions.

Motor controls - General

Motor controls should conform to all the electrical data stamped on the motor data plate. Complete instructions for installation, operation, and maintenance are included with the controlling device.

External wiring

Wiring to the motor should be installed in conformance with the National Electrical Code and any local codes.

Troubleshooting

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

No liquid delivered

CAUSES	CURES
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 head too high.	Check pipe friction losses. Large 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. Or 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.
7. Impeller completely plugged.	Dismantle pump and clean impeller.

Not enough liquid delivered

CAUSES	CURES
8. Air leaks in suction piping.	If liquid pumped is water or other non-explosive, and explosive gas or dust is not present, test flanges for leakage with 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 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. b. Sub-cool suction piping at inlet to lower entering liquid temperature. c. Pressurize suction vessel.
15. Defective impeller.	Inspect impeller, bearings and shaft. Replace if damaged or vane sections badly eroded.
16. Defective packing.	Replace packing and sleeves if badly worn.
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 1-1/2 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.	Symptoms are an overloaded drive and about 1/3 rated capacity from pump. Compare rotation of motor with directional arrow on pump casing.
20. Too small impeller diameter (probable cause if none of above).	Check with factory to see if a larger impeller can be used: otherwise, cut pipe losses or increase speed -or both, as needed. But be careful not to seriously overload drive.

Not enough pressure

CAUSES	CURES
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 over rate pump to point where it will provide adequate pressure despite condition. Better to provide gas separation chamber on suction line near pump, and periodically exhaust accumulated gas. See item 14.
26. Too small impeller diameter. (Probable cause if none of above.)	See item 20.

Pump operates for short time, then stops

CAUSES	CURES
27. Incomplete priming.	Free pump, piping and valves of all air. If high points in suction line prevent this, they need correcting. See page 21.
28. Suction lift too high.	See item 3.
29. Air leaks in suction piping.	See item 8.
30. Air leaks in stuffing box.	See item 9.
31. Air or gases in liquid.	See item 25.

Pump takes too much power

CAUSES	CURES
32. Head lower than rating; thereby pumping too much liquid.	Machine impeller's OD to size advised by factory.
33. Cavitation	See item 14.
34. Mechanical defects	See items 15, 16 and 17.
35. Suction inlet not immersed enough.	See item 18.
36. 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.
37. Wrong direction of rotation.	See item 6
38. Stuffing boxes too tight.	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. Casing distorted by excessive strains from suction or discharge piping.	Check alignment. Examine pump for friction between impeller and casing. Replace damaged parts.
40. Shaft bent due to damage through shipment, operation or overhaul.	Check deflection of rotor by turning on bearing journals. Total indicator run-out should not exceed 0.001 on shaft and 0.004 inch on impeller wearing surface.
41. Mechanical failure of critical pump parts.	Check bearings and impeller for damage. Any irregularity in these parts will cause a drag on shaft.
42. Misalignment	Realign pump and driver.
43. 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.
44. Electrical defects	The voltage and frequency of the electrical current may be lower than that for which motor was built; or there may be defects in motor. The motor may not be ventilated properly due to a poor location.
45. Mechanical defects in turbine, engine or other type of drive exclusive of motor.	If trouble cannot be located, consult factory.

Maintenance

General maintenance

Operating conditions vary so widely that to recommend one schedule of preventative maintenance for all centrifugal pumps is not possible. Yet some sort of regular inspection must be planned and followed. We suggest a permanent record be kept of the periodic inspections and maintenance performed on your pump. This recognition of maintenance procedure will keep your pump in good working condition, and prevent costly breakdowns.

One of the best rules to follow in the proper maintenance of your centrifugal pump is to keep a record of actual operating hours. Then, after a predetermined period of operation has elapsed, the pump should be given a thorough inspection. The length of this operating period will vary with different applications, and can only be determined from experience. New equipment, however, should be examined after a relatively short period of operation. The next inspection period can be lengthened somewhat. This system can be followed until a maximum period of operation is reached which should be considered the operating schedule between inspections.

Maintenance of pump due to flood damage

The servicing of centrifugal pumps after a flooded condition is a comparatively simple matter under normal conditions.

Bearings are a primary concern on 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 relubricate 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.

Next, 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. Mechanical seals should be cleaned and thoroughly flushed.

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

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.

Bearing lubrication - grease

Grease lubricated ball bearings are packed with grease at the factory and ordinarily will require no attention before starting provided the pump has been stored in a clean, dry place prior to its first operation. The bearings should be watched the first hour or so after the pump has been started to see that they are operating properly.

The importance of proper lubrication cannot be over emphasized. It is difficult to say how often a bearing should be greased, since that depends on the conditions of operation. It is well to add one ounce of grease at regular intervals, but it is equally important to avoid adding too much grease. For average operating conditions, it is recommended that 1oz. of grease be added at intervals of three to six months, and only clean grease be used. It is always best if unit can be stopped while grease is added to avoid overloading.

NOTE: Excess grease is the most common cause of overheating.

The bearing frame should be kept clean, since any contamination of foreign matter which gets into the housing will destroy bearings in a short time. When cleaning bearings, use a bearing cleaning solvent, or an industrial cleaning solvent. Do not use gasoline. Use lint free cloths. Do not use waste rags.

A regular ball bearing grease should be used, but a standard commercial vaseline can be substituted if necessary.

Do not use graphite. A NGLI No. 1 or 2 grease is generally satisfactory for operation at ordinary temperatures, the lighter grease for operation at high speed or low room temperature.

Mineral greases with a soda soap base are recommended. Grease made from animal or vegetable oils are not recommended due to the danger of deterioration and forming of acid. Most of the leading oil companies have special bearing greases which are satisfactory. For specific recommendations, consult the factory.

The maximum desirable operating temperature for ball bearings is 180°F. Should the temperature of the bearing frame rise above 180°F, the pump should be shut down to determine the cause.

Grease lubricated bearings should not be used where temperature of the pumped liquid exceeds 350°F.

NOTE: A bearing frame which feels hot to the touch of the hand is not necessarily running hot. Check with an accurate temperature measuring device to be sure.

Stuffing box

The standard stuffing box consists of rings of packing, (See assembly section for number of rings) a seal cage, and a gland. A shaft sleeve which extends through the box and under the gland is normally provided to protect the shaft.

A tapped hole is supplied in the stuffing box directly over the seal cage to introduce a clean, clear sealing medium. The stuffing box must at all times be supplied with sealing liquid at a high enough pressure to keep the box free from foreign matter, which would quickly destroy the packing and score the shaft sleeve.

Water lubrication

Only a sufficient volume of sealing liquid to create a definite direction of flow from the stuffing box inward to the pump casing is required, but the pressure is important. Apply seal water at a rate of 0.5 - 1.0 GPM, at 5 - 10 PSI above stuff box operating pressure.

We recommend that piping supplying sealing liquid to stuffing box be sized to supply a sufficient volume of water at the required pressure, based on the location of the pump (or pumps) with respect to the liquid source. A small pipe can be utilized for the connection to the stuffing box. A valve should be installed to adjust and regulate sealing liquid and a gauge installed to check pressure to the box.

External sealing liquid should be adjusted to the point where the packing runs only slightly warm, with a very slow drip from the stuffing box. Excess pressure from an external source can be very destructive to packing. More pressure is required, however, for abrasive slurries than for clear liquids. Examination of the leakage will indicate whether to increase or decrease external pressure. If slurry is present in the leakage, increase the pressure until only clear liquid drips from the box. If the drippage is corrosive or harmful to personnel, it should be collected and piped away.

A common error is to open the external piping valve wide and then control the drippage by tightening the packing gland. Actually, a combination of both adjustments is essential to arrive at the optimum condition. The life of packing and sleeve depends on this careful control more than any other factor.

Grease lubrication

Pump stuffing boxes are also suitable for grease lubrication. Several types of grease lubricators are available. When using a grease lubricator, grease pressure to the stuffing box should be equal to the pump discharge pressure.

Packing

All pumps are packed before shipment, unless otherwise requested. All packings used are the highest grade material. Before pump is put into operation, check the condition of the packing. If pump is installed within 60 days after shipment, the packing will be in good condition with a sufficient supply of lubrication. If pump is stored for a longer period, it may be necessary to repack the stuffing box. In all cases, however, we recommend an inspection of the packing before pump is started.

Fiber 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 on the market have the desired qualities. For specific recommendations, consult the factory.

When a pump with fiber packing is first started, it is advisable to have the packing slightly loose without causing an air leak. As pump runs in, gradually tighten the gland bolts evenly. The gland should never be drawn to the point where packing is compressed too tightly, and no leakage occurs. This will cause the packing to burn, score the shaft or shaft sleeve, and prevent liquid from circulating through the stuffing box, cooling the packing. The stuffing box is improperly packed or adjusted if friction in the box prevents turning the rotating element by hand. A properly operated packed stuffing box should run lukewarm with a slow drip of sealing liquid. After the pump has been in operation for some time and the packing has been completely run-in, drippage from the stuffing box should be at least 40 to 60 drops per minute. This will indicate proper packing and shaft sleeve lubrication and cooling.

NOTE: *Eccentric operation of the shaft, or sleeve, through the packing could result in excess leakage that cannot be compensated for. Correction of this defect is very important.*

Packing should be checked frequently and replaced as service indicates. Six months might be a reasonable expected life, depending on operating conditions. It is impossible to give any exact predictions. A packing tool may be used to remove all old packing from the stuffing box. Never reuse old and lifeless packing or merely add some new rings. Make sure that the stuffing box is thoroughly cleaned before new packing is installed. Also check the condition of the shaft or sleeve for possible scoring or eccentricity, making replacements where necessary.

New packing should be placed carefully into the stuffing box. If molded rings are used, the rings should be opened sideways, and the joints pushed into the stuffing box first. The rings are installed one at a time, each ring seated firmly, and the joints staggered so they are not in line. The joints should be kept toward the upper side of the shaft and should be at about a 90 degree angle from each preceding joint.

If coil packing is used, cut one ring to accurate size with either a butt or mitered joint. An accurately cut butt joint is superior to a poor fitting mitered joint. Fit the ring over the shaft to assure proper length. Then remove and cut all other rings to the first sample. When the rings are placed around the shaft, a tight joint should be formed. Place the first ring in the bottom of the stuffing box. Then install each succeeding ring, staggering the joints as described above, making sure each ring is firmly seated.

Make sure the seal cage is properly located in the stuffing box under the sealing water inlet. The function of the seal cage is to establish a liquid seal around the shaft, prevent leakage of air through the stuffing box, and lubricate the packing. If it is not properly located, it serves no purpose.

Mechanical shaft seals

General

A mechanical shaft seal is supplied in place of a packed stuffing box where specifically requested. Mechanical seals are preferred over packing on some applications because of better sealing qualities and longer serviceability. Leakage is eliminated when a seal is properly installed, and normally the life of the seal is much greater than that of packing on similar applications.

General instructions for operation of the various mechanical sealing arrangements are included below. It is not feasible to include detailed instructions for all mechanical seals in this booklet because of the almost unlimited number of possible combinations and arrangements. Instead, seal manufacturer's instructions will be included as a separate supplement to this book where required.

1. Mechanical seals are precision products and should be treated with care. Use special care when handling seals. Clean oil and clean parts are essential to prevent scratching the finely lapped sealing faces. Even light scratches on these faces could result in leaky seals.
2. Normally, mechanical seals require no adjustment or maintenance, except routine replacement of worn, or broken parts.
3. A mechanical seal which has been used should not be put back into service until the sealing faces have been replaced or relapped. (Relapping is generally economical only in seals two inches in size and above.)

Four important rules which should always be followed for optimum seal life are:

1. Keep the seal faces as clean as possible.
2. Keep the seal as cool as possible.
3. Assure that the seal always has proper lubrication.
4. If seal is lubricated with filtered fluid, clean filter frequently.

Cleaning without dismantling pump

We recommend that an increasing suction nozzle or suction diffuser, bolted to the suction flange, be supplied by Goulds Water Technology. (If this is not done, a short section of pipe so designed that it can be readily dropped out of the line can be installed adjacent to the suction flange.) With this arrangement, any matter clogging the impeller is accessible by removing the nozzle (or pipe section).

Other cleaning methods include running an auger into the pump through the clean out hole in the suction nozzle, or through the casing handhole. This should free any clogging in the impeller eye.

If the pump cannot be freed of clogging after the above methods have been tried, dismantle the unit as previously described to locate the trouble.

Maintenance time table

Every Month	Check bearing temperature with a thermometer, not by hand. If bearings are running hot (over 180°), it may be the result of too much lubricant. If changing the lubricant does not correct the condition, disassemble and inspect the bearings.
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 color. Wash out the bearings with a clean industrial solvent and replace the grease with the proper type as recommended.
Every 6 Months	<p>Check the packing and replace if necessary. Use the grade recommended. Be sure the seal cages are centered in the stuffing box at the entrance of the stuffing box piping connection.</p> <p>Check shaft or shaft sleeve for scoring. Scoring accelerates packing wear.</p> <p>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.</p>
Every Year	<p>Remove the rotating element. Inspect thoroughly for wear, and order replacement parts if necessary.</p> <p>Check wearing clearances.</p> <p>Remove any deposit or scaling. Clean out stuffing box piping.</p> <p>Measure total dynamic suction and discharge head as a test of pipe connection. Record the figures and compare them with the figures of the last 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 reflect also in poor performance of the pump while in operation.</p>



Xylem, Inc.
 2881 East Bayard Street Ext., Suite A
 Seneca Falls, NY 13148
 Phone: (800) 453-6777
 Fax: (888) 322-5877
www.xylem.com/gouldswatertechnology

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