GOULDS PUMPS

Installation, Operation, and Maintenance Manual

Model 3355

ITT

Table of Contents

1 Introduction and Safety

1.1 Introduction

Purpose of this manual

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

- Installation
- Operation
- Maintenance

CAUTION:
Failure to observe the instructions contained in this manual could result in personal injury and/or property damage, and may void the warranty. Read this manual carefully before installing and using the product.

NOTICE:
Save this manual for future reference and keep it readily available.

1.1.1 Requesting other information

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

Always specify the exact product type and serial number when requesting technical information or spare parts.

1.2 Safety

WARNING:

- The operator must be aware of the pumpage and take appropriate safety precautions to prevent physical injury.
- Risk of serious injury or death. If any pressure-containing device is over-pressurized, it can explode, rupture, or discharge its contents. It is critical to take all necessary measures to avoid over-pressurization.
- Risk of death, serious personal injury, and property damage. Installing, operating, or maintaining the unit using any method not prescribed in this manual is prohibited. Prohibited methods include any modification to the equipment or use of parts not provided by ITT. If there is any uncertainty regarding the appropriate use of the equipment, please contact an ITT representative before proceeding.
- Risk of serious personal injury. Applying heat to impellers, propellers, or their retaining devices can cause trapped liquid to rapidly expand and result in a violent explosion. This manual clearly identifies accepted methods for disassembling units. These methods must be adhered to. Never apply heat to aid in their removal unless explicitly stated in this manual.
- Risk of serious personal injury or property damage. Dry running may cause rotating parts within the pump to seize to non-moving parts. Do not run dry.

- Running a pump without safety devices exposes operators to risk of serious personal injury or death. Never operate a unit unless appropriate safety devices (guards, etc.) are properly installed. See specific information about safety devices in other sections of this manual.
- Risk of death, serious personal injury, and property damage. Heat and pressure buildup can cause explosion, rupture, and discharge of pumpage. Never operate the pump with suction and/or discharge valves closed.
- Precautions must be taken to prevent physical injury. The pump may handle hazardous and/or toxic fluids. Proper personal protective equipment should be worn. Pumpage must be handled and disposed of in conformance with applicable environmental regulations.
- If the pump or motor is damaged or leaking, electric shock, fire, explosion, liberation of toxic fumes, physical harm, or environmental damage may result. Do not operate the unit until the problem has been corrected or repaired.

CAUTION:
Risk of injury and/or property damage. Operating a pump in an inappropriate application can cause over pressurization, overheating, and/or unstable operation. Do not change the service application without the approval of an authorized ITT representative.

WARNING:
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

1.2.1 Safety terminology and symbols

About safety messages

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

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

Hazard levels

Hazard level	Indication
 **DANGER:**	A hazardous situation which, if not avoided, will result in death or serious injury
 **WARNING:**	A hazardous situation which, if not avoided, could result in death or serious injury
 **CAUTION:**	A hazardous situation which, if not avoided, could result in minor or moderate injury
NOTICE:	• A potential situation which, if not avoided, could result in undesirable conditions • A practice not related to personal injury

Hazard categories

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

Electrical hazards are indicated by the following specific symbol:

ELECTRICAL HAZARD:

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

- Crush hazard
- Cutting hazard
- Arc flash hazard

1.2.1.1 The Ex symbol

The Ex symbol indicates safety regulations for Ex-approved products when used in atmospheres that are potentially explosive or flammable.

1.2.2 Environmental safety

The work area

Always keep the station clean to avoid and/or discover emissions.

Waste and emissions regulations

Observe these safety regulations regarding waste and emissions:

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

WARNING:
If the product has been contaminated in any way, such as from toxic chemicals or nuclear radiation, do NOT send the product to ITT until it has been properly decontaminated and advise ITT of these conditions before returning.

Electrical installation

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

1.2.3 User safety

General safety rules

These safety rules apply:

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

Safety equipment

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

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

Electrical connections

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

Noise

WARNING:
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.

Temperature

WARNING:
Equipment and piping surfaces may exceed 130ºF (54ºC) 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.

1.2.3.1 Wash the skin and eyes

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

Condition	Action
Chemicals or hazardous fluids in eyes	1. Hold your eyelids apart forcibly with your fingers. 2. Rinse the eyes with eyewash or running water for at least 15 minutes. 3. Seek medical attention.
Chemicals or hazardous fluids on skin	1. Remove contaminated clothing. 2. Wash the skin with soap and water for at least 1 minute. 3. Seek medical attention, if necessary.

1.2.4 Ex-approved products

Follow these special handling instructions if you have an Ex-approved unit.

Personnel requirements

These are the personnel requirements for Ex-approved products in potentially explosive atmospheres:

- All work on the product must be carried out by certified electricians and ITT-authorized mechanics. Special rules apply to installations in explosive atmospheres.
- All users must know about the risks of electric current and the chemical and physical characteristics of the gas, the vapor, or both present in hazardous areas.
- Any maintenance for Ex-approved products must conform to international and national standards.

ITT disclaims all responsibility for work done by untrained and unauthorized personnel.

Product and product handling requirements

These are the product and product handling requirements for Ex-approved products in potentially explosive atmospheres:

- Only use the product in accordance with the approved motor data.
- The Ex-approved product must never run dry during normal operation. Dry running during service and inspection is only permitted outside the classified area.
- Before you start work on the product, make sure that the product and the control panel are isolated from the power supply and the control circuit, so they cannot be energized.
- Do not open the product while it is energized or in an explosive gas atmosphere.
- Make sure that thermal contacts are connected to a protection circuit according to the approval classification of the product, and that they are in use.
- Intrinsically safe circuits are normally required for the automatic level-control system by the level regulator if mounted in zone 0.
- The yield stress of fasteners must be in accordance with the approval drawing and the product specification.
- Do not modify the equipment without approval from an authorized ITT representative.
- Only use parts that are provided by an authorized ITT representative.

- Do not operate the pump in processes that can cause shock waves or adiabatic compression (e.g. high pressure gases or oxidizing gases).

1.2.5 Description of ATEX

The ATEX directives are a specification enforced in Europe for electrical and non-electrical equipment installed in Europe. ATEX deals with the control of potentially explosive atmospheres and the standards of equipment and protective systems used within these atmospheres. The relevance of the ATEX requirements is not limited to Europe. Other explosive directives are mentioned below. You can apply these guidelines to equipment installed in any potentially explosive atmosphere.

1.2.5.1 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).

1.3 Product warranty

Coverage

ITT undertakes to remedy faults in products from ITT under these conditions:

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

Limitations

The warranty does not cover faults caused by these situations:

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

ITT assumes no liability for these situations:

- Bodily injuries
- Material damages
- Economic losses

Warranty claim

ITT products are high-quality products with expected reliable operation and long life. However, should the need arise for a warranty claim, then contact your ITT representative.

2 Transportation and Storage

2.1 Inspect the delivery

2.1.1 Inspect the package

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

2.1.2 Inspect the unit

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

2.2 Transportation guidelines

2.2.1 Precautions

WARNING:

- Stay clear of suspended loads.
- Observe accident prevention regulations in force.

2.2.2 Pump handling and lifting

Precautions for moving the pump

Use care when moving pumps. Consult with a lifting and rigging specialist before lifting or moving the pump to avoid possible damage to the pump or injury to personnel.

WARNING:
Dropping, rolling or tipping units, or applying other shock loads, can cause property damage and/or personal injury. Ensure that the unit is properly supported and secure during lifting and handling.

CAUTION:
Risk of injury or equipment damage from use of inadequate lifting devices. Ensure lifting devices (such as chains, straps, forklifts, cranes, etc.) are rated to sufficient capacity.

Precautions for lifting the pump

WARNING:

- Dropping, rolling or tipping units, or applying other shock loads, can cause property damage and/or personal injury. Ensure that the unit is properly supported and secure during lifting and handling.
- Risk of serious personal injury or equipment damage. Proper lifting practices are critical to safe transport of heavy equipment. Ensure that practices used are in compliance with all applicable regulations and standards.
- Lifting and handling heavy equipment poses a crush hazard. Use caution during lifting and handling and wear appropriate Personal Protective Equipment (PPE, such as steel-toed shoes, gloves, etc.) at all times. Seek assistance if necessary.
- Safe lifting points are specifically identified in this manual. It is critical to lift the equipment only at these points. Integral lifting eyes or eye bolts on pump and motor components are intended for use in lifting the individual components only.

NOTICE:

- Make sure that the lifting equipment supports the entire assembly and is only used by authorized personnel.
- Do not attach sling ropes to shaft ends.

Lifting the pump

Hoist a bare pump using suitable slings under the bearing housing saddle on each end.

Figure 1: Example of the proper lifting method for a bare pump

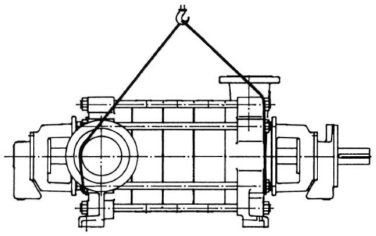


Figure 2: Example of the proper lifting method for a bare pump

Baseplate-mounted units have lifting points for use with proper lifting devices.

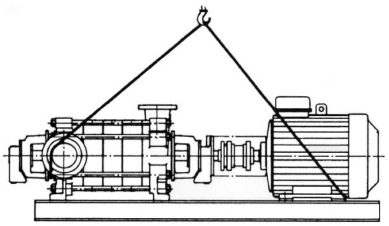


Figure 3: Example of the proper lifting method for baseplate-mounted units with a driver

2.3 Storage guidelines

2.3.1 Storage location

The product must be stored in a covered and dry location free from heat, dirt, and vibrations.

NOTICE:

- Protect the product against humidity, heat sources, and mechanical damage.
- Do not place heavy weights on the packed product.

2.3.2 Pump storage requirements

Storage requirements depend on the amount of time that you store the unit. The normal packaging is designed only to protect the unit during shipping.

Length of time in storage	Storage requirements
Upon receipt/short-term (less than six months)	• Store in a covered and dry location.
Long-term (more than six months)	• Store in a covered and dry location. • Store the unit free from heat, dirt, and vibrations. • Rotate the shaft by hand several times at least every three months.

You can purchase long-term storage treatment with the initial unit order or you can purchase it and apply it after the units are already in the field. Contact your local ITT sales representative.

3 Product Description

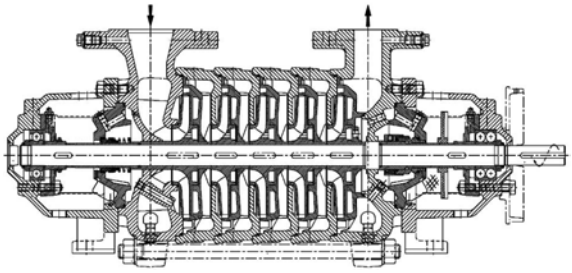
3.1 General description

The Goulds Model 3355 is a radially-split, segmented casing, multistage pump that is designed with modular interstage components. This pump is manufactured in cast iron and 316 stainless steel. This pump can be configured in two ways:

- Radial suction (RS) configuration
- End suction (ES) configuration

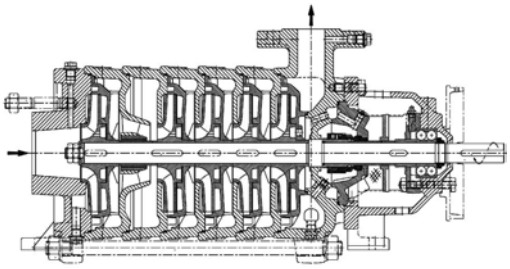
Radial suction configuration

This configuration features radial suction and discharge nozzles. You can position each nozzle either vertically or horizontally at 90° to either side. This design consists of two robust bearing housings with traditional bearings and mechanical seals on each end of the pump.



End suction configuration

This configuration features an end suction nozzle in conjunction with a radial discharge nozzle. You can position the radial discharge nozzle either vertically or horizontally at 90° to either side. The suction end of the pump utilizes a product-lubricated bearing that elminates the need for a second bearing housing and mechanical seal.



Direction of rotation

The standard pump rotation is clockwise. As an option, the radial suction (RS) configuration can be shaft-driven from the suction end in a counterclockwise rotation.

Intended applications

These pumps are well-suited for reverse osmosis and boiler feed applications.

3.1.1 Part description

Casing

The pump consists of three pressure boundary parts:

- Suction casing - available in an end suction (ES) or radial suction (RS) configuration

  The suction casing has 150 or 300 lb. flanges and the discharge casing has 300 or 600 lb. flanges.
- Discharge casing
- Interstage casings - number is dependent on the number of stages

Diffusers

Multi−vane diffusers provide smooth pulsation−free operation and eliminate radial loads in order to increase the life of the bearing. This pump uses a diffuser design that is not an integral part of the interstage casing. Each diffuser is precision machined to perfectly match the impeller hydraulics.

Impeller

The impeller is enclosed and keyed to the shaft. An inducer option is available for the end suction arrangement.

Seal chamber

- The tapered bore seal chamber is self-venting and offers maximum cooling and flushing at the seal face which increases the mechanical seal life.
- The standard seal arrangement features a single-balanced component seal on the discharge end and a single-unbalanced component seal on the suction end of the RS configuration.
- Internal flushing (Plan 01) is standard.
- External piping plans are not required.

Shaft

The shaft is sized to transmit the required power across all operating conditions of the pump. Impeller keyways are staggered in order to maintain a rotational shaft balance.

Shaft sleeves

Renewable shaft sleeves protect the shaft in the seal chamber area which provides a longer shaft life.

Bearings

- Bearings are grease lubricated.
- The thrust bearing consists of:
  - A double-row thrust bearing for pump sizes 1.5 x 2.5−7 and 2.5 x 4−8
  - Two angular contact ball bearings for pump sizes 4 x 5−10 and 5 x 6−11

  These thrust bearing configurations provide bi-directional load-carrying capability.
- The RS configuration uses a grease-lubricated radial ball bearing.
- The ES configuration uses a product−lubricated radial bearing located between the first and second stages.

Baseplate

The pump and motor are mounted on a common baseplate. The rigid, fabricated steel design reduces vibration and helps to maintain the positive alignment of the pump and motor.

Couplings

The standard baseplate design facilitates non−spacer couplings.

Coupling guard

Steel coupling guards are available and are designed to comply with OSHA requirements.

3.2 Nameplate information

Important information for ordering

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

When you order spare parts, identify this pump information:

- Model
- Size
- Serial number
- Item numbers of the required parts

Item numbers can be found in the spare parts list.

Refer to the nameplate on the pump casing for most of the information. See Parts List for item numbers.

Nameplate types

Nameplate	Description
Pump casing	Provides information about the hydraulic characteristics of the pump.
Pump	The formula for the pump size is: Discharge x Suction - Nominal Maximum Impeller Diameter in inches. (Example: 2x3-8)
Ex	If applicable, your pump unit might have an Ex nameplate affixed to the pump, the baseplate, or the discharge head. The nameplate provides information about the Ex specifications of this pump.

Nameplate on the pump casing using English units

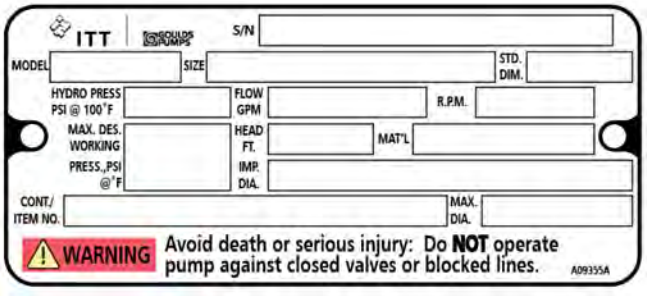


Figure 4: Nameplate on the pump casing using English units

Table 1: Explanation of nameplate on the pump casing

Nameplate field	Explanation
IMPLR. DIA.	Impeller diameter, in inches
MAX. DIA.	Maximum impeller diameter, in inches

Nameplate field	Explanation
GPM	Rated pump flow, in gallons per minute
FT HD	Rated pump head, in feet
RPM	Rated pump speed, revolutions per minute
MOD.	Pump model
SIZE	Size of the pump
STD. NO.	ANSI standard designation
MAT L. CONST.	Material of which the pump is constructed
SER. NO.	Serial number of the pump
MAX DSGN PSI @ 100ºF	Maximum pressure at 100ºF according to the pump design

Nameplate on the pump casing using metric units

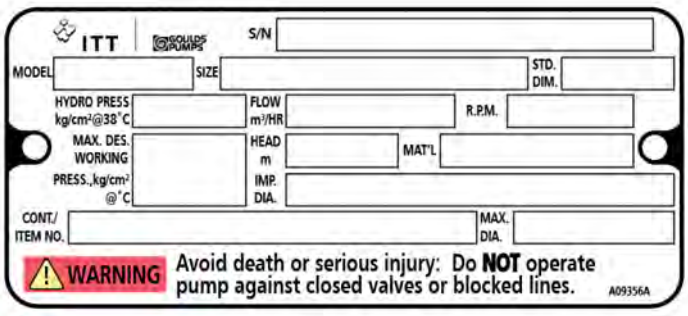


Figure 5: Nameplate on pump casing using metric units

Table 2: Explanation of the nameplate on the pump casing

Nameplate field	Explanation
IMPLR. DIA.	Impeller diameter
MAX. DIA.	Maximum impeller diameter
M^3/HR	Rated pump flow, in cubic meters per hour
M HD	Rated pump head, in meters
RPM	Rated pump speed, in revolutions per minute
MOD.	Pump model
SIZE	Size of the pump
STD. NO.	
MAT L. CONST	Material of which the pump is constructed
SER. NO.	Serial number of the pump
MAX. DSGN KG/CM^3 @ 20°C	Kilograms per cubic centimeter at 20°C

Ex nameplate

Figure 6: Ex nameplate

Nameplate field	Explanation
II	Group 2
2	Category 2
G/D	Use when gas and dust are present
T4	Temperature class

The code classification marked on the equipment should be in accordance with the specified area where the equipment will be installed. If it is not, please contact your ITT/Goulds representative before proceeding.

WARNING:
Use of equipment unsuitable for the environment can pose risks of ignition and/or explosion. Ensure the pump driver and all other auxiliary components meet the required area classification at the site. If they are not compatible, do not operate the equipment and contact an ITT representative before proceeding.

4 Installation

4.1 Pre-installation

Precautions

WARNING:

- When installing in a potentially explosive environment, ensure that the motor is properly certified.
- All equipment being installed must be properly grounded to prevent unexpected discharge. Discharge can cause equipment damage, electric shock, and result in serious injury. Test the ground lead to verify it is connected correctly.

NOTICE:

- Electrical connections must be made by certified electricians in compliance with all international, national, state and local regulations.
- Supervision by an authorized ITT representative is recommended to ensure proper installation. Improper installation may result in equipment damage or decreased performance.

4.1.1 Pump location guidelines

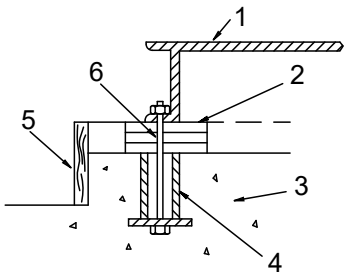
Guideline	Explanation/comment
Keep the pump as close to the liquid source as practically possible.	This minimizes the friction loss and keeps the suction piping as short as possible.
Make sure that the space around the pump is sufficient. A minimum of 1 meter | 3 feet is the recommendation.	This facilitates ventilation, inspection, maintenance, and service.
If you require lifting equipment such as a hoist or tackle, make sure that there is enough space above the pump.	This makes it easier to properly use the lifting equipment and safely remove and relocate the components to a safe location.
Protect the unit from weather and water damage due to rain, flooding, and freezing temperatures.	This is applicable if nothing else is specified.
Do not install and operate the equipment in closed systems unless the system is constructed with properly-sized safety devices and control devices.	Acceptable devices: • Pressure relief valves • Compression tanks • Pressure controls • Temperature controls • Flow controls If the system does not include these devices, consult the engineer or architect in charge before you operate the pump.
Take into consideration the occurrence of unwanted noise and vibration.	The best pump location for noise and vibration absorption is on a concrete floor with subsoil underneath.

4.1.2 Foundation requirements

Requirements

- The location and size of the foundation bolt holes must match those shown on the assembly drawing provided with the pump data package.
- The foundation must weigh between two and three times the weight of the complete pump, baseplate, and drive assembly.
- Provide a flat, substantial concrete foundation in order to prevent strain and distortion when you tighten the foundation bolts.

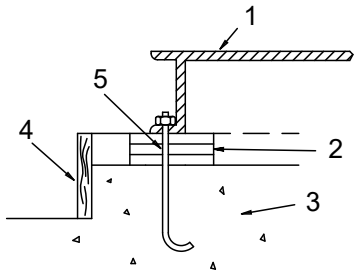
Sleeve-type bolts



Item	Description
1.	Baseplate
2.	Shims
3.	Foundation
4.	Sleeve
5.	Dam
6.	Bolt

Figure 7: Sleeve type bolts

J-type bolts



Item	Description
1.	Baseplate
2.	Shims or wedges
3.	Foundation
4.	Dam
5.	Bolt

Figure 8: J-type bolts

4.2 Baseplate-mounting procedures

4.2.1 Prepare the baseplate for mounting

1. Remove all the attached equipment from the baseplate.
2. Clean the underside of the baseplate completely.
3. If applicable, coat the underside of the baseplate with an epoxy primer.
   Use an epoxy primer only if using an epoxy-based grout.
4. Remove the rust-proofing coat from the machined mounting pads using an appropriate solvent.
5. Remove water and debris from the foundation-bolt holes.

4.2.2 Install the baseplate using shims or wedges

Required tools:

- Two sets of shims or wedges for each foundation bolt
- Two machinist's levels
- Baseplate-leveling worksheet

1. If you use sleeve-type bolts, fill the bolt sleeves with packing material or rags to prevent grout from entering the bolt holes.
2. Put the sets of wedges or shims on each side of each foundation bolt.
   Make sure that the wedges extend 19 mm | 0.75 in. to 38 mm | 1.5 in. above the foundation to provide adequate space for grouting. The wedges will provide adequate support for the baseplate after it is grouted.
3. Lower the baseplate carefully onto the foundation bolts.
4. Put the machinist's levels across the mounting pads of the driver and the mounting pads of the pump.

   NOTICE:

   Remove all dirt from the mounting pads in order to ensure that the correct leveling is achieved. Failure to do so can result in equipment damage or decreased performance.

5. Level the baseplate both lengthwise and across by adding or removing shims or moving the wedges.

   These are the leveling tolerances:

   - A maximum difference of 0.250 mm | 0.010 in. lengthwise
   - A maximum difference of 0.125 mm | 0.005 in. across

   You can use the baseplate-leveling worksheet when you take the readings.
6. Hand-tighten the nuts for the foundation.

4.2.3 Install the baseplate using jackscrews

Tools required:

- Anti-seize compound
- Jackscrews
- Bar stock
- Two machinist's levels

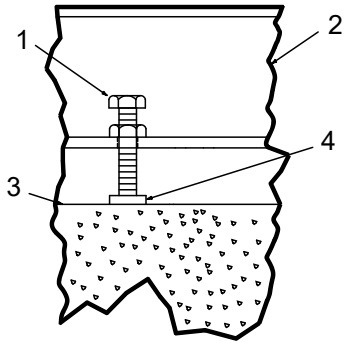
1. Apply an anti-seize compound on the jackscrews.
   The compound makes it easier to remove the screws after you grout.
2. Lower the baseplate carefully onto the foundation bolts and perform these steps:

a) Cut the plates from the bar stock and chamfer the edges of the plates in order to reduce stress concentrations.

b) Put the plates between the jackscrews and the foundation surface.

c) Use the four jackscrews in the corners in order to raise the baseplate above the foundation.

d) Make sure that the center jackscrews do not touch the foundation surface yet.



Item	Description
1.	Jackscrew
2.	Baseplate
3.	Foundation
4.	Plate

Figure 9: Jackscrews

3. Level the driver mounting pads:

NOTICE:

Remove all dirt from the mounting pads in order to ensure that the correct leveling is achieved. Failure to do so can result in equipment damage or decreased performance.

---

a) Put one machinist's level lengthwise on one of the two pads.

b) Put the other machinist's level across the ends of the two pads.

c) Level the pads by adjusting the four jackscrews in the corners.

Make sure that the machinist's level readings are as close to zero as possible, both lengthwise and across.

4. Turn the center jackscrews down so that they rest on their plates on the foundation surface.
5. Level the pump mounting pads:

NOTICE:

Remove all dirt from the mounting pads in order to ensure that the correct leveling is achieved. Failure to do so can result in equipment damage or decreased performance.

---

a) Put one machinist's level lengthwise on one of the two pads.

b) Put the other level across the center of the two pads.

c) Level the pads by adjusting the four jackscrews in the corners.

Make sure that the machinist's level readings are as close to zero as possible, both lengthwise and across.

6. Hand-tighten the nuts for the foundation bolts.
7. Check that the driver's mounting pads are level and adjust the jackscrews and the foundation bolts if necessary.

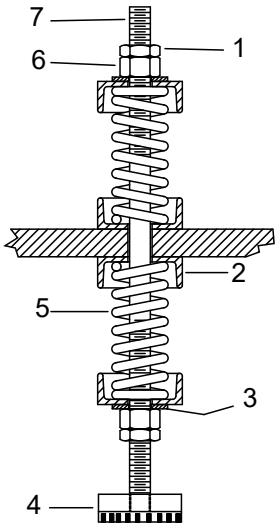
4.2.4 Install the baseplate using spring mounting

NOTICE:
The spring-mounted baseplate is designed only to support piping loads from thermal expansion. Ensure that the suction and discharge piping are supported individually. Failure to do so may result in equipment damage.

The foundation pads are not provided with the baseplate. Make sure that the foundation pads are 316 stainless-steel plates, which have a 16-20 micro-inch surface finish.

Before you start this procedure, make sure that the foundation pads are correctly installed on the foundation/floor (see the manufacturer's instructions).

1. Put the baseplate on a support above the foundation/floor.
   Make sure that there is enough space between the baseplate and the foundation/floor in order to install the spring assemblies.
2. Install the lower part of the spring assembly:
   a) Screw the lower jam nut onto the spring stud.
   b) Screw the lower adjusting nut onto the spring-stud, on top of the jam nut.
   c) Set the lower adjusting nut to the correct height.
   The correct height depends on the required distance between the foundation/floor and the baseplate.
   d) Put a washer, a follower, a spring, and one more follower onto the lower adjusting nut.
3. Install the spring assembly on the baseplate:
   a) Insert the spring assembly into the baseplate's anchorage hole from below.
   b) Put a follower, a spring, another follower, and a washer onto the spring stud.
   c) Fasten the spring assembly with the upper adjusting nut by hand.
4. Thread the upper jam nut onto the spring stud by hand.
5. Repeat steps 2 through 4 for all the spring assemblies.
6. Lower the baseplate so that the spring assemblies fit into the foundation pads.
7. Level the baseplate and make the final height adjustments:
   a) Loosen the upper jam nuts and adjusting nuts.
   b) Adjust the height and level the baseplate by moving the lower adjusting nuts.
   c) When the baseplate is level, tighten the top adjusting nuts so that the top springs are not loose in their followers.
8. Fasten the lower and upper jam nuts on each spring assembly.



1. Upper jam nut
2. Follower
3. Washer
4. Foundation pads
5. Spring
6. Upper adjusting nut
7. Spring stud

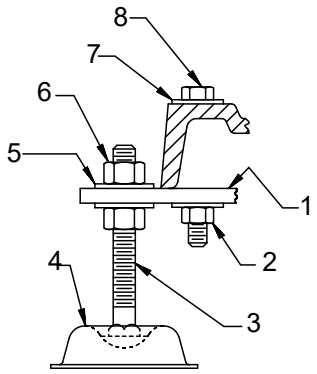
Figure 10: Example of an installed spring assembly

4.2.5 Install the baseplate using stilt mounting

NOTICE:
The stilt-mounted baseplate is not designed to support static piping loads. Ensure that the suction and discharge piping are supported individually. Failure to do so may result in equipment damage.

1. Put the baseplate on a support above the foundation/floor.
   Make sure that there is enough space between the baseplate and the foundation/floor to install the stilts.
2. Install the lower part of the stilt assembly:
   a) Screw the lower jam nut and adjusting nut onto the stilt.
   b) Set the lower adjusting nut to the correct height.
   The correct height depends on the required distance between the foundation/floor and the baseplate.
   c) Put a washer onto the lower adjusting- nut.
3. Install the stilt assembly on the baseplate:
   a) Insert the stilt assembly into the baseplate's anchorage hole from below.
   b) Put a washer onto the stilt.
   c) Fasten the stilt assembly with the upper adjusting nut by hand.
4. Screw the upper jam nut onto the stilt by hand.
5. Repeat steps 2 through 4 for all the stilt assemblies.

6. Lower the baseplate so that the stilts fit into the foundation cups.
7. Level the baseplate and make the final height adjustments:
   a) Loosen the upper jam nuts and adjusting nuts.
   b) Adjust the height and level the baseplate by moving the lower adjusting nuts.
   c) When the baseplate is level, tighten the top adjusting nuts.
8. Fasten the lower and upper jam nuts on each stilt.

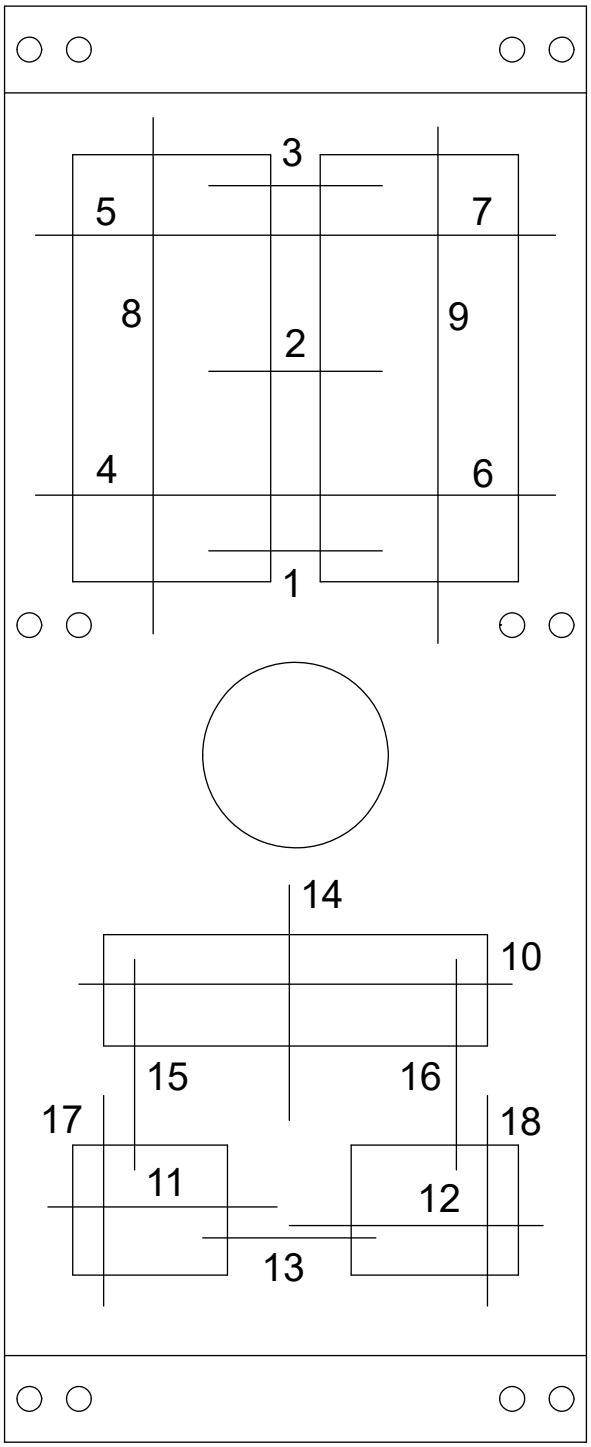


1. Mounting plate
2. Mounting nut
3. Stilt bolt
4. Foundation cups
5. Washer
6. Upper adjustment nut
7. Mounting washer
8. Mounting bolt

Figure 11: Example of an installed stilt assembly

4.2.6 Baseplate-leveling worksheet

Level measurements



1)_____

2)_____

3)_____

4)_____

5)_____

6)_____

7)_____

8)_____

9)_____

10)_____

11)_____

12)_____

13)_____

14)_____

15)_____

16)_____

17)_____

18)_____

4.3 Pump-to-driver alignment

Precautions

WARNING:

- Failure to disconnect and lock out driver power may result in serious physical injury or death. Always disconnect and lock out power to the driver before performing any installation or maintenance tasks.
  - Electrical connections must be made by certified electricians in compliance with all international, national, state, and local rules.
  - Refer to driver/coupling/gear manufacturer's installation and operation manuals (IOM) for specific instructions and recommendations.

4.3.1 Alignment checks

When to perform alignment checks

You must perform alignment checks under these circumstances:

- The process temperature changes.
- The piping changes.
- The pump has been serviced.

Types of alignment checks

Type of check	When it is used
Initial alignment (cold alignment) check	Prior to operation when the pump and the driver are at ambient temperature.
Final alignment (hot alignment) check	After operation when the pump and the driver are at operating temperature.

Initial alignment (cold alignment) checks

When	Why
Before you grout the baseplate	This ensures that alignment can be accomplished.
After you grout the baseplate	This ensures that no changes have occurred during the grouting process.
After you connect the piping	This ensures that pipe strains have not altered the alignment. If changes have occurred, you must alter the piping to remove pipe strains on the pump flanges.

Final alignment (hot alignment) checks

When	Why
After the first run	This ensures correct alignment when both the pump and the driver are at operating temperature.
Periodically	This follows the plant operating procedures.

4.3.2 Permitted indicator values for alignment checks

NOTICE:
The specified permitted reading values are valid only at operating temperature. For cold settings, other values are permitted. The correct tolerances must be used. Failure to do so can result in misalignment. Contact ITT for further information.

When dial indicators are used to check the final alignment, the pump and drive unit are correctly aligned when these conditions are true:

- The Total Indicated Reading (T.I.R.) is at 0.05 mm | 0.002 in. or less at operating temperature.
- The tolerance of the indicator is 0.0127 mm per mm | 0.0005 in. per in. of indicator separation for the reverse dial indicator or laser method when the pump and driver are at operating temperature.

4.3.3 Alignment measurement guidelines

Guideline	Explanation
Rotate the pump coupling half and the driver coupling half together so that the indicator rods have contact with the same points on the driver coupling half.	This prevents incorrect measurement.
Move or shim only the driver in order to make adjustments.	This prevents strain on the piping installations.
Make sure that the hold-down bolts for the driver are tight when you take indicator measurements.	This keeps the driver stationary since movement causes incorrect measurement.
Make sure that the hold-down bolts for the driver are loose before you make alignment corrections.	This makes it possible to move the driver when you make alignment corrections.
Check the alignment again after any mechanical adjustments.	This corrects any misalignments that an adjustment may have caused.

4.3.4 Attach the dial indicators for alignment

You must have two dial indicators in order to complete this procedure.

1. Attach two dial indicators on the pump coupling half (X):
   a) Attach one indicator (P) so that the indicator rod comes into contact with the perimeter of the driver coupling half (Y).
   This indicator is used to measure parallel misalignment.
   b) Attach the other indicator (A) so that the indicator rod comes into contact with the inner end of the driver coupling half.
   This indicator is used to measure angular misalignment.
2. Rotate the pump coupling half (X) in order to check that the indicators are in contact with the driver coupling half (Y) but do not bottom out.
3. Adjust the indicators if necessary.

4.3.5 Pump-to-driver alignment instructions

4.3.5.1 Perform angular alignment for a vertical correction

1. Set the angular alignment indicator to zero at the top-center position (12 o'clock) of the driver coupling half (Y).
2. Rotate the indicator to the bottom-center position (6 o'clock).
3. Record the indicator reading.

When the reading value is...	Then...
Negative	The coupling halves are farther apart at the bottom than at the top. Perform one of these steps: • Add shims in order to raise the feet of the driver at the shaft end. • Remove shims in order to lower the feet of the driver at the other end.
Positive	The coupling halves are closer at the bottom than at the top. Perform one of these steps: • Remove shims in order to lower the feet of the driver at the shaft end. • Add shims in order to raise the feet of the driver at the other end.

4.3.5.2 Perform angular alignment for a horizontal correction

1. Set the angular alignment indicator (A) to zero on left side of the driver coupling half (Y), 90° from the top-center position (9 o'clock).
2. Rotate the indicator through the top-center position to the right side, 180° from the start position (3 o'clock).
3. Record the indicator reading.

When the reading value is...	Then...
Negative	The coupling halves are farther apart on the right side than the left. Perform one of these steps: • Slide the shaft end of the driver to the left. • Slide the opposite end to the right.
Positive	The coupling halves are closer together on the right side than the left. Perform one of these steps: • Slide the shaft end of the driver to the right. • Slide the opposite end to the left.

4.3.5.3 Perform parallel alignment for a vertical correction

Before you start this procedure, make sure that the dial indicators are correctly set up.

A unit is in parallel alignment when the parallel indicator (P) does not vary by more than as measured at four points 90° apart at the operating temperature.

1. Set the parallel alignment indicator (P) to zero at the top-center position (12 o'clock) of the driver coupling half (Y).
2. Rotate the indicator to the bottom-center position (6 o'clock).
3. Record the indicator reading.

When the reading value is...	Then...
Negative	The pump coupling half (X) is lower than the driver coupling half (Y). Remove shims of a thickness equal to half of the indicator reading value under each driver foot.
Positive	The pump coupling half (X) is higher than the driver coupling half (Y). Add shims of a thickness equal to half of the indicator reading value to each driver foot.

4. Repeat the previous steps until the permitted reading value is achieved.

NOTICE:

The specified permitted reading values are valid only at operating temperature. For cold settings, other values are permitted. The correct tolerances must be used. Failure to do so can result in misalignment. Contact ITT for further information.

4.3.5.4 Perform parallel alignment for a horizontal correction

A unit is in parallel alignment when the parallel indicator (P) does not vary by more than as measured at four points 90° apart at the operating temperature.

1. Set the parallel alignment indicator (P) to zero on the left side of the driver coupling half (Y), 90° from the top-center position (9 o'clock).
2. Rotate the indicator through the top-center position to the right side, 180° from the start position (3 o'clock).
3. Record the indicator reading.

When the reading value is...	Then...
Negative	The driver coupling half (Y) is to the left of the pump coupling half (X).
Positive	The driver coupling half (Y) is to the right of the pump coupling half (X).

4. Slide the driver carefully in the appropriate direction.

NOTICE:

Make sure to slide the driver evenly. Failure to do so can negatively affect horizontal angular correction.

5. Repeat the previous steps until the permitted reading value is achieved.

4.3.5.5 Perform complete alignment for a vertical correction

1. Set the angular and parallel dial indicators to zero at the top-center position (12 o'clock) of the driver coupling half (Y).
2. Rotate the indicators to the bottom-center position (6 o'clock).
3. Record the indicator readings.
4. Make corrections according to the separate instructions for angular and parallel alignment until you obtain the permitted reading values.

4.3.5.6 Perform complete alignment for a horizontal correction

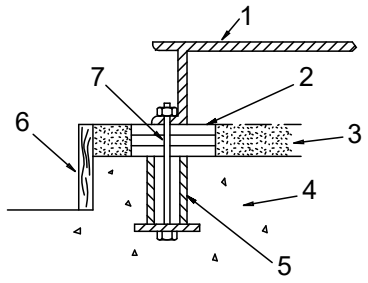
1. Set the angular and parallel dial indicators to zero at the left side of the driver coupling half (Y), 90° from the top-center position (9 o'clock).
2. Rotate the indicators through the top-center position to the right side, 180° from the start position (3 o'clock).
3. Record the indicator readings.
4. Make corrections according to the separate instructions for angular and parallel alignment until you obtain the permitted reading values.

4.4 Grout the baseplate

Required equipment:

- Cleaners: Do not use an oil-based cleaner because the grout will not bond to it. See the instructions provided by the grout manufacturer.

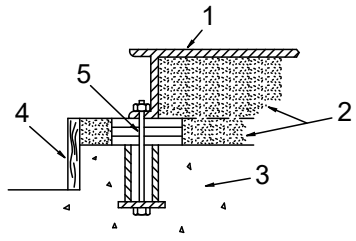
1. Clean all the areas of the baseplate that will come into contact with the grout.
2. Build a dam around the foundation.
3. Thoroughly wet the foundation that will come into contact with the grout.
4. Pour grout through the grout hole into the baseplate up to the level of the dam.
   When you pour the grout, remove air bubbles from it by using one of these methods:
   - Puddle with a vibrator.
   - Pump the grout into place.
5. Allow the grout to set.



Item	Description
1.	Baseplate
2.	Shims or wedges
3.	Grout
4.	Foundation
5.	Sleeve
6.	Dam
7.	Bolt

Figure 12: Pour grout into baseplate

6. Fill the remainder of the baseplate with grout, and allow the grout to set for at least 48 hours.



Item	Description
1.	Baseplate
2.	Grout
3.	Foundation
4.	Dam
5.	Bolt

Figure 13: Fill remainder of baseplate with grout

7. Tighten the foundation bolts.
8. Recheck the alignment.

4.5 Piping checklists

4.5.1 Fastening

WARNING:
Risk of serious personal injury or property damage. Fasteners such as bolts and nuts are critical to the safe and reliable operation of the product. Ensure appropriate use of fasteners during installation or reassembly of the unit.

- Use fasteners of the proper size and material only.
- Replace all corroded fasteners.
- Ensure that all fasteners are properly tightened and that there are no missing fasteners.

4.5.2 General piping checklist

Precautions

WARNING:

- Risk of premature failure. Casing deformation can result in misalignment and contact with rotating parts, causing excess heat generation and sparks. Flange loads from the piping system, including those from the thermal expansion of the piping, must not exceed the limits of the pump.
- Risk of serious personal injury or property damage. Fasteners such as bolts and nuts are critical to the safe and reliable operation of the product. Ensure appropriate use of fasteners during installation or reassembly of the unit.
  - Use fasteners of the proper size and material only.
  - Replace all corroded fasteners.
  - Ensure that all fasteners are properly tightened and that there are no missing fasteners.

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

CAUTION:
Never draw piping into place at the flanged connections of the pump. This can impose dangerous strains on the unit and cause misalignment between the pump and driver. Pipe strain adversely affects the operation of the pump, which results in physical injury and damage to the equipment.

Ex Flange loads from the piping system, including those from the 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.

NOTICE:
Vary the capacity with the regulating valve in the discharge line. Never throttle the flow from the suction side. This action can result in decreased performance, unexpected heat generation, and equipment damage.

Piping guidelines

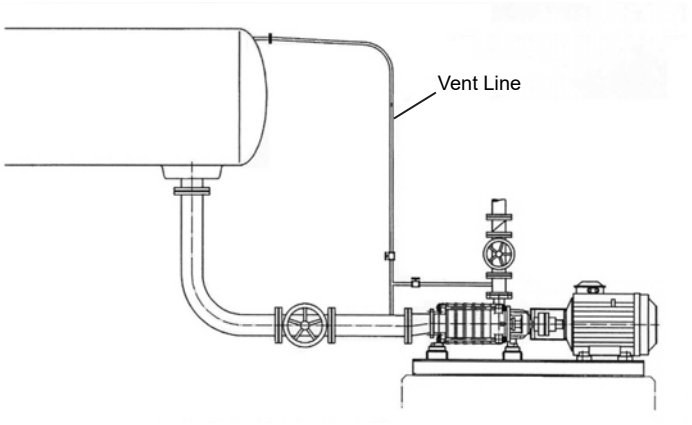
Guidelines for piping are given in the Hydraulic Institute Standards available from the Hydraulic Institute at 9 Sylvan Way, Parsippany, NJ 07054-3802. You must review this document before you install the pump.

Checklist

Check	Explanation/comment	Checked
Check that all piping is supported independently of, and lined up naturally with, the pump flange.	• Strain on the pump • Misalignment between the pump and the drive unit	
Keep the piping as short as possible.	This helps to minimize friction losses.	
Keep the piping as straight as possible. Avoid unnecessary bends. Use 45° or long radius 90° fittings where necessary.	This helps to minimize friction losses.	
Check that only necessary fittings are used.	This helps to minimize friction losses.	
Make sure that the inside diameters match properly when you use flange joints.	—	
Do not connect the piping to the pump until: • The grout for the baseplate or sub-base becomes hard. • The grout for the pit cover becomes hard. • The hold-down bolts for the pump and the driver are tightened.	—	
Make sure that all the piping joints and fittings are airtight.		
If the pump handles corrosive fluids, make sure that the piping allows you to flush out the liquid before you remove the pump.		
Make sure that all piping components, valves and fittings, and pump branches are clean prior to assembly.	—	
Make sure that the isolation and check valves are installed in the discharge line.	Locate the check valve between the isolation valve and the pump. This will permit inspection of the check valve. The isolation valve is required for regulation of flow, and for inspection and maintenance of the pump. The check valve prevents pump or seal damage due to reverse flow through the pump when the driver is turned off.	
Use cushioning devices.	This protects the pump from surges and water hammer if quick-closing valves are installed in the system.	

Check	Explanation/comment	Checked
In no case should loads on the pump flanges exceed the limits stated in API Standard 610, 11th Edition (ISO 13709).	Bottom of casing should be supported by a solid foundation or casing feet should be used.	

Example: Piping installation with a vent line



4.5.3 Suction-piping checklist

Performance curve reference

Net positive suction head available ($NPSH_A$) must always exceed NPSH required ($NPSH_R$) as shown on the published performance curve of the pump.

Suction-piping checks

Check	Explanation/comment	Checked
Check that the distance between the inlet flange of the pump and the closest elbow is at least two pipe diameters.	This minimizes the risk of cavitation in the suction inlet of the pump due to turbulence.	
Check that elbows in general do not have sharp bends.	—	
Check that the suction piping is one or two sizes larger than the suction inlet of the pump. Install an eccentric reducer between the pump inlet and the suction piping.	The suction piping must never have a smaller diameter than the suction inlet of the pump.	
Check that the eccentric reducer at the suction flange of the pump has the following properties: • Sloping side down • Horizontal side at the top		

Check	Explanation/comment	Checked
Suggested suction strainers are used. Check that they are at least three times the area of the suction piping. Monitor the pressure drop across the suction strainer. An increased pressure drop across the strainer of 34.5 kPa | 5 psi indicates that the strainer should be removed and cleaned. After a period of time (24 hours minimum) system flushing should be complete and the suction strainer can be removed.	Suction strainers help to prevent debris from entering the pump. Mesh holes with a minimum diameter of 1.6 mm | 1/16 in. are recommended. Liquids with specific gravity less than 0.60 a pressure drop across the suction strainer may be due to ice buildup. Ice buildup can cause turbulence, low pressure areas and pumpage vaporization.	
If more than one pump operates from the same liquid source, check that separate suction-piping lines are used for each pump.	This recommendation helps you to achieve a higher pump performance and prevent vapor locking especially with specific gravity of liquid less than 0.60.	
If necessary, make sure that the suction piping includes a drain valve and that it is correctly installed.	—	
Assure adequate insulation is applied for liquids with specific gravity less than 0.60.	To assure sufficient NPSHa.	

Liquid source below the pump

Check	Explanation/comment	Checked
Make sure that the suction piping is free from air pockets.	This helps to prevent the occurrence of air and cavitation in the pump inlet.	
Check that the suction piping slopes upwards from the liquid source to the pump inlet.	—	
If the pump is not self-priming, check that a device for priming the pump is installed.	Use a foot valve with a diameter that is at least equivalent to the diameter of the suction piping.	

Liquid source above the pump

Check	Explanation/comment	Checked
Check that an isolation valve is installed in the suction piping at a distance of at least two times the pipe diameter from the suction inlet.	This permits you to close the line during pump inspection and maintenance. Do not use the isolation valve to throttle the pump. Throttling can cause these problems: • Loss of priming • Excessive temperatures • Damage to the pump • Voiding the warranty	
Make sure that the suction piping is free from air pockets.	This helps to prevent the occurrence of air and cavitation in the pump inlet.	
Check that the piping is level or slopes downward from the liquid source.	—	
Make sure that no part of the suction piping extends below the suction flange of the pump.	—	

Check	Explanation/comment	Checked
Make sure that the suction piping is adequately submerged below the surface of the liquid source.	This prevents air from entering the pump through a suction vortex.	

4.5.4 Discharge piping checklist

Checklist

Check	Explanation/comment	Checked
Check that an isolation valve is installed in the discharge line. For specific gravity less than 0.60, minimize distance from pump discharge.	The isolation valve is required for: • Priming • Regulation of flow • Inspection and maintenance of the pump • Reduce risk of pumpage vaporization and vapor locking at low flow rates for low specific gravity liquids.	
Check that a check valve is installed in the discharge line, between the isolation valve and the pump discharge outlet.	The location between the isolation valve and the pump allows inspection of the check valve. The check valve prevents damage to the pump and seal due to the back flow through the pump, when the drive unit is shut off. It is also used to restrain the liquid flow.	
If increasers are used, check that they are installed between the pump and the check valve.		
If quick-closing valves are installed in the system, check that cushioning devices are used.	This protects the pump from surges and water hammer.	

4.5.5 Final piping checklist

Check	Explanation/comment	Checked
Check that the shaft rotates smoothly.	Rotate the shaft by hand. Make sure there is no rubbing that can lead to excess heat generation or sparks.	
Re-check the alignment to make sure that pipe strain has not caused any misalignment.	If pipe strain exists, then correct the piping.	

5 Commissioning, Startup, Operation, and Shutdown

5.1 Preparation for startup

WARNING:

- Risk of serious physical injury or death. Exceeding any of the pump operating limits (e.g. - pressure, temperature, power, etc.) could result in equipment failure, such as explosion, seizure, or breach of containment. Assure that the system operating conditions are within the capabilities of the pump.
- Risk of death or serious injury. Leaking fluid can cause fire and/or burns. Ensure all openings are sealed prior to filling the pump.
- Breach of containment can cause fire, burns, and other serious injury. Failure to follow these precautions before starting the unit may lead to dangerous operating conditions, equipment failure, and breach of containment.
- Risk of explosion and serious physical injury. Do not operate pump with blocked system piping or with suction or discharge valves closed. This can result in rapid heating and vaporization of pumpage.
- Risk of serious injury or death. If any pressure-containing device is over-pressurized, it can explode, rupture, or discharge its contents. It is critical to take all necessary measures to avoid over-pressurization.
- Risk of breach of containment and equipment damage. Ensure the pump operates only between minimum and maximum rated flows. Operation outside of these limits can cause high vibration, mechanical seal and/or shaft failure, and/or loss of prime.

WARNING:

- Risk of death, serious personal injury, and property damage. Heat and pressure buildup can cause explosion, rupture, and discharge of pumpage. Never operate the pump with suction and/or discharge valves closed.
- Running a pump without safety devices exposes operators to risk of serious personal injury or death. Never operate a unit unless appropriate safety devices (guards, etc.) are properly installed.
-  The coupling used in an Ex classified environment must be properly certified.
- Failure to disconnect and lock out driver power may result in serious physical injury or death. Always disconnect and lock out power to the driver before performing any installation or maintenance tasks.
    - Electrical connections must be made by certified electricians in compliance with all international, national, state, and local rules.
    - Refer to driver/coupling/gear manufacturer's installation and operation manuals (IOM) for specific instructions and recommendations.

-  Risk of explosive hazard and premature failure from sparks and heat generation. Ensure bearings are properly lubricated prior to startup.
- Risk of seizure, breach of containment, or explosion. Ensure balance line is installed and piped back to either the pump suction or suction vessel. This prevents rapid vaporization of the pumped fluid.

Precautions

WARNING:
The mechanical seal used in an Ex-classified environment must be properly certified.

CAUTION:
When a cartridge mechanical seal is used, ensure that the set screws in the seal locking ring are tightened and that the centering clips have been removed prior to startup. This prevents seal or shaft sleeve damage by ensuring that the seal is properly installed and centered on the sleeve.

NOTICE:

- Verify the driver settings before you start any pump. Refer to the applicable drive equipment IOMs and operating procedures.

NOTICE:
You must follow these precautions before you start the pump:

- Flush and clean the system thoroughly to remove dirt or debris in the pipe system in order to prevent premature failure at initial startup.
- Bring variable-speed drivers to the rated speed as quickly as possible.
- If temperatures of the pumped fluid will exceed 93°C | 200°F, then warm up the pump prior to operation. Circulate a small amount of fluid through the pump until the casing temperature is within 38°C | 100°F of the fluid temperature. Accomplish this by flowing fluid from pump inlet to discharge drain (optionally, the casing vent can be included in warm-up circuit but not required). Soak for (2) hours at process fluid temperature.

At initial startup, do not adjust the variable-speed drivers or check for speed governor or over-speed trip settings while the variable-speed driver is coupled to the pump. If the settings have not been verified, then uncouple the unit and refer to instructions supplied by the driver manufacturer.

5.2 Remove the coupling guard

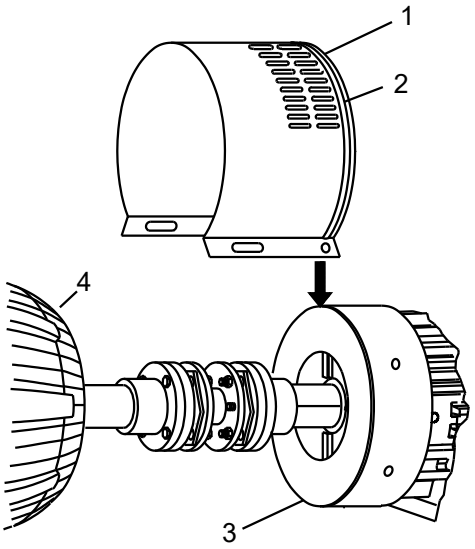
1. Remove the nut, bolt, retainer and washer from the slotted hole in the center of the coupling guard.
2. Slide the driver half of the coupling guard toward the pump.
3. Remove the nut, bolt, retainer and washer from the driver half of the coupling guard.
4. Remove the driver half of the coupling guard:
   a) Slightly spread the bottom apart.

b) Lift upwards.

5. Remove the remaining nut, bolt, retainer and washer from the pump half of the coupling guard. It is not necessary to remove the end plate from the pump side of the bearing housing. You can access the bearing-housing tap bolts without removing this end plate if maintenance of internal pump parts is necessary.
6. Remove the pump half of the coupling guard:

   a) Slightly spread the bottom apart.

   b) Lift upwards.



Item	Description
1.	Pump half of the coupling guard
2.	Annular groove
3.	Deflector fan guard
4.	Driver

Figure 14: Coupling guard

5.3 Check the rotation

WARNING:

- Starting the pump in reverse rotation can result in the contact of metal parts, heat generation, and breach of containment. Ensure correct driver settings prior to starting any pump.
- Failure to disconnect and lock out driver power may result in serious physical injury or death. Always disconnect and lock out power to the driver before performing any installation or maintenance tasks.
  - Electrical connections must be made by certified electricians in compliance with all international, national, state, and local rules.
  - Refer to driver/coupling/gear manufacturer's installation and operation manuals (IOM) for specific instructions and recommendations.

1. Lock out power to the driver.

2. Make sure that the coupling hubs are fastened securely to the shafts.
3. Unlock power to the driver.
4. Make sure that everyone is clear, and then jog the driver long enough to determine that the direction of rotation corresponds to the arrow on the bearing housing or close-coupled frame.
5. Lock out power to the driver.

5.4 Couple the pump and driver

WARNING:

- Failure to disconnect and lock out driver power may result in serious physical injury or death. Always disconnect and lock out power to the driver before performing any installation or maintenance tasks.
  - Electrical connections must be made by certified electricians in compliance with all international, national, state, and local rules.
  - Refer to driver/coupling/gear manufacturer's installation and operation manuals (IOM) for specific instructions and recommendations.

1. Check the gap between the coupling hubs against the dimensions shown on the general arrangement drawing or as stamped on the coupling hub. For any necessary adjustment, move the driver not the pump.

   Motors with sleeve bearings may be manufactured with 6.35 or 12.7 mm | 1/4 or 1/2 in. end movement (float) in the motor rotor. For limited end-float arrangement, the gap between the coupling halves must be set in a different manner. If specific directions are not indicated in the motor instructions, then follow this procedure:

   NOTICE:

   If the driver was mounted at the factory, the setting for the coupling is already determined.

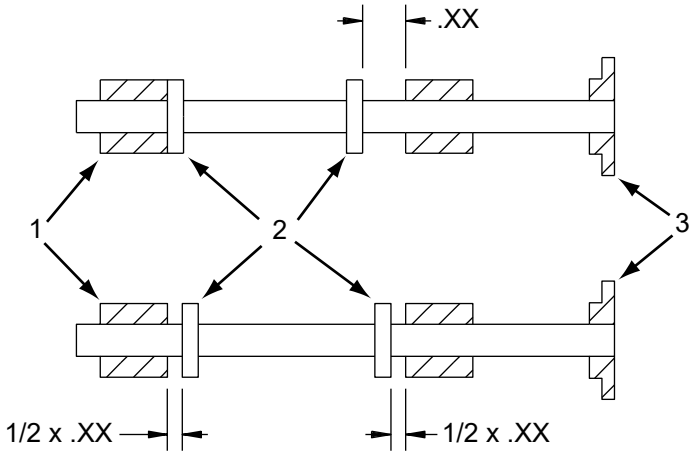
   a) Slide the rotor towards the outboard end of the motor as far as it will go and mark the shaft at the motor frame.

   b) Slide the rotor towards the inboard end of the motor as far as it will go and mark the shaft again.

   The distance between the marks should be either 6.35 or 12.7 mm | 1/2 or 1/4 in. if the motor is arranged for limited end-float travel.

   c) Scribe a third mark on the shaft halfway between the scribe marks made in the previous steps.

   d) Clamp the rotor in place.



1. Sleeve bearing
2. Thrust collar
3. Coupling

Figure 15: Driver shaft centering

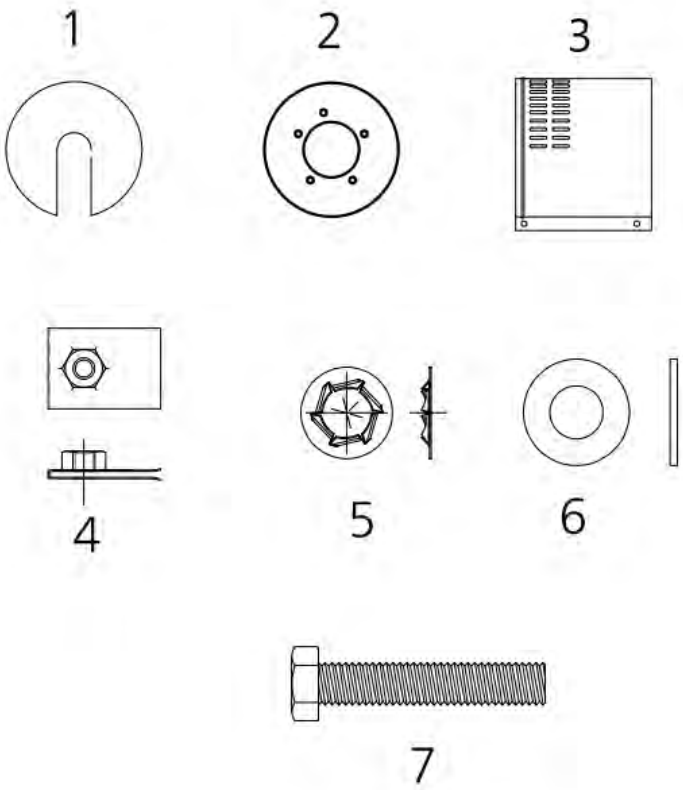
2. Use the instructions from the coupling manufacturer to lubricate and install the coupling.
3. Check the angular and parallel alignment of the coupling halves. See Pump-to-driver alignment in the Installation chapter.

5.4.1 Install the coupling guard

WARNING:

- Running a pump without safety devices exposes operators to risk of serious personal injury or death. Never operate a unit unless appropriate safety devices (guards, etc.) are properly installed.
- Failure to disconnect and lock out driver power may result in serious physical injury or death. Always disconnect and lock out power to the driver before performing any installation or maintenance tasks.
    - Electrical connections must be made by certified electricians in compliance with all international, national, state, and local rules.
    - Refer to driver/coupling/gear manufacturer's installation and operation manuals (IOM) for specific instructions and recommendations.

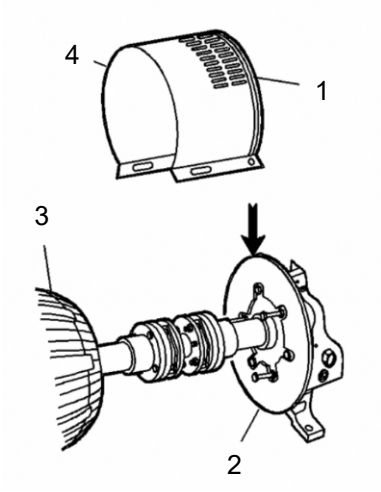
WARNING:
The coupling guard used in an Ex classified environment must be properly certified and constructed from a spark resistant material.



Part No.	Description	Part No.	Description
1	Cover driver	5	Retainer (Qty 3)
2	Cover pump	6	Washer (Qty 4)
3	Guard (Qty 2)	7	Hex head bolt (Qty 3)
4	U-nut (Qty 3)		

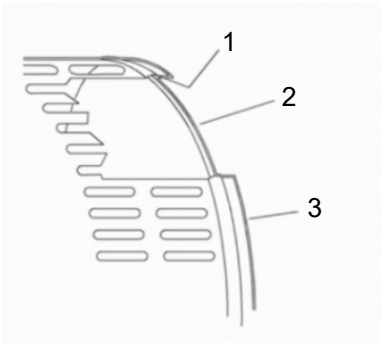
Figure 16: Required parts

1. De-energize the motor, place the motor in a locked-out position, and place a caution tag at the starter that indicates the disconnect.
2. Put the pump-side end plate in place.
   If the pump-side end plate is already in place, make any necessary coupling adjustments and then proceed to the next step.
3. Slightly spread the opening of the coupling guard half and place it over the pump end plate.
   a) The annular groove in the guard is located around the end plate.
   b) Position the opening (flange) so that it does not interfere with the piping but still allows for access when you install the bolts.



Item	Description
1.	Annular groove
2.	Pump-side end plate
3.	Driver
4.	Pump half of the coupling guard

Figure 17: Align pump end guard half with annular groove



Item	Description
1.	Annular groove
2.	End plate (pump end)
2.	Guard half

Figure 18: Annular groove in coupling guard

4. Place one washer over the bolt and insert the bolt through the round hole at the front end of the guard half.

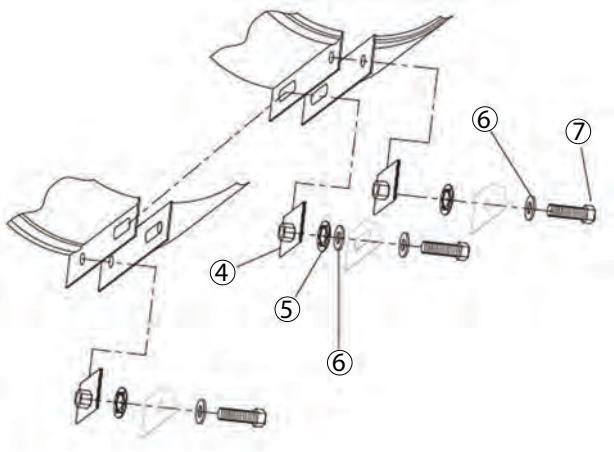


Figure 19: Captured hardware component assembly

5. Install the bolt retainer over the exposed end of the bolt, and the U-Nut into the slot in the coupling guard if it was not done from the factory.
6. Thread bolt into the U-Nut and tighten firmly.
7. Slightly spread the opening of the remaining coupling guard half and place it over the installed coupling guard half so that the annular groove in the remaining coupling guard half faces the motor.

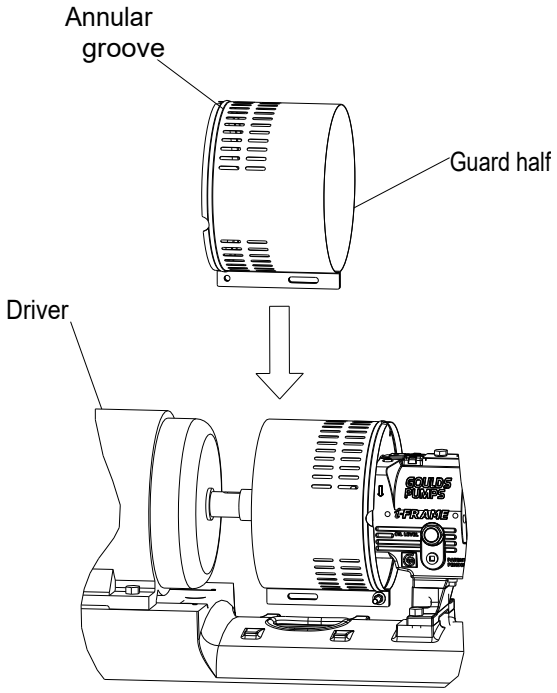


Figure 20: Placement of driver half of coupling guard

8. Place the end plate over the driver shaft and locate the end plate in the annular groove at the rear of the coupling guard half.

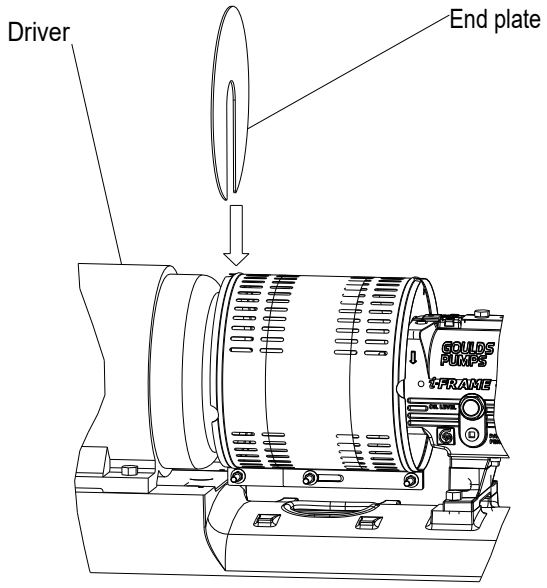


Figure 21: Placement of driver half of coupling guard

9. Hand-tighten only. Repeat Steps 4 through 6 for the rear end of the coupling guard half. The hole is located on the driver-side of the coupling guard half.
10. Slide the driver-half of the coupling guard towards the motor so that the coupling guard completely covers the shafts and coupling.

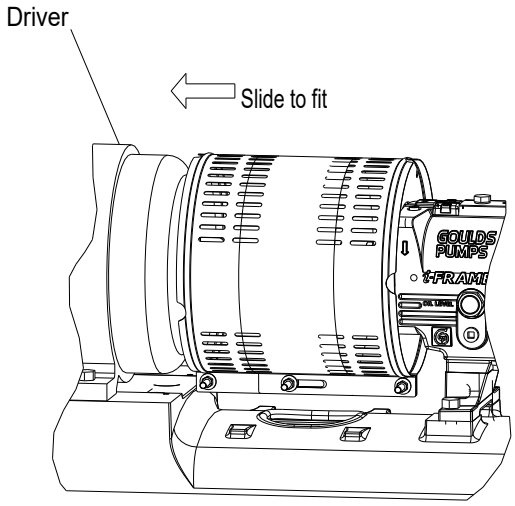


Figure 22: Slide driver-half of coupling guard towards motor

11. Repeat Steps 4 through 6 for the center slots in the coupling guard.
12. Tighten all nuts on the guard assembly.

5.4.2 Install the shaft guard - if provided

WARNING:

- Running a pump without safety devices exposes operators to risk of serious personal injury or death. Never operate a unit unless appropriate safety devices (guards, etc.) are properly installed.
- Failure to disconnect and lock out driver power may result in serious physical injury or death. Always disconnect and lock out power to the driver before performing any installation or maintenance tasks.
    - Electrical connections must be made by certified electricians in compliance with all international, national, state, and local rules.
    - Refer to driver/coupling/gear manufacturer's installation and operation manuals (IOM) for specific instructions and recommendations.

Exposed rotating shaft between pump seal and bearing frame. Avoid contact and/or install proper guarding. If guarding is not provided with the pump, contact Goulds for price and availability of proper guarding.

5.5 Pump priming

CAUTION:
Do not run the pump dry.

Never start the pump until it has been properly primed. Several different methods of priming can be used, depending on the type of installation and service involved.

5.5.1 Prime the pump with the suction supply above the pump

1. Slowly open the suction isolation valve.
2. Open the air vents on the suction and discharge piping, the casing, the seal chamber, and the seal piping, if provided, until all air is vented and only the pumped fluid flows out.
3. Close the air vents.

5.5.2 Prime the pump with the suction supply below the pump

Use a foot valve and an outside source of liquid in order to prime the pump. The liquid can come from one of these sources:

- A priming pump
- A pressurized discharge line
- Another outside supply

1. Close the discharge isolation valve.
2. Open the air vent in the casing.
3. Open the air vents in the seal covers.
4. Open the valve in the outside supply line until only liquid escapes from the vent valves.
5. Close the vent.
6. Close the outside supply line.

5.5.3 Other methods of priming the pump

You can also use these methods in order to prime the pump:

- Prime by ejector
- Prime by automatic priming pump

5.6 Start the pump

WARNING:

- Risk of equipment damage, seal failure and breach of containment. Ensure all flush and cooling systems are operating correctly prior to starting pump.
-

NOTICE:

- Risk of equipment damage due to dry operation. Immediately observe the pressure gauges. If discharge pressure is not quickly attained, stop the driver immediately, reprime, and attempt to restart the pump.
- On frame mounted units, ensure that the oil level is correct prior to starting pump. Close coupled pumps do not have oil lubricated bearings.

NOTICE:

Risk of equipment damage on pure or purge-oil mist-lubricated units. Remove the viewing port plugs to verify that oil mist is flowing properly. Reinstall the plugs after confirming.

Before you start the pump, you must perform these tasks:

- Open the suction valve.
- Open any recirculation or cooling lines.

1. Fully close or partially open the discharge valve, depending on system conditions.
2. Start the driver.
3. Slowly open the discharge valve until the pump reaches the desired flow.
4. Immediately check the pressure gauge to ensure that the pump quickly reaches the correct discharge pressure.
5. If the pump fails to reach the correct pressure, perform these steps:
   a) Stop the driver.
   b) Prime the pump again.
   c) Restart the driver.
6. Monitor the pump while it is operating:
   a) Check the pump for bearing temperature, excessive vibration, and noise.
   b) If the pump exceeds normal levels, then shut down the pump immediately and correct the problem.
7. Repeat steps 5 and 6 until the pump runs properly.

5.7 Pump operation precautions

General considerations

WARNING:

- Risk of serious personal injury or property damage. Dry running may cause rotating parts within the pump to seize to non-moving parts. Do not run dry.
- Risk of explosion and serious physical injury. Do not operate pump with blocked system piping or with suction or discharge valves closed. This can result in rapid heating and vaporization of pumpage.

NOTICE:

- Vary the capacity with the regulating valve in the discharge line. Never throttle the flow from the suction side. This action can result in decreased performance, unexpected heat generation, and equipment damage.
- Risk of equipment damage from unexpected heat generation. Do not overload the driver. Ensure that the pump operating conditions are suitable for the driver. The driver can overload in these circumstances:
  - The specific gravity or viscosity of the fluid is greater than expected
  - The pumped fluid exceeds the rated flow rate.

Operation at reduced capacity

WARNING:

- Risk of breach of containment and equipment damage. Excessive vibration levels can cause damage to bearings, stuffing box, seal chamber, and/or mechanical seal. Observe pump for vibration levels, bearing temperature, and excessive noise. If normal levels are exceeded, shut down and resolve.
- Risk of explosion and serious physical injury. Do not operate pump with blocked system piping or with suction or discharge valves closed. This can result in rapid heating and vaporization of pumpage.
- Risk of equipment damage and serious physical injury. Heat build-up can cause rotating parts to score or seize. Observe pump for excessive heat build-up. If normal levels are exceeded, shut down and resolve.

NOTICE:

- Cavitation can cause damage to the internal surfaces of the pump. Ensure net positive suction head available ($NPSH_A$) always exceeds NPSH required ($NPSH_3$) as shown on the published performance curve of the pump.
-

Operation under freezing conditions

NOTICE:

Do not expose an idle pump to freezing conditions. Drain all liquid that will freeze that is inside the pump and any auxiliary equipment. Failure to do so can cause liquid to freeze and damage

the pump. Note that different liquids freeze at different temperatures. Some pump designs do not drain completely and may require flushing with a liquid that doesn't freeze.

5.8 Shut down the pump

WARNING:
Precautions must be taken to prevent physical injury. The pump may handle hazardous and/or toxic fluids. Proper personal protective equipment should be worn. Pumpage must be handled and disposed of in conformance with applicable environmental regulations.

1. Slowly close the discharge valve.
2. Shut down and lock out the driver to prevent accidental rotation.

5.9 Make the final alignment of the pump and driver

WARNING:

- Failure to disconnect and lock out driver power may result in serious physical injury or death. Always disconnect and lock out power to the driver before performing any installation or maintenance tasks.
  - Electrical connections must be made by certified electricians in compliance with all international, national, state, and local rules.
  - Refer to driver/coupling/gear manufacturer's installation and operation manuals (IOM) for specific instructions and recommendations.
- Misalignment can cause decreased performance, equipment damage, and even catastrophic failure of frame-mounted units leading to serious injury. Proper alignment is the responsibility of the installer and the user of the unit. Check the alignment of all drive components prior to operating the unit.
  - Follow the coupling installation and operation procedures from the coupling manufacturer.

You must check the final alignment after the pump and driver are at operating temperature. For initial alignment instructions, see the Installation chapter.

1. Run the unit under actual operating conditions for enough time to bring the pump, driver, and associated system to operating temperature.
2. Shut down the pump and the driver.
3. Remove the coupling guard.
   See Remove the coupling guard in the Maintenance chapter.
4. Check the alignment while the unit is still hot.
   Refer to 4.3 Pump-to-driver alignment on page 27 in the Installation chapter.
5. Reinstall the coupling guard.
6. Restart the pump and driver.

6 Maintenance

6.1 Maintenance schedule

Maintenance inspections

A maintenance schedule includes these types of inspections:

- Routine maintenance
- Routine inspections
- Three-month inspections
- Annual inspections

Shorten the inspection intervals appropriately if the pumped fluid is abrasive or corrosive or if the environment is classified as potentially explosive.

Routine maintenance

Perform these tasks whenever you perform routine maintenance:

- Lubricate the bearings.
- Inspect the seal.
- Perform a vibration analysis.
- Monitor the discharge pressure.
- Monitor the temperature.

Routine inspections

Perform these tasks whenever you check the pump during routine inspections:

- Check the level and condition of the oil through the sight glass on the bearing frame.
- Check for unusual noise vibration, and bearing temperatures.
- Check the pump and piping for leaks.
- Analyze the vibration.*
- Check that there is no leakage from the mechanical seal.

NOTICE:
*If equipped, temperature and vibration levels can be retrieved by using your i-ALERT® monitoring sensor and app.

Three-month inspections

Perform these tasks every three months:

- Check that the foundation and the hold-down bolts are tight.
- Check the shaft alignment, and realign as required.

Annual inspections

Perform these inspections one time each year:

- Check the pump capacity.
- Check the pump pressure.
- Check the pump power.

If the pump performance does not satisfy your process requirements, and the process requirements have not changed, then perform these steps:

1. Disassemble the pump.
2. Inspect it.
3. Replace worn parts.

6.2 Bearing maintenance

6.2.1 Ball bearing types

Grease lubricated bearings

Pump size	Suction side, radial suction	Discharge side, radial and end suction
1.5 x 2.5-7	6306-C3	5306 A
2.5 x 4-8	6307-C3	5307 A C3
4 x 5-10	6308-C3	2x 7308 BECBM
5 x 6-11	6310-C3	2x 7310 BECBM

6.2.2 Grease lubrication schedule

Pump size	Grease quantity		Re-lubrication intervals				
	Suction side, in ounces	Discharge side, in ounces	3550 rpm	2950 rpm	2200 rpm	1750 rpm	1450 rpm
			Operating hours				
1.5 x 2.5-7	0.25	0.40	3800	4300	5500	6000	6500
2.5 x 4-8	0.30	0.50	3500	4000	5000	5500	6000
4 x 5-10	0.40	0.75	3300	3800	4500	5000	5500
5 x 6-11	0.55	1.10	2500	3300	4300	4800	5000

6.2.3 Lubricating-grease requirements

Precautions

NOTICE:

- Avoid equipment damage or decreased performance. Never mix greases of different consistencies (NLGI 1 or 3 with NLGI 2) or with different thickeners. For example, never mix a lithium-based grease with a polyurea based grease. If it is necessary to change the grease type or consistency, remove the rotor and old grease from the housing before re-greasing.

Grease recommendations based on temperature

Most pumps use Sunoco 2EP grease.

This table shows which brand of grease to use when lubricating the pump.

Brand	When temperature of pumped fluid is less than 177°C | 350°F - NLGI consistency 2
Mobil	Mobilux EP2
Exxon	Unirex N2

Brand	When temperature of pumped fluid is less than 177°C | 350°F - NLGI consistency 2
Sunoco	Mutipurpose 2EP
SKF	LGMT 2

6.2.4 Regrease the grease-lubricated bearings

NOTICE:
Risk of equipment damage. Ensure that the grease container, the greasing device, and the fittings are clean. Failure to do so can result in impurities entering the bearing housing while regreasing the bearings.

1. Wipe dirt from the grease fittings.
2. Insert the amount of grease as noted in the Grease Lubrication Schedule above through the grease fitting. If grease comes out the lip seal or the heat flinger, make sure that the cavity is not completely filled with grease.
3. Wipe off any excess grease.
4. Recheck the alignment.

The bearing temperature usually rises after you regrease due to an excess supply of grease. Temperatures return to normal in about two to four operating hours as the pump runs and purges the excess grease from the bearings.

6.2.5 Lubricate the bearings after a shutdown period

1. Flush out the bearings and bearing frame with a light oil to remove contaminants.
   During flushing, make sure to rotate the shaft slowly by hand.
2. Flush the bearing housing with the proper lubricating oil to ensure oil quality after cleaning.

6.3 Shaft-seal maintenance

6.3.1 Mechanical-seal maintenance

WARNING:

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

CAUTION:
Running a mechanical seal dry, even for a few seconds, can cause seal failure and physical injury. Never operate the pump without liquid supplied to the mechanical seal.

Cartridge-type mechanical seals

Cartridge-type mechanical seals are commonly used. Cartridge seals are preset by the seal manufacturer and require no field settings. Cartridge seals installed by the user require disengagement of the holding clips prior to operation, allowing the seal to slide into place. If the seal has been installed in the pump by ITT, these clips have already been disengaged.

Other mechanical seal types

For other types of mechanical seals, refer to the instructions provided by the seal manufacturer for installation and setting.

Reference drawing

The manufacturer supplies a reference drawing with the data package. Keep this drawing for future use when you perform maintenance and seal adjustments. The seal drawing specifies the required flush fluid and attachment points.

Before you start the pump

Check the seal and all flush piping.

Mechanical seal life

The life of a mechanical seal depends on the cleanliness of the pumped fluid. Due to the diversity of operating conditions, it is not possible to give definite indications as to the life of a mechanical seal.

6.4 Disassembly

6.4.1 Disassembly precautions

WARNING:

- Failure to disconnect and lock out driver power may result in serious physical injury or death. Always disconnect and lock out power to the driver before performing any installation or maintenance tasks.
  - Electrical connections must be made by certified electricians in compliance with all international, national, state, and local rules.
  - Refer to driver/coupling/gear manufacturer's installation and operation manuals (IOM) for specific instructions and recommendations.
- Risk of serious personal injury. Applying heat to impellers, propellers, or their retaining devices can cause trapped liquid to rapidly expand and result in a violent explosion. This manual clearly identifies accepted methods for disassembling units. These methods must be adhered to. Never apply heat to aid in their removal unless explicitly stated in this manual.
- Handling heavy equipment poses a crush hazard. Use caution during handling and wear appropriate Personal Protective Equipment (PPE, such as steel-toed shoes, gloves, etc.) at all times.
- Precautions must be taken to prevent physical injury. The pump may handle hazardous and/or toxic fluids. Proper personal protective equipment should be worn. Pumpage must be handled and disposed of in conformance with applicable environmental regulations.
- Risk of serious physical injury or death from rapid depressurization. Ensure pump is isolated from system and pressure is relieved before disassembling pump, removing plugs, opening vent or drain valves, or disconnecting piping.
- Risk of serious personal injury from exposure to hazardous or toxic liquids. A small amount of liquid will be present in certain areas like the seal chamber upon disassembly.

CAUTION:

- Risk of physical injury from sharp edges. Wear heavy work gloves when handling impellers.
- Avoid injury. Worn pump components can have sharp edges. Wear appropriate gloves while handling these parts.

- Risk of physical injury from hot bearings. Wear insulated gloves when using a bearing heater.

6.4.2 Tools required

In order to disassemble the pump, you need these tools:

- Bearing puller
- Cleaning agents and solvents
- Dial indicators
- Feeler gauges
- Induction heater
- Lifting sling
- Micrometer
- Rubber mallet
- Screwdriver
- Spanner wrench
- Torque wrench with sockets
- Wrenches
- Lifting eyebolt (dependent on pump / motor size)

6.4.3 Drain the pump

CAUTION:

- Risk of physical injury. Allow all system and pump components to cool before handling.
- If the pumped fluid is non-conductive, drain and flush the pump with a conductive fluid under conditions that will not allow for a spark to be released to the atmosphere.

6.4.4 Prepare for disassembly

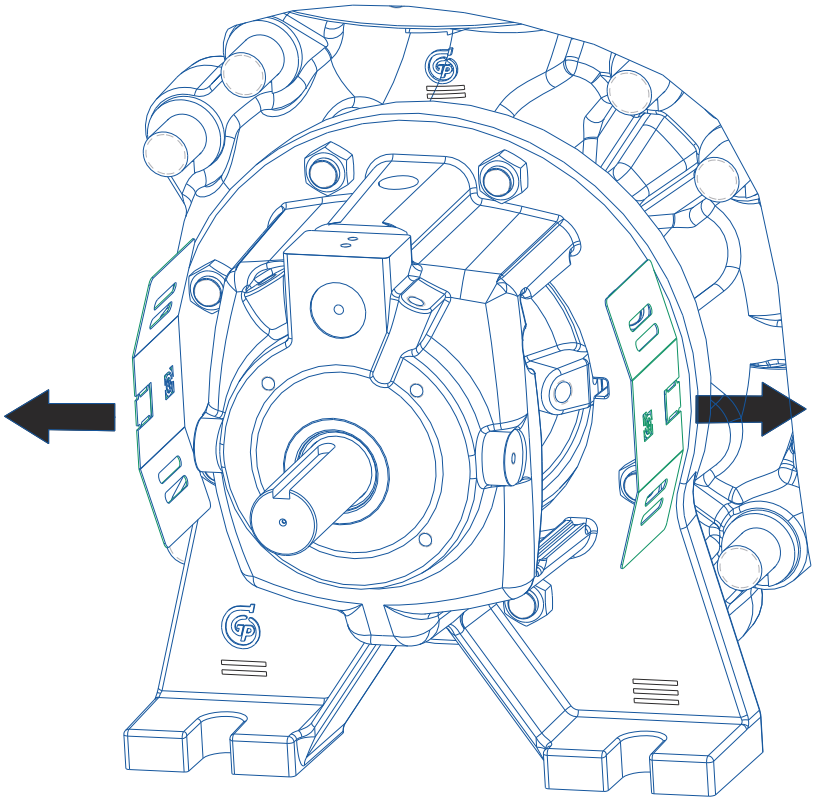
WARNING:
Dropping, rolling or tipping units, or applying other shock loads, can cause property damage and/or personal injury. Ensure that the unit is properly supported and secure during lifting and handling.

Before you begin, refer to the appropriate sectional drawing for either the radial suction or end suction configuration.

1. If you plan to disassemble the entire pump for maintenance work, place the pump in a vertical position with the suction nozzle facing up.
   A workbench with a hole that is approximately 0.50 in. (1.27 cm) larger than the shaft is helpful in such cases.
2. For pump sizes 1.5 x 2.5-7 and 2.5 x 4-8, place the pump on the coupling guard adapter (234A).
3. For pump sizes 4 x 5-10 and 5 x 6-11, stand the pump vertically with an additional support. You must also have a hoist or a second person for disassembly.

6.4.5 Remove the shaft guard - if provided

1. Remove each shaft guard half.
2. Retain each guard half for reinstallation.



6.4.6 Disassemble the discharge end ball bearing for the radial suction configuration

1. Remove the coupling halves.
2. Remove the flinger guards (499) if applicable.
3. Place the pump in a horizontal position.
4. Raise the discharge casing (100D) with wooden blocks so that the feet of the bearing bracket (228C) are exposed by approximately 0.50 in. (1.27 cm).
5. Move back the thrower (248) or heat flinger (123B) if applicable.
6. Unscrew the nuts (425 and 427H) and then pull the bearing cover (119) off the bearing bracket (228C).
7. Remove the bearing bracket (228C) by tapping the bearing flange lightly in an axial direction.

   After the bearing bracket (228C) has been removed, you can freely move the shaft in an axial direction approximately 1/8 in. (0.30 cm). Standard shaft seals can absorb this adjustment without their function being impaired. In the case of special shaft seals, follow the operating instructions of the seal.
8. Unscrew the shaft nut (136A) with a spanner wrench. The shaft nut has a securing device that prevents it from coming loose.

   NOTICE:
   Never re-use shaft nuts (136A).
9. Remove the ball bearings (409) with the bearing puller.
10. Check the shaft surface for damage. Grind away any furrows.

6.4.7 Disassemble the pump body

1. Loosen the nuts (357F) and remove the tie rod (356S).
2. Remove the suction casing (100F) and remove the O-ring (412K).

3. Loosen the impeller nuts (304) and remove the washer (199).
4. Dismantle the impeller (101) and diffuser (150) and then remove the impeller key (178). Mark all parts for reassembly.
5. Remove the intermediate bearing housing (134C) and bearing sleeve (310).
6. Dismantle the pump in stages down to the discharge casing.
7. Invert the remaining portion of the pump.
   Note that the bearing bracket (228C) faces up.

6.4.8 Disassemble the suction end ball bearings

1. Remove the heat flinger guards (499) if applicable.
2. Place the pump in a horizontal position and then raise the suction casing (100F) with wooden blocks so that the feet of the bearing bracket (228C) are exposed by approximately 0.50 in. (1.27 cm).
3. Move back the thrower (248) or heat flinger (123B) if applicable.
4. Unscrew the nuts (425 and 427H) and then pull the bearing cover (119) off the bearing bracket (228C).
5. Remove the bearing bracket (228C) by tapping the bearing flange lightly in an axial direction.
6. Unscrew the shaft nut (136A) with a spanner wrench. The shaft nut has a securing device that prevents it from becoming loose.

   NOTICE:
   Never re-use the shaft nut (136A).

7. Remove the ball bearings (112) with the bearing puller.
8. Check the shaft surface for damage. Grind away any burs.

6.4.9 Remove the shaft seal

1. Remove the roller bearings (112) with a gear puller.
2. Remove bearing cover (119), spacer sleeve (157) and thrower (248) or heat flinger (123B) if applicable.
3. Remove shaft sleeve key (401).
4. Remove seal cover (184). Pre-treat fitting surface between the seal cover and the casing with compatible lubricant.
5. Slide off shaft sleeve (104 and 126) and pull out O-ring (412F).
6. Press out the seat ring of the mechanical seal (383 and 383S) from the seal cover (184) using even pressure.
7. Slide the rotating unit of the mechanical seal off the shaft sleeve (104 & 126). If the mechanical seal has set screws these must first be removed.
8. Clean and check all parts for wear. Mechanical seals must always be replaced.

6.5 Preassembly inspections

6.5.1 Replacement guidelines

Inspection

Clean and check the condition of all parts that have been removed. In case of doubt, replace components. You must always replace wearing parts, such as ball bearings, and seals.

Mechanical seal location

Mechanical seals are located on the suction side for the (RS configuration and the discharge side for the RS and ES configurations.

Shaft sleeve location

Shaft sleeves (104 and 126) and the mechanical seals (383S and 383) are separate components. Mark the position of these parts so that you can mount them in the same position during reassembly.

6.6 Reassembly

6.6.1 Prepare for reassembly

1. Clean all components and remove any rust.
2. For the RS configuration, screw in and secure the throttling element (252) on the suction casing (100F).
3. For the RS configuration, provide a bore that is 0.16 in. (0.41 cm) in diameter in order to ventilate the sealing chamber.
   This bore must always be located in the top position. Depending on the location of the suction casing nozzle, use one of the three cast depressions for this drilled hole.
4. Screw in the stud bolts (356A).
5. ES? Screw in and secure the throttling element (252) (use correct bore) to the discharge casing (100D).
6. Screw in the stud bolts (356A).
7. Hammer in the pin (445E) of the seal cover (184).
8. Screw in the stud bolts (356C) on the bearing bracket (228C).
9. Screw in the lubricating nipple (193B) of the bearing cover (119).
10. For the ES configuration, press in the bearing bushing (197A) of the intermediate bearing housing (134C).
11. Clamp the shaft in a vertical position (122) using soft protective wedges. Make sure that the coupling end points upwards.

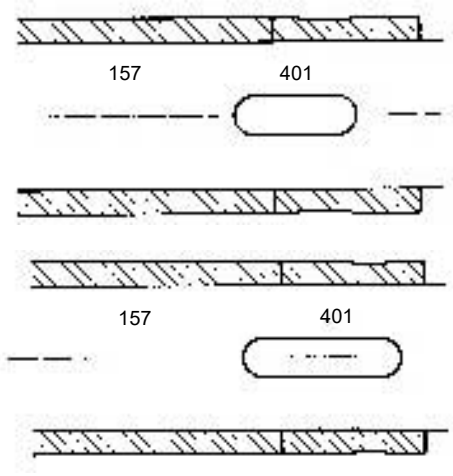
6.6.2 Reassemble the shaft seal

CAUTION:
Placing the pump in a vertical position is required for assembly.

1. Always use a lubricant when mounting mechanical seals. Do not use mineral grease or oil if you are not absolutely certain that it is compatible with the O-ring material.
2. Insert the seat ring of the mechanical seal (383 & 383S) in the seal cover (184). Slide the rotating unit of the mechanical seal (383 and 383S) onto the shaft sleeve (104 and 126) and secure with set screw (if required).
3. Slide on the O-ring (412F) and apply a lubricating agent, such as silicon grease, using a brush.
4. Lubricate the shaft sleeve (104 and 126) on the I.D. so that the O-ring groove remains clean (start approximately ½” inside).

   NOTICE:
   Standard O-rings made of EP rubber are not resistant to mineral oil or greases.
5. Slide on the shaft sleeve (104 and 126). When sliding on the shaft sleeve, make sure that the O-ring can slide easily into the groove.
6. Insert the O-ring (412H) in the casing and secure it with silicon grease.
   If possible, make sure that the O-ring is touching the outer diameter. You can pull the O-ring in order to slightly enlarge it.
7. Carefully mount the seal cover (184). Use caution that the pin is in the correct direction (445E) with the groove in the bearing bracket.

8. Insert the shaft sleeve key (401) and slide on the spacer sleeve (157). Make sure that the pump spacer sleeve is assembled in the following direction:



9. Screw the bearing cover (119) to the bearing bracket (228C).
10. Grease the contact surface of the thrower (248) and bring the thrower or heat flinger (123B) into position on the spacer sleeve (157), whichever is applicable.
    The thrower sits in a groove on the spacer sleeve while the heat flinger blades need to be positioned approximately ¾" from the bearing cover studs (356C).

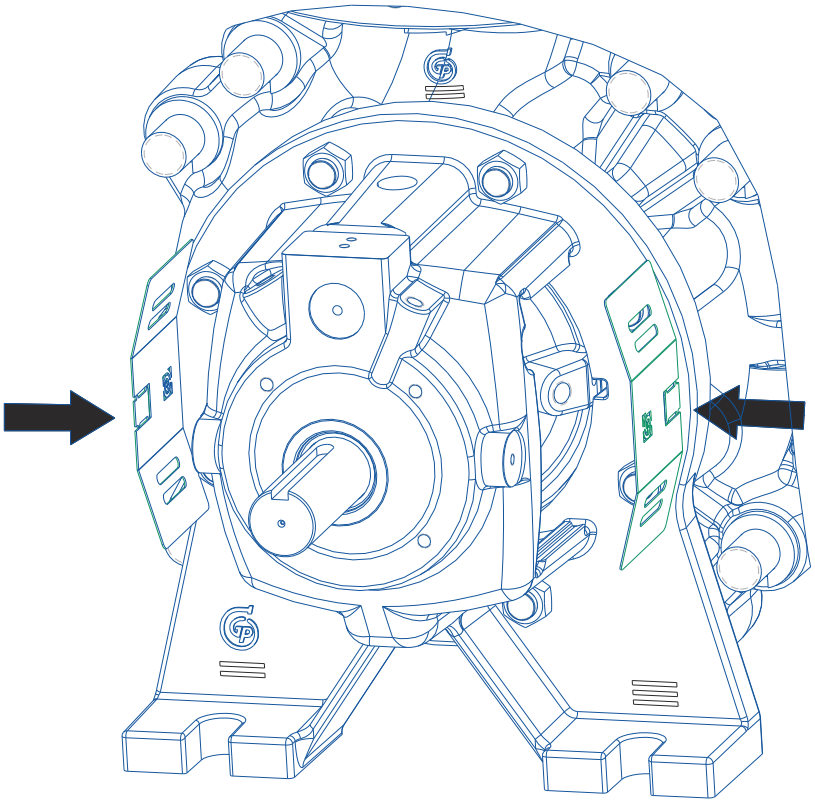
6.6.3 Install the shaft guard - if provided

WARNING:

- Running a pump without safety devices exposes operators to risk of serious personal injury or death. Never operate a unit unless appropriate safety devices (guards, etc.) are properly installed.
- Failure to disconnect and lock out driver power may result in serious physical injury or death. Always disconnect and lock out power to the driver before performing any installation or maintenance tasks.
    - Electrical connections must be made by certified electricians in compliance with all international, national, state, and local rules.
    - Refer to driver/coupling/gear manufacturer's installation and operation manuals (IOM) for specific instructions and recommendations.

Exposed rotating shaft between pump seal and bearing frame. Avoid contact and/or install proper guarding. If guarding is not provided with the pump, contact Goulds for price and availability of proper guarding.

1. Assemble a guard half from each side of the pump and fasten to the bearing frame.



6.6.4 Reassemble the suction end ball bearings

The variants are:

- The suction end ball bearing is a single radial ball bearing (112) for all pump sizes.

1. Clean and lubricate the fitting surfaces between the bearing bracket (228C) and suction casing (110F).
2. Preheat the new bearing (112) to a maximum of 230°F (110°C) and slide it onto the shaft (122).
3. Tighten the new shaft nut (136A) while the bearing is still hot, then turn it back one quarter of a turn.
4. After the bearing cools down, pack the bearing completely with grease making sure that grease gets under the cage.
   When the pump is started the bearing will run hot for several minutes until the excess grease is purged. It will then return to a normal operating temperature. When the bearing is installed in the bearing housing, the cavities on either side should be filled with grease for about 1/3 of the volume.
5. Fit the bearing bracket (228C) and insert the seal cover (184).
6. Screw the bearing cover (119) to the bearing bracket (228C).
7. Grease the contact surface of the thrower (248) and bring the thrower or heat flinger (123B) into position on the spacer sleeve (157).
   The thrower sits in a groove on the spacer sleeve while the heat flinger blades need to be positioned approximately 0.75 in. (1.91 cm) from the bearing cover studs (356C).
8. Align the surfaces of the pump feet. Make sure the pump is on an even surface.

9. Lay the discharge casing (100D) horizontally so that you can insert the shaft (122).
10. Place the pre-mounted unit on the discharge casing (100D) and tighten the nuts (425) firmly. See the Torque values table.
11. Rotate the shaft (122) and make sure it runs smoothly.
12. Replace the flinger guards (499) if applicable.

6.6.5 Reassemble the pump body

1. Invert the pump. Make sure that the free shaft points upwards and is vertical.
2. Lubricate the shaft (122). Make sure that the lubricant is compatible with the shaft O-ring material.
3. Check the position of the impeller. Insert a diffuser (150L) and slide the impeller (101) until it is impact.

CAUTION:
If a pump is assembled with new impellers, the first and last stages are always provided with full diameter impellers. If only one impeller is available with the full diameter, it must be used as the first stage.

Assembly work always starts with the final stage.

4. Remove the impeller and diffuser once more, then insert the O-ring (497D), and re-insert the diffuser (150L/150).
5. Insert the key (178 or 178E) for the impeller that you plan to mount.
6. Mount the impeller (101).
   Note that as the O-ring (497D) presses on the diffuser (150L/150), the setting will not be correct at first.
7. Generously grease the O-ring (412K) with silicon grease and grease the stage casing (100G). Do not twist the O-ring.
8. Place the stage casing (100G) on levelly and force it down sharply. Hit it with a plastic hammer until it impacts.
9. For the ES configuration, assemble the pump down to the intermediate bearing housing (134C).
10. For the RS configuration, assemble the pump down to the suction casing (100F)
11. For the RS configuration, slide on the sleeve (310) and mount the suction casing (100F) with the O-ring (312F). Make sure that the lines are in the correct position.

6.6.6 Complete the reassembly for the end suction configuration

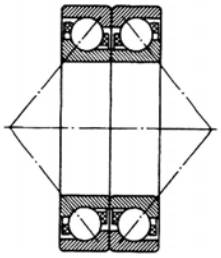
1. Slide on the bearing sleeve (310) and lubricate the bearing surface.
2. Mount the intermediate bearing housing (134C) with the bearing bushing (197A) as for stage casing.
3. Mount the first stage of the pump and then secure the impeller (101) with a washer (199) and nuts (304).
4. Tighten the first nut (304) securely.
5. Turn the nut back a one-quarter turn and secure it with a counter nut.
6. Mount the suction casing (100F) with an O-ring (412K) and assemble the tie rod (356S) and nuts (357F) together slightly.
7. Align the bearing surface of the pump feet and place the pump on a flat surface.
8. Tighten the nuts (357F). See the torque values table.
9. Rotate the shaft (122) in order to verify that it turns freely.

6.6.7 Reassemble the discharge end ball bearings for the radial suction configuration

1. Clean and lubricate the fitting surfaces between the bearing bracket (228C) and the discharge casing (110D).
2. Preheat the new bearing (409) to a maximum of 230°F (110°C) and slide it onto the shaft (122).

The variants are:

- Sizes 1.5 x 2.5-7 and 2.5 x 4-8: Roller bearing (409), double row angular ball bearings (single bearing)
- Sizes 4 x 5-10 and 5 x 6-11: Roller bearing (409), paired angular ball bearings in back-to-back arrangement



3. Tighten the shaft nut (136A) while the bearing is still hot.
4. After the bearing cools down, pack the bearing completely with grease making sure that grease gets under the cage.
   When the pump is started the bearing will run hot for several minutes until the excess grease is purged. It will then return to a normal operating temperature. When the bearing is installed in the bearing housing, the cavities on either side should be filled with grease for about 1/3 of the volume.
5. Fit the bearing bracket (228C) and screw it on lightly for the time being.
6. Screw the bearing cover (119) to the bearing bracket (228C).
7. Grease the contact surface of the thrower (248) and bring the thrower or heat flinger (123B) into position on the spacer sleeve (157).
   The thrower sits in a groove on the spacer sleeve. Make sure that the heat flinger blades are positioned approximately 0.75 in. (1.91 cm) from the bearing cover studs (356C).
8. Align the surfaces of the pump feet. Make sure that the pump is on an even surface.
9. Lay the discharge casing (100D) horizontally so that the shaft can be inserted (122).
10. Place the pre-mounted unit on the discharge casing (100D) and tighten the nuts (425) firmly. See the Torque values table.
11. Rotate the shaft (122) in order to make sure that it turns freely.
12. Mount the coupling half. You might need to preheat to a maximum of 230°F (110°C).

6.7 Assembly references

6.7.1 Torque values

Table 3: Maximum torque values, in ft-lbs (Nm) for 1.5 x 2.5-7 and 2.5 x 4-8 pumps

Thread joint	Screw	Hexagonal nut	Quality	Pump size					
				1.5 x 2.5-7			2.5 x 4-8		
				Size	Dry	Lubricated	Size	Dry	Lubricated
Tie bolt	356S	357F	8.8	3/4-11UNC	190 (258)	142 (193)	1- 8UNC	325 (441)	295 (400)
Bearing bracket (228C) with suction casing (100F) or discharge casing (100D)	356A	425	8.8	8 x M12	31 (42)	28 (38)	8 x M12	42 (57)	38 (52)

Table 4: Maximum torque values, in ft-lbs (Nm) for 4 x 5-10 and 5 x 6-11 pumps

Thread joint	Screw	Hexagonal nut	Quality	Pump size					
				4 x 5-10			5 x 6-11		
				Size	Dry	Lubricated	Size	Dry	Lubricated
Tie bolt	356S	357F	8.8	1- 8UNC	244 (331)	222 (301)	1- 8UNC	352 (477)	320 (434)
Bearing bracket (228C) with suction casing (100F) or discharge casing (100D)	356A	425	8.8	8 x M16	71 (96)	64 (87)	8 x M20	112 (152)	99 (134)

6.7.2 Gap widths

Area A - Gap between the sleeve and suction casing

Pump size	Nominal diameter	Gap "new" (inches)				Maximum permissible gap
		All iron and stainless fitted		Stainless steel		
		Minimum	Maximum	Minimum	Maximum	
1.5 x 2.5-7	1.575	0.004	0.006	0.010	0.012	0.020
2.5 x 4-8	1.850	0.006	0.008	0.012	0.014	0.022
4 x 5-10	2.165	0.006	0.008	0.012	0.014	0.022
5 x 6-11	2.559	0.008	0.010	0.014	0.016	0.024

Area B - Gap between the impeller hub and diffuser

Pump size	Nominal diameter	Gap "new" (inches)				Maximum permissible gap
		All iron and stainless fitted		Stainless steel		
		Minimum	Maximum	Minimum	Maximum	
1.5 x 2.5-7	1.496	0.006	0.008	0.012	0.014	0.020
2.5 x 4-8	1.772	0.006	0.008	0.012	0.014	0.020
4 x 5-10	2.047	0.006	0.008	0.012	0.014	0.020
5 x 6-11	2.559	0.006	0.008	0.012	0.014	0.020

Area C - Gap between impeller and casings

Pump size	Nominal diameter	Gap "new" (inches)				Maximum permissible gap
		All iron and stainless fitted		Stainless steel		
		Minimum	Maximum	Minimum	Maximum	
1.5 x 2.5-7	3.346	0.006	0.008	0.012	0.014	0.020
2.5 x 4-8	4.134	0.006	0.008	0.012	0.014	0.020
4 x 5-10	5.315	0.006	0.008	0.012	0.014	0.020
5 x 6-11	6.693	0.006	0.008	0.012	0.014	0.020

Area D - Gap between the impeller and diffuser

Pump size	Nominal diameter	Gap "new" (inches)				Maximum permissible gap
		All iron and stainless fitted		Stainless steel		
		Minimum	Maximum	Minimum	Maximum	
1.5 x 2.5-7	3.346	0.006	0.008	0.012	0.014	0.020

Pump size	Nominal diameter	Gap "new" (inches)				Maximum permissible gap
		All iron and stainless fitted		Stainless steel		
		Minimum	Maximum	Minimum	Maximum	
2.5 x 4-8	4.134	0.006	0.008	0.012	0.014	0.020
4 x 5-10	5.315	0.006	0.008	0.012	0.014	0.020
5 x 6-11	6.693	0.006	0.008	0.012	0.014	0.020

Area E - Gap between the shaft and discharge casing

Pump size	Nominal diameter	Gap "new" (inches)				Maximum permissible gap
		All iron and stainless fitted		Stainless steel		
		Minimum	Maximum	Minimum	Maximum	
1.5 x 2.5-7	1.575	0.004	0.006	0.010	0.012	0.020
2.5 x 4-8	1.772	0.004	0.006	0.010	0.012	0.022
4 x 5-10	2.047	0.006	0.008	0.012	0.014	0.022
5 x 6-11	2.441	0.008	0.010	0.012	0.014	0.024

Area F - Gap between the bearing sleeve and bearing bushing

Pump size	Nominal diameter	Gap "new" (inches)				Maximum permissible gap
		All iron and stainless fitted		Stainless steel		
		Minimum	Maximum	Minimum	Maximum	
1.5 x 2.5-7	1.378	0.002	0.003	0.002	0.014	0.020
2.5 x 4-8	1.575	0.002	0.003	0.002	0.014	0.020
4 x 5-10	1.772	0.002	0.003	0.002	0.014	0.020
5 x 6-11	2.362	0.003	0.004	0.003	0.014	0.020

6.7.3 Nozzle loads

Direction of forces

- Fx = force along the x - axis
- Fy = force along the y - axis
- Fz = force along the z - axis

Direction of moments

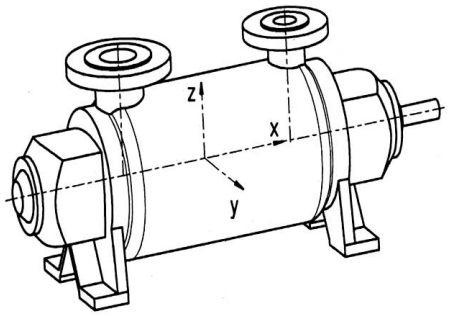
- Mx = moment around the x - axis
- My = moment around the y - axis
- Mz = moment around the z - axis

Formula

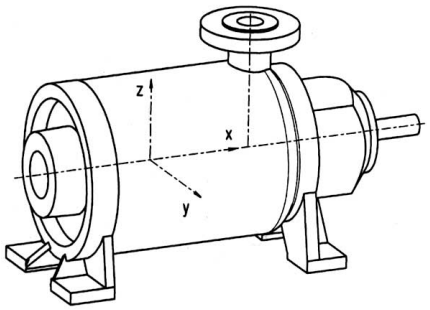
$$\sum F = \sqrt{(Fx^2 + Fy^2 + Fz^2)}$$

$$\sum M = \sqrt{(Mx^2 + My^2 + Mz^2)}$$

Radial suction



End suction



Maximum allowable nozzle loads

Nozzle loads for the suction flange and discharge flange are separate. Do not exceed the stated permissible forces and moments.

Nozzle configuration	Flange size (in)	Forces in lbf (N)				Moments in ft-lbs (Nm)			
		Fx	Fy	Fz	Σ F	Mx	My	Mz	Σ M
Vertical nozzle perpendicular to the shaft (RS)	1.5	74 (330)	67 (300)	85 (380)	133 (590)	206 (280)	103 (140)	140 (190)	273 (370)
	2.5	126 (560)	115 (510)	139 (620)	220 (980)	258 (350)	147 (200)	192 (260)	354 (480)
	4	202 (900)	182 (810)	227 (1010)	355 (1580)	324 (440)	192 (260)	243 (330)	450 (610)
	5	254 (1130)	227 (1010)	281 (1250)	443 (1970)	420 (570)	258 (350)	324 (440)	590 (800)
	6	304 (1350)	274 (1220)	348 (1550)	531 (2360)	516 (700)	324 (440)	398 (540)	730 (990)
Horizontal nozzle perpen dicular to the shaft (RS)	1.5	74 (330)	85 (380)	67 (300)	133 (590)	206 (280)	103 (140)	140 (190)	273 (370)
	2.5	126 (560)	139 (620)	115 (510)	220 (980)	258 (350)	147 (200)	192 (260)	354 (480)
	4	202 (900)	227 (1010)	182 (810)	355 (1580)	324 (440)	192 (260)	243 (330)	450 (610)
	5	254 (1130)	281 (1250)	227 (1010)	443 (1970)	420 (570)	258 (350)	324 (440)	590 (800)
	6	304 (1350)	337 (1500)	274 (1220)	531 (2360)	516 (700)	324 (440)	398 (540)	730 (990)

Nozzle configuration	Flange size (in)	Forces in lbf (N)				Moments in ft-lbs (Nm)			
		Fx	Fy	Fz	Σ F	Mx	My	Mz	Σ M
Horizontal nozzle parallel to the shaft (ES)	2.5	139 (620)	126 (560)	115 (510)	220 (980)	258 (350)	147 (200)	192 (260)	354 (480)
	4	227 (1010)	202 (900)	182 (810)	416 (1850)	324 (440)	192 (260)	243 (330)	450 (610)
	5	281 (1250)	254 (1130)	227 (1010)	443 (1970)	420 (570)	258 (350)	324 (440)	590 (800)
	6	337 (1500)	304 (1350)	274 (1220)	531 (2360)	516 (700)	324 (440)	398 (540)	730 (990)

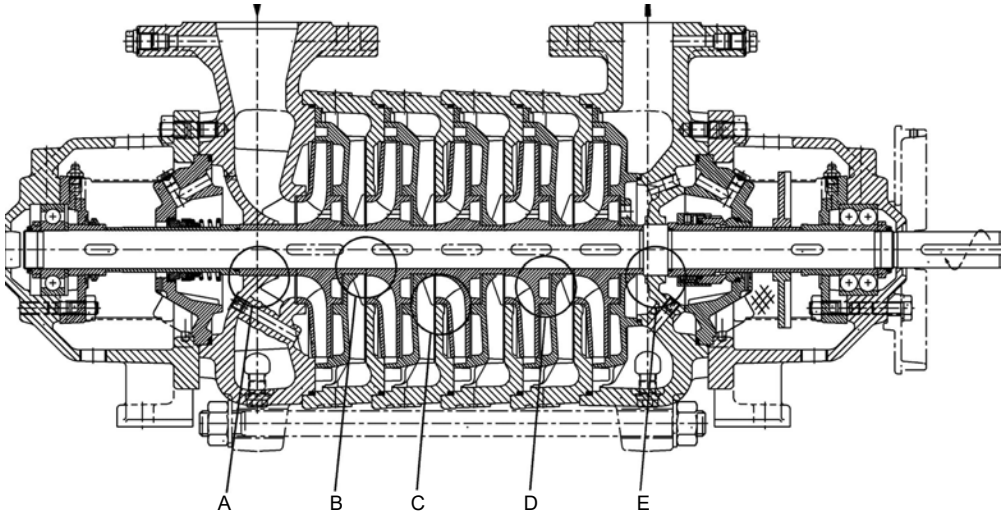
6.7.4 Recommended minimum flows

CAUTION:
The recommended minimum flow is intended for brief periodic operation. It is not to be used as a design point. Extended operation at the minimum flow can cause pump damage.

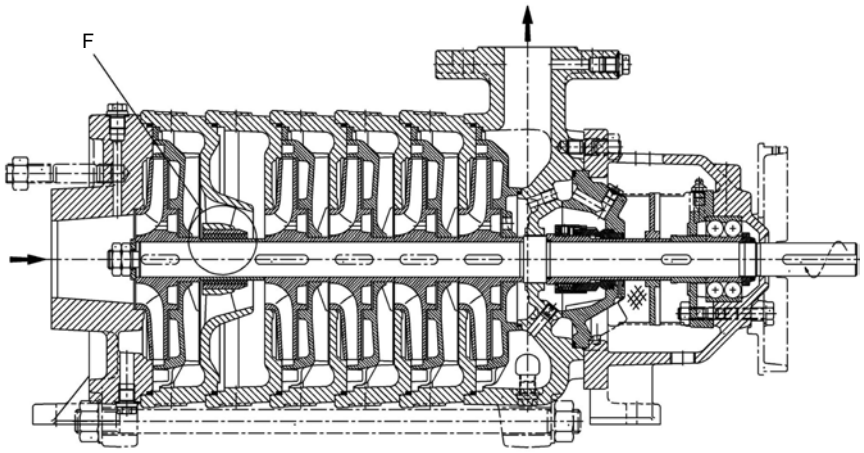
Pump Size	60 hertz				50 hertz			
	3600 rpm		1800 rpm		3000 rpm		1500 rpm	
	QMIN operation (gpm)	QBEP full diameter (gpm)	QMIN operation(gpm)	QBEP full diameter (gpm)	QMIN operation (gpm)	QBEP full diameter (gpm)	QMIN operation (gpm)	QBEP full diameter (gpm)
1.5 x 2.5-7A	33	117	11	60	26	98	9	50
1.5 x 2.5-7B	33	176	11	87	26	147	9	70
2.5 x 4- 8A	53	300	26	145	40	247	22	120
2.5 x 4- 8B	70	400	37	210	57	324	30	167
4 x 5- 10A	106	600	53	310	88	500	44	245
4 x 5- 10B	154	925	75	412	128	725	62	360
5 x 6- 11A	374	1100	185	595	308	1015	155	480
5 x 6- 11B	589	1470	286	735	485	1235	238	635

6.7.5 Wearing parts and dimensions

Radial suction



End suction



7 Troubleshooting

7.1 Alignment troubleshooting

Symptom	Cause	Remedy
Horizontal (side-to-side) alignment cannot be obtained (angular or parallel).	The driver feet are bolt-bound.	Loosen the pump's hold-down bolts, and slide the pump and driver until you achieve horizontal alignment.
	The baseplate is not leveled properly and is probably twisted.	1. Determine which corners of the baseplate are high or low. 2. Remove or add shims at the appropriate corners. 3. Realign the pump and driver.
Vertical (top-to-bottom) alignment cannot be obtained (angular or parallel).	The baseplate is not leveled properly and is probably bowed.	1. Determine if the center of the baseplate should be raised or lowered. 2. Level screws equally at the center of the baseplate. 3. Realign the pump and driver.

7.2 Operation troubleshooting

Symptom	Cause	Remedy
The flow rate is too low.	The back pressure is too high.	Open the discharge valve a little further.
		Reduce the resistance in the discharge pipe. Clean the filter if necessary.
		Use a larger impeller. Make sure to take note of the available motor power.
	The speed is too low.	Increase the speed. Check the available motor power.
		Compare the speed of the motor with the specified pump speed. See the rating place.
		When you adjust the speed (frequency transformer), check the reference value settings.
	The impeller diameter is too small.	Use a larger impeller. Check the available motor power.
	The pump and/or pipes are not completely filled with liquid.	Fill the pump and/or pipes with liquid.
		Vent the pump and/or pipes.
	The pump or suction/intake pipe is blocked.	Clean the pipes.
	There is an air pocket in the pipeline.	Vent the pipes.
		Improve the pathway of the pipes.
	The NPSH is too low.	Increase the liquid level.
		Increase the suction pressure.
		Reduce the resistance in the intake/suction pipe. Change the course and pipe size, open the shutoff valves, and clean the filters.
	Air is being sucked into the pipes.	Increase the liquid level.

Symptom	Cause	Remedy
		Check that the suction pipe is vacuum-tight.
		Provide valves and fittings in the suction pipe with water seal.
	The direction of rotation is wrong.	Change the motor rotation.
	The inner components are suffering from wear.	Replace the worn parts.
	Density and/or viscosity of the pumped liquid is too high.	Seek assistance
The flow rate stops after a period of time.	The pump or suction/intake pipe is blocked.	Clean the pipes.
	The NPSH is too low.	Increase the liquid level.
		Increase the suction pressure.
		Reduce the resistance in the intake/ suction pipe. Change the course and pipe size, open the shutoff valves, and clean the filters.
	Air is being sucked into the pipes.	Increase the liquid level.
		Check that the suction pipe is vacuum-tight.
		Provide valves and fittings in the suction pipe with water seal.
	The inner components are suffering from wear.	Replace any worn parts.
	The density and/or viscosity of the pumped liquid is too high.	Seek assistance.
The head is too low.	The back pressure and discharge pressure are too low.	Throttle the discharge valve.
	The speed is too low.	Increase the speed. Check the available motor power.
		Compare the speed of the motor with the specified pump speed. See the rating plate.
		When you adjust the speed (frequency transformet), check the reference value settings.
	The impeller diameter is too small.	Use a larger impeller. Make sure to check the available motor power.
	The pump and/or pipes are not completely filled with liquid.	Fill the pump and/or pipes with liquid.
		Vent the pump and/or pipes.
	The pump or suction/intake pipe are blocked.	Clean the pipes.
	There is an air pocked in the pipeline.	Vent the pipeline.
		Improve the path of the pipes.
	The NPSH of the system is too low.	Increase the liquid level.
		Increase the suction pressure.
		Reduce the resistance in the intake/ suction pipe. Change the course and pipe size, open the shutoff valves, and clean the filters.
	Air is being sucked into the pipes.	Increase the liquid level.

Symptom	Cause	Remedy
		Check that the suction pipe is vacuum-tight.
		Provide valves and fittings in the suction pipe with water seal.
	The direction of rotation is wrong.	Change the motor rotation.
	The inner components are suffering from wear.	Replace the worn parts.
	The density and/or viscosity of the pumped liquid is too high.	Seek assistance.
The head is too high.	The speed is too high.	Reduce the speed.
		Compare the speed of the motor with the specified pump speed. See the rating plate.
		When you adjust the speed (frequency transformer), check the reference value setting.
	The impeller diameter is too large.	Use a smaller impeller.
The drive mechanism is overloaded	The back pressure and discharge pressure are too low.	Throttle the discharge valve.
	The speed is too high.	Reduce the speed.
		Compare the speed of the motor with the specified pump speed. See the rating plate.
		When you adjust the speed (frequency transformer), check the reference value setting.
	The impeller diameter is too large.	Use a smaller impeller.
	The density and/or viscosity of the pumped liquid is too high.	Seek assistance.
	The shaft seal is worn.	Replace the mechanical seal.
		Check the sealing, flushing, and cooling pipe (pressure).
		Avoid running the pump dry.
	There is not enough sealing.	Tighten the screws.
		Replace the mechanical seal.
	The discharge pressure is too low.	Increase the minimum amount being carried. Open the control valves and bypass piping.
	There is not enough hydraulic thrust balance.	Clean the relief holes in the impeller.
		Replace the worn impeller and wear rings.
The pump is not running quietly.	The pump and/or pipes are not completely filled with liquid.	Fill with liquid
		Vent the pump and/or pipes.
	The NPSH is too low.	Increase the liquid level.
		Increase the suction pressure.
		Reduce the resistance in the intake/ suction pipe. Change the course and pipe size, open the shutoff valves, and clean the filters.
	The inner components are suffering from wear.	Replace the worn parts.

Symptom	Cause	Remedy
	Forces in the pipeline are too high and the pump is under strain.	Change the position of the support pipes and use compensators.
		Check that the foundation plate and frame are properly cast and in place.
	There is too much, not enough, or the wrong type of lubricant.	Change the lubricant.
	The electrical supply is incorrect.	Check the voltage of all phases (2-phase running).
		Check the cable connections.
		Check the fuses.
	The sealing is insufficient.	Tighten the screws.
		Replace the mechanical seal.
	There is not enough hydraulic thrust balance.	Clean the relief holes in the impeller.
		Replace the worn impeller and wear rings.
	There is system-related vibration (resonance).	Seek assistance.
The pump casing becomes warm during operation.	The pump or suction/intake pipe is blocked	Clean the pump and pipes.
	The NPSH is too low.	Increase the liquid level.
		Increase the suction pressure.
		Reduce the resistance in the intake/ suction pipe. Change the path and pipe size, open the shutoff valves, and clean the filters.
	The inner components are suffering from wear.	Replace the worn parts.
	There is system-related vibration (resonance).	Seek assistance.
The temperature in the shaft sealing area is too high.	The shaft seal is worn.	Replace the mechanical seal.
		Check the sealing, flushing, and cooling pipe (pressure).
		Do not run the pump dry.
	There are lines and rough spots on the shaft or shaft sleeve.	Replace the worn parts.
	There are deposits on the mechanical seal.	Clean the mechanical seal.
		Replace the mechanical seal if necessary.
		Provide additional rinsing or quench.
	The coupling is not aligned.	Align the pump.
The temperature at the bearing is too high.	The back pressure is too high.	Open the discharge valve more.
		Reduce resistance in the discharge pipe. Clean the filter if necessary.
		Use a larger impeller. Make sure to note the available motor power.
	The back pressure and the discharge pressure are too low.	Throttle the discharge valve.
	The speed is too high.	Reduce the speed.
		Compare the speed of the motor with the specified pump speed. See the rating plate.

Symptom	Cause	Remedy
		When you adjust the speed (frequency transformer), check the reference value setting.
	The inner components are suffering from wear.	Replace the worn parts.
	The forces in the pipeline are too high and the pump is under strain.	Change the position of the support pipes and use compensators.
		Check that the foundation plate and frame are properly cast and in place.
	There is either too much, too little, or the wrong type of lubricant.	Change the lubricant.
	The electrical supply is not correct.	Check the voltage of all phases (2-phase running).
		Check the cable connections.
		Check the fuses.
	There is not enough sealing.	Tighten the screws.
		Replace the mechanical seal.
	The bearing is damaged.	Replace the bearing.
		Check the lubricant and bearing space for pollutants. Rinse the oil area.
	There is not enough hydraulic thrust balance.	Clean the relief holes in the impeller.
		Replace the worn impeller and wear rings.
	There is system-related vibration (resonance).	Seek assistance.
The pump is leaking.	There is not enough sealing.	Tighten the screws.
		Replace the mechanical seal.
	The discharge pressure is too high.	Reduce the amount of pressure that is carried. Throttle the control valve.
There are leaks at the shaft seal.	The shaft seal is worn.	Replace the mechanical seal.
		Check the sealing, flushing, and cooling pipes (pressure).
		Do not run the pump dry.
	There are deposits on the mechanical seal.	Clean the mechanical seal.
		Replace the mechanical seal if necessary.
		Provide additional rinsing or quench if necessary.
	The impeller is out of balance.	Remove any blocks or deposits.
		Replace the impeller is it is broken or unevenly worn.
		Check the shafts to make sure that they are running true.
	The coupling is not aligned.	Align the pump.
	The coupling distance is too small.	Correct this.
	Forces in the pipeline are too high and the pump unit is under strain.	Change the position of the support pipes and use compensators.
		Check that the foundation plate and frame are properly cast and in place.
	There is not enough sealing.	Tighten the screws.

Symptom	Cause	Remedy
		Replace the mechanical seal.

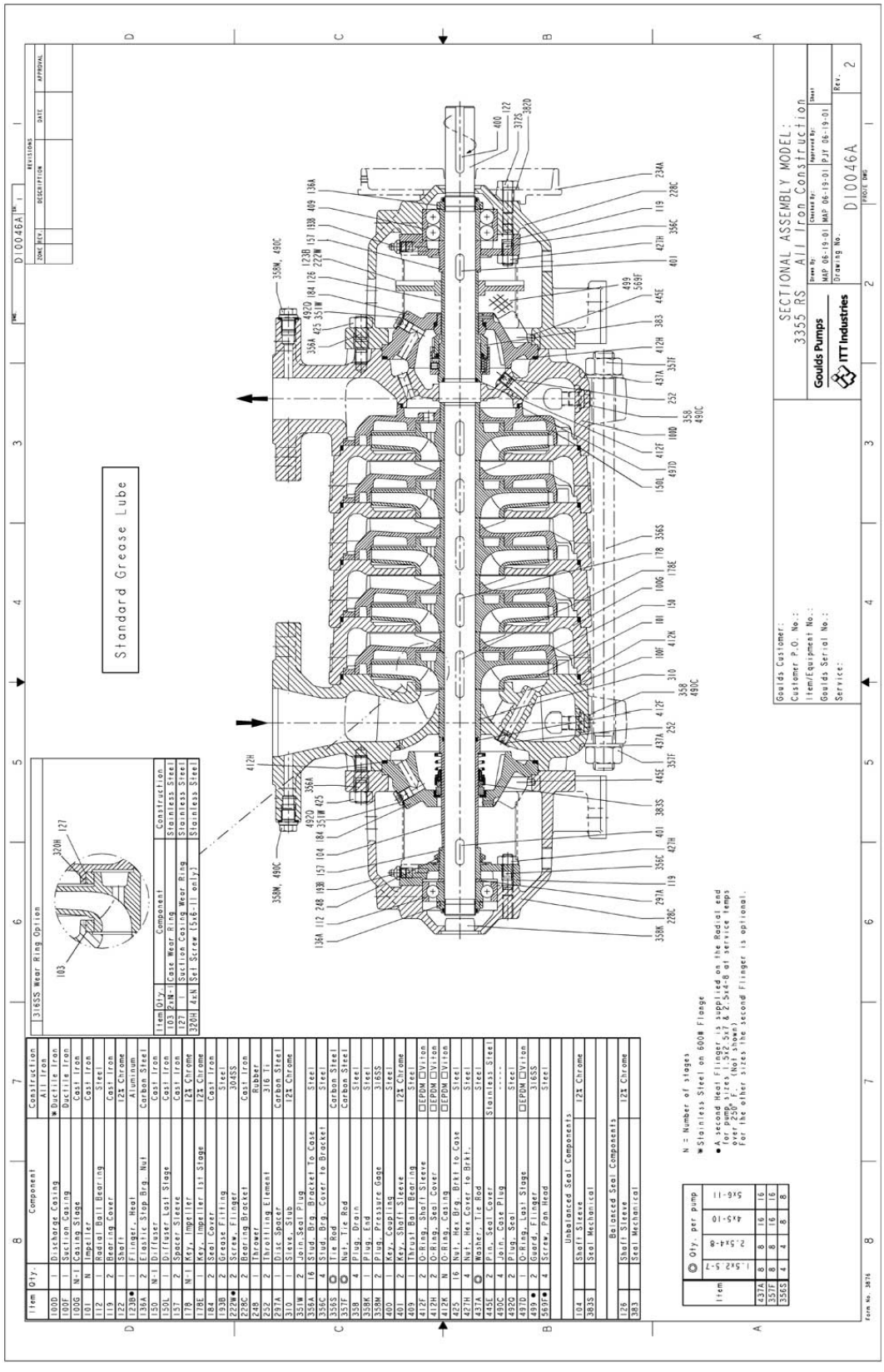
8 Parts Listings and Cross-sectional Drawings

8.1 Recommended spare parts

Select spare parts that will last for two years of continuous operation. If no other guidelines are applicable, stock the number of parts listed in this table.

Spare part	**Number of pumps (includes stand-by pumps)**						
	2	**3**	**4**	**5**	**6/7**	**8/9**	**10 or more**
	Number of spare parts						
Impeller	i	i	i	2i	2i	3i	30%
Diffuser	i/2	i/2	i/2	i	i	3i/2	15%
Wear ring, casing	2i	2i	2i	4i	4i	6i	30%
Shaft with key and shaft screws/nuts	1	1	2	2	2	3	30%
Ball bearing	1	1	2	2	2	3	30%
Bearing shaft nut (2 for radial suction)	2	3	4	5	6	8	90%
Shaft sleeve	2	2	2	3	3	4	50%
O-rings for pump casing sets	4	6	8	8	9	12	150%
Other O-ring sets	4	6	8	8	9	10	100%
Mechanical seal (sets for radial suction)	2	3	4	5	6	7	90%
i = Number of stages							

8.2 Radial suction all-iron cross-sectional

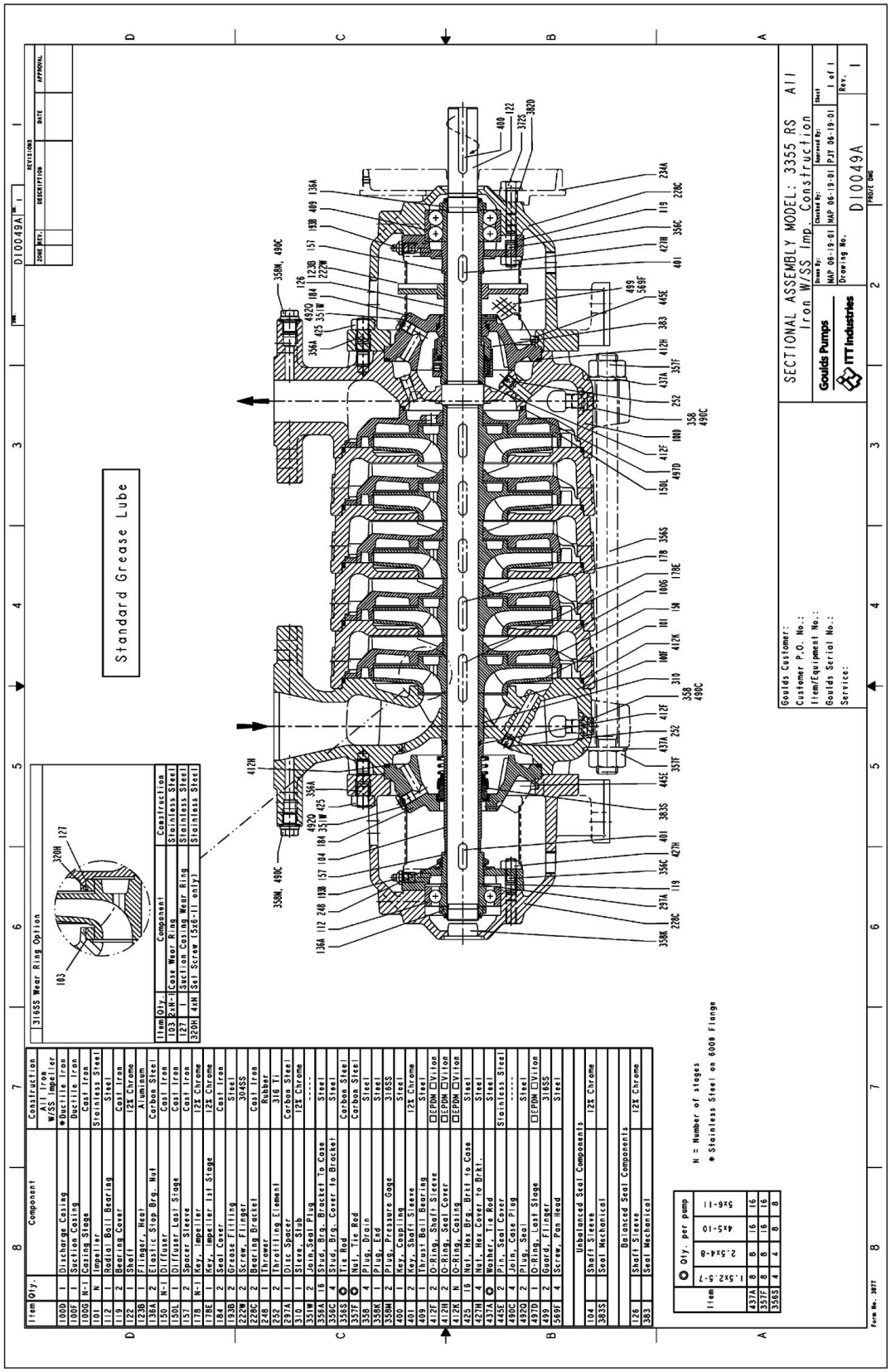


Item	Qty.	Component	Construction
100D	1	Discharge Casing	All Iron
100F	1	Suction Casing	■ Ductile Iron
100G	N-1	Casing Stage	Ductile Iron
101	N	Impeller	Cast Iron
112	1	Radial Ball Bearing	Steel
119	2	Bearing Cover	Cast Iron
122	1	Shaft	12% Chrome
123B●	1	Flinger, Heat	Aluminum
136A	2	Elastic Stop Nut	Carbon Steel
150	N-1	Diffuser	Cast Iron
150L	1	Diffuser Last Stage	Cast Iron
157	2	Spacer Sleeve	Cast Iron
178	N-1	Key, Impeller	12% Chrome
178E	1	Key, Impeller 1st Stage	12% Chrome
184	2	Seal Cover	Cast Iron
193B	2	Grease Fitting	Steel
222●●	2	Screw, Flinger	304SS
228C	2	Bearing Bracket	Cast Iron
248	2	Thrower	Steel
297A	1	Disc Spacer	Carbon Steel
310	1	Sleeve, Stub	12% Chrome
351W	2	Lbrn Seal Plug	Steel
356A	16	Stud, Brg. Bracket To Case	Steel
356C	4	Stud, Brg. Cover to Bracket	Steel
356S	○	Tie Rod	Carbon Steel
357F	○	Nut, Tie Rod	Carbon Steel
358	4	Plug, Drain	Steel
358K	1	Plug, End	Steel
358M	2	Plug, Pressure Gage	316SS
400	1	Key, Coupling	Steel
401	2	Key, Shaft Sleeve	12% Chrome
409	1	Thrust Ball Bearing	Steel
412F	2	O-Ring, Shaft Sleeve	□EPDM □Viton
412H	2	O-Ring, Seal Cover	□EPDM □Viton
412K	N	O-Ring, Casing	□EPDM □Viton
425	16	Nut, Hex Brg. Brkt to Case	Steel
427H	4	Nut, Hex Cover to Brkt.	Steel
437A	○	Washer, Tie Rod	Steel
445E	2	Pin, Seal Cover	Stainless Steel
490C	4	Pipe, Case Plug	Steel
497D	2	Pipe, Seal Stage	□EPDM □Viton
499	● 2	O-Ring, Heat Flinger	316SS
569F●	4	Screw, Pan Head	Steel
		Unbalanced Seal Components	
104		Shaft Sleeve	12% Chrome
383S		Seal Mechanical	
		Balanced Seal Components	
126		Shaft Sleeve	12% Chrome
383		Seal Mechanical	

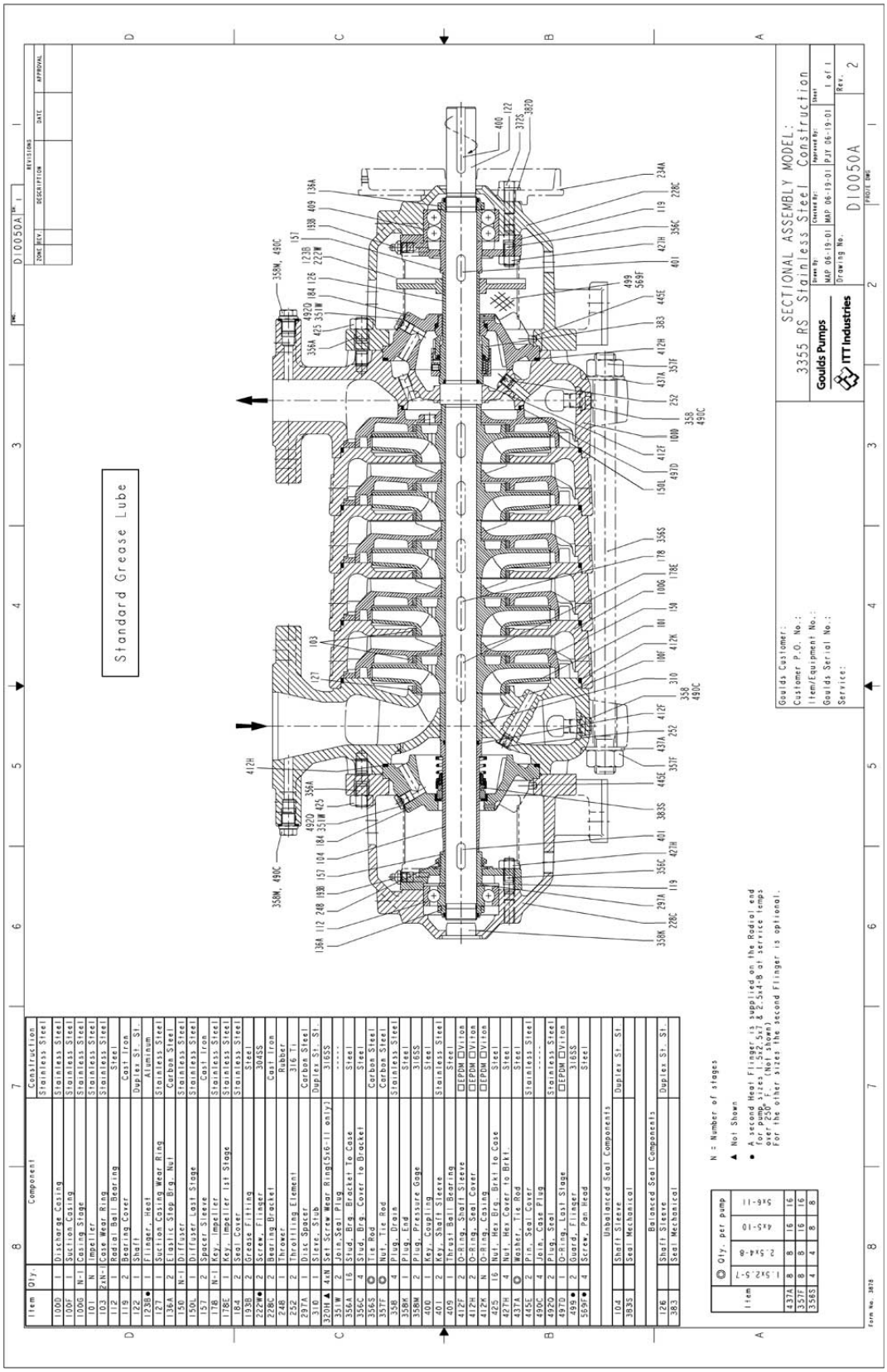
Item	○ Qty. per pump			
	1-1.5x2 1.5x3 & 2x3	2-3x4-6	4x5-10	5x6-11
437A	8	8	16	16
357F	8	8	16	16
356S	4	4	8	8

Item	Qty.	Component	Construction
103	P+N-1	Case Wear Ring	Stainless Steel
127	1	Suction Casing Wear Ring	Stainless Steel
320H	4xN	Set Screw (5x6-11 only)	Stainless Steel

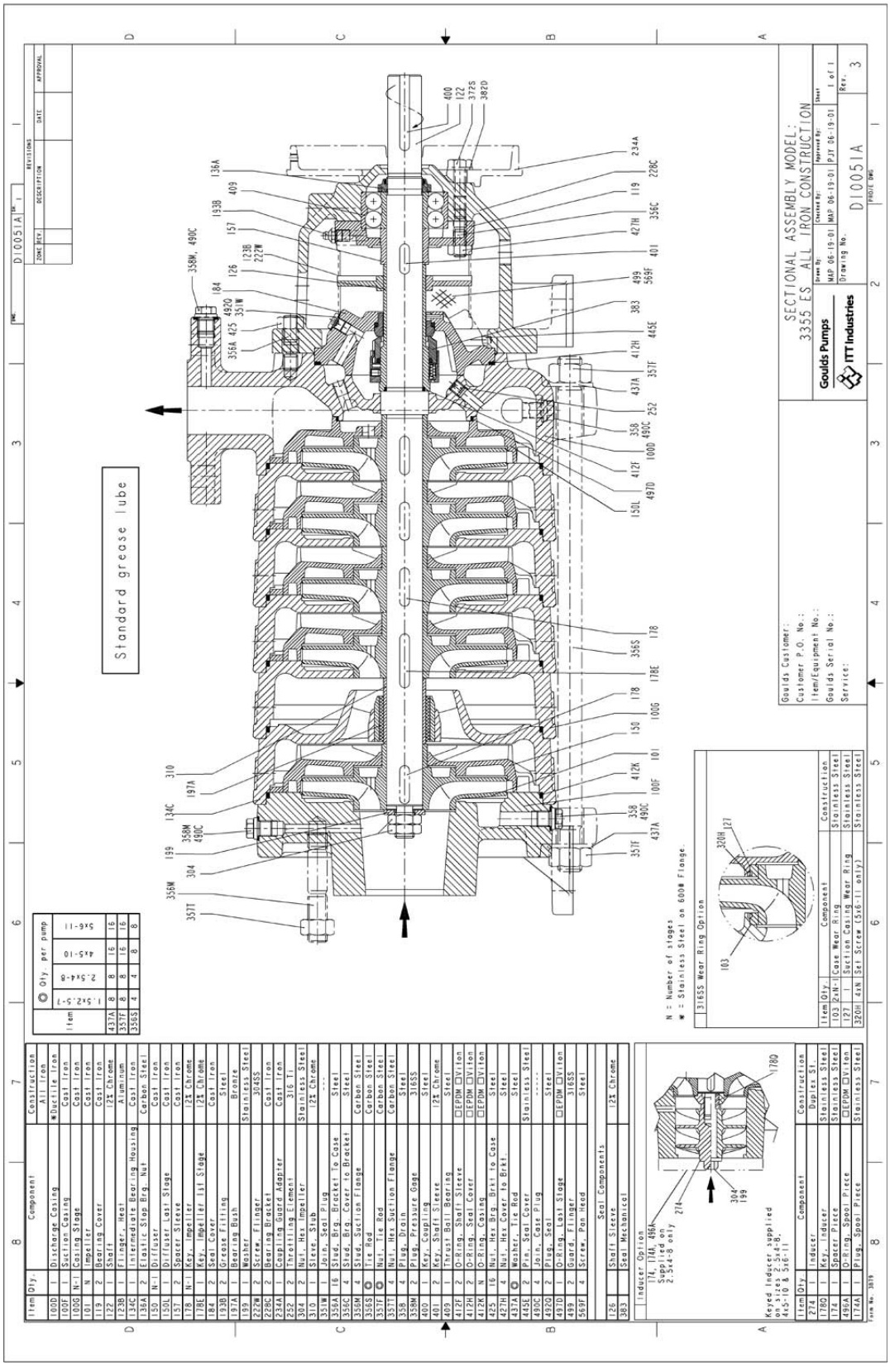
8.3 Radial suction all iron with stainless steel impeller cross sectional



8.4 Radial suction stainless steel cross-sectional



8.5 End-suction all-iron cross-sectional



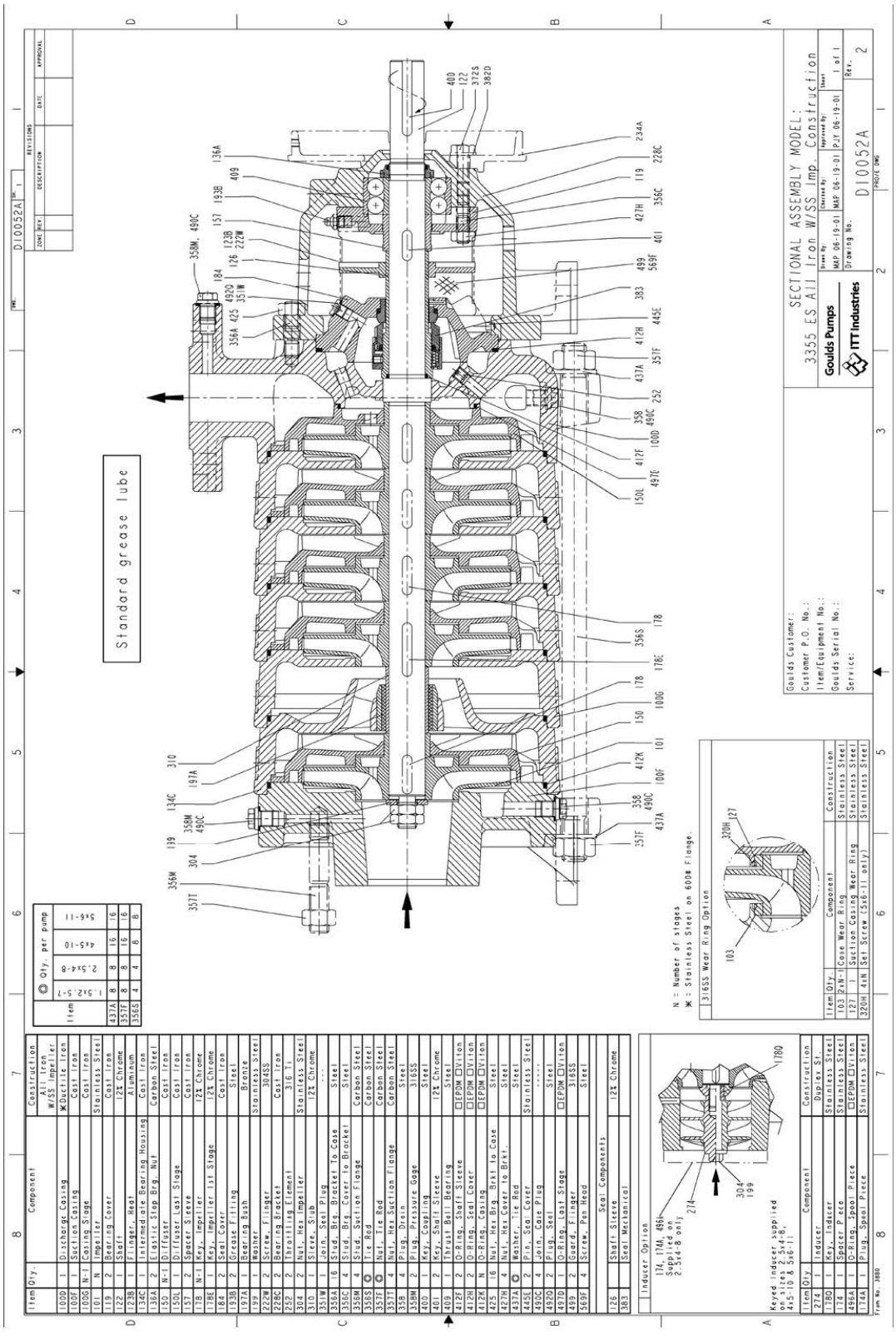
Item	Qty	Component	Construction
100D	1	Discharge Casing	●Ductile Iron
100F	1	Suction Casing	Cast Iron
100G	N-1	Casing Stage	Cast Iron
101	N	Impeller	Cast Iron
119	2	Bearing Cover	Cast Iron
122	1	Shaft	12% Chrome
123B	1	Flinger, Heat	Aluminum
134C	1	Intermediate Bearing Housing	Cast Iron
136A	2	Elastic Stop Brg. Nut	Carbon Steel
150	N-1	Diffuser	Cast Iron
150L	1	Diffuser Last Stage	Cast Iron
157	2	Spacer Sleeve	Cast Iron
178	N-1	Key, Impeller	12% Chrome
178E	1	Key, Impeller 1st Stage	12% Chrome
184	2	Seal Cover	Cast Iron
193B	2	Grease Fitting	Steel
197A	1	Bearing Bush	Bronze
199	1	Washer	Stainless Steel
222M	2	Screw, Flinger	304SS
228C	2	Bearing Bracket	Cast Iron
234A	1	Coupling Guard Adapter	Cast Iron
252	2	Throttling Element	316 Ti
304	2	Nut, Hex Impeller	Stainless Steel
310	1	Stem, Stub	12% Chrome
315W	1	Drain, Seal Plug	Steel
356A	16	Stud, Brg. Bracket To Case	Carbon Steel
356C	4	Stud, Brg. Cover to Bracket	Steel
356M	4	Stud, Suction Flange	Carbon Steel
356S	○	Tie Rod	Carbon Steel
357F	○	Nut, Tie Rod	Carbon Steel
357T	4	Nut, Hex Suction Flange	Carbon Steel
358	4	Plug, Drain	Steel
358M	2	Plug, Pressure Gage	316SS
400	1	Key, Coupling	Steel
401	2	Key, Shaft Sleeve	12% Chrome
409	1	Thrust Ball Bearing	Steel
412F	2	O-Ring, Shaft Sleeve	□EPDM □Viton
412H	2	O-Ring, Seal Cover	□EPDM □Viton
412K	N	O-Ring, Casing	□EPDM □Viton
425	16	Nut, Hex Brg. Brkt to Case	Steel
427H	4	Nut, Hex Cover to Brkt	Steel
437A	○	Washer, Tie Rod	Steel
445E	2	Pin, Seal Cover	Stainless Steel
490C	4	Join, Case Plug	-----
492Q	2	Plug, Seal	Steel
497D	1	O-Ring, Last Stage	□EPDM □Viton
499	2	Guard, Flinger	316SS
569F	4	Screw, Pan Head	Steel
		Seal Components	
126	2	Shaft Sleeve	12% Chrome
383	2	Seal Mechanical	

Item	Qty	Component	Construction
274	1	Inducer	Duplex SS
178D	1	Key, Inducer	Stainless Steel
124	1	Spacer Piece	Stainless Steel
496A	1	O-Ring, Spool Piece	□EPDM □Viton
124A	1	Plug, Spool Piece	Stainless Steel

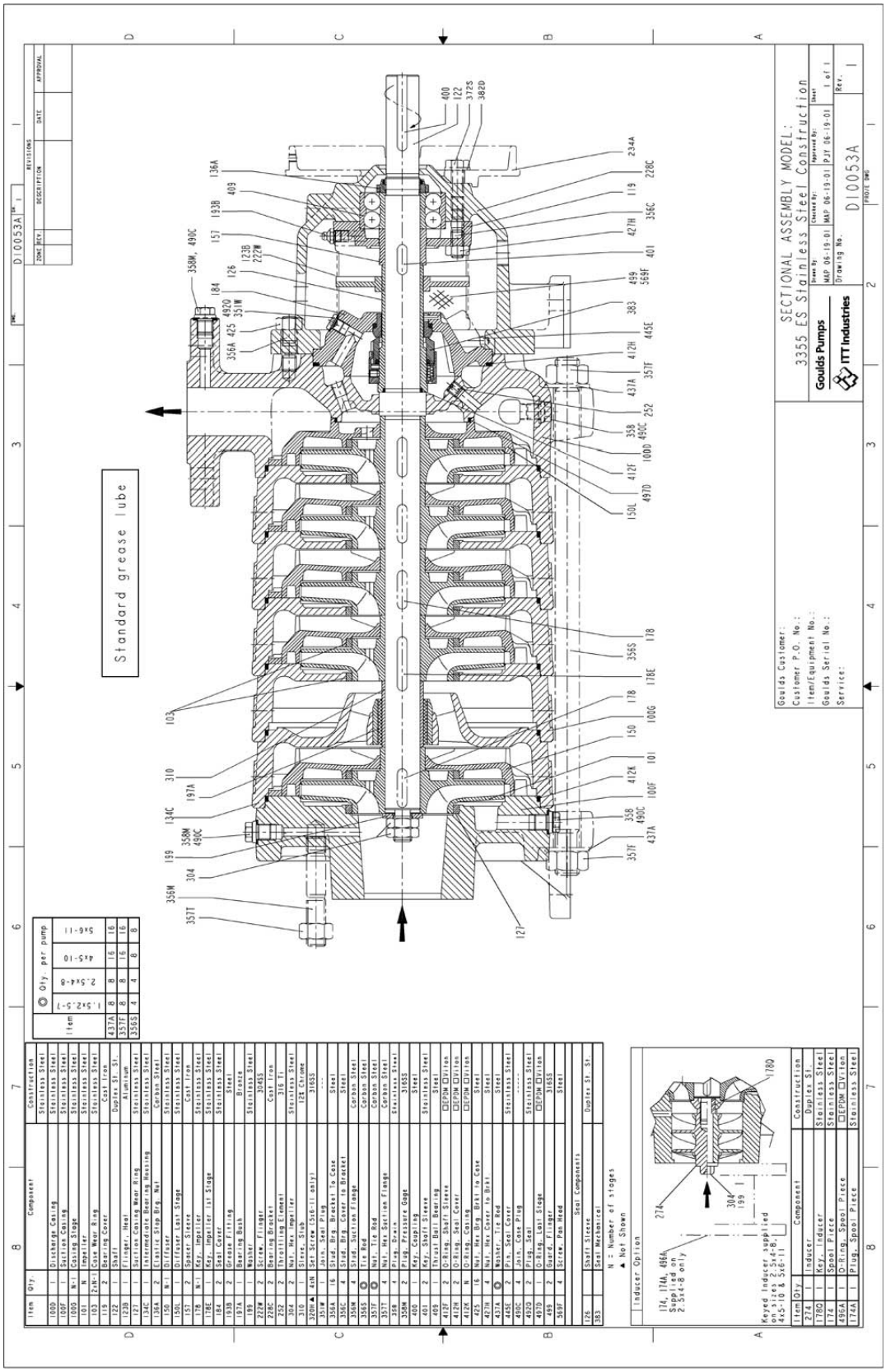
Item	Qty	Component	Construction
103	2(N-1)	Case Wear Ring	Stainless Steel
127	1	Suction Casing Wear Ring	Stainless Steel
320H	4(N)	Set Screw (316-11 only)	Stainless Steel

Item	Qty per pump		
	1.5x2-5,5-7	2.5x4-8	4x5-10	5x6-11
437A	8	16	16
357F	8	8	16	16
356S	4	4	8	8

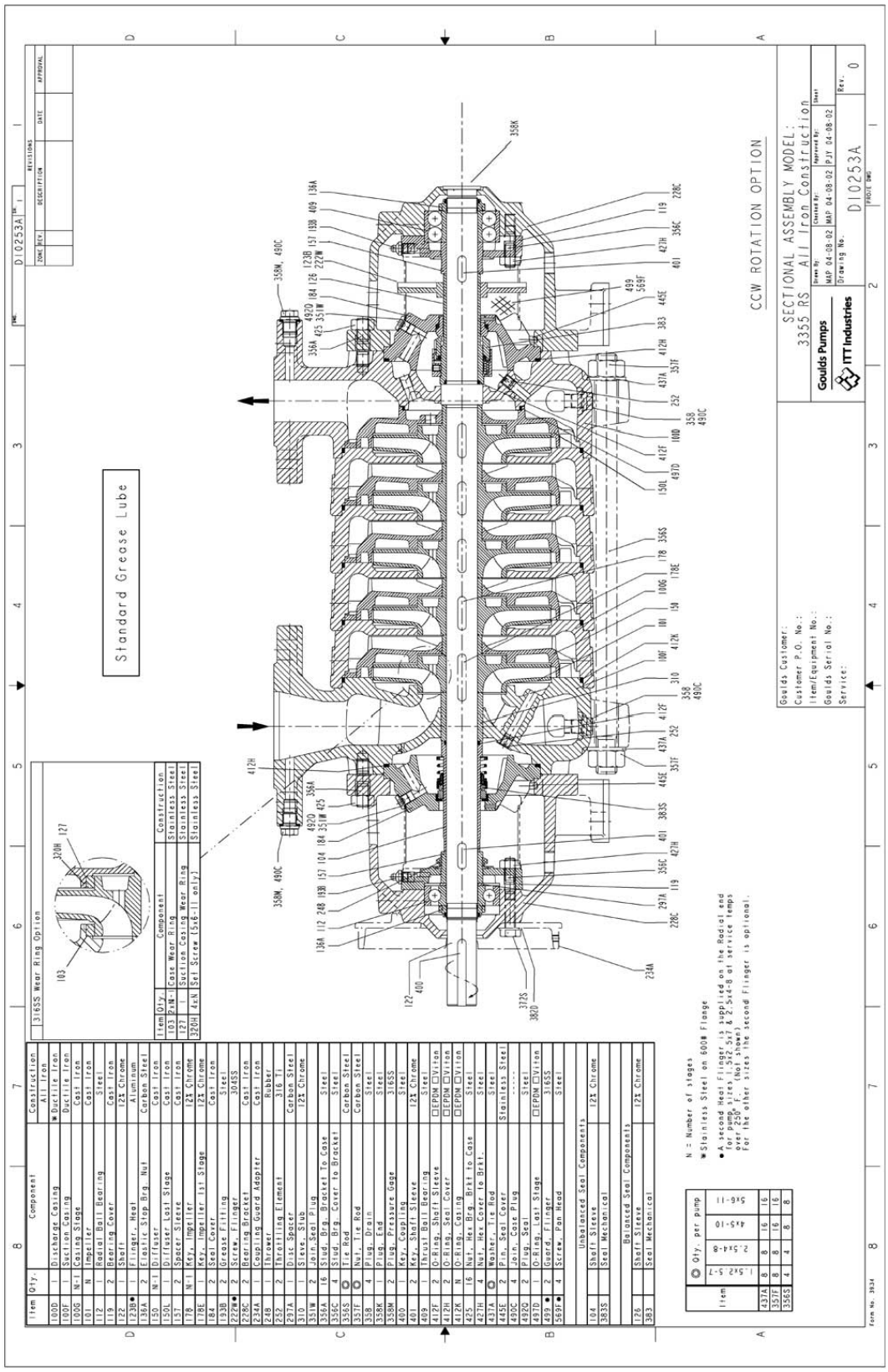
8.6 End-suction all-iron with stainless steel impeller cross-sectional



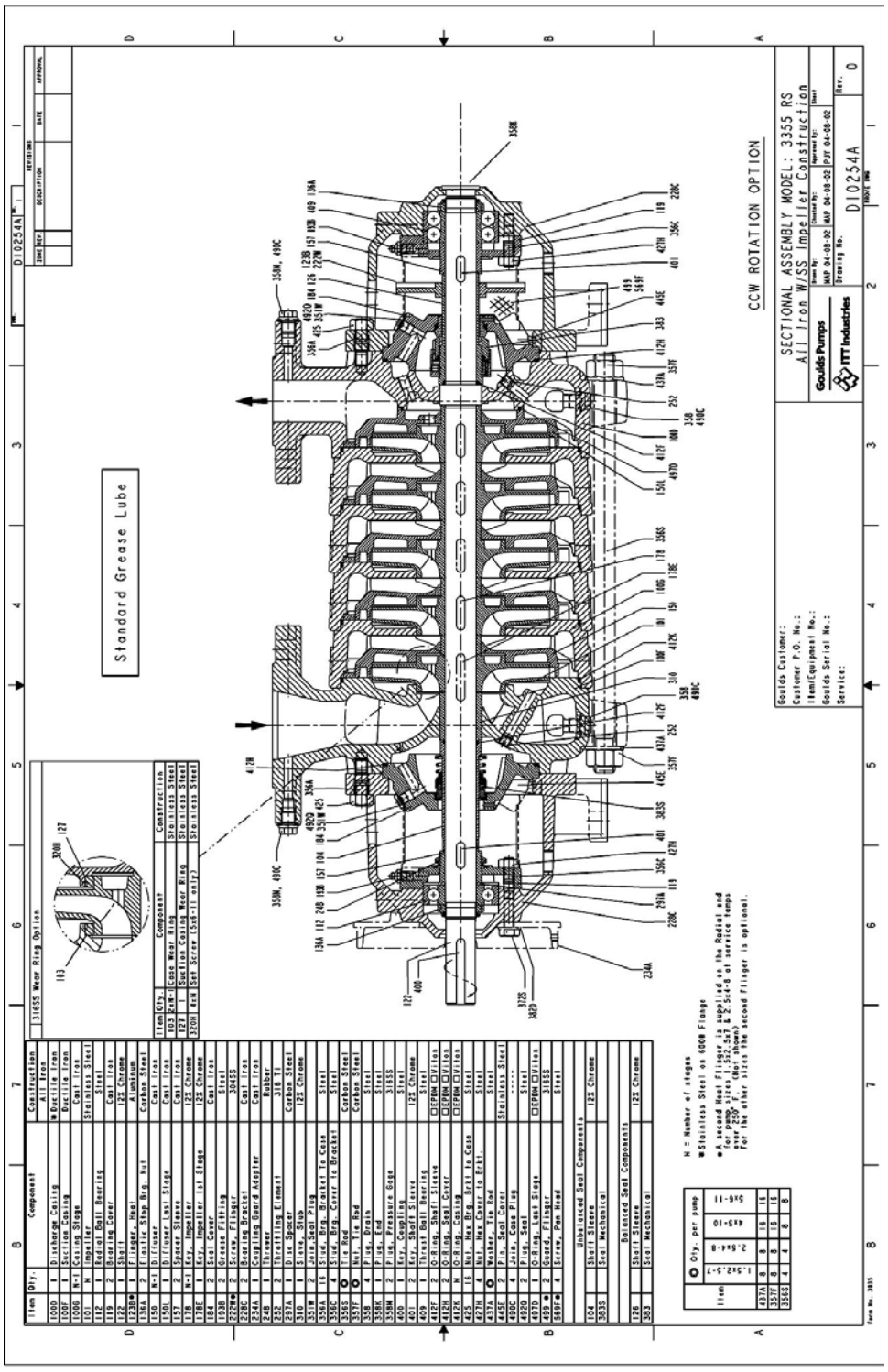
8.7 End-suction stainless steel cross-sectional



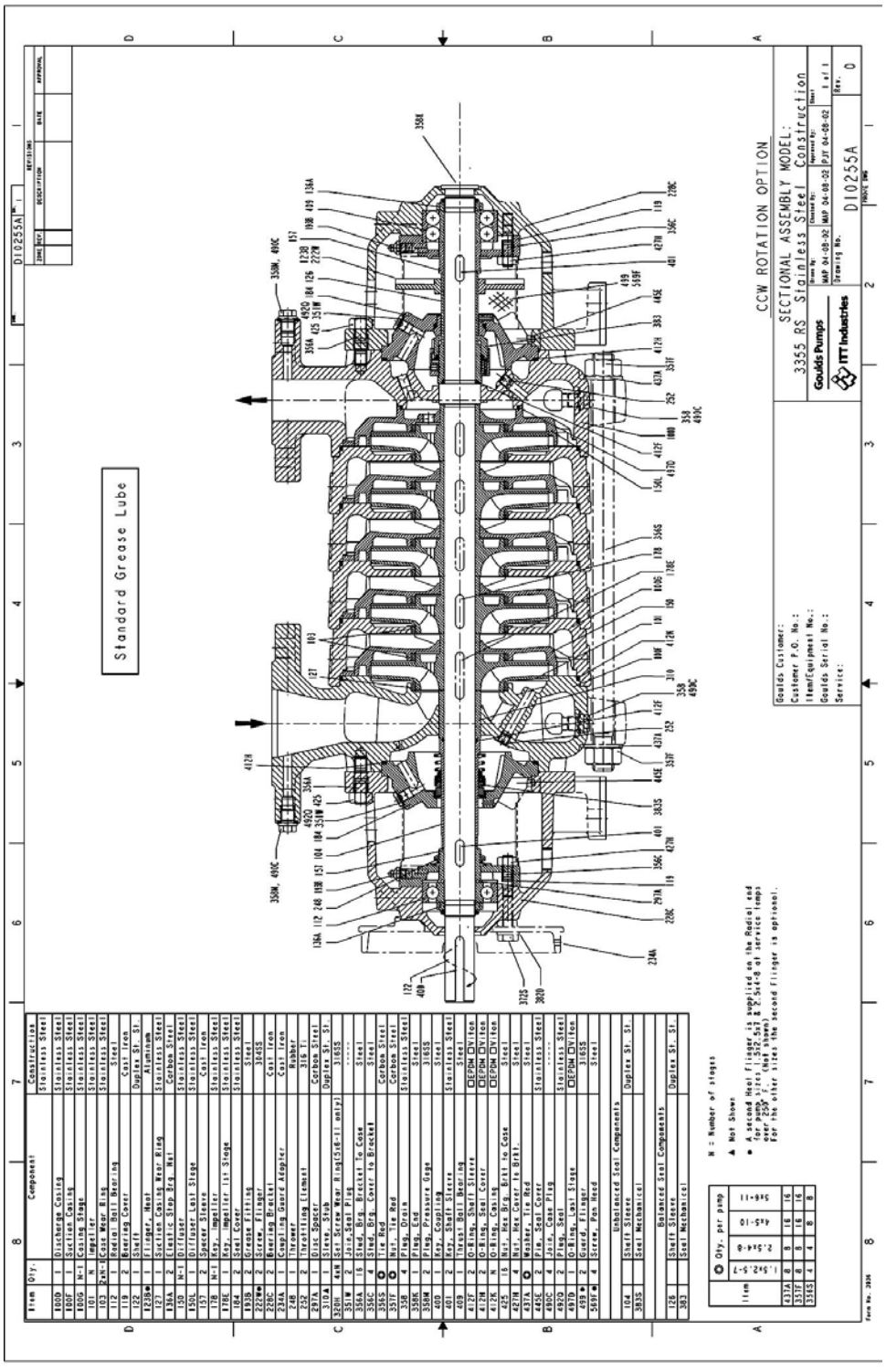
8.8 Radial suction (counterclockwise rotation) all-iron cross-sectional



8.9 Radial suction (counterclockwise rotation) all-iron with stainless steel impeller cross-sectional



8.10 Radial suction (counterclockwise rotation) stainless steel cross-sectional



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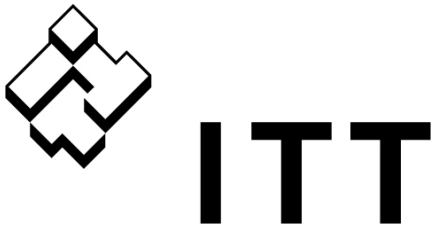

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