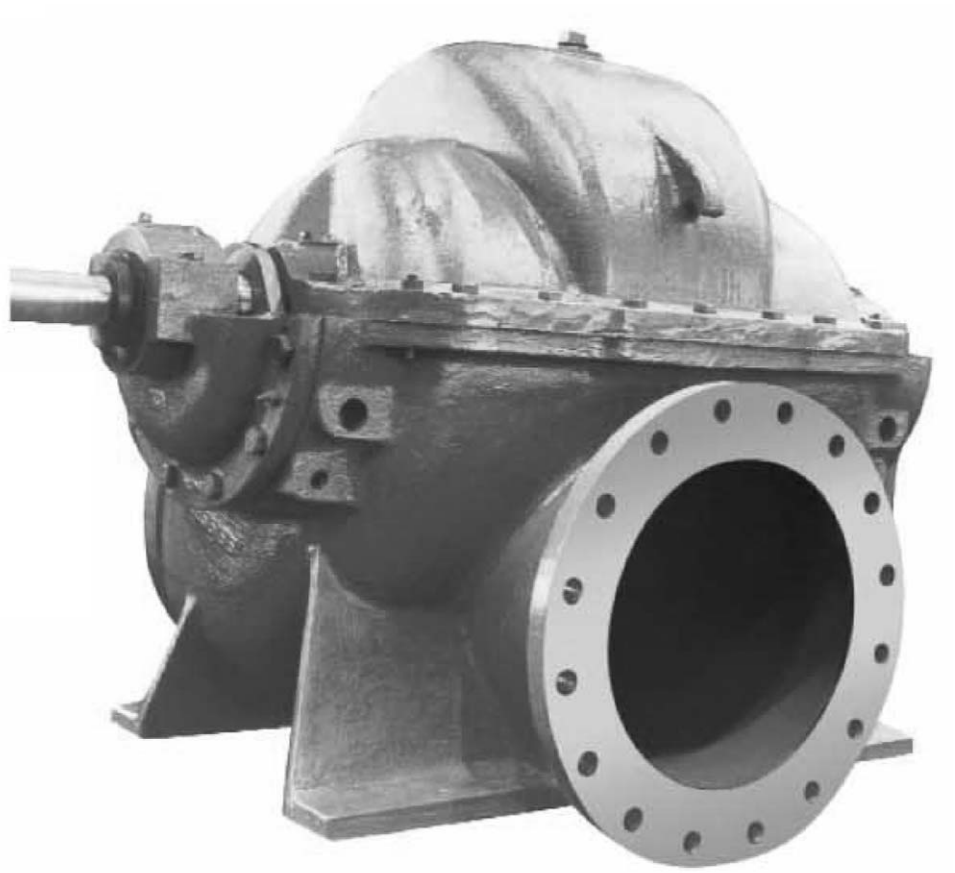
GOULDS PUMPS

Installation, Operation and Maintenance Instructions



Model 3498

Goulds Pumps

ITT Industries

FOREWORD

This manual provides instructions for the Installation, Operation, and Maintenance of the Goulds Pumps Model 3498, a double suction, horizontally split case pump. This manual covers the standard product plus common options that are available. For special options, supplemental instructions are supplied. **This manual must be read and understood before installation and maintenance.**

The design, materials, and workmanship incorporated in the construction of Goulds pumps make them capable of giving long, trouble-free service. The life and satisfactory service of any mechanical unit, however, is enhanced and extended by correct application, proper installation, periodic inspection, condition monitoring and careful maintenance. This instruction manual was prepared to assist operators in understanding the construction and the correct methods of installing, operating, and maintaining these pumps.

ITT Industries - Goulds Pumps shall not be liable for physical injury, damage or delays caused by a failure to observe the instructions for Installation, Operation, and Maintenance contained in this manual.

NOTE: When pumping unit is installed in a potentially explosive atmosphere, the instructions after the Ex symbol must be followed. Personal injury and/or equipment damage may occur if these instructions are not followed. If there is any question regarding these requirements or of the equipment is to be modified, please contact a Goulds representative before proceeding.

Warranty is valid only when genuine ITT Industries - Goulds Pumps parts are used.

Use of the equipment on a service other than stated in the order will nullify the warranty, unless written approval is obtained in advance from ITT Industries - Goulds Pumps.

Supervision by an authorized ITT Industries - Goulds Pumps representative is recommended to assure proper installation.

Additional manuals can be obtained by contacting your local ITT Industries - Goulds Pumps representative or by calling 1-(800)-446-8537.

THIS MANUAL EXPLAINS

- **Proper Installation**
- **Start-up Procedures**
- **Operation Procedures**
- **Routine Maintenance**
- **Pump Overhaul**
- **Troubleshooting**
- **Ordering Spare or Repair Parts**

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IMPORTANT SAFETY NOTICE

To: Our Valued Customers

User safety is a major focus in the design of our products. Following the precautions outlined in this manual will minimize your risk of injury.

ITT Goulds pumps will provide safe, trouble-free service when properly installed, maintained, and operated.

Safe installation, operation, and maintenance of ITT Goulds Pumps equipment are an essential end user responsibility. This *Pump Safety Manual* identifies specific safety risks that must be considered at all times during product life. Understanding and adhering to these safety warnings is mandatory to ensure personnel, property, and/or the environment will not be harmed. Adherence to these warnings alone, however, is not sufficient — it is anticipated that the end user will also comply with industry and corporate safety standards. Identifying and eliminating unsafe installation, operating and maintenance practices is the responsibility of all individuals involved in the installation, operation, and maintenance of industrial equipment.

Please take the time to review and understand the safe installation, operation, and maintenance guidelines outlined in this Pump Safety Manual and the Instruction, Operation, and Maintenance (IOM) manual. Current manuals are available at www.gouldspumps.com/literature_ioms.html or by contacting your nearest Goulds Pumps sales representative.

These manuals must be read and understood before installation and start-up.

For additional information, contact your nearest Goulds Pumps sales representative or visit our Web site at www.gouldspumps.com.

SAFETY WARNINGS

Specific to pumping equipment, significant risks bear reinforcement above and beyond normal safety precautions.

⚠ WARNING

A pump is a pressure vessel with rotating parts that can be hazardous. Any pressure vessel can explode, rupture, or discharge its contents if sufficiently over pressurized causing death, personal injury, property damage, and/or damage to the environment. All necessary measures must be taken to ensure over pressurization does not occur.

⚠ WARNING

Operation of any pumping system with a blocked suction and discharge must be avoided in all cases. Operation, even for a brief period under these conditions, can cause superheating of enclosed pumpage and result in a violent explosion. All necessary measures must be taken by the end user to ensure this condition is avoided.

⚠ WARNING

The pump may handle hazardous and/or toxic fluids. Care must be taken to identify the contents of the pump and eliminate the possibility of exposure, particularly if hazardous and/or toxic. Potential hazards include, but are not limited to, high temperature, flammable, acidic, caustic, explosive, and other risks.

⚠ WARNING

Pumping equipment Instruction, Operation, and Maintenance manuals clearly identify accepted methods for disassembling pumping units. These methods must be adhered to. Specifically, applying heat to impellers and/or impeller retaining devices to aid in their removal is strictly forbidden. Trapped liquid can rapidly expand and result in a violent explosion and injury.

ITT Goulds Pumps will not accept responsibility for physical injury, damage, or delays caused by a failure to observe the instructions for installation, operation, and maintenance contained in this Pump Safety Manual or the current IOM available at www.gouldspumps.com/literature.

SAFETY

DEFINITIONS

Throughout this manual the words **WARNING**, **CAUTION**, **ELECTRICAL, and ATEX** are used to indicate where special operator attention is required.

Observe all Cautions and Warnings highlighted in this Pump Safety Manual and the IOM provided with your equipment.

⚠ **WARNING**
Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

Example: Pump shall never be operated without coupling guard installed correctly.

⚠ **CAUTION**
Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

Example: Throttling flow from the suction side may cause cavitation and pump damage.

ELECTRICAL HAZARD

Indicates the possibility of electrical risks if directions are not followed.

Example: Lock out driver power to prevent electric shock, accidental start-up, and physical injury.

When installed in potentially explosive atmospheres, the instructions that follow the Ex symbol must be followed. Personal injury and/or equipment damage may occur if these instructions are not followed. If there is any question regarding these requirements or if the equipment is to be modified, please contact an ITT Goulds Pumps representative before proceeding.

Example: Improper impeller adjustment could cause contact between the rotating and stationary parts, resulting in a spark and heat generation.

GENERAL PRECAUTIONS

⚠ WARNING

A pump is a pressure vessel with rotating parts that can be hazardous. Hazardous fluids may be contained by the pump including high temperature, flammable, acidic, caustic, explosive, and other risks. Operators and maintenance personnel must realize this and follow safety measures. Personal injuries will result if procedures outlined in this manual are not followed. ITT Goulds Pumps will not accept responsibility for physical injury, damage or delays caused by a failure to observe the instructions in this manual and the IOM provided with your equipment.

General Precautions		
WARNING		NEVER APPLY HEAT TO REMOVE IMPELLER. It may explode due to trapped liquid.
WARNING		NEVER use heat to disassemble pump due to risk of explosion from tapped liquid.
WARNING		NEVER operate pump without coupling guard correctly installed.
WARNING		NEVER run pump below recommended minimum flow when dry, or without prime.
WARNING		ALWAYS lock out power to the driver before performing pump maintenance.
WARNING		NEVER operate pump without safety devices installed.
WARNING		NEVER operate pump with discharge valve closed.
WARNING		NEVER operate pump with suction valve closed.
WARNING		DO NOT change service application without approval of an authorized ITT Goulds Pumps representative.
WARNING		**Safety Apparel:** • Insulated work gloves when handling hot bearings or using bearing heater • Heavy work gloves when handling parts with sharp edges, especially impellers • Safety glasses (with side shields) for eye protection • Steel-toed shoes for foot protection when handling parts, heavy tools, etc. • Other personal protective equipment to protect against hazardous/toxic fluids
WARNING		**Receiving:** Assembled pumping units and their components are heavy. Failure to properly lift and support equipment can result in serious physical injury and/or equipment damage. Lift equipment only at specifically identified lifting points or as instructed in the current IOM. Current manuals are available at www.gouldspumps.com/literature_ioms.html or from your local ITT Goulds Pumps sales representative. Note: Lifting devices (eyebolts, slings, spreaders, etc.) must be rated, selected, and used for the entire load being lifted.
WARNING		**Alignment:** Shaft alignment procedures must be followed to prevent catastrophic failure of drive components or unintended contact of rotating parts. Follow coupling manufacturer's coupling installation and operation procedures.

General Precautions		
WARNING		Before beginning any alignment procedure, make sure driver power is locked out. Failure to lock out driver power will result in serious physical injury.
CAUTION		**Piping:** Never draw piping into place by forcing at the flanged connections of the pump. This may impose dangerous strains on the unit and cause misalignment between pump and driver. Pipe strain will adversely effect the operation of the pump resulting in physical injury and damage to the equipment.
WARNING		**Flanged Connections:** Use only fasteners of the proper size and material.
WARNING		Replace all corroded fasteners.
WARNING		Ensure all fasteners are properly tightened and there are no missing fasteners.
WARNING		**Startup and Operation:** When installing in a potentially explosive environment, please ensure that the motor is properly certified.
WARNING		Operating pump in reverse rotation may result in contact of metal parts, heat generation, and breach of containment.
WARNING		Lock out driver power to prevent accidental start-up and physical injury.
WARNING		The impeller clearance setting procedure must be followed. Improperly setting the clearance or not following any of the proper procedures can result in sparks, unexpected heat generation and equipment damage.
WARNING		If using a cartridge mechanical seal, the centering clips must be installed and set screws loosened prior to setting impeller clearance. Failure to do so could result in sparks, heat generation, and mechanical seal damage.
WARNING		The coupling used in an ATEX classified environment must be properly certified and must be constructed from a non-sparking material.
WARNING		Never operate a pump without coupling guard properly installed. Personal injury will occur if pump is run without coupling guard.
WARNING		Make sure to properly lubricate the bearings. Failure to do so may result in excess heat generation, sparks, and / or premature failure.
CAUTION		The mechanical seal used in an ATEX classified environment must be properly certified. Prior to start up, ensure all points of potential leakage of process fluid to the work environment are closed.
CAUTION		Never operate the pump without liquid supplied to mechanical seal. Running a mechanical seal dry, even for a few seconds, can cause seal damage and must be avoided. Physical injury can occur if mechanical seal fails.
WARNING		Never attempt to replace packing until the driver is properly locked out and the coupling spacer is removed.
WARNING		Dynamic seals are not allowed in an ATEX classified environment.
WARNING		DO NOT operate pump below minimum rated flows or with suction and/or discharge valve closed. These conditions may create an explosive hazard due to vaporization of pumpage and can quickly lead to pump failure and physical injury.

General Precautions		
WARNING		Ensure pump is isolated from system and pressure is relieved before disassembling pump, removing plugs, opening vent or drain valves, or disconnecting piping.
WARNING		**Shutdown, Disassembly, and Reassembly:** Pump components can be heavy. Proper methods of lifting must be employed to avoid physical injury and/or equipment damage. Steel toed shoes must be worn at all times.
WARNING		The pump may handle hazardous and/or toxic fluids. Observe proper decontamination procedures. Proper personal protective equipment should be worn. Precautions must be taken to prevent physical injury. Pumpage must be handled and disposed of in conformance with applicable environmental regulations.
WARNING		Operator must be aware of pumpage and safety precautions to prevent physical injury.
WARNING		Lock out driver power to prevent accidental startup and physical injury.
CAUTION		Allow all system and pump components to cool before handling them to prevent physical injury.
CAUTION		If pump is a Model NM3171, NM3196, 3198, 3298, V3298, SP3298, 4150, 4550, or 3107, there may be a risk of static electric discharge from plastic parts that are not properly grounded. If pumped fluid is non-conductive, pump should be drained and flushed with a conductive fluid under conditions that will not allow for a spark to be released to the atmosphere.
WARNING		Never apply heat to remove an impeller. The use of heat may cause an explosion due to trapped fluid, resulting in severe physical injury and property damage.
CAUTION		Wear heavy work gloves when handling impellers as sharp edges may cause physical injury.
CAUTION		Wear insulated gloves when using a bearing heater. Bearings will get hot and can cause physical injury.

ATEX CONSIDERATIONS and INTENDED USE

Special care must be taken in potentially explosive environments to ensure that the equipment is properly maintained. This includes but is not limited to:

1. Monitoring the pump frame and liquid end temperature.
2. Maintaining proper bearing lubrication.
3. Ensuring that the pump is operated in the intended hydraulic range.

The ATEX conformance is only applicable when the pump unit is operated within its intended use. Operating, installing or maintaining the pump unit in any way that is not covered in the Instruction, Operation, and Maintenance manual (IOM) can cause serious personal injury or damage to the equipment. This includes any modification to the equipment or use of parts not provided by ITT Goulds Pumps. If there is any question regarding the intended use of the equipment, please contact an ITT Goulds representative before proceeding. Current IOMs are available at www.gouldspumps.com/literature_ioms.html or from your local ITT Goulds Pumps Sales representative.

All pumping unit (pump, seal, coupling, motor and pump accessories) certified for use in an ATEX classified environment, are identified by an ATEX tag secured to the pump or the baseplate on which it is mounted. A typical tag would look like this:

The CE and the Ex designate the ATEX compliance. The code directly below these symbols reads as follows:

II = Group 2
2 = Category 2
G/D = Gas and Dust present
T4 = Temperature class, can be T1 to T6 (see Table 1)

Table 1

Code	Max permissible surface temperature °F (°C)	Max permissible liquid temperature °F (°C)
T1	842 (450)	700 (372)
T2	572 (300)	530 (277)
T3	392 (200)	350 (177)
T4	275 (135)	235 (113)
T5	212 (100)	Option not available
T6	185 (85)	Option not available

The code classification marked on the equipment must be in accordance with the specified area where the equipment will be installed. If it is not, do not operate the equipment and contact your ITT Goulds Pumps sales representative before proceeding.

PARTS

The use of genuine Goulds parts will provide the safest and most reliable operation of your pump. ITT Goulds Pumps ISO certification and quality control procedures ensure the parts are manufactured to the highest quality and safety levels.

Please contact your local Goulds representative for details on genuine Goulds parts.

GENERAL INFORMATION

PUMP DESCRIPTION

This product line consists of 64 sizes of double suction, horizontally split case pumps from size 12x16-28 through size 66x70-60.

Casing - The casing is close-grained Cast Iron or Ductile Iron, and is of axially-split double-volute design with suction and discharge flanges and mounting feet cast integral with the lower half casing. Tapped and plugged holes are provided for priming, vent, drain and gauge connections. Upper half casing is removable without disturbing suction or discharge piping. Flanges are of (125/125#) (125/250#) (250/250#) ASA Standard. Suction and Discharge are on a common centerline in both the horizontal and vertical planes.

Impeller - The impeller is of the enclosed double-suction type made of (bronze) (cast iron) (316 stainless steel) and statically and hydraulically balanced. The impeller is keyed to the shaft and positioned axially by the shaft sleeves. Hub has sufficient metal thickness to allow machining for installation of impeller rings.

Shaft - The shaft is made of (AISI 4140, 316 stainless steel, 17-4 ph) and of ample size to operate under load with a minimum of deflection.

Shaft Sleeves - The shaft sleeves are made of (bronze) (420 hardened stainless steel) **[packing only]** (316 stainless steel)(cast iron) and will protect the shaft from wear and from contact with the pumped liquid. An O-ring is furnished under sleeve to prevent leakage.

Stuffing Box - The stuffing box consists of at least six (6) rings of die formed, graphite, acrylic yarn packing and a split type gland to permit removal and access to packing. Ample space is provided for repacking the stuffing box. Arrangement provides for field or factory conversion to mechanical seals without machine work.

Casing Rings - The casing rings are made of (bronze) (cast iron) (316 stainless steel) and are installed with an anti-rotation device.

Bearings - The bearings are grease lubricated or oil lubricated. The inboard or coupling end bearing is either a single or double row anti-friction bearing. The outboard bearing is a double row anti-friction bearing which is retained by bearing locknut and lockwasher.

Bearing Housings - The bearing housings are bolted and doweled to the end of the lower half casing and will assure positive alignment of the rotating element. The housings provide a fit for the inboard bearing that allows freedom for thermal expansion while the outboard bearing is clamped in place to take all thrust loads and keep the rotating element in its proper axial location.

Baseplate - The baseplate is sufficiently rigid to support the pump and driver and is steel with a drip pan beneath the pump end. The drip pan contains a tapped drain connection.

Coupling - Coupling is an all metal type.

The coupling used in an ATEX classified environment must be properly certified.

Coupling Guard - The coupling guard shall be all metal.

The coupling guard used in an ATEX classified environment must be constructed from a non-sparking material.

Rotation - Pump has a clockwise or counterclockwise rotation when viewed from its driven end.

NAMEPLATE INFORMATION

Every pump has a Goulds Pumps nameplate that provides information about the pump. The nameplate is located on the pump casing.

Special tags which provide additional information (mechanical seal data, etc.) and special tagging required by customers are located on the pump casing or on the bearing frame.

The standard nameplate (Fig. 1) provides information about the pump size, type, serial number, rated head, capacity, speed, impeller diameter, model number, and maximum field hydrostatic test pressure.

The Identification No. is a number which the end user of the pump requests to be put on the nameplate to identify the pump in his operation.

The year indicates the year in which the pump was built.

Rating and hydrostatic test pressure are expressed in English units. Note the format of pump size: Discharge x Suction - Nominal Impeller Diameter in inches, for example, 24x24-26.

The frame plate provides information concerning the bearings and their lubrication. The inboard and outboard bearing numbers refer to the bearing manufacturer's numbers.

When ordering spare parts you will need to identify pump model, size, serial number, and the catalog number of required parts. Pump information can be taken from the Goulds Pumps nameplate. Catalog numbers can be found in this manual.

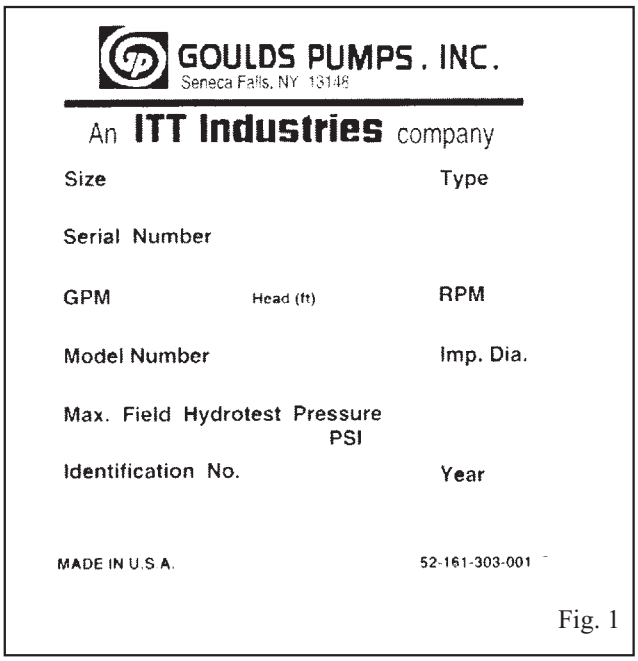

Fig. 1

If applicable, your pump unit may have the following ATEX tag affixed to the pump and/or baseplate. See the *Safety* section for a description of the symbols and codes.

INSTALLATION

RECEIVING THE PUMP

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

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. Goulds Pumps has determined that proper and correct alignment can only be made by accepted erection practices. Refer to the following paragraphs on "Foundation," "Baseplate Setting," "Grouting Procedure," "Alignment Procedure," and "Doweling."

LIFTING THE PUMP

The following instructions are for the safe lifting of your pump.

The unit should be unloaded and handled by lifting equally at four or more points on the baseplate. The lugs on the upper half casing are designed for lifting the upper half casing only.

HORIZONTAL

Bare Pump

1. Using a nylon sling, chain, or wire rope, hitch around both bearing housings. (See Fig. 2)

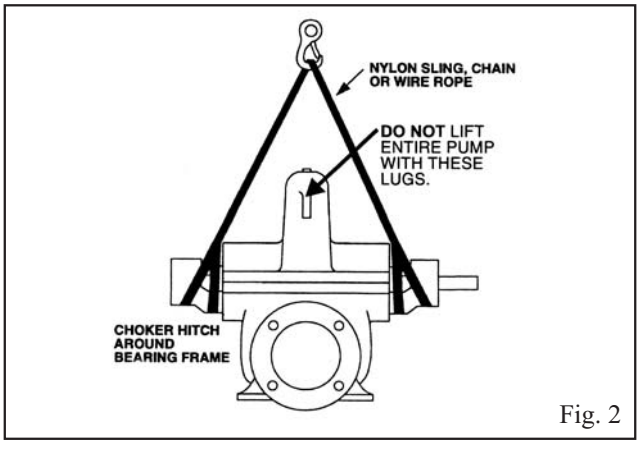

Fig. 2

Pump, Base, And Driver

2. Care must be taken to size equipment for unbalanced loads which may exist if the driver is not mounted on the base at the time of lifting. Driver may or may not be mounted at the factory.

3. Pump, base, and driver assemblies where the base length exceeds 100 inches may not be safe to lift as a complete assembly. Damage to the baseplate may occur. If the driver has been mounted on the baseplate at the factory, it is safe to lift the entire assembly. If driver has not been mounted at the factory and the overall baseplate length exceeds 100 inches, do not lift entire assembly consisting of pump, base, and driver. Instead, lift the pump and baseplate to its final location without the driver. Then mount the driver.

Bases supplied with lifting holes

Large bases are supplied with lifting holes in the sides or the ends of the base. (See Fig. 3)

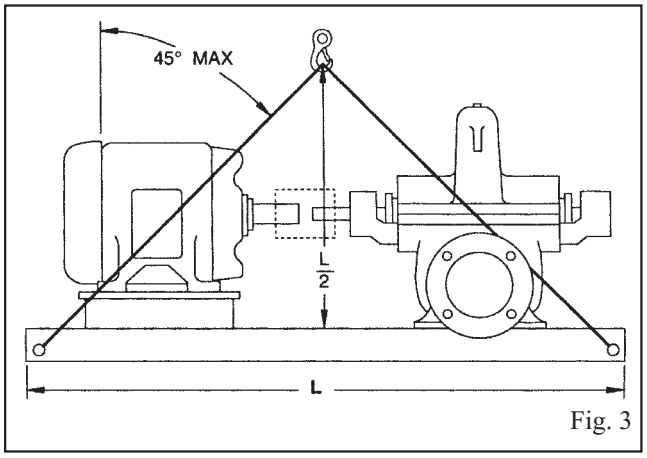

Fig. 3

Using ANSI/OSHA Standard "S" hooks, place the "S" hooks in the holes provided in the four corners of the base. Be sure the points of the hooks do not touch the bottom of the pump base. Attach nylon slings, chains, or wire rope to the "S" hooks. Size the equipment for the load so the lift angle will be less than 45° from the vertical.

Bases supplied without lifting holes

Place one sling around the outboard bearing housing.

⚠ WARNING

Do not use lugs on top half of casing.

Place the remaining sling around the back end of the driver as close to the mounting feet as possible. Make certain sling will not damage housing cover or conduit boxes.

Join the free ends of the slings together and place over the lifting hook. Use extreme care when positioning sling under the driver so it cannot slip off (See Fig. 4).

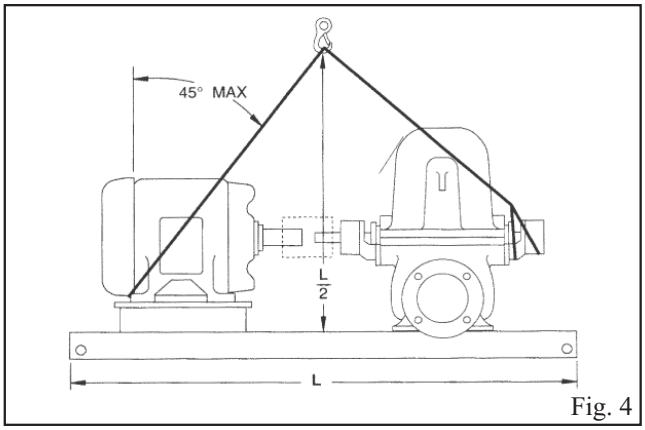

Fig. 4

VERTICAL

Half Pedestal

1. Place nylon sling chain or wire rope around both flanges. Use a latch hook or standard shackle and end loops.

   Be sure the lifting equipment is of sufficient length to keep the lift angle less than 30° from the vertical (See Fig. 5).

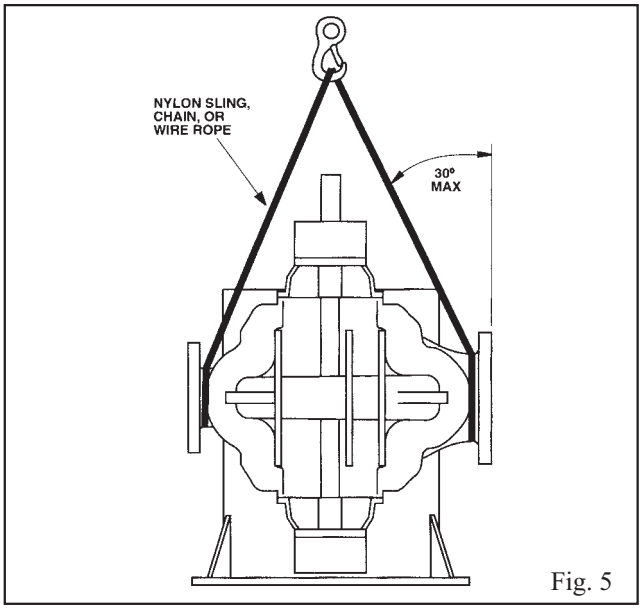

Fig. 5

Full Pedestal

2. Install eye bolts in the three holes provided at the top of the support, being sure to tighten securely. Attach chain or wire rope using latch hook or standard shackle and end loop.

   Be sure to use shoulder eye bolts that are manufactured per ANSI B18.15 and sized to fit the holes provided.

   Be sure lifting equipment is of sufficient length to keep the lift angle less than 30° from the vertical (See Fig. 6).

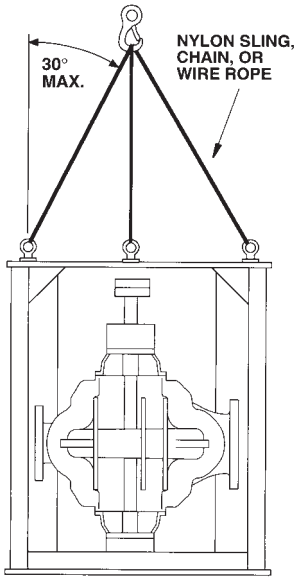

Fig. 6

STORAGE REQUIREMENTS

Consider a Unit in Storage When:

1. It has been delivered to the job site and is awaiting installation.
2. It has been installed, but operation is delayed pending completion of planned construction.
3. There are long period (30 days) between operation cycles.
4. The plant or department is shut down.

TEMPORARY STORAGE OF EQUIPMENT

This procedure applies to horizontal and vertical pumps only for storage of one month or less. For longer periods, refer to LONG TERM STORAGE OF EQUIPMENT. Accessories such as motors, steam turbines, gears, etc., must be handled in accordance with the respective manufacturer's recommendations.

Oil Lube Frames

Storage requirements vary depending on length of storage and the climatic environment.

If the equipment is not to be installed and operated soon after arrival, store in a clean, dry, well ventilated place, free from vibration and rapid or wide variations in temperatures.

On all rotating equipment, rotate the shaft several revolutions every week to coat the bearings with lubricant, retard oxidation or corrosion, and prevent possible brinelling. Shaft extensions and other exposed machine surfaces should be coated with an easily removable rust preventative such as Tectyl No. 502C, Valvoline Oil Company, Division of Ashland Petroleum Company.

NOTE: Oil lubricated pumps are shipped without lubricant. Fill the frame completely with oil for storage. Before putting equipment into operation, drain the oil to proper level.

Grease Lube Frames

Storage requirements vary depending on length of storage and the climatic environment.

If the equipment is not to be installed and operated soon after arrival, store in a clean, dry, well ventilated place, free from vibration and rapid or wide variations in temperatures.

On all rotating equipment, rotate the shaft several revolutions every week to coat the bearings with lubricant, retard oxidation or corrosion, and prevent possible brinelling. Shaft extensions and other exposed machine surfaces should be coated with an easily removable rust preventative such as Tectyl No. 502C, Valvoline Oil Company, Division of Ashland Petroleum Company.

LONG TERM STORAGE OF EQUIPMENT

The following procedure applies to horizontal and vertical pumps only for storage of one month or longer. Accessories such as motors, steam turbines, gears, etc. must be handled in accordance with the respective manufacturer's recommendations.

Follow the same procedure for temporary storage in addition to the following:

Bearing Frames

Oil Lubrication

Pumps with oil lubrication are shipped from the factory without oil in the bearing frame. To prepare these frames for storage:

1. Fill the bearing frame full with a lubricating oil containing a rust preventative such as Mobilarma 500 Series oil. If this oil is to be used for initial operation of the equipment, care should be taken to select an oil suited to the intended operating temperature of the pump. Check the supplier's technical data and the pump instruction book for this information.
2. Seal all vents and apply a waterproof tape around the oil seals in the bearing frames.

CAUTION

Prior to using, drain all oil from the frame in case any moisture has accumulated. Then refill to proper level using the correct oil specified in the instruction book.

Grease Lubrication

Pumps are shipped from the factory with the bearings pre-greased and should require no further lubrication.

It is recommended, however, that if the pumps are to be stored in a humid environment or outside, add ½ ounce of corrosion inhibiting concentrated oil such as Cortec's VCI-329 to the frame. Seal all vents and apply a waterproof tape around the grease seals in the bearing frame.

Stuffing Box

Packing

Remove gland, lantern ring, packing base ring (if applicable), and packing from stuffing box. If the packing is in good condition, it may be saved; otherwise, it should be discarded. Thoroughly clean and dry interior of the stuffing box and shaft sleeve. Coat all interior parts of the stuffing box, except for stainless materials with a soft film rust preventative such as Valvoline Tectyl 502C or Cortec's VCI-369.

Seal end of stuffing box with waterproof tape.

NOTE: This tape will have to be removed and replaced when the shaft is rotated.

Store gland, packing base ring, packing and lantern ring until pump is ready to be put into service.

Mechanical Seal

Double Face Seal

Open uppermost flushing tap on stuffing box and fill cavity with a lightweight (#10-#20) rust preventative oil such as Mobilarma 500.

Single Face Seal

Remove flushing water plug to stuffing box and spray an oil base volatile corrosion inhibitor such as Cortec's VCI-329 into the stuffing box cavity. Be sure to coat as much of the interior of the cavity as possible.

The above procedures are not required if the seal box is of a stainless material.

For both types of mechanical seals, regardless of material, seal all vent and drain lines. Seal the point where the shaft exits the box using waterproof tape.

NOTE: This tape will have to be removed and replaced when the shaft is rotated.

NOTE: The majority of mechanical seals provided have elastomer materials made of Buna-N, Neoprene, or Viton™ which are not affected by hydrocarbon based lubricants. If your pump has seals with materials other than the above, it will be necessary to check the compatibility of that material with the manufacturer of the rust preventative used.

Final Preparation – Pumps of Non-Stainless Material

Coat all exposed machined surfaces (flanges, faces, shafts, exposed locating fits, etc.) with a firm rust preventative such as Valvoline Tectyl 890. Place a volatile corrosion inhibitor device in the pump casing such as Cortec's VCI 309, 101, or 110, depending on the pump size and application.

WARNING

For potable water, food, beverage, etc., pumps, the corrosion inhibitor must be non-toxic. FAILURE TO FOLLOW INSTRUCTIONS COULD RESULT IN INJURY OR DEATH.

Regardless of material, cement rubber diaphragm flange covers over the suction and discharge flanges. Protect these rubber diaphragm covers with hardboard material. Make sure all vents, drains, or plugs are tightly sealed.

The pump is now ready to be placed in storage.

NOTE: Storage locations that are near a source of vibration such as railroad or truck traffic, heavy machinery, or impacting machinery must be avoided to prevent false brinelling of the pump bearings.

Indoor Storage

Little extra preparation is needed if indoor storage area is dry and clean. Care should be taken to prevent extremes in temperature (below 32°F and above 110°F). Also, keep the pump out of direct sunlight and covered to protect it from dust and dirt. Care should be taken to prevent moisture build-up around the pump, either by allowing proper ventilation or tightly sealing the pump in the cover with a suitable amount of desiccant to ensure dryness.

If indoor storage area is humid or dirty, such as an unfinished building, treat the pump as if it were to be stored outdoors.

Outdoor Storage

Pump should be covered to protect it from weather and direct sunlight. All coverings should be properly secured to withstand high wind. Care must be exercised in covering pumps to prevent moisture build-up under the cover. This can be done either by allowing proper ventilation or tightly sealing cover with suitable amount of desiccant to ensure dryness.

Extreme heat and cold are to be avoided, as rubber parts and seals could age prematurely (below 32°F and above 110°F).

Installed but Not in Service

Preparation for storage under these conditions is the same as for indoor and outdoor, except the suction and discharge piping will serve as flange covers.

The suction and discharge valves must be tightly closed and all water removed from the pump and attached piping. The Interior of the pump and piping must be thoroughly dried.

Preparation procedures should be repeated every 12 months.

Maintenance

Indoor

The only maintenance required will be to rotate the pump shaft 10-15 times twice a month. This operation is to recoat the bearings with grease or oil and to prevent false brinelling. Be sure the shaft comes to rest in different positions.

Outdoor

Storage area should be inspected weekly, and after storms, for damage to protective covers. Shafts should be rotated 10-15 turns three times a month.

Preparation procedure should be repeated every six months for normal environments, and every two months for corrosive environments (such as salt air).

Installed, But Not In Service

Follow same procedures as for indoor storage, except inspect the casing area once a month for moisture build-up, replacing volatile corrosion inhibitor at that time.

Preparation for Operation

1. Remove all rust inhibitor from exposed machined surfaces using the method described by the supplier.
2. Remove all corrosion protection devices or material from pump casing.
3. If the pump has packing, repack pump using the method described in the instruction book.
4. If the pump has mechanical seals, drain protective oil from seal cavity. Flush cavity with clean water or seal lubricant for five minutes before start-up.
5. Remove flange covers, tape, and all unnecessary pipe plugs.
6. Oil lubricated frames.

   Drain rust preventative oil from frames and replace with fresh oil. Note some rust preventative oils such as the Mobilarma 500 can be used in the bearing frame for start-up and initial running. Check the supplier's technical data and the pump instruction book to ensure the oil used is of suitable viscosity and grade for the intended application. If this is the case, drain the oil from the bearing frame to the level indicated on the sight gauge. When the oil used to protect the bearing

   frame is used to run the pump on start-up, this oil should be changed initially at half the recommended time for oil changes (see instruction manual). Remove tape from breather and seals.
7. Grease lubricated frames.

   No special methods are required to prepare for start-up. The corrosion inhibitor oil can be left in the frame. Remove tape from breather and seals.

   If the pumps are started with the factory supplied grease, it is recommended that they be re-greased initially at half the recommended grease interval.

Manufacturers of Recommended Products:

1. The Cortec Corporation
   310 Chester Street
   St. Paul, MN 55107

2. Valvoline Oil Company
   Division of Ashland Petroleum Company
   Contact Local Sales Officer or Ashland, Kentucky

3. Mobil Oil Corporation
   Contact Local Sales Office

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.

Pumps must be fully primed at all times during operation.

When installing the pump, consider its location in relation to the system to assure that sufficient Net Positive Suction Head (NPSHA) is available at the pump inlet connection. Available NPSH must always equal or exceed the required NPSH (NPSHR) 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, the electrical characteristics of the power source should be identical to those shown on motor data plate.

FOUNDATION

It is of prime importance to provide a foundation permanent and rigid enough to absorb any vibration and maintain the true alignment of a direct connected unit. (*Hydraulic Institute Standards* recommends the foundation weigh at least five [5] times the weight of the pump unit.) Usually a concrete foundation on a solid base with embedded foundation bolts of the proper size located with the aid of general arrangement drawings is quite satisfactory.

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 3/4 to 1-1/2 inches of the finished height as shown in Fig. 7. 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 Fig. 7. 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.

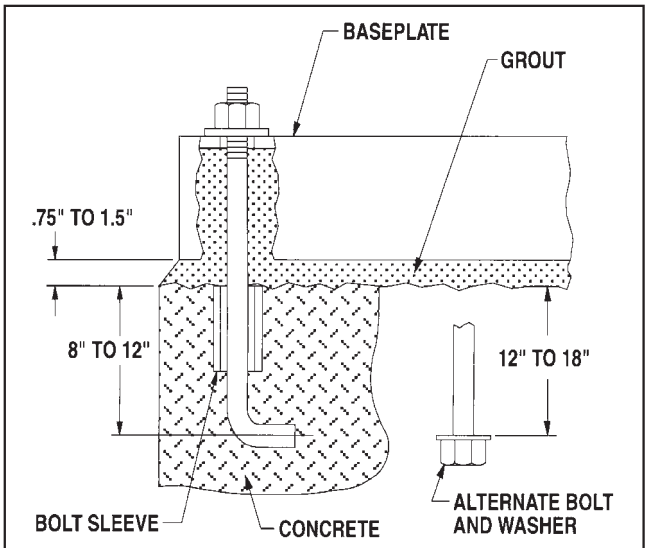

Fig. 7

SETTING THE BASEPLATE (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 Pumps 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.
2. By adding or removing shims under the base, level and plumb the pump shaft and flanges. The baseplate 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. Final alignment procedures are covered under "Alignment Procedure."

GROUTING PROCEDURE

Grout compensates for uneven foundation, distributes weight of unit, and prevents shifting. Use an approved, non-shrinking grout (such as Embeco 636 by Master Builders, Cleveland, Ohio or equivalent), as follows, after setting and leveling unit. (See Fig. 8).

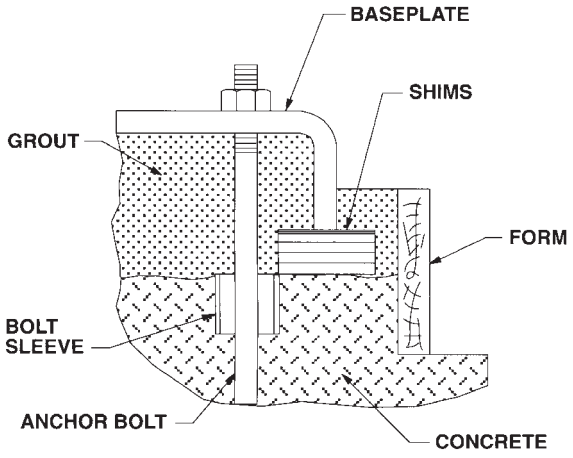

Fig. 8

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.
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.

ALIGNMENT PROCEDURE

Alignment procedures must be followed to prevent unintended contact of rotating parts. Follow coupling manufacturer's installation and operation procedures.

Proper rough alignment must be made during unit setting and grouting. See previous section.

There are two forms of misalignment between the pump shaft and the driver shaft as follows:

1. **Angular misalignment** — shafts have axis concentric at intersection, but not parallel.
2. **Parallel offset misalignment** — shafts have axis parallel, but offset.

The necessary tools for checking alignment are: (1) a straight edge and a taper gauge or set of feeler gauges or, (2) a dial indicator with mounting magnet and extension bars.

Check and correct for angular misalignment before correcting parallel alignment. Final alignment should be made by moving and shimming the motor on its base until the coupling hubs are within the recommended tolerances measured in total run out. All measurements should be taken with the pump and driver bolts tightened. Final alignment check should be made after the unit has attained its final operating temperature.

Method 1 - Using straight edge and taper gauges or feelers (Fig. 9):

Proceed with this method only if satisfied that face and outside diameters of the coupling halves are square and concentric with the coupling bores. If this condition does not exist or elastomeric couplings do not make this method convenient, use Method 2.

Check for angular alignment by inserting the taper or feeler gauges between the coupling faces at 90° intervals. The unit is in angular alignment when these four (4) measurements are the same, or within recommended tolerances.

Check for parallel alignment by placing a straight edge across both coupling rims on all four sides. The unit is in parallel alignment when the straight edge rests evenly across both coupling rims in all four (4) positions.

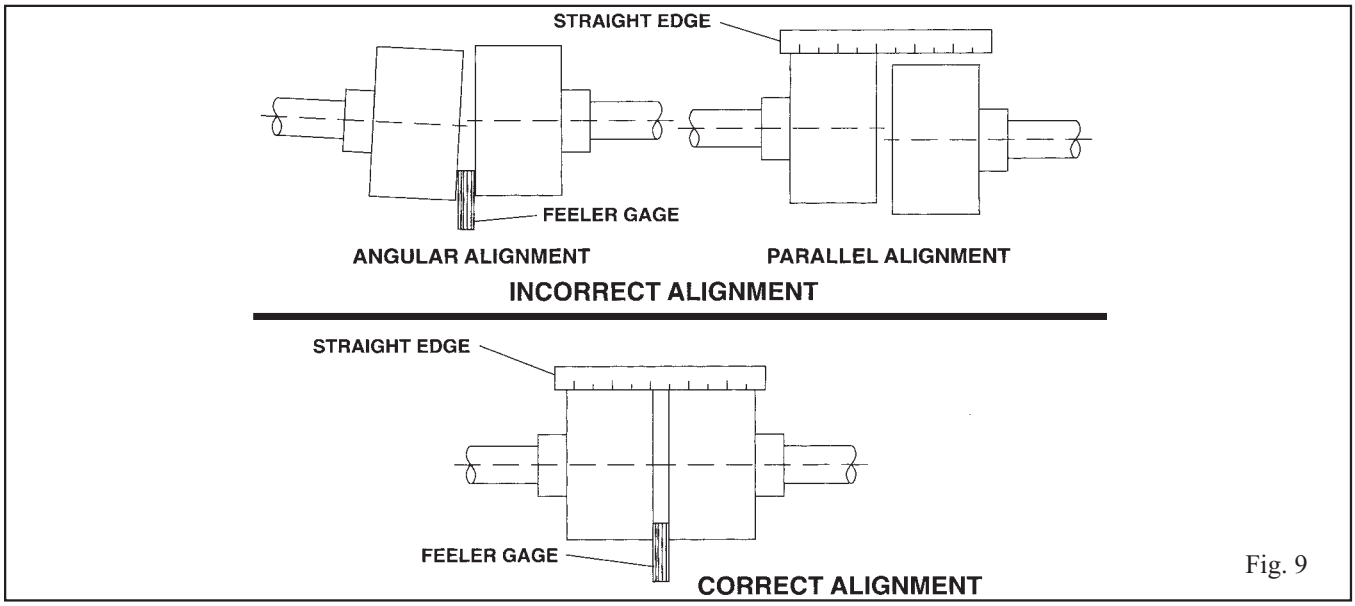

Fig. 9

Method 2 - Dial Indicators (Fig. 10):

A dial indicator can be used to attain more accurate alignment.

Fasten the indicator stand or magnetic base to the pump half of the coupling and adjust the assembly until the indicator button is resting on the other half coupling periphery.

Set the dial to zero and chalk mark the coupling half where the button rests. Also place a separator between the coupling halves so bearing slack does not affect the readings. (Chalk and separators are not necessary on the elastomeric couplings that have not been disconnected.) Rotate both shafts by the same amount; i.e., all readings must be made with the button on the chalk mark.

The dial readings will indicate whether the driver has to be raised, lowered or moved to either side. Accurate alignment of shaft centers can be obtained with this method even where faces or outside diameters of the coupling are not square or concentric with the bores. After each adjustment, recheck both parallel and angular alignments.

Permissible coupling misalignment should be per the coupling manufacturer's recommendation.

NOTE: Gross deviations in squareness or concentricity may cause rotation unbalance problems and if so must be corrected.

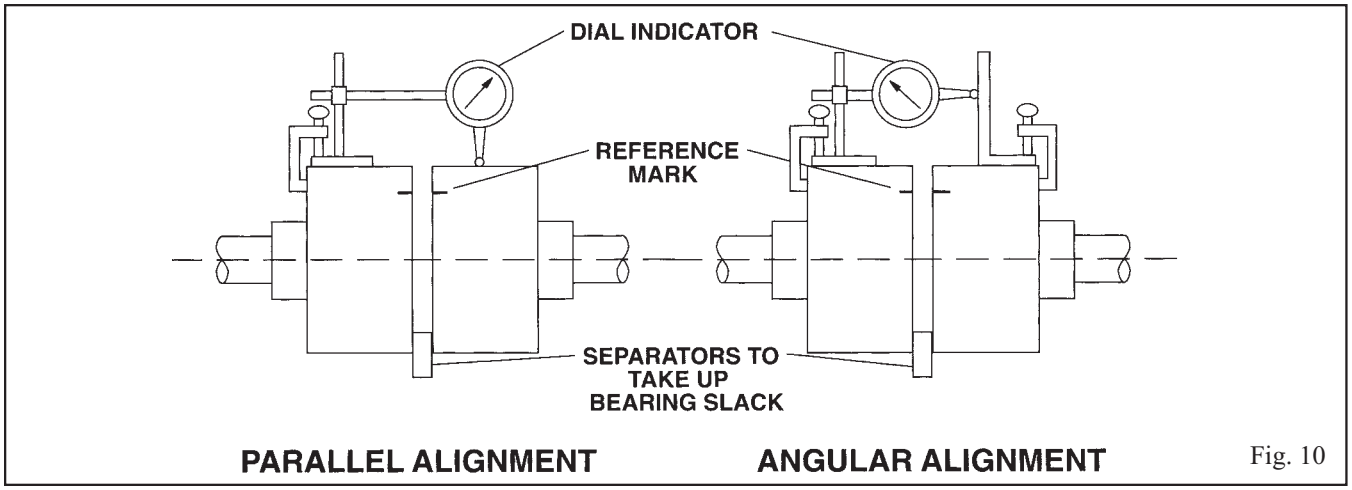

Fig. 10

DOWELING

Pump units may, if desired, (or required in specification) be doweled on diagonally opposite feet. This should not be done until the unit has been run for a sufficient length of time and alignment is within the above alignment tolerance.

SUCTION AND DISCHARGE PIPING

Flange loads from the piping system, including those from thermal expansion of the piping, must not exceed the limits of the pump. Casing deformation can result in contact with rotating parts which can result in excess heat generation, sparks and premature failure.

The introduction of pumpage into a piping system which is not well designed or adjusted may cause strain on the pump, leading to misalignment or even impeller rubbing. Since slight strain may go unnoticed, final alignment should be done with the system full and up to final temperature.

Pipe flanges should not impose any strain on the pump. This can be checked by a dial indicator. Any strain must be corrected by adjustments in the piping system.

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

Piping should always be run to the pump.

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

Both the suction and discharge piping should be independently anchored 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 and spacer sleeves 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. When using rubber expansion joints, follow the recommendations of the *Technical Handbook on Rubber Expansion Joints and Flexible Pipe Connectors.* 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° or long radius 90° fittings 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.

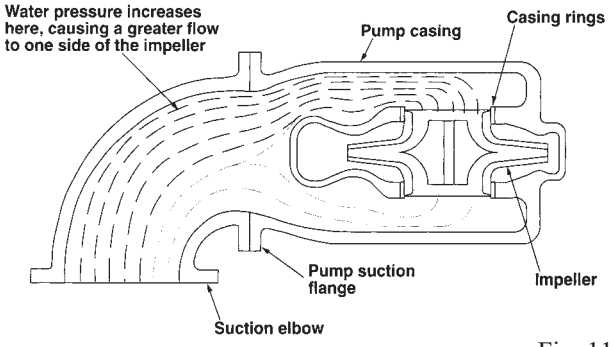

Fig. 11

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 Fig. 12)

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. A minimum of five (5) pipe diameters between any elbow or tee and the pump should be allowed. If a long suction pipe is required, it should be one or two sizes larger than the suction opening, depending on its length.

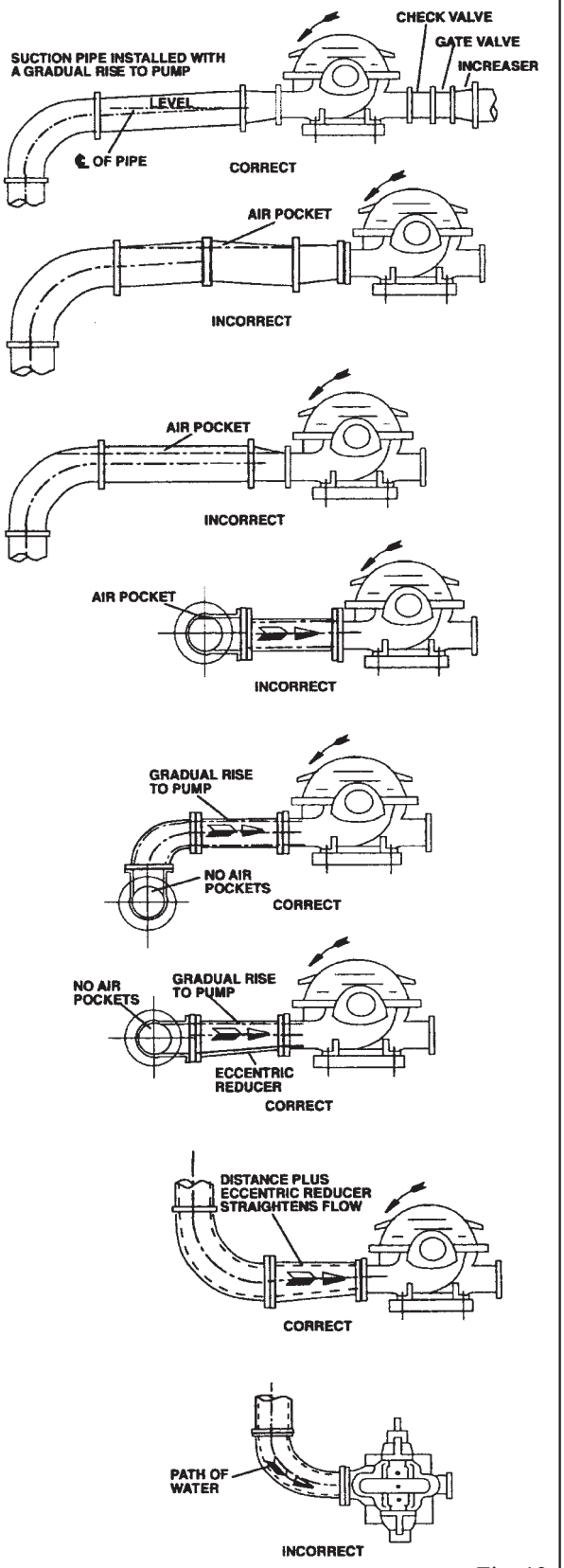

Fig. 12

CAUTION

An elbow should not be used directly before the suction of a double suction pump if its plane is parallel to the pump shaft. This can cause an excessive axial load or NPSH problems in the pump due to an uneven flow distribution (See Fig. 11). If there is no other choice, the elbow should have straightening vanes to help evenly distribute the flow.

Eccentric reducers should be limited to one pipe size reduction each to avoid excessive turbulence and noise. They should be of the conical type. Contour reducers are not recommended.

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 can become filled with air and 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 concentric reducer in a horizontal suction line, as it tends to form an air pocket in the top of the reducer and the pipe.

Fig. 12 shows some correct and incorrect suction piping arrangements.

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 *Discharge Piping*.)
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.

CAUTION

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, the 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.

A check valve and an isolating gate valve should be installed in the discharge line. 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 provided. 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 LUBRICATION

Contaminants in the pumped liquid must not enter the stuffing box. These contaminants may cause severe abrasion or corrosion of the shaft, or shaft sleeve, and rapid packing or mechanical seal 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 or seal. The most important consideration is to establish the optimum flushing pressure that will keep contaminants from the stuffing box cavity. If this pressure is too low, fluid being pumped may enter the stuffing box. If the pressure is too high, excessive packing or seal wear may result; and extreme heat may develop in the shaft causing higher bearing temperatures. The most desirable condition, therefore, is to use a seal water pressure 15-20 psig above the maximum stuffing box pressure.

If the pump system pressure conditions vary, packing adjustment becomes difficult. Consideration should be given to using a mechanical seal (See *Mechanical Seals)*.

PACKING

Packed stuffing boxes are not allowed in an ATEX classified environment.

Pumps are normally shipped with the packing set loose. 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 in the* Preventive Maintenance *section of this manual

On some applications, it is possible to use internal liquid lubrication (pumped liquid) to lubricate packing. Only when all of the conditions prevail, can this be done:

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. Lubrication (pumped liquid) has lubricating qualities.
5. Liquid is non-toxic and non-volatile.

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 any of the above conditions cannot be met.

The standard stuffing box consists of six (6) rings of packing and a split type gland. A shaft sleeve which extends through the box and under the gland is 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.

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 approximately 0.5-1.0 GPM at a pressure approximately 15 to 20 psig above the suction pressure. (Approximately one [1] drop per second).

One recommended method to minimize error in regulating flushing water is a “Controlled Pressure System” (Fig. 13). 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.

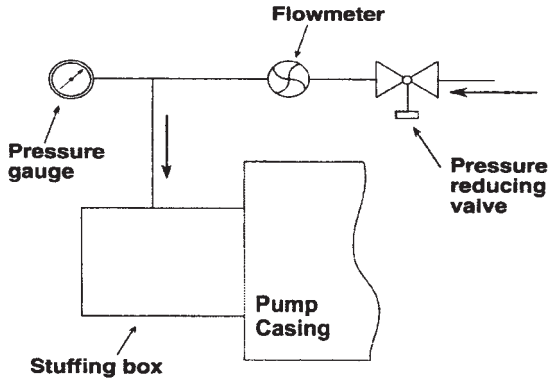

Fig. 13

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.

MECHANICAL SEALS

The mechanical seal used in an ATEX classified environment must be properly certified.

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 parts may be ordered from your Goulds Pumps Sales Representative.

Just as with packing, the mechanical seal chamber must be supplied, at all times, with a source of clean, clear liquid to flush and lubricate the seal. The most important consideration is to establish the optimum flushing pressure that will keep contaminants from the seal cavity. If this pressure is too low, fluid being pumped may enter the stuffing box. If the pressure is too high, excessive seal wear may result.

When contaminants are present in the pumpage, an external source of clean seal water must be supplied. Supply approximately 0.5 - 1.0 GPM at a pressure approximately 15 to 20 psig above the suction pressure.

Fig. 13 shows the recommended "Controlled Pressure System" for a mechanical seal. Seal water enters the seal chamber, lubricates the seal face, and exits into the pump itself. Positive flow in the seal water line indicates adequate seal water pressure.

CARTRIDGE SEALS

Follow the appropriate lubrication directions for mechanical seals given in this section. Most cartridge seals provide flushing connections on their glands. use the cartridge seal gland flushing taps (if provided) for your seal water connections instead of the stuffing box tap. The quench taps on the glands (if present) are normally only used in chemical applications. Consult seal manufacturer's literature for more detailed information.

The mechanical seal must have an appropriate seal flush system. Failure to do so will result in excess heat generation and seal failure.

CYCLONE SEPARATOR

If the fluid being pumped contains sediment and there is no external, clean water source available to flush the packing or mechanical seals, a cyclone separator can be used to remove most of the sediment from the liquid being pumped so it can be used to flush the seals. The separator is placed in the seal water piping line and removes the sediment to an external drain (normally back to the pump suction line).

OPERATION

PRE-START CHECKS

When installing in a potentially explosive environment, ensure that the motor is properly certified.

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

1. Check alignment between pump and driver. See the section on alignment for alignment requirements.

All equipment being installed must be properly grounded to prevent unexpected static electric discharge.

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

Rotate shaft by hand to ensure it rotates smoothly and there is no rubbing which could lead to excess heat generation and sparks.

5. Check stuffing box adjustment, lubrication, and piping.
6. Check driver lubrication.

Bearings must be lubricated properly in order to prevent excess heat generation, sparks, and premature failure.

7. Assure that pump bearings are properly lubricated.
8. Assure that coupling is properly lubricated, if required.
9. Assure that pump is full of liquid and all valves are properly set and operational, with the discharge valve and the suction valve open. Purge all air from top of casing.
10. 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.

Cooling systems such as those for bearing lubrication, mechanical seal systems, etc, where provided, must be operating properly to prevent excess heat generation, sparks, and premature failure.

Check for magnetism on the pump shaft and degauss the shaft if there is any detectable magnetism. Magnetism will attract ferritic objects to the impeller, seal and bearings which can result in excess heat generation, sparks, and premature failure.

Leakage of process liquid may result in creating an explosive atmosphere. Ensure the materials of the pump casing, impeller, shaft, sleeves, gaskets, and seals are compatible with the process liquid.

Leakage of process liquid may result in creating an explosive atmosphere. Follow all pump and seal assembly procedures.

A build-up of gases within the pump, sealing system and/or process piping system may result in an explosive environment within the pump or process piping system. Ensure process piping system, pump, and sealing system are properly vented prior to operation.

Sealing systems that are not self purging or self venting, such as plan 23, require manual venting prior to operations. Failure to do so will result in excess heat generation and seal failure.

PRIMING

If the pump is installed with a positive head on the suction, it can be primed by opening the suction valve, and loosening the vent plug on the top of the casing (Do not remove), allowing air to be purged from 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.

Ensure that pump and systems are free of foreign objects before operating and that objects cannot enter the pump during operation. Foreign objects in the pumpage or piping system can cause blockage of flow which can result in excess heat generation, sparks, and premature failure.

FLUSHING

New and old systems should be flushed to eliminate all foreign matter. Heavy scale, welding splatter and wire or other large foreign matter can clog the pump impeller. This will reduce the capacity of the pump causing cavitation, excessive vibration, and/or damage to close clearance parts (wear rings, seals, sleeves, etc.)

FILLING

Vents should be located at the highest point so entrained gases and air can escape. However, if the gases are flammable, toxic, or corrosive they should be vented to an appropriate place to prevent harm to personnel or other parts of the system. Pipe hangers and anchors should be checked to make sure they are properly set to take the additional weight of the pumpage.

All drains should be closed when filling the system. Filling should be done slowly so that excessive velocities do not cause rotation of the pumping elements which may cause damage to the pump or its driver. The adequacy of the anchors and hangers may be checked by mounting a dial indicator off of any rigid structure not tied to the piping and setting the indicator button on the pump flange in the axial direction of the nozzle. If the indicator moves, as the filling proceeds, the anchors and supports are not adequate or set properly and should be corrected.

STARTING

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

CAUTION

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. Start the pump driver (turbines and engines may require warming up; consult the manufacturer's instructions).
6. When the pump is operating at full speed, check to see that the check valve has opened up. Check valve must open 5 seconds or less after start-up to prevent damage to pump by operating at zero flow.
7. Adjust the liquid seal valves to produce the recommended pressure for either the mechanical seal or packed stuffing box.

OPERATIONAL CHECKLIST

1. **Driver/Pump Rotation**
   Check rotation each time the motor leads have been disconnected. Be sure that the driver operates in the direction indicated by the arrow on the pump casing. Rough operation and extreme vibration can result if the pump is operated in the wrong direction.

2. **Stuffing Box Adjustment**
   Make stuffing box packing gland and lubrication adjustments.

3. **Flow**
   An accurate measurement of flow rate (volume/time) is difficult in the field. Venturi meters, flow nozzles, orifice plates, or timing the draw down in the wet well are all possible methods. Record any reading for future reference.

4. **Pressure**
   Check and record both suction and discharge pressure gauge readings for future reference. Also, record voltage, amperage per phase, kilowatts if an indicating watt meter is available, and pump speed.

5. **Temperature**

   Do not insulate bearing housings as this can result in excess heat generation, sparks, and premature failure.

   Check and record bearing temperatures using a thermometer. Temperature should not exceed 180° F.

   NOTE: Just because bearing housings are too hot to touch does not mean that they are running too hot for proper operation.

6. **Vibration and Sound**
   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 depending on the operating characteristics and the structure. Refer to the Centrifugal Pump section of the *Hydraulic Institute Standards* for a complete description and charts on various pumps.

   Field sound levels are difficult to measure because of background noise from piping, valves, drivers, gears, etc. Follow recommendations in the *Hydraulic Institute Standards.*

SHUTDOWN

The following steps will take care of most normal shutdowns of the pump, i.e. maintenance. 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 the sections on storage and freeze protection.

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

FREEZE PROTECTION

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

1. Drain the pump; remove all liquid 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 Pumps. This can be used in conjunction with a field test, if one is required. All Goulds Pumps 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.

DEFINITIONS

To aid in calculating pump performance, the following test information and definitions are included for reference. See *Appendix III* for other useful formulas, and *Appendix IV* for a Field Test Report Sheet.

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:

$$\text{Head in feet} = \frac{psig \times 2.31}{sg}$$

Where sg = specific gravity of the liquid pumped
Where sg = 1.0 for water at 70°

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 manometer 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° 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° shall be taken as 62.34 pounds per cubic foot.

Horsepower

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

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

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

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

Where *Bhp* = Brake horsepower delivered

Kw input = Real input power (kw)

Eff. = Motor efficiency

Pump Efficiency

Pump efficiency can be calculated by the formula:

$$\text{Pump Efficiency} = \frac{\text{Total head x GPM}}{\text{3960 x Bph}} \text{x specific gravity}$$

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 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.

PREVENTIVE MAINTENANCE

GENERAL MAINTENANCE

The* Preventive Maintenance *section must be adhered to in order to keep the applicable ATEX classification of the equipment. Failure to follow these procedures will void the ATEX classification for the equipment.

Operating conditions vary so widely that to recommend one schedule of preventive 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.

5

MAINTENANCE TIMETABLE

INSPECTION INTERVALS

Inspection intervals should be shortened appropriately if the pumpage is abrasive and/or corrosive, or if the environment is classified as potentially explosive.

EVERY MONTH

Check bearing temperature with a thermometer, not by hand. If bearings are running hot (over 180° F), it may be the result of too much or too little lubricant. If changing the lubricant and/or adjusting to proper level does not correct the condition, disassemble and inspect the bearings. Lip seals bearing on the shaft may also cause the housing to run hot. Lubricate lip seals to correct this condition.

EVERY 3 MONTHS

Check the oil on oil lubricated units. Check grease lubricated bearings for saponification. This condition is usually caused 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

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.

Take vibration readings on the bearing housings. Compare the readings with the last set of readings to check for possible pump component failure (e.g. bearings).

Check shaft or shaft sleeve for scoring. Scoring accelerates packing wear.

Check alignment of pump and driver. Shim up units if necessary. If misalignment reoccurs 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. Correct as necessary.

EVERY YEAR

Remove the upper half of the casing. Inspect the pump thoroughly for wear, and order replacement parts if necessary.

Check wear ring clearances. Replace when clearances become three (3) times their normal clearance or when a significant decrease in discharge pressure for the same flow rate is observed.

Remove any deposit or scaling. Clean out stuffing box piping.

Measure total dynamic suction and discharge head as a test of pump performance and pipe condition. 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.

NOTE: The above timetable is based on the assumption that after startup, the unit has been constantly monitored and such a schedule was found to be consistent with operation, as shown by stable readings. Extreme or unusual applications or conditions should be taken into consideration when establishing the maintenance intervals.

MAINTENANCE OF FLOOD DAMAGED PUMPS

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.

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 1 oz. 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 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.

OIL

Bearings must be lubricated properly in order to prevent excess heat generation, sparks and premature failure.

The oil-lubricated pumps may have an oiling ring, in which the oil is picked up from the reservoir by a rotating oil ring and deposited on the shaft and bearings inside the bearing housing; or they may have an oil slinger, which creates a shower of fine droplets over the entire interior of the bearing cavity.

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 erection. 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.

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 . . . . 215-SSU-240 SSU

(2) Saybolt viscosity at 210° F . . . . . .49 SSU

(3) Viscosity index, minimum 95

(4) API gravity 28-33

(5) Pour point, maximum . . . . . +20° F

(6) Flash point, minimum . . . . . 400° F

(7) Additives . . . . . Rust & Oxidation Inhibitors

(8) ISO Viscosity 46

NOTE: Oils from different supplies should not be mixed.

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. It should also be non-foaming with a viscosity of about 150-200 SSU at 100°F. (Approximately SAE-20.)

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 180°F. Should the temperature of the bearing frame exceed 180°F (measure by thermometer), shut down pump to determine the cause.

SEALING INFORMATION

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 15 -20 PSI above stuffing 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 lubrication are available. When using a grease lubricator, grease pressure to the stuffing box should be equal to the pump discharge pressure.

PACKING

Pumps are normally shipped with the packing set loose. 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.

The standard packing is a soft, square, non-asbestos fiber 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° 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.

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.

Problem	Item	Probable Cause	Remedy
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. Check mechanical seal or packing.
	3	Suction lift too high (a negative suction gauge reading).	If there is no obstruction at inlet and suction valves are open, 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	System static head too high.	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 driver.
	5	Speed to low.	Check whether motor is directly across-the-line and receiving full voltage. 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. If rotation is correct with arrow, check the relationship of the impeller with casing. (This will require removing casing upper half.)
	7	No rotation.	Check power, coupling, line shaft and shaft keys.
	8	Impeller loose on shaft.	Check key, locknut and set screws.
	9	Impeller completely plugged.	Dismantle pump and clean impeller.
	10	System head or required discharge head too high.	Check pipe friction losses. Large piping may correct condition. Check that valves are wide open.
No Liquid Delivered	11	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.
	12	Air leaks in stuffing box.	Replace packing and sleeves if appropriate or increase seal lubricant pressure to above atmosphere.
	13	Speed too low.	See item 5.
	14	Discharge head too high.	See item 10.
	15	Suction lift too high.	See item 3.
	16	Impeller partially plugged.	See item 9.
	17	Cavitation; insufficient NPSHA (Net Positive Suction Head Available).	a. Increase positive suction head on pump by lowering pump or increasing suction pipe and fittings size. b. Sub-cool suction piping at inlet to lower entering liquid temperature. c. Pressurize suction vessel.
	18	Defective Impeller and/or wear rings.	Inspect impeller and wear rings. Replace if damaged or vane sections are badly eroded or if wear ring clearance is 3 times normal.
	19	Foot valve too small or partially obstructed.	Area through ports of valve should be at least as large as area of suction pipe (preferably 1.5 times). If strainer is used, net clear area should be 3 to 4 times area of suction pipe.
	20	Suction inlet not immersed deep enough.	If inlet cannot be lowered or if eddies through which air is sucked persists when it is lowered, chain a board to suction pipe. It will be drawn into eddies, smothering the vortex.
	21	Wrong direction of rotation.	Symptoms are an overloaded driver and about one third rated capacity from pump. Compare rotation of motor with directional arrow on pump casing. If rotation is correct with arrow, impeller may have to be turned 180°. (See CHANGING ROTATION)
	22	System head too high.	See item 4.
	23	Defective mechanical seal.	Repair or replace seal.

TROUBLESHOOTING, con't

Problem	Item	Probable Cause	Remedy
Not Enough Pressure	24	Speed too low.	See item 5.
	25	Air leaks in suction piping or stuffing box.	See item 11.
	26	Mechanical defects.	See item 18.
	27	Vortex at suction inlet.	See item 20.
	28	Obstruction in liquid passages.	Check to see if suction and discharge valves are fully open. Dismantle pump and inspect passages and casing. Remove obstruction.
	29	Air or gases in liquid.	May be possible to over rate pump to a point where it will provide adequate pressure despite condition. Better provide gas separation chamber on suction line near pump and periodically exhaust accumulated gas. See item 17.
Pump Operates For a Short Time, Then Stops	30	Insufficient NPSHA.	See item 17.
	31	System head too high.	See items 4 & 10.
Pump Takes Too Much Power	32	Head lower than rating; thereby pumping too much liquid.	Machine impeller's O.D. to size advised by factory, or reduce speed.
	33	Cavitation.	See item 17.
	34	Mechanical defects.	See items 18, 19, 21, and 23.
	35	Suction inlet not immersed.	See item 20.
	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 box glands too tight.	Release gland pressure. Tighten reasonably. If sealing liquid does not flow while pump operates, replace packing.
	39	Casing distorted by excessive strains from suction or discharge piping.	Check alignment. Examine pump for rubbing between impeller and casing. Replace damaged parts. Re-pipe pump.
	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 .002" on shaft and .004" on impeller wearing surface.
	41	Mechanical failure of critical pump parts.	Check wear rings 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.	Check voltage on motor. Check speed versus pump nameplate rating.
	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 do 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.

DISASSEMBLY & REASSEMBLY

DISASSEMBLY

The numbers used in the following procedures are part numbers identified on the Pump Assembly Pix drawing. Use acceptable mechanical practices when working on pump to avoid unnecessary damage to parts.

1. Disconnect coupling. Refer to coupling manufacturer's instructions.
2. Drain pump by opening vent plug and removing drain plug on discharge and suction nozzles.
3. Remove gland bolts, slide gland plates (107) away to disconnect mechanical seal faces.
4. Remove all casing main joint nuts and dowels. Use jacking screws in two tapped holes to break joint. Lift casing cover by cast lugs.
5. **Gasket**

   A strong Garlock 3000 gasket is placed between the pump half casings at the factory. The gasket may be readily replaced, when necessary, with the same or similar material of the same thickness as original and cut to proper shape. Heavier gaskets must not be used, as they hold the casing apart allowing leakage around the wearing rings. A lighter gasket will place undue stress on the casing rings.
6. Remove bolting holding bearing housings caps to bearing housings (134D). Mark the caps to know to what end they belong. Lift up the caps. The entire rotating element may now be lifted out.
7. Pull coupling half and key off shaft. Remove bearing end plate (111).
8. Remove both casing rings (127).
9. Remove radial bearing (168).
10. Remove locknut and lockwasher (136 & 382) and pull off thrust bearing (410).
11. Remove bearing endplates and bearing seals (333A & 332A).

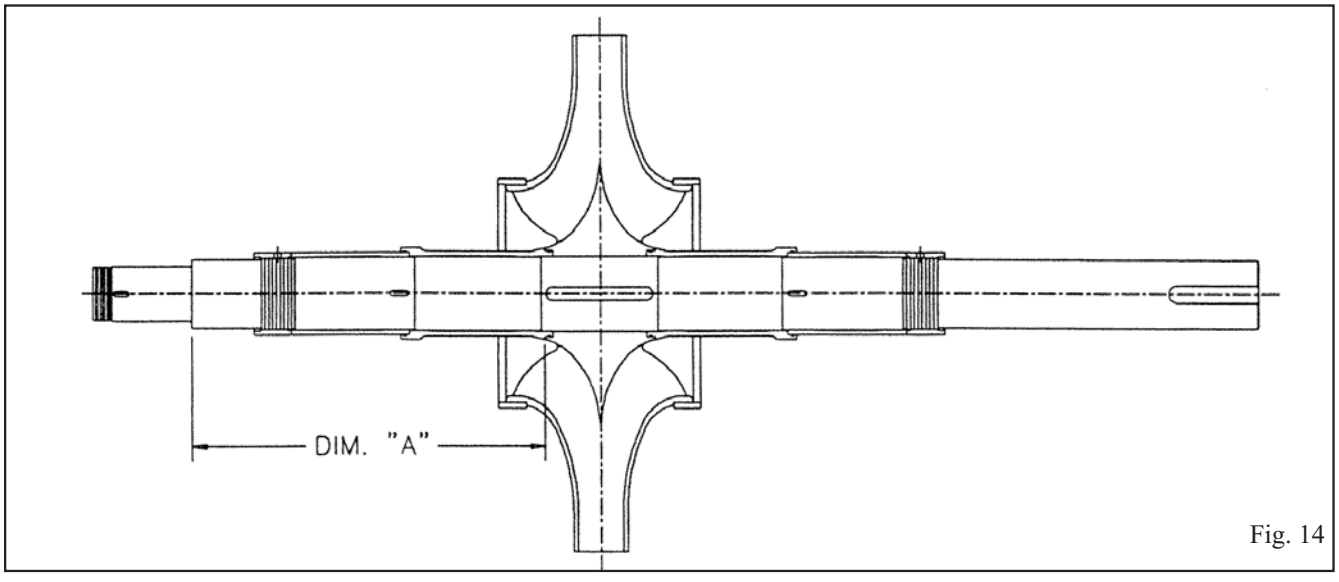

Fig. 14

12. Remove gland plates (107) at both ends. Be careful not to damage the static seal ring which is mounted inside the gland plate. Refer to mechanical seal supplier's drawing and instructions for details.

13. Before removing the rotating assembly of mechanical seal, note and mark its axial position on shaft sleeve. For mechanical seal to work properly, installation distance from the face of stuffing box is important. See mechanical seal drawing for dimension. Remove mechanical seals.

14. Remove sleeve nuts (124 & 130) using a proper "C" wrench. Watch for LEFT HAND thread on one of them. Hand of the thread is decided by shaft rotation, refer to Pump Assembly Pix drawing. For CCW rotation (124) is RH thread, (130) is LH thread. For CW rotation (130) is LH thread, (124) is RH thread.

15. Remove outboard sleeves and keys from each end. To remove the impeller and the inboard sleeves, hold the shaft vertically and allow it to drop on a block of wood a number of times. The weight of the impeller will force it and the shaft sleeves off. If this does not work, apply a light press. Before removing impeller, record Dimension "A" from impeller hub face to thrust bearing shoulder (see Fig. 14) to facilitate assembly.

16. **Wear Rings**

The impeller and wear ring clearance setting procedures must be followed. Improperly setting the clearance or not following any of the proper procedures can result in sparks, unexpected heat generation, and equipment damage.

When the rings are worn to twice the original clearance, they should be replaced. The rings on the impeller can be cut in two with a cold chisel and removed. Heat each new impeller wear ring to 270° - 300°F and slide it onto the impeller. Hold rings against the impeller shoulder until they cool.

ASSEMBLY

(Refer to Pump Assembly Pix Drawing)

1. All O-rings, seals, and gaskets should be replaced with new parts during assembly. All reusable parts should be cleaned of all foreign matter before reassembling. The main casing joint gasket should be made using the upper half as a template. Lay the gasket material on the casing joint and mark it by pressing it against the edges of the casing. Trim the gasket so that it is flush with the inside edges of casing.

2. Install impeller key on shaft. Using Dimension "A" recorded when dismantling, (See Fig. 14) install impeller on shaft.

3. Install spacer sleeves, O-rings, stuffing-box sleeves, and shaft sleeve nuts. Install mechanical seals on shaft.

4. Install casing rings (See Fig. 15).

5. Install bearing seals (333A & 332A) and bearing endplates onto shaft.

6. Install thrust bearing (410) on shaft complete with lock washer and locknut (382 & 136).

7. Install radial bearing (168).

8. Install pump coupling half and key per coupling supplier's instructions.

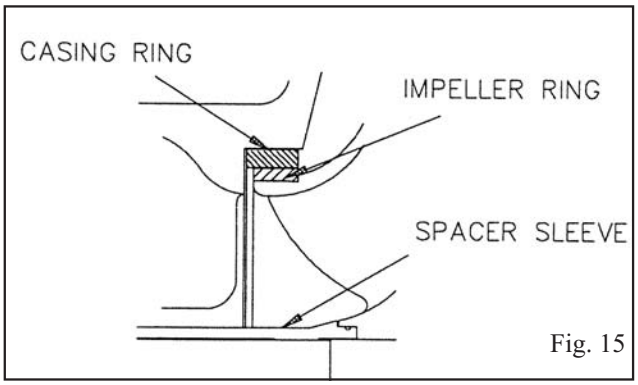

Fig. 15

9. Assembly rotating element in lower half casing. Locate casing rings over pins in lower half casing.

10. Bolt down bearing housings caps.

11. Lower upper half casing in place and locate using the taper dowels. Install casing main joint studs/nuts. Torque uniformly the casing main studs/nuts according to the torque valves as indicated on the respective Section Assembly Pix drawing.

12. Rotate shaft by hand to assure that it turns smoothly and is free from rubbing and binding.

13. Tighten mechanical seal glands (107).

14. Install coupling, check alignment to driver and correct if necessary.

LIMITED END FLOAT COUPLINGS

For units with drivers having sleeve bearings, the coupling halves are set to limit total shaft axial movement to less than one-half of the motor rotor assembly end float. This is accomplished by inserting a phenolic disc, or equivalent, of a specified thickness between the motor and pump shaft. (See Fig. 16)

Most 3498 pump installations use the all metal, gear type coupling. Where limited end float gear type couplings are used, the coupling hubs are slip-fit onto the pump and motor shafts. After installation of the coupling covers and hubs; with the motor set on its Magnetic Center, butt the pump and motor shafts with the phenolic disc inserted between them. (The pump thrust bearing limits end float toward the pump, and the coupling covers limit end float towards the motor.) The thrust bearing of the pump is large enough to carry any magnetic thrust developed by the motor when aligned properly.

Once the above instructions have been followed completely the Alignment Procedures found in the Installation section should then be followed.

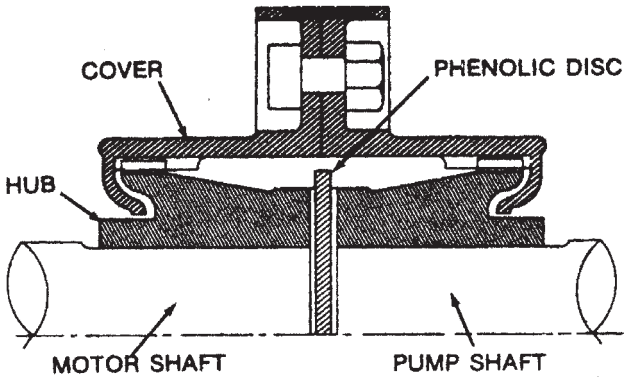

Fig. 16

APPENDIX I

INSTRUCTIONS FOR ORDERING PARTS

When ordering parts for 3498 pumps, be sure to furnish the following information to the Goulds Pumps stocking distributor in your area:

- Serial Number
- Pump Size & Type
- Pump Model Number
- Pump Frame Number
- Description of Part
- Catalog Code
- Quantity Required
- Definite Billing and Shipping Instructions
- Date Required

Parts should be ordered as far in advance of their need as possible, since circumstances beyond the control of Goulds Pumps may reduce existing stocks. All parts are not carried in stock. Some are made for each order. If replacement parts required are to be made of different materials than originally specified, give exact requirements and the reason for changing. Special care in furnishing the above information with the original order for parts will facilitate shipment.

APPENDIX II

TOOLS

To disassemble and assemble 3498 pumps, use conventional tools.

APPENDIX III

USEFUL FORMULAS

USEFUL FORMULAS

1) Head (ft.) = $\frac{\text{Pressure (psig)} \times 2.31}{\text{S.G.}}$ S.G. = Specific gravity; S.G. of water = 1.0 at 70° F

2) TDH (ft.) = Total Dynamic Head (ft.) = (Disch. Pressure gauge reading - Suct. Pressure gauge reading + (Discharge velocity head - Suction velocity head + (Elevation correction to disch. gauge - Elevation correction to suct. gauge)

3) PUMP INPUT HP (BHP) - calculated:

Single Phase Motor	Three Phase Motor
$BHP = \frac{Amps \times Volts \times n_m \times p.f.}{746}$	$BHP = \frac{Avg.\ Amps \times Volts \times 1.732 \times n_m \times p.f.}{746}$

Where n_m = motor efficiency, p.f. = Motor power factor, Avg. Amps = $\frac{leg\ 1 + leg\ 2 + leg\ 3}{3}$

4) Pump Efficiency (n_p): $n_p = \frac{GPM \times TDH}{3960 \times BHP}$

5) Affinity Laws for correcting GPM, TDH, and BHP for speed (RPM):

$\frac{GPM_1}{GPM_2} = \frac{RPM_1}{RPM_2}$ or $GPM_1 = GPM_2 \times \frac{RPM_1}{RPM_2}$

$\frac{TDH_1}{TDH_2} = \left(\frac{RPM_1}{RPM_2}\right)^2$ or $TDH_1 = TDH_2 \times \left(\frac{RPM_1}{RPM_2}\right)^2$

$\frac{BHP_1}{BHP_2} = \left(\frac{RPM_1}{RPM_2}\right)^3$ or $BHP_1 = BHP_2 \times \left(\frac{RPM_1}{RPM_2}\right)^3$

6) NPSHA determination:

NPSHA = Net Positive Suction Head Available

NPSHA = (Atmospheric pressure - Vapor pressure of liquid + Total suction head)

Total Suction Head = (Suction pressure gauge reading + Suction velocity head + Elevation correction to suction gauge)

NOTE: NPSHA must always be greater than NPSHR (NPSHA ≥ NPSHR) for the pump to operate without concern of cavitation.

NPSHR refers to Net Positive Suction Head Required by pump. This is a published value obtained from the Pump Manufacturer's curve.

7

Field Test Report

Date _____

Pump Size _____ Pump Type _____
Pump Serial Number _____ Impeller Diameter (in.) _____
Manufacturer's Pump Curve Number _____

MOTOR:** Rated HP _____ Volts _____ S.F. _____
F.L. Amps _____ F.L. Eff _____ P.F. _____
Phase _____

RATING: GPM _____ Head _____ RPM _____
Suction gauge pipe size _____ inches
Discharge gauge connection pipe size _____ inches
Discharge gauge elevation corr. _____ feet
Barometric pressure _____ inches Hg x 1.13 = _____ feet water
Liquid pumped _____ S.G. _____
Liquid temperature _____ °F
Liquid vapor pressure _____ psi x 2.31 = _____feet water

POINT	Discharge Pressure Gauge		Suction Pressure Gauge		Velocity Head (feet)		Total Dynamic Head (TDH_2)	FLOW		RPM_2	Motor Volts	Motor Amps			Avg. Amps	Pump BHP_2 (calc'd)	Pump Eff. (calc'd)	Affinity Law Corrections				Calc'd NPSHA	NPSHR*
								Reading	Convert to GPM_2			Leg 1	Leg 2	Leg 3				RPM_1	TDH_1	GPM_1	BHP_1		
	(PSI.)	(ft.)	(PSI.)	(ft.)	Disc.	Suct.																	
1																							
2																							
3																							
4																							
5																							
6																							
7																							
8																							
9																							
10																							

* NPSHR taken from manufacturer's pricebook curve.
** Motor information taken off motor nameplate.
See sheet 2 of 2 for useful formulas.

Type of flow measurement device: _____

Readings taken by: _____

Comments: _____

_____

HOW TO ORDER

When ordering parts call
1-800-446-8537, or
your local Goulds Pumps Representative

EMERGENCY SERVICE

Emergency Parts Service is available
24 hours / day, 365 days / year …
Call 1-800-446-8537

Visit our website at www.gouldspumps.com

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