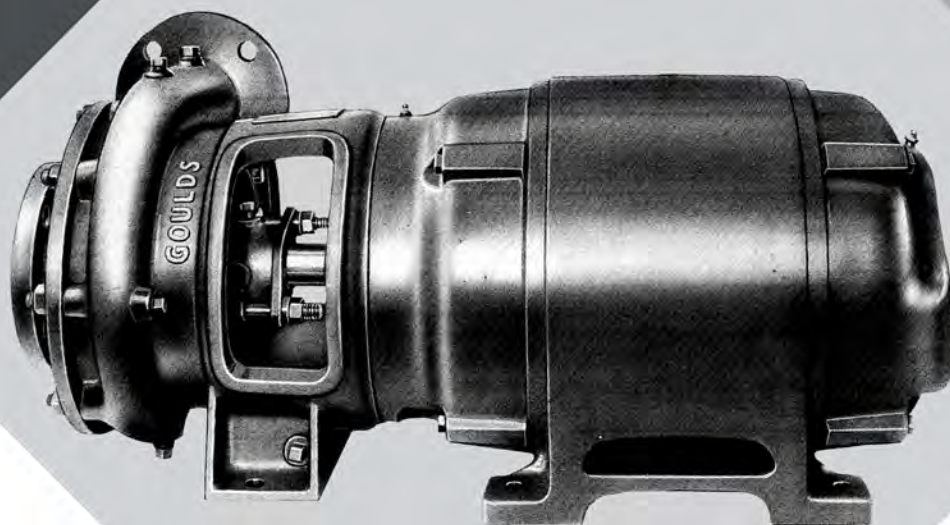


 **GOULDS PUMPS**

Installation, Operation and Maintenance Instructions

3655



ITT

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Foreword

To provide industry with a line of rugged, dependable, enclosed impeller "close coupled" pumps, Goulds developed Model 3655.

The life and satisfactory service of any mechanical unit, however, is enhanced and extended by correct application, proper installation, periodic inspection and maintenance. This instruction book was prepared so operators will understand the construction and the correct method for installing, operating and maintaining these pumps.

Read thoroughly Sections [2 Installation on page 11](#), [3 Preparation for operation on page 15](#), [4 Starting Pump on page 17](#), and [5 Operation on page 18](#) and be sure to follow the instructions for installation and operation. Sections [6 Trouble check list on page 20](#) and [7 Care and maintenance on page 23](#) are answers to trouble and maintenance questions. Keep this instruction book handy for reference. Kindly direct any questions or suggestions to the attention of the Engineering Application Division, Goulds Pumps Inc., Seneca Falls, N. Y.

1 Safety

1.1 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 <https://www.gouldspumps.com/en-US/Tools-and-Resources/Literature/> 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 <https://www.gouldspumps.com>

1.2 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 <http://www.gouldspumps.com/literature>.

1.3 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 the 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:**WARNING:**

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.

ATEX:**WARNING:**

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.






1.4 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.

Table 1: 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		<p>Safety Apparel:</p> <ul style="list-style-type: none"> • 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		<p>Receiving:</p> <p>Assembled pumping units and their components are heavy. Failure to properly lift and support equipment can result in serious physical injury and/or</p>

		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.
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.

1.4 General precautions

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.
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.

WARNING		<p>Noise:</p> <p>Sound pressure levels may exceed 80 dbA in operating process plants. Clear visual warnings or other indicators should be available to those entering an area with unsafe noise levels. Personnel should wear appropriate hearing protection when working on or around any equipment, including pumps. Consider limiting personnel's exposure time to noise or, where possible, enclosing equipment to reduce noise. Local law may provide specific guidance regarding exposure of personnel to noise and when noise exposure reduction is required.</p>
WARNING		<p>Temperature:</p> <p>Equipment and piping surfaces may exceed 130°F (54°C) in operating process plants. Clear visual warnings or other indicators should alert personnel to surfaces that may reach a potentially unsafe temperature. Do not touch hot surfaces. Allow pumps operating at a high temperature to cool sufficiently before performing maintenance. If touching a hot surface cannot be avoided, personnel should wear appropriate gloves, clothing, and other protective gear as necessary. Local law may provide specific guidance regarding exposure of personnel to unsafe temperatures.</p>
WARNING		<p>This product contains Carbon Black a chemical known to the State of California to cause cancer. For more information go to www.P65Warnings.ca.gov</p>



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

Description of Ex-Directives

The Ex-directives are a specification enforced in Europe and the United Kingdom for electrical and non-electrical equipment installed in those locations. Ex-directives deal with the control of potentially explosive atmospheres and the standards of equipment and protective systems used within these atmospheres. The relevance of the Ex-requirements is not limited to Europe or the UK. You can apply these guidelines to equipment installed in any potentially explosive atmosphere.

Guidelines for compliance

Compliance is fulfilled only when you operate the unit within its intended use. Do not change the conditions of the service without the approval of an ITT representative. When you install or maintain explosion proof products, always comply with the directive and applicable standards (for example, IEC/EN 60079-14).

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

The Ex 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 <https://www.gouldspumps.com/en-US/Tools-and-Resources/Literature/IOMs/> or from your local ITT Goulds Pumps Sales representative.

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

If applicable, your pump may have either a CE Ex (ATEX) tag or UKCA Ex tag affixed to the pump. See the Safety section for a description of the symbols and codes. Typical nameplate only shown below, the actual area classification may be different.



Figure 1: Typical Ex pump nameplate

Table 2: Temperature class definitions

Code	Maximum permissible pumpage temperature in °C °F	Minimum permissible pumpage temperature in °C °F
T1	450 842	372 700
T2	300 572	277 530
T3	200 392	177 350
T4	135 275	113 235
T5	100 212	Option not available
T6	85 185	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.

II - Group – Non Mining Equipment

2 = Category 2

G/D = Gas and Dust present

T4 = Temperature class, can be T1 to T6 (see Table)

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.

1.6 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.

2 Installation

2.1 Location

Pumping unit should be placed as close as practical to the source of supply. Head room and floor space allotted to the pump should be sufficient for inspection and maintenance.

2.2 Foundation

The foundation should be substantial in order to absorb any vibration and to form a permanent rigid support for the pump.

2.3 Mounting pump

The *close-coupled* pump may be mounted in any horizontal or vertical position except with pump above motor. Its construction with the pump installed on the extended motor shaft eliminates coupling and the alignment procedures normally involved.

Group "S" and "M" pumps have two hold down bolt holes in the motor adapter foot (108). Group "L" pumps have two hold down bolt holes in the pump foot. All pumps have four hold down bolt holes in the motor feet.

Depending upon the motor frame, the adapter or pump foot may be higher or lower than the motor feet. Shim as required, then bolt all feet securely to foundation. Be careful not to twist or distort feet.

2.4 Piping - general

1. All piping must be supported independently of the pump. The piping should always "line-up" naturally with the pump flanges. Never draw the piping into place by use of force at the flanged suction and discharge connections of the pump.
2. The piping, both suction and discharge, should be as short and direct as possible. Avoid all unnecessary elbows, bends and fittings, as they increase the friction losses in the piping. The size of pipe and fittings should be carefully selected and of sufficient size to keep the friction losses as low as practical.
3. Piping must not be connected to the pump until the pump unit hold down bolts have been tightened.
4. When handling liquids at elevated temperatures, arrangements must be made for expansion loops or expansion joints so that the linear expansion of the pipe will not cause the pumping unit to be drawn out of alignment.

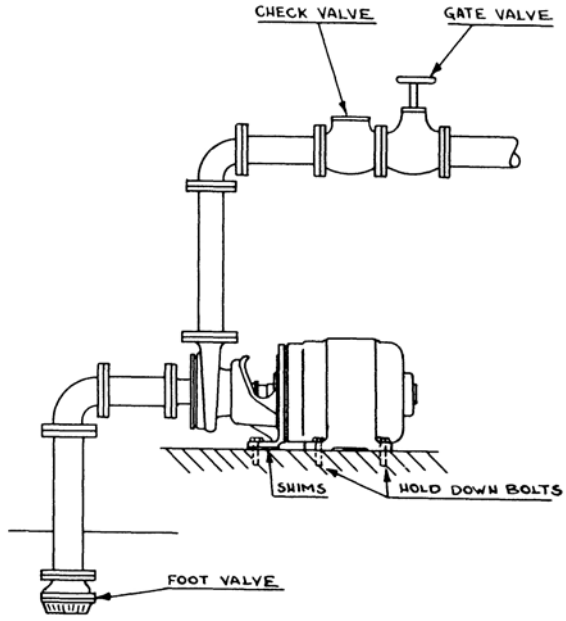


Figure 2:

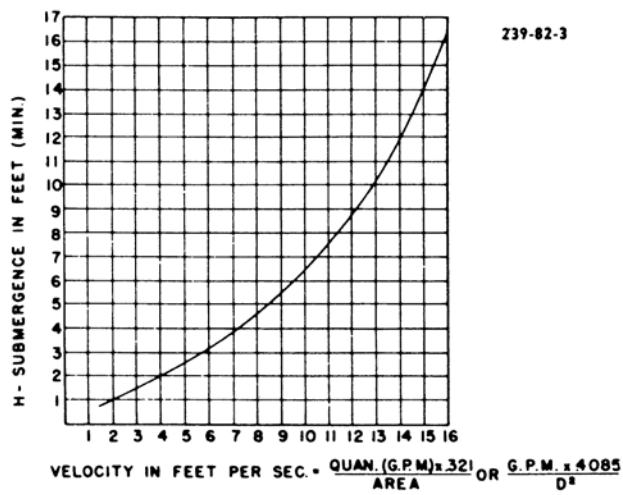
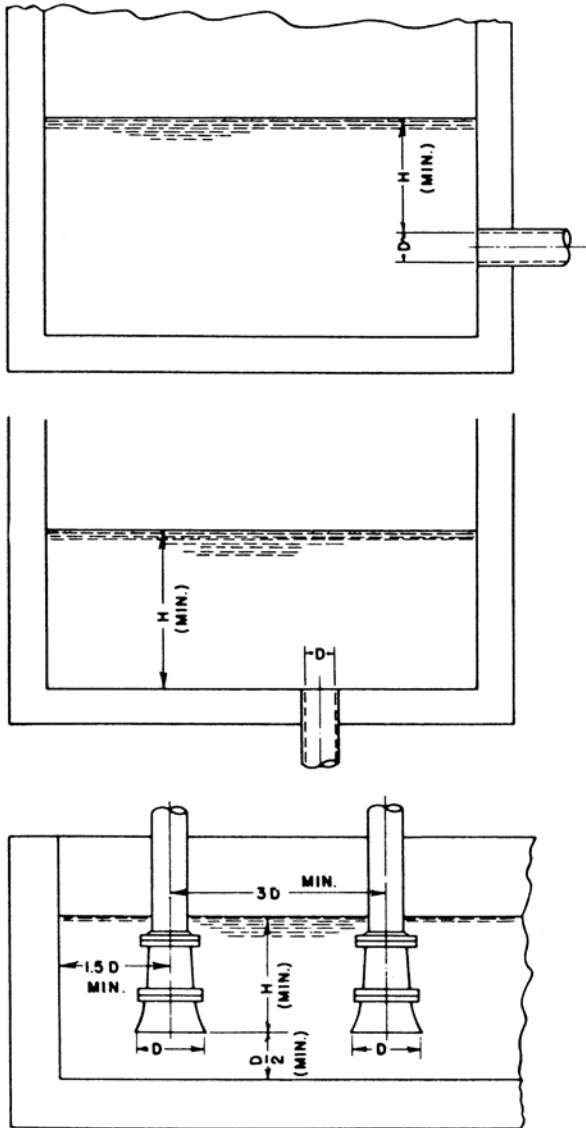


Figure 3:

2.5 Piping - suction

1. Properly installed suction piping is of extreme importance for trouble-free centrifugal pump operation.
 1. The suction pipe should be as large or larger than the pump suction.
 2. Increasesers, if used, should be eccentric and preferably at or near the pump suction flange.
 3. A centrifugal pump should never be throttled for capacity adjustment on the suction side.

Installation with pump above source of supply - suction lift:

1. Keep suction pipe free from air pockets.
 1. Piping should slope upwards from source of supply.
 2. No portion of piping should extend above the pump suction nozzle.
2. All joints must be air tight.
3. The suction pipe should always be submerged into the source of supply as shown in Figure 2.
4. A foot valve should only be used if necessary for priming, or, if the pump is to be used on intermittent service and is required to hold its prime.
5. Suction strainers when used should have a net free area of at least three times the suction pipe area.

Installations with pump below source of supply - suction head or flooded suction:

1. A gate valve should be installed in the suction line to permit closing the line for pump inspection and maintenance.
2. The size of the entrance from the source of supply or minimum submergence over the entrance should be calculated from the data as shown in Figure 2 for applicable condition to prevent air from being drawn into the pump.

2.6 Piping - discharge

1. A gate valve and a check valve should be installed in the discharge line. The check valve should be located between the gate valve and pump to permit inspection of the check valve. The gate valve is required for priming, regulation of flow capacity and for inspection and maintenance of the pump.
2. Increasesers, if used in discharge line, should be placed between the check valve and the pump.

2.7 Connection of piping

Connect suction and discharge piping. Rotate the pump shaft by hand several complete revolutions to be sure that there is no binding and that all parts are free.

If the connection of the piping causes unit to rub, correct piping to relieve strain on the pump.

2.8 Check rotation

These pumps are built in right hand construction, i.e., clockwise rotation when viewed from driver end. The direction of rotation is marked on the pump casing. Make sure that driver rotates in the same direction.

3 Preparation for operation

3.1 Bearings

The bearings are located in and are part of the motor. Refer to separate motor instructions. There are no bearings in the pump.

3.2 Stuffing box

These pumps are furnished with packed stuffing box. In the box of fittings accompanying the pump will be found the stuffing box packing.

When installing the packing, twist the rings sideways just enough to get them around the shaft.

Do not attempt to pull rings straight out to get them over shaft.

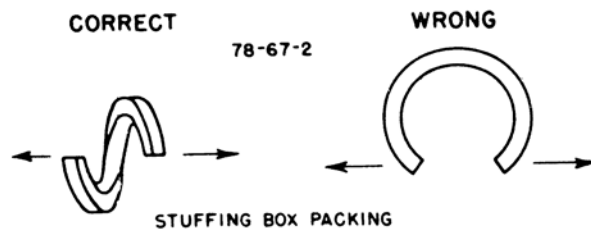


Figure 4: Stuffing box packing

1. Slide the Lantern ring (105) out and away from the stuffing box. (See Sectional assembly parts and interchangeability chart). Insert three rings of packing, staggering the joints. The Lantern ring should then be inserted in the stuffing box. When it is in its proper position, it will be directly opposite the sealing inlet connection.
2. After the Lantern ring is in place, insert two more rings of packing, staggering the joints. One extra ring is furnished in each set of packing. The extra ring may be added as required.
3. Place one gland half in lower position in stuffing box. Slide cupped washers over studs and on the bosses of the gland to hold gland halves together.
4. Place the two gland nuts on the studs and draw up evenly but not tight.

3.3 Connection of sealing liquid or grease lubricator

If the stuffing box is above atmospheric pressure, and the pumpage is clean, normal gland leakage of 40-60 drops per minute is usually sufficient to lubricate and cool the packing, and sealing liquid is not required.

Sealing liquid or grease lubricator is required:

1. When abrasive particles in the pumpage could score the shaft.
2. Stuffing box below atmospheric pressure (pump running with suction lift or suction source under vacuum). Under these conditions, the packing will not be cooled and lubricated, and air will be drawn into the pump.

Sealing liquid may be supplied by recirculating pumpage to the Lantern ring through a line from the casing to 1/4" pipe tap connection (3/8" on Group "L") in the stuffing box. The other connection is plugged. If the liquid is abrasive, an outside source of clean compatible liquid must be used at a pressure 20 to 40 psi above suction pressure.

A grease lubricator is supplied when the use of recirculating pumpage or of outside sealing liquid is not desired. The grease should be compatible with, and insoluble in, the pumpage.

The quenching liquid must be from an outside source and should be piped with flexible pipe into the opening in the upper gland half and out the opening in the lower gland half. A shut-off valve should be installed in the quenching line.

3.4 Connection of piping to quenching gland

A quench type gland can be supplied on special order with tapped holes in the top and lower gland halves. Quenching is recommended on applications where the liquid pumped is at a temperature of 82° C | 180°F. or higher, and also when the pump is handling volatile or toxic liquids in order to smother the gland leakage, which then can be piped away.

3.5 Mechanical seals

Mechanical seals of various types and makes may be supplied on special order. If supplied they were properly installed and adjusted at the factory. No further adjustment is required. Connect circulating line between stuffing box and pump casing if not already connected. This line assures sufficient pumpage to seal for cooling and lubrication. Check separate seal instruction sheet to determine type of seal installed and any special instruction for the specific seal supplied.

3.6 Connection of drain piping

Drain piping can be connected to the tapped openings in the adapter, to carry away stuffing box leakage. Openings are 1/2" pipe tap on Group "S", 3/4" on Groups "M" and "L".

4 Starting Pump

4.1 Priming

The pump must always be fully primed - all air removed and the suction pipe full of liquid - before pump is started.

If the pump is run dry, the rotating parts within the pump may gall and seize to the stationary parts as they depend on the liquid being pumped for lubrication.

4.2 Adjustment of stuffing box gland

With pump running at rated speed, stuffing box gland can be adjusted. Draw gland nuts up evenly and only one-sixth of a turn at a time, allowing sufficient time between adjustments for the packing to adjust itself and the effect on the leakage to be observed. If any sign of heating is evident, shut down the pump and allow the box to cool. Several starts may be necessary before the box runs cool. Do not back off the gland nuts on a hot box as this will usually result in liquid leaking between the outer edge of the packing and the stuffing box bore. Remember that it takes newly installed packing some time to "run in" and that during this period, frequent attention and careful adjustments are necessary. See [3.2 Stuffing box on page 15](#) for final adjustments of gland.

4.3 Installation check final

Final check of installation can only be accomplished after unit has been run under actual operating conditions for a sufficient length of time to bring the unit up to stabilize operating temperature.

After warm-up period has elapsed, stop the unit and check the expansion of pump and motor. This may be done by loosening motor adapter hold down bolts to determine if motor has expanded more than adapter. Shims under adapter may need to be added or removed.

Strains imposed by expansion of piping should also be checked.

5 Operation

5.1 Stuffing box

Stuffing box with packing rings without quenching gland and grease lubricator.

Periodically inspect stuffing box to see that there is sufficient leakage to lubricate the packing and maintain a cool box. Never draw up packing so that the stuffing box heats, as this will cause damage to both packing and shaft. Always draw up gland nuts evenly and only when pump is running.

After pump has been in operation for some time and the packing has been completely run in, at least 40 to 60 drops per minute of the liquid should be allowed to trickle from the stuffing box at all times for cooling and lubricating the packing and shaft sleeve.

Stuffing box with packing rings with quenching glands.

The same precautions as described above apply. However, the amount of leakage through the packing cannot be so readily ascertained, due to the quenching liquid. In most cases, the valve on the quenching liquid supply line can be shut off for a short period and the amount of leakage determined. In no instance should the gland be drawn up tight.

Stuffing box with packing rings with grease lubricator.

Operation is the same as directed in [5.1 Stuffing box on page 18](#), with the addition that the handle on the lubricator should be given a turn or two about every 100 hours of operation.

5.2 Operating at reduced capacities

Do not operate a centrifugal pump at greatly reduced capacities or with discharge gate valve closed because the energy required to drive the pump is converted into heat. If this condition exists over a long period, the temperature of the liquid in the pump may increase until the boiling point is reached. If this occurs, the rotating parts are exposed to vapor with no lubrication and they may score or even seize to the stationary parts; and furthermore, if running clearances have enlarged due to wear, seizure may not take place. Continued operation under these conditions may create an explosive hazard due to the confined vapor under high pressure and temperature.

To guard against possible damage, protective devices are available, such as:

1. Liquid temperature relay or thermostat which will shut-off the unit if the liquid temperature in the pump exceeds a predetermined maximum. This device guards against possible damage due to running the pump against a closed valve.
2. Constant open by-pass orifice between the pump discharge and any check or regulating valve in the discharge line. The liquid through the orifice is returned to the suction source. The amount of liquid by-passed is a function of input horsepower and the allowable temperature rise. This device also is insurance against damage due to running the pump against a closed discharge valve or very low flow conditions.
3. Bearing temperature relay which will shut the unit down if the bearing temperature exceeds a predetermined maximum.
4. Low suction pressure control which will shut off the unit should the suction pressure drop below a pre-established minimum.

A centrifugal pump should never be throttled for capacity adjustment on the suction side.

5.3 Operating at reduced head

On motor driven pumps, when discharge head or pressure is allowed to drop considerably below the rated point for any length of time, the motor should be watched for heating because the pump capacity increases rapidly with reduced head, as does horsepower consumption. If this condition is likely to persist, arrangements should be made either to manually or automatically throttle the discharge valve to build up head to a safe point.

5.4 Operating with surge conditions in line

If pump is installed with a quick closing valve in discharge line that closes when pump is running, dangerous pressure surges may be built up that can cause damage to the pump or line. In services of this kind, some cushioning arrangement must be provided to protect the pumping equipment.

5.5 Operating under freezing conditions

When exposed to freezing conditions and pump is standing idle, liquid inside the pump should be drained by removing drain plug in bottom of casing (100) and opening pipe plug at top.

6 Trouble check list

6.1 No liquid delivered

1. Priming - casing and suction pipe not completely filled with liquid.
2. Speed too low.
3. Discharge head too high. Check total head (particularly friction loss).
4. Suction lift too high (suction pipe may be too small or long, causing excessive friction loss). Check with vacuum or compound gauge.
5. Impeller or suction pipe or opening completely plugged.
6. Wrong direction of rotation.
7. Air pocket in suction line.
8. Stuffing box packing worn - or liquid seal plugged - allowing leakage of air into pump casing.
9. Air leak in suction line.
10. Not enough suction head for hot or volatile liquids. Check carefully as this is a frequent cause of trouble on such service.

*1 When connected to electric motors, check whether motor wiring is correct and receives full voltage. When connected to steam turbines, make sure that turbine receives full steam power.

6.2 Not enough liquid delivered

1. Priming-casing and suction pipe not completely filled with liquid.
2. *1Speed too low.
3. Discharge head higher than anticipated. Check total head (particularly friction loss).
4. Suction lift too high (suction pipe may be too small or long, causing excessive friction loss). Check with vacuum or compound gauge.
5. Impeller or suction pipe or opening partially plugged.
6. Wrong direction of rotation.
7. Air pocket in suction line.
8. Stuffing box packing worn - or liquid seal plugged-allowing leakage of air into pump casing.
9. Air leak in suction line.
10. Not enough suction head for hot or volatile liquids. Check carefully as this is a frequent cause of trouble on such service.
11. Foot valve too small.
12. Foot valve or suction pipe not immersed deeply enough.
13. Mechanical defects:
 1. Impeller clearance too great.
 2. Impeller damage.

*1 When connected to electric motors, check whether motor wiring receives full voltage. When connected to steam turbines, make sure that the turbine receives full steam pressure.

6.3 Not enough pressure

1. *1Speed too low.

2. Air or gases in liquid.
3. Impeller diameter may be too small.
4. Mechanical defects:
 1. Impeller clearance too great.
 2. Impeller damaged.
5. Wrong direction of rotation.
6. Be sure pressure gauge is in correct place on discharge nozzle or discharge pipe.

*1 When connected to electric motors, check whether motor wiring receives full voltage. When connected to steam turbines, make sure that the turbine receives full steam pressure.

6.4 Pump works awhile and then quits

1. Leaky suction line.
2. Stuffing box packing worn - or liquid seal plugged - allowing leakage of air into pump casing.
3. Air pocket in suction line.
4. Not enough suction head for hot or volatile liquids. Check carefully as this is a frequent cause of trouble on such service.
5. Air or gases in liquid.
6. Suction lift too high (suction pipe may be too small or long, causing excessive friction loss.) Check with vacuum or compound gauge.
7. Impeller plugged.

6.5 Pump takes too much power

1. Speed too high.
2. Head lower than rating, pumps too much liquid.
3. Liquid heavier than anticipated. Check viscosity and specific gravity.
4. Mechanical defects:
 1. Shaft bent.
 2. Rotating element binds.
 3. Stuffing box too tight.
5. Wrong direction of rotation.

6.6 Pump leaks excessively at stuffing box

1. Packing is worn or not properly lubricated.
2. Packing is incorrectly inserted or not properly run in.
3. Packing is not right kind for liquid handled.
4. Shaft sleeve scored.

6.7 Pump is noisy

1. Hydraulic noise - cavitation, suction lift too high. Check with vacuum or compound gauge.
2. Mechanical defects:
 1. Shaft bent.

6.7 Pump is noisy

2. Rotating parts bind, are loose or broken.
3. Bearings worn out.

*When connected to electric motors, check whether motor wiring is correct and receives full voltage. When connected to steam turbines, make sure that turbine receives full steam pressure.

7 Care and maintenance

7.1 Lubrication

The bearings are located in and are part of the motor. Refer to separate motor instructions for care and maintenance.

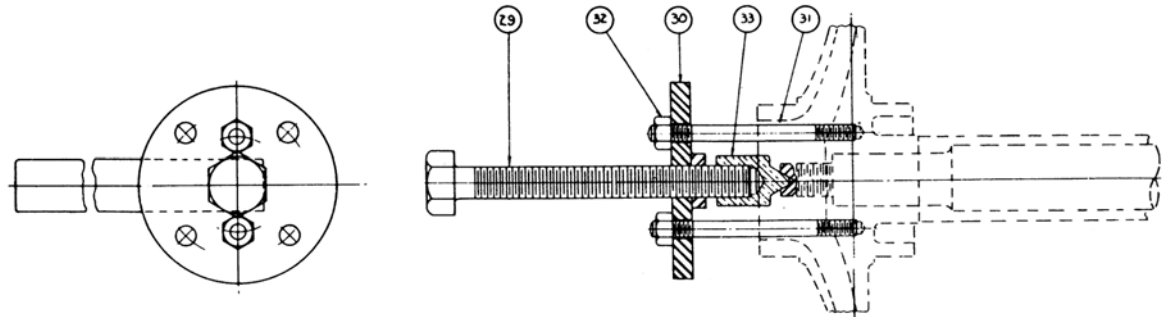
7.2 Repacking stuffing box

1. Loosen gland nuts and side gland along shaft out of stuffing box. Remove gland halves from pump.
2. Remove the outer rings of packing with the aid of a packing hook
3. Remove Lantern ring (105) by inserting a wire hook in the slots in the outer edge of the ring and pulling ring from box.
4. Remove the three inner rings of packing with the aid of a packing hook.
5. Remove all foreign matter from stuffing box.
6. Install stuffing box packing as described in [3.2 Stuffing box on page 15](#).

7.3 Replacing shaft sleeve

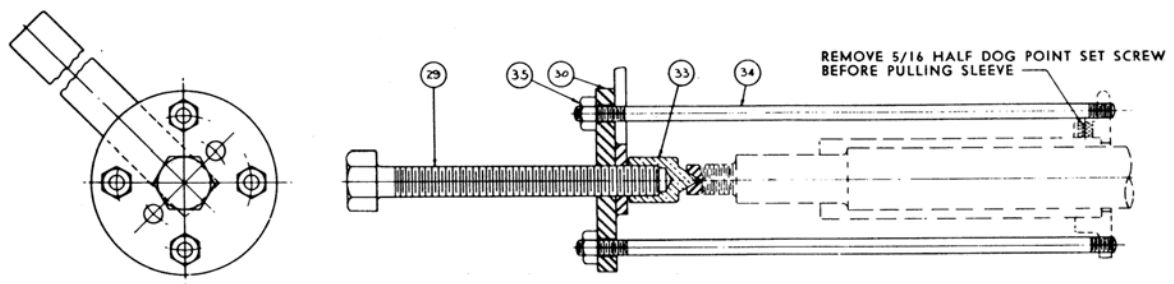
The shaft sleeve must be in good condition to effectively seal the fluid through the stuffing box.

1. Shut off and disconnect all piping including seal piping to stuffing box if supplied.
2. Drain liquid from pump.
3. Unscrew nuts from studs (356) in casing and remove suction cover (182).
4. Remove impeller nut (304) and impeller washer (199) from shaft.
5. By use of a suitable puller similar to that shown in Fig. 4 pull impeller from shaft. (Puller must push against shaft as shown. Do not use a type that pulls from casing). All impellers are provided with two tapped holes to facilitate use of a puller. If key (178) remained in shaft remove it.
6. Remove stuffing box gland (107).
7. Remove bolts (370) and pull casing (100) from motor adapter (108).
8. Remove stuffing box packing and Lantern ring (105) from casing. Retain Lantern ring.
9. Loosen set screw in deflector (123) until deflector will rotate on sleeve.
10. By use of a suitable puller similar to that shown in Fig. 5, pull shaft sleeve (126) from shaft. All deflectors are provided with tapped holes to facilitate use of a puller.
11. Replace deflector on shaft and slide it against motor.
12. Be sure shaft is clean. Place a few drops of oil on shaft and press new shaft sleeve (126) on shaft, being sure that sleeve keyway and shaft keyway are in alignment.
13. Fasten deflector (123) to shaft sleeve (126) by tightening set screw, being sure that point of set screw enters hole in shaft sleeve.



Part No.	Name	Qty.	Material
29	Puller screw	1	Steel
30	Puller plate	1	Steel
31	Impeller puller rods	2	Steel
32	Hex nuts	2	Steel
33	Puller bushing	1	Brass

Figure 6: Parts required to make (1) complete impeller puller



Part No.	Name	Qty.	Material
29	Puller screw	1	Steel
30	Puller plate	1	Steel
33	Puller bushing	1	Brass
34	Sleeve puller rods	4	Steel
35	Hex nuts	4	Steel

Figure 7: Parts required to make (1) complete sleeve puller

14. Slide Lantern ring along shaft sleeve and wire temporarily to deflector (123).
15. Replace casing (100) and bolts (370).
16. Replace impeller key (178) in shaft, being sure that key enters keyway in sleeve.
17. Slide impeller on shaft as far as possible.
18. Using a soft metal hammer, tap evenly on center of impeller until shaft threads protrude beyond impeller.
19. Push impeller on the remaining distance with impeller nut (304) and washer (199).
20. Replace suction cover (182), gasket (351) and nuts on studs (356).
21. Repack stuffing box with new packing as directed in [3.2 Stuffing box on page 15](#).
22. Connect all piping.
23. Start pump as directed in [4 Starting Pump on page 17](#).

7.4 Wearing rings

Casing wearing rings are provided for both hubs of the impeller on some sizes and only on the suction hub on others. Refer to Sectional assembly parts and interchangeability chart. These rings allow a small clearance to be maintained between the rotating impeller and the stationary casing wearing rings. For proper hydraulic performance these clearances should be maintained as indicated below. Ring should be replaced when clearances have worn to those listed under replacement clearance.

Table shows original clearances and suggested replacement clearances as follows:

Ring Bore Dia., In.	Diametrical Clearance, In.	
	Original	Replacement
Under 2" Dia.	0.010-0.014	0.020-0.024
2" to 2-1/2" Dia.	0.011-0.015	0.021-0.025
2-1/2" to 3-1/2" Dia.	0.014-0.018	0.024-0.028
3-1/2" to 4-1/2" Dia.	0.016-0.020	0.026-0.030
Over 4-1/2" Dia.	0.018-0.022	0.028-0.032

To check ring clearances or for replacement proceed as follows:

1. Shut off all piping and disconnect suction piping.
2. Drain liquid from pump.
3. Unscrew nuts from studs (356) and remove cover (182) from casing.

If pump has only a suction wearing ring, as indicated from Sectional assembly parts and interchangeability chart then check outside diameter of impeller hub and inside diameter of casing wearing ring in casing cover.

If pump is designed with two wearing rings:

4. Remove impeller nut (304) and washer (199).
5. By use of a suitable puller similar to that shown in Fig. 4 pull impeller from shaft. (Puller must push against shaft as shown. Do not use a type that pulls from casing). All impellers are provided with two tapped holes to facilitate use of a puller.
6. Check diameters of both hubs and rings. If clearances are excessive, the rings should be replaced. See recommended clearance chart above.
7. Remove rings from cover and casing.
8. Clean bore in which rings seat and press new rings evenly into place.
9. Replace impeller, washer, nut and casing cover all directed in [7.3 Replacing shaft sleeve on page 23](#) Steps 16. through 23..

7.5 Replacing impeller

1. Shut off all piping and disconnect suction piping.
2. Drain liquid from pump.
3. Unscrew nuts on studs (356) and remove suction cover (182) from casing.
4. Remove impeller nut (304) and impeller washer (199) from shaft.
5. By use of a suitable puller similar to that shown in Fig. 4 pull impeller from shaft. (Puller must push against shaft as shown. Do not use a type that pulls from casing). All impellers are provided with two tapped holes to facilitate use of a puller.
6. Check diameters of impeller hubs and wearing rings to determine if new rings are needed. Replace rings in suction cover or casing if necessary. Refer to recommended clearance chart at left.
7. Slide new impeller on shaft as far as possible.

8. Using a soft metal hammer, tap evenly on center of impeller until shaft threads protrude beyond impeller.
9. Push impeller on the remaining distance with impeller nut (304) and washer (199).
10. Replace suction cover (182) and nuts on studs (356) .
11. Connect suction piping.
12. Start pump as directed in [4 Starting Pump on page 17](#).

7.6 Replacing casing

1. Shut off and disconnect all piping including the seal piping if supplied.
2. Drain liquid from pump.
3. Unscrew nuts from studs (356) and remove suction cover (182) from casing.
4. Remove impeller nut (304) and impeller washer (199) from shaft.
5. By use of a suitable puller similar to that shown in Fig. 4 pull impeller from shaft. (Puller must push against shaft as shown. Do not use a type that pulls from casing). All impellers are provided with two tapped holes to facilitate use of a puller.
6. Remove stuffing box gland (107).
7. Unscrew hex head machine bolts (370) and remove casing from motor adapter.
8. Remove old packing and Lantern ring from stuffing box. Discard old packing but replace Lantern ring on shaft sleeve.
9. New casings are supplied with wearing ring if design requires it.
10. Place new casing in position on motor adapter, insert and tighten hex bolts (370).
11. Oil shaft and key.
12. Slide impeller on shaft and key as far as possible.
13. Using a soft metal hammer, tap evenly on center of impeller until shaft threads protrude beyond impeller.
14. Push impeller on the remaining distance with impeller nut (304) and washer (199).
15. Replace suction cover (182), gasket (351) and nuts on studs (356).
16. Connect all piping.
17. Repack stuffing box as directed in [3.2 Stuffing box on page 15](#).
18. Start pump as directed in [4 Starting Pump on page 17](#).

7.7 Spare parts

To ensure against possible long and costly "down-time" periods, especially on critical services it is advisable to have spare parts on hand.

1. One set of group parts should be maintained for every one to three pumps of that particular group size in operation. Pumps of the same group size have all parts interchangeable except casing, suction cover, impeller and wearing rings - see Sectional assembly parts and interchangeability chart. The following is a list of recommended group parts:
 1. Stuffing box packing (106) - 1 set required
 2. Stuffing box gland complete (107) - one required
 3. Impeller Key (178) - one required
 4. Impeller nut (304) - one required
 5. Impeller washer (199) - one required
 6. Shaft sleeve (126) - one required
2. For each size pump it is suggested that one set of wearing rings be maintained.
3. The shaft is a part of the motor.

7.8 Instructions for ordering repair parts

Repair orders will be handled with the minimum of delay if the following directions are followed:

1. Give the Model No., Size of the pump and Serial Number. This data can all be obtained from the nameplate.
2. Write plainly the names, part numbers and material of the parts required. These names and numbers should agree with those on the sectional assembly Sectional assembly parts and interchangeability chart.
3. Give the number of parts required.
4. Give complete shipping instructions.

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