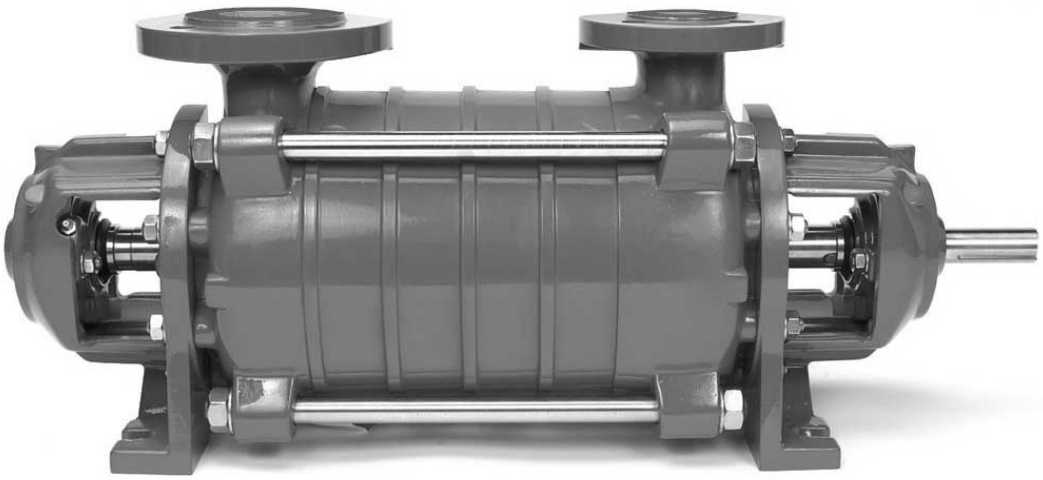
ITT

Goulds Pumps

Installation, Operation, and Maintenance Manual

Model 3355



Engineered for life

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Introduction and Safety

Introduction

Purpose of this manual

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

- Installation
- Operation
- Maintenance

CAUTION:

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

NOTICE:

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

Requesting other information

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

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

Safety

WARNING:

- The operator must be aware of safety precautions to prevent physical injury.
- Any pressure-containing device can explode, rupture, or discharge its contents if it is over-pressurized. Take all necessary measures to avoid over-pressurization.
- Operating, installing, or maintaining the unit in any way that is not covered in this manual could cause death, serious personal injury, or damage to the equipment. This includes any modification to the equipment or use of parts not provided by ITT. If there is a question regarding the intended use of the equipment, please contact an ITT representative before proceeding.
- Do not change the service application without the approval of an authorized ITT representative.
- Never operate the pump without safety devices installed.
- Never operate the pump with the discharge valve closed.

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

The Ex symbol

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

Environmental safety

The work area

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

Recycling guidelines

Always recycle according to these guidelines:

1. Follow local laws and regulations regarding recycling if the unit or parts are accepted by an authorized recycling company.
2. If the first guideline is not applicable, then return the unit or parts to your ITT representative.

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.

Electrical installation

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

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:

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

NOTICE:

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

Electrical connections

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

Wash the skin and eyes

Do the following if chemicals or hazardous fluids have come into contact with your eyes or your skin:

If you need to wash your...	Then...
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.
Skin	1. Remove contaminated clothing. 2. Wash the skin with soap and water for at least one minute. 3. Seek medical attention, if required.

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 (including IEC/EN 60079-17).

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.

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. You can apply these guidelines to equipment installed in any potentially explosive atmosphere.

ATEX guidelines

ATEX 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 ATEX-compliant equipment, always comply with the directive and applicable standards in IEC/EN 60079–14.

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.

Transportation and Storage

Inspect the delivery

Inspect the package

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

Inspect the unit

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

Transportation guidelines

Precautions

WARNING:

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

Pump handling and lifting

Precautions for moving the pump

Use care when moving pumps.

WARNING:

Make sure that the pump cannot roll or fall over and injure people or damage property.

NOTICE:

Use a forklift truck with sufficient capacity to move the pallet with the pump unit on top.

Precautions for lifting the pump

WARNING:

Crush hazard. The unit and the components can be heavy. Use proper lifting methods and wear steel-toed shoes at all times.

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.

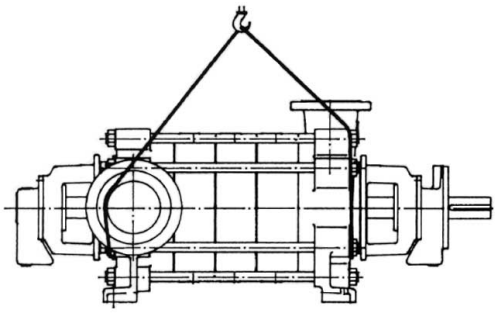


Figure 1: Example of the proper lifting method for a bare pump

Baseplate-mounted units have lifting points for use with proper lifting devices. The arrows point to the lifting points.

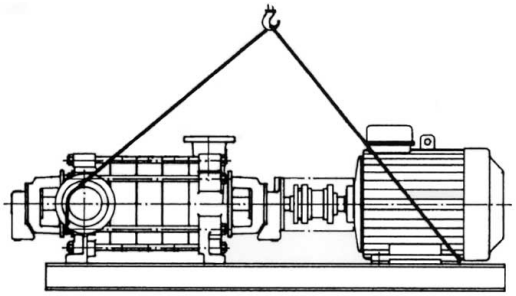


Figure 2: Example of the proper lifting method for baseplate-mounted units with a driver

Storage guidelines

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.

Pump storage requirements

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

Length of time in storage	Storage requirements
Upon receipt/short-term (less than six months)	• Store in a covered and dry location.

Length of time in storage	Storage requirements
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 pump order or you can purchase it and apply it after the pumps are already in the field. Contact your local ITT sales representative.

Product Description

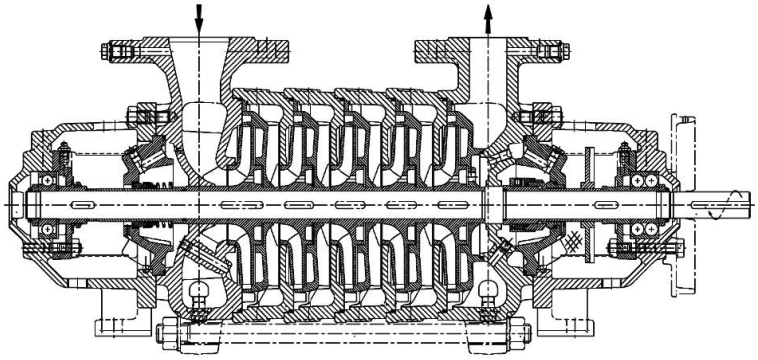
General description

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

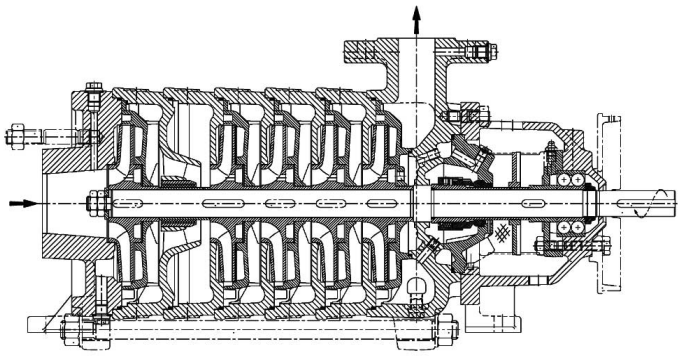
Radial suction configuration

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.

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.

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

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

Nameplate on the pump casing using English units

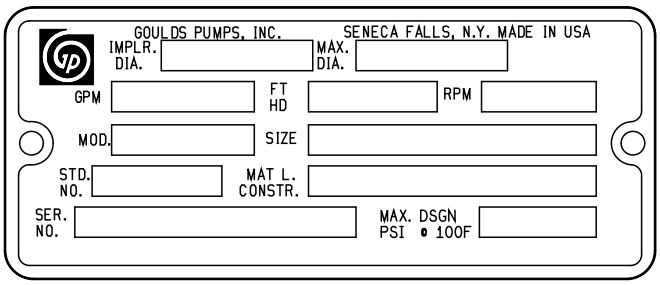


Table 1: Explanation of nameplate on the pump casing

Nameplate field	Explanation
IMPLR. DIA.	Impeller diameter, in inches
MAX. DIA.	Maximum impeller diameter, in inches
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 @ 100F	Maximum pressure at 100ºF according to the pump design

ATEX nameplate

Nameplate field	Explanation
II	Group 2
2	Category 2
G/D	Pump can be used when gas and dust are present
T4	Temperature class

Table 2: Temperature class definitions

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

NOTICE: Make sure that the code classifications on the pump are compatible with the specific environment in which you plan to install the equipment. If they are not compatible, do not operate the equipment and contact your ITT representative before you proceed.

Installation

Preinstallation

Precautions

WARNING:

- When installing in a potentially explosive environment, make sure that the motor is properly certified.
- You must earth (ground) all electrical equipment. This applies to the pump equipment, the driver, and any monitoring equipment. Test the earth (ground) lead to verify that it is connected correctly.

NOTICE: Supervision by an authorized ITT representative is recommended to ensure proper installation. Failure to do so may result in equipment damage or decreased performance.

Pump location guidelines

WARNING:

Assembled units and their components are heavy. Failure to properly lift and support this equipment can result in serious physical injury and/or equipment damage. Lift equipment only at the specifically identified lifting points. Lifting devices such as eyebolts, slings, and spreaders must be rated, selected, and used for the entire load being lifted.

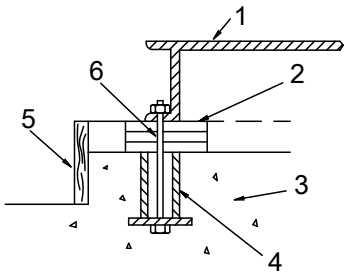
Guideline	Explanation/comment
Keep the pump as close to the liquid source as practically possible.	This minimizes the friction loss and keeps the suction piping as short as possible.
Make sure that the space around the pump is sufficient. A minimum of 3 feet (1 meter) is the recommendation.	This facilitates 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.

Foundation requirements

Requirements

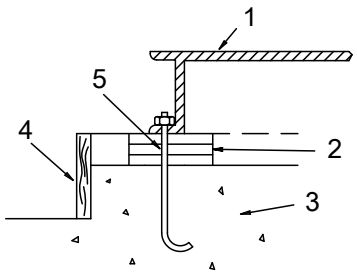
- The foundation must be able to absorb any type of vibration and form a permanent, rigid support for the pump unit.
- The location and size of the foundation bolt holes must match those shown on the assembly drawing provided with the pump data package.
- The foundation must weigh between two and three 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 and J-type foundation bolts are most commonly used. Both designs allow movement for the final bolt adjustment.

Sleeve-type bolts



1. Baseplate
2. Shims or wedges
3. Foundation
4. Sleeve
5. Dam
6. Bolt

J-type bolts



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

Baseplate-mounting procedures

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 you used 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.

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 0.75 in. (19 mm) to 1.5 in. (38 mm) 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 make sure that you achieve the correct leveling. 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 0.125 in. (3.2 mm) lengthwise
   - A maximum difference of 0.059 in. (1.5 mm) across

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

Pump-to-driver alignment

Precautions

WARNING:

- Follow shaft alignment procedures in order to prevent catastrophic failure of drive components or unintended contact of rotating parts. Follow the coupling installation and operation procedures from the coupling manufacturer.
- Always disconnect and lock out power to the driver before you perform any installation or maintenance tasks. Failure to disconnect and lock out driver power will result in serious physical injury.

NOTICE: Proper alignment is the responsibility of the installer and the user of the unit. Check the alignment of frame-mounted units before you operate the unit. Failure to do so can result in equipment damage or decreased performance.

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.

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. You must use the correct tolerances. Failure to do so can result in misalignment and reduced pump reliability.

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 indicator runout is a maximum of 0.002 in. (0.05 mm) at operating temperature.
- The tolerance of the indicator is 0.0005 in./in. (0.0127 mm/mm) of indicator separation at operating temperature.

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 feet 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 feet 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.

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.

Pump-to-driver alignment instructions

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.

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.

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 to zero at the top-center position (12 o'clock) of the driver coupling half.

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. Add shims of a thickness equal to half of the indicator reading value to each driver foot.

NOTICE:

You must use an equal amount of shims with each driver foot to prevent misalignment. Failure to do so can result in equipment damage or decreased performance.

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

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 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 is to the left of the pump coupling half.
Positive	The driver coupling half is to the right of the pump coupling half.

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.

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.

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.

Grout the baseplate

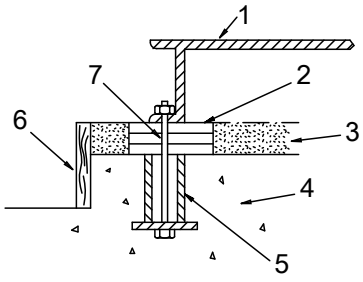
Required equipment:

- 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.

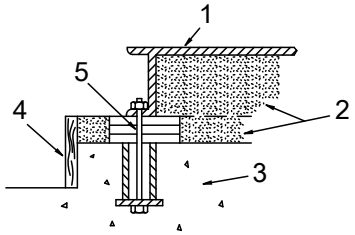
   When you pour the grout, remove air bubbles from it by using one of these methods:

   - Puddle with a vibrator.
   - Pump the grout into place.
5. Allow the grout to set.



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

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



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

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

Piping checklists

Fastening

WARNING:

- Only use fasteners of the proper size and material.
- Replace all corroded fasteners.
- Make sure that all fasteners are properly tightened and that there are no missing fasteners.

General piping checklist

Precautions

CAUTION:

- Never draw piping into place by using force 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.
- 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.

NOTICE:

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.

Piping guidelines

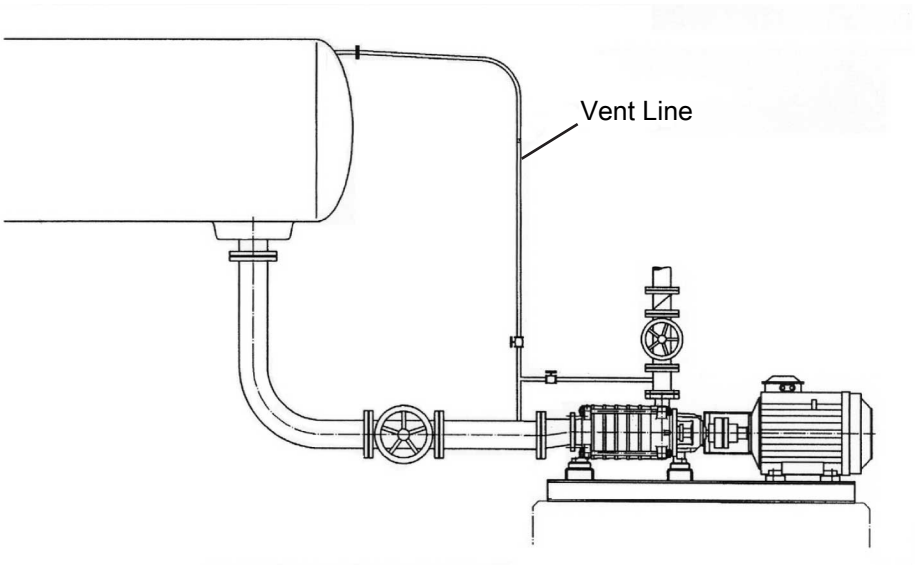
Guidelines for piping are given in the Hydraulic Institute Standards available from the Hydraulic Institute at 9 Sylvan Way, Parsippany, NJ 07054-3802. You must review this document before you install the pump.

Checklist

Check	Explanation/comment	Checked
Check that all piping is supported independently of, and lined up naturally with, the pump flange.	This helps to prevent: • Strain on the pump • Misalignment between the pump and the drive unit • Wear on the pump bearings, seal, and shafting	
Keep the piping as short as possible.	This helps to minimize friction losses.	
Check that only necessary fittings are used.	This helps to minimize friction losses.	
Do not connect the piping to the pump until: • The grout for the baseplate or sub-base 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.	This prevents air from entering the piping system or leaks that occur during operation.	

Check	Explanation/comment	Checked
If the pump handles corrosive fluids, make sure that the piping allows you to flush out the liquid before you remove the pump.	—	
If the pump handles liquids at elevated temperatures, make sure that the expansion loops and joints are properly installed.		
Make sure that all piping components, valves and fittings, and pump branches are clean prior to assembly.	—	

Example: Piping installation with a vent line



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		
If suction strainers or suction bells are used, check that they are at least three times the area of the suction piping.	Suction strainers help to prevent clogging.	

Check	Explanation/comment	Checked
	Mesh holes with a minimum diameter of 1/16 in. (1.6 mm) are recommended.	
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.	
If necessary, make sure that the suction piping includes a drain valve and that it is correctly installed.	—	

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.	—	
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.	

Discharge piping checklist

Checklist

Check	Explanation/comment	Checked
Check that an isolation valve is installed in the discharge line.	The isolation valve is required for: • Priming • Regulation of flow • Inspection and maintenance of the pump	
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.	

Check	Explanation/comment	Checked
	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.	

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.	

Commissioning, Startup, Operation, and Shutdown

Preparation for startup

WARNING:

- Any pressure-containing device can explode, rupture, or discharge its contents if it is over-pressurized. Take all necessary measures to avoid over-pressurization.
- Failure to follow these precautions before you start the pump will lead to serious personal injury and equipment failure.
- Do not operate the pump below the minimum rated flows or with the suction or discharge valves closed. These conditions can create an explosive hazard due to vaporization of pumped fluid and can quickly lead to pump failure and physical injury.
- Never operate the pump without the coupling guard correctly installed.
- The coupling used in an ATEX classified environment must be properly certified.
- Always disconnect and lock out power to the driver before you perform any installation or maintenance tasks. Failure to disconnect and lock out driver power will result in serious physical injury.
- Operating the pump in reverse rotation can result in the contact of metal parts, heat generation, and breach of containment.
- Make sure to properly lubricate the bearings. Failure to do so can result in excess heat generation, sparks, and premature failure.

Precautions

NOTICE:

- Verify the driver settings before you start the pump.

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 200°F (93°C), then warm up the pump prior to operation. Circulate a small amount of fluid through the pump until the casing temperature is within 100°F (38°C) of the fluid temperature.

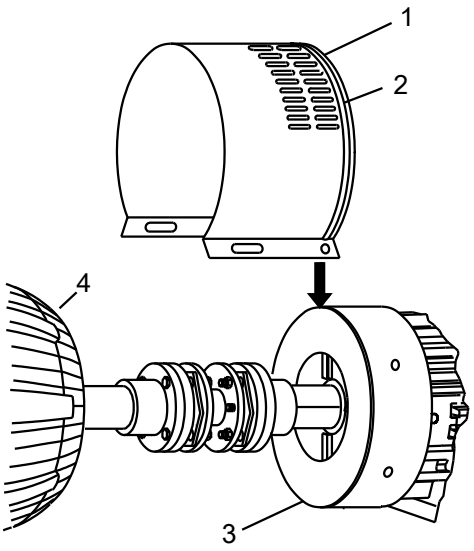
At initial startup, do not adjust the variable-speed drivers or check for speed governor or over-speed trip settings while the variable-speed driver is coupled to the pump. If the settings have not been verified, then uncouple the unit and refer to instructions supplied by the driver manufacturer.

Remove the coupling guard

1. Remove the nut, bolt, and washers 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, and washers from the driver half of the coupling guard.
4. Remove the driver-side end plate.
5. Remove the driver half of the coupling guard:
   a) Slightly spread the bottom apart.
   b) Lift upwards.
6. Remove the remaining nut, bolt, and washers 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.

7. Remove the pump half of the coupling guard:
   a) Slightly spread the bottom apart.
   b) Lift upwards.



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

Check the rotation

WARNING:

- Operating the pump in reverse rotation can result in the contact of metal parts, heat generation, and breach of containment.
- Always disconnect and lock out power to the driver before you perform any installation or maintenance tasks. Failure to disconnect and lock out driver power will result in serious physical injury.

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.

Couple the pump and driver

WARNING:

- Always disconnect and lock out power to the driver before you perform any installation or maintenance tasks. Failure to disconnect and lock out driver power will result in serious physical injury.
- The coupling used in an Ex-classified environment must be properly certified and must be constructed from a non-sparking material.

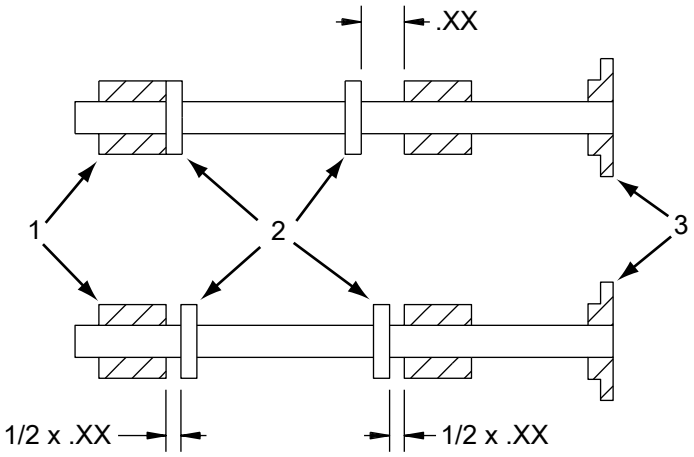
1. Check the gap between the coupling hubs against the dimensions shown on the elevation drawing or as stamped on the coupling hub. For any necessary adjustment, move the driver not the pump.

   Motors with sleeve bearings may be manufactured with 1/4 or 1/2 in. (6.35 or 12.7 mm) 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 1/2 or 1/4 in. (6.35 or 12.7 mm) 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

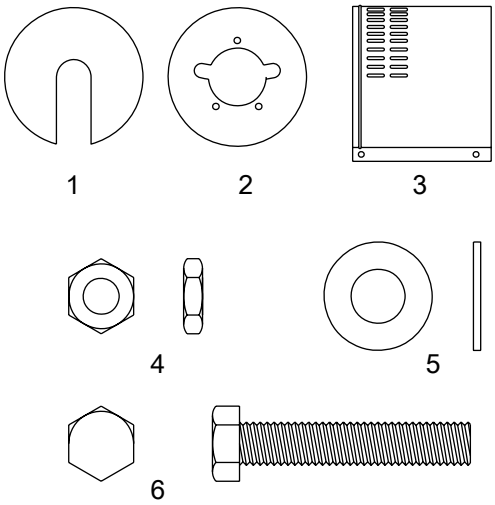
2. Use the instructions from the coupling manufacturer to lubricate and install the coupling.
3. Check the angular and parallel alignment of the coupling halves. See Pump-to-driver alignment in the Installation chapter.

Install the coupling guard

WARNING:

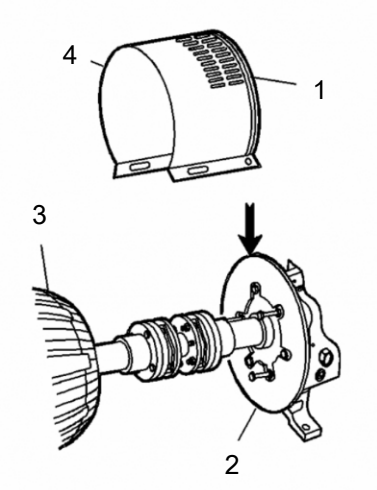
- Never operate a pump without a properly installed coupling guard. Personal injury will occur if you run the pump without a coupling guard.
- Always disconnect and lock out power to the driver before you perform any installation or maintenance tasks. Failure to disconnect and lock out driver power will result in serious physical injury.
- The coupling used in an Ex-classified environment must be properly certified and must be constructed from a non-sparking material.

Required parts:



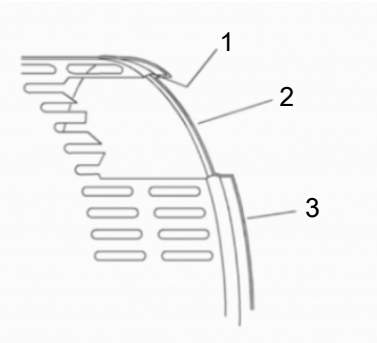
1. End plate, drive end
2. End plate, pump end
3. Guard half, 2 required
4. 3/8-16 nut, 3 required
5. 3/8 in. washer
6. 3/8-16 x 2 in. hex head bolt, 3 required

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-half of the coupling guard in place:
   a) Slightly spread the bottom apart.
   b) Place the coupling guard half over the pump-side end plate.



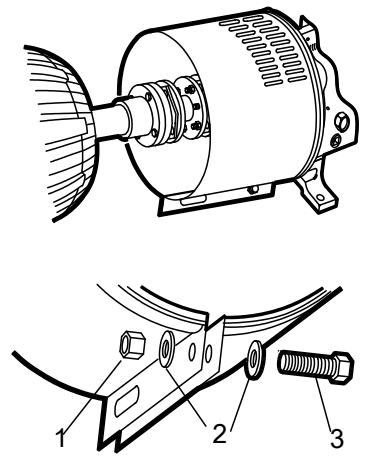
1. Annular groove
2. Pump-side end plate
3. Driver
4. Pump half of the coupling guard

The annular groove in the coupling guard half must fit around the end plate.



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

3. Use a bolt, a nut, and two washers to secure the coupling guard half to the end plate. Tighten securely.



1. Nut
2. Washer
3. Bolt

4. Put the driver half of the coupling guard in place:
   a) Slightly spread the bottom apart.
   b) Place the driver half of the coupling guard over the pump half of the coupling guard.

The annular groove in the coupling guard half must face the motor.

5. Place the driver-side end plate over the motor shaft.
6. Place the driver-side end plate in the annular groove of the driver-half of the coupling guard.
7. Use a bolt, a nut, and two washers to secure the coupling guard half to the end plate. Hand-tighten only.

   The hole is located on the driver-side of the coupling guard half.
8. Slide the driver-half of the coupling guard towards the motor so that the coupling guard completely covers the shafts and coupling.
9. Use a nut, a bolt, and two washers to secure the coupling guard halves together.
10. Tighten all nuts on the guard assembly.

WARNING:
Never operate the pump without the coupling guard correctly installed.

Pump priming

CAUTION:
Do not run the pump dry, because this might damage the pump and/or the steady bearings.

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.

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.

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 valves 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 valves.
6. Close the outside supply line.

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

Start the pump

CAUTION:

- Immediately observe the pressure gauges. If discharge pressure is not quickly attained, stop the driver, reprime, and attempt to restart the pump.
- Observe the pump for vibration levels, bearing temperature, and excessive noise. If normal levels are exceeded, shut down the pump and resolve the issue.

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.

Pump operation precautions

General considerations

CAUTION:

- Vary the capacity with the regulating valve in the discharge line. Never throttle the flow from the suction side since this can result in decreased performance, unexpected heat generation, and equipment damage.
- Do not overload the driver. Driver overload can result in unexpected heat generation and equipment damage. The driver can overload in these circumstances:
  - The specific gravity of the pumped fluid is greater than expected.
  - The pumped fluid exceeds the rated flow rate.
- Make sure to operate the pump at or near the rated conditions. Failure to do so can result in pump damage from cavitation or recirculation.

Operation at reduced capacity

WARNING:

Never operate any pumping system with a blocked suction and discharge. Operation, even for a brief period under these conditions, can cause confined pumped fluid to overheat, which results in a violent explosion. You must take all necessary measures to avoid this condition.

CAUTION:

- Avoid excessive vibration levels. Excessive vibration levels can damage the bearings, stuffing box or seal chamber, and the mechanical seal, which can result in decreased performance.
- Avoid increased radial load. Failure to do so can cause stress on the shaft and bearings.
- Avoid heat build-up. Failure to do so can cause rotating parts to score or seize.
- Avoid cavitation. Failure to do so can cause damage to the internal surfaces of the pump.

Operation under freezing conditions

NOTICE:

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

Shut down the pump

WARNING:

The pump can handle hazardous and toxic fluids. Identify the contents of the pump and observe proper decontamination procedures in order to eliminate the possible exposure to any hazardous or toxic fluids. Wear the proper personal protective equipment. Potential hazards include, but are not limited to, high temperature, flammable, acidic, caustic, explosive, and other risks. You must handle and dispose of pumped fluid in compliance with the applicable environmental regulations.

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

Make the final alignment of the pump and driver

WARNING:

- Always disconnect and lock out power to the driver before you perform any installation or maintenance tasks. Failure to disconnect and lock out driver power will result in serious physical injury.
- Follow shaft alignment procedures in order to prevent catastrophic failure of drive components or unintended contact of rotating parts. 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.

   See Pump-to-driver alignment in the Installation chapter.
5. Reinstall the coupling guard.
6. Restart the pump and driver.

Maintenance

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 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.

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.

Bearing maintenance

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

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

Lubricating-grease requirements

Precautions

NOTICE:

- 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. Doing so may result in decreased performance.
- Remove the bearings and old grease if you need to change the grease type or consistency. Failure to do so may result in equipment damage or decreased performance.

Bearing temperature

Bearing temperatures are generally about 20°F (18°C) greater than bearing-housing outer surface temperatures.

This table shows the type of grease required for the operating temperature of the pump.

Bearing temperature	Type of grease
5°F to 230°F (-15°C to 110°C)	Use a lithium-based mineral-oil grease with a consistency of NLGI 2.
Exceed 350°F (177°C)	Use a high-temperature grease. Mineral-oil greases should have oxidation stabilizers and a consistency of NGLI 3.

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 350°F (177°C) - NLGI consistency 2
Mobil	Mobilux EP2
Exxon	Unirex N2
Sunoco	Mutipurpose 2EP

Brand	When temperature of pumped fluid is less than 350°F (177°C) - NLGI consistency 2
SKF	LGMT 2

Regrease the grease-lubricated bearings

NOTICE:

Make sure that the grease container, the greasing device, and the fittings are clean. Failure to do this can result in impurities entering the bearing housing when you regrease the bearings.

1. Wipe dirt from the grease fittings.
2. Fill both of the grease cavities through the fittings with a recommended grease until the fresh grease comes out of the relief holes.
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.

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.

Shaft-seal maintenance

Mechanical-seal maintenance

WARNING:

The mechanical seal used in an Ex-classified environment must be properly certified. Prior to startup, make sure that all areas that could leak pumped fluid to the work environment are closed.

CAUTION:

Never operate the pump without liquid supplied to mechanical seal. If you run a mechanical seal dry, even for a few seconds, this can cause seal damage. Physical injury can occur if a mechanical seal fails.

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.

Disassembly

Disassembly precautions

WARNING:

- Installation, Operation, and Maintenance manuals clearly identify accepted methods for disassembling units. These methods must be adhered to. Trapped liquid can rapidly expand and result in a violent explosion and injury. Never apply heat to impellers, propellers, or their retaining devices to aid in their removal.
- Make sure that the pump is isolated from the system and that pressure is relieved before you disassemble the pump, remove plugs, open vent or drain valves, or disconnect the piping.
- Always disconnect and lock out power to the driver before you perform any installation or maintenance tasks. Failure to disconnect and lock out driver power will result in serious physical injury.
- Crush hazard. The unit and the components can be heavy. Use proper lifting methods and wear steel-toed shoes at all times.
- The pump can handle hazardous and toxic fluids. Identify the contents of the pump and observe proper decontamination procedures in order to eliminate the possible exposure to any hazardous or toxic fluids. Wear the proper personal protective equipment. Potential hazards include, but are not limited to, high temperature, flammable, acidic, caustic, explosive, and other risks. You must handle and dispose of pumped fluid in compliance with the applicable environmental regulations.
- Never apply heat to remove an impeller. The use of heat may cause an explosion due to trapped liquid, resulting in severe physical injury and property damage.

CAUTION:

- Wear heavy work gloves when you handle impellers. The sharp edges can cause physical injury.
- Wear insulated gloves when you use a bearing heater. Bearings get hot and can cause physical injury.

NOTICE:

Make sure that all replacement parts are available before you disassemble the pump for overhaul.

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

Drain the pump

CAUTION:

- Allow all system and pump components to cool before you handle them to prevent physical injury.

1. Close the isolation valves on the suction and discharge sides of the pump.

   You must drain the system if no valves are installed.
2. Open the drain valve.

   Do not proceed until liquid stops coming out of the drain valve. If liquid continues to flow from the drain valve, the isolation valves are not sealing properly and you must repair them before you proceed.
3. Drain the liquid from the piping and flush the pump if it is necessary.
4. Disconnect all auxiliary piping and tubing.
5. Remove the coupling guard.
6. Disconnect the coupling.
7. Unbolt the pump from the piping system and the baseplate.

Prepare for disassembly

WARNING:

Make sure that the pump cannot roll or fall over and injure people or damage property.

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.

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.

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.

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).

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

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.

Preassembly inspections

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.

Reassembly

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.

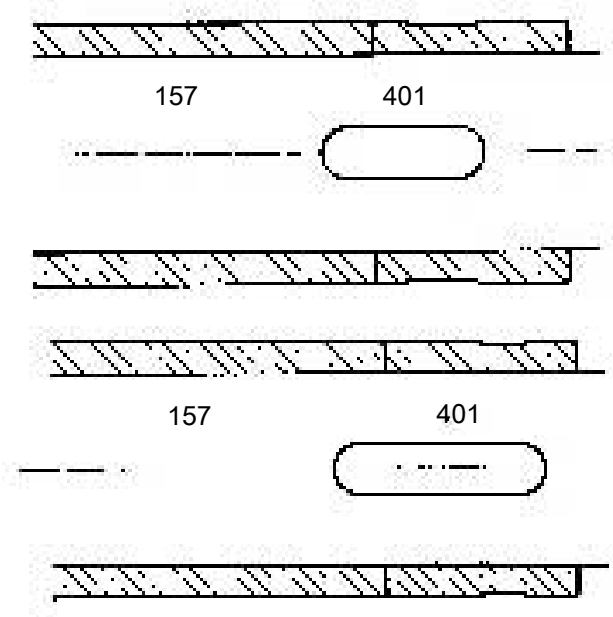
Reassemble the shaft seal

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:



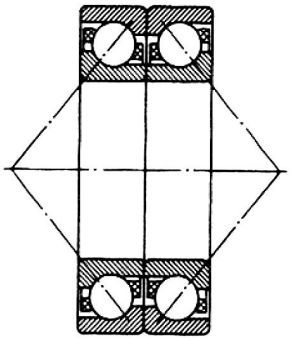
9. Screw the bearing cover (119) to the bearing bracket (228C).
10. Grease the contact surface of the thrower (248) and bring the thrower or heat flinger (123B) into position on the spacer sleeve (157), whichever is applicable.

    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).

Reassemble the suction end ball bearings

The variants are:

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



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, fill 60% of the space in the ball bearing (112) with grease.

   Make sure that you do not add grease to the bearing housing or cover cavities around the bearing. This area must remain clear for excess grease that may be purged from the bearing as it runs, and for the grease that is added during re-lubrication.
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.

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.

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.

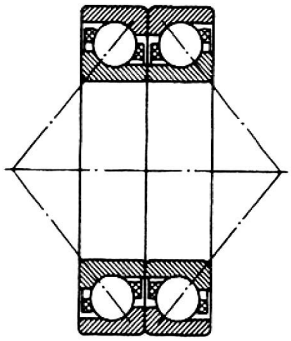
Reassemble the discharge end ball bearings for the radial suction configuration

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 has cooled, fill 60% of the space in the ball bearings (409) with grease.

   Do not add grease to the bearing housing or cover cavities around the bearing. This area must remain clear for excess grease that may be purged from the bearing as it runs, and for the grease that is added during re-lubrication.
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).

Assembly references

Torque values

Maximum torque values, in ft-lbs (Nm)

Thread joint	Screw	Hexagonal nut	Quality (minimum)	Pump size											
				1.5 x 2.5-7			2.5 x 4-8			4 x 5-10			5 x 6-11		
				Size	Dry	Lubricated	Size	Dry	Lubricated	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)	1-8UNC	244 (331)	222 (301)	1-8UNC	352 (477)	320 (434)

Thread joint	Screw	Hexagonal nut	Quality (minimum)	Pump size											
				1.5 x 2.5-7			2.5 x 4-8			4 x 5-10			5 x 6-11		
				Size	Dry	Lubricated	Size	Dry	Lubricated	Size	Dry	Lubricated	Size	Dry	Lubricated
Bearing bracket (228C) with a 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)	8 x M16	71 (96)	64 (87)	8 x M20	112 (152)	99 (134)

Gap widths

Area A - Gap between the sleeve and suction casing

Pump size	Nominal diameter	Gap "new"				Maximum permissable 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"				Maximum permissable 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"				Maximum permissable 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"				Maximum permissable 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 E - Gap between the shaft and discharge casing

Pump size	Nominal diameter	Gap "new"				Maximum permissable 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"		Maximum permissable gap
		All iron, stainless fitted, and stainless steel		
		Minimum	Minimum	
1.5 x 2.5-7	1.378	0.002	0.003	0.005
2.5 x 4-8	1.575	0.002	0.003	0.005
4 x 5-10	1.772	0.002	0.003	0.005
5 x 6-11	2.362	0.003	0.004	0.006

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

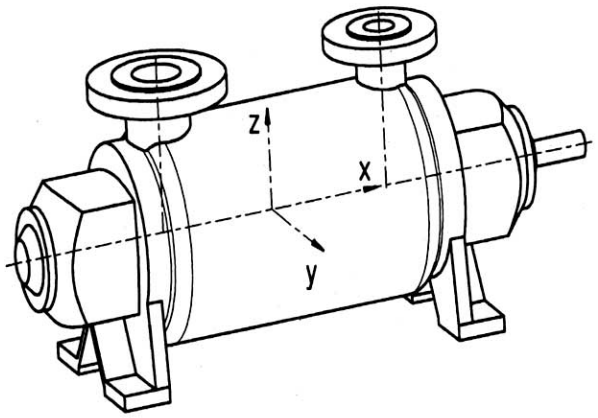
- Mx = moment around the x - axis
- My = moment around the y - axis
- Mz = moment around the z - axis

Formula

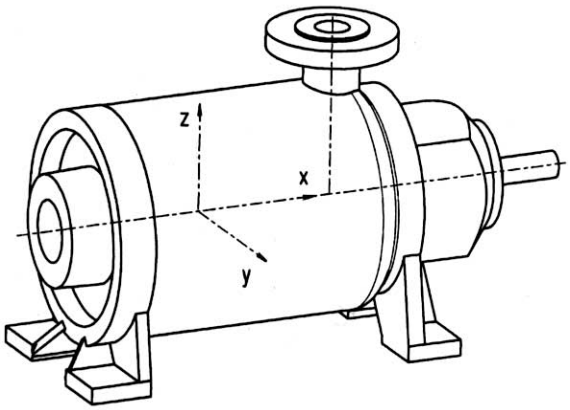
$$\sum F = \sqrt{(Fx^2 + Fy^2 + Fz^2)}$$

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

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 diameter, in inches	Forces, in lbf (Nm)				Moments, in ft-lbs (Nm)			
		Fx	Fy	Fz	Σ F	Mx	My	Mz	Σ M
Vertical nozzle perpendicular to the shaft (Fig. 17, 18).	1.5	74 (100)	67 (91)	85 (115)	133 (180)	207 (281)	103 (140)	140 (190)	273 (370)
	2.5	126 (171)	115 (156)	139 (188)	220 (298)	258 (350)	148 (201)	192 (260)	354 (480)
	4.0	202 (274)	182 (247)	227 (308)	355 (481)	325 (441)	192 (260)	243 (329)	450 (610)
	5.0	254 (344)	227 (308)	281 (381)	443 (601)	420 (569)	258 (350)	325 (441)	590 (800)
	6.0	303 (411)	274 (371)	337 (457)	531 (720)	516 (700)	325 (441)	398 (540)	730 (990)
Horizontal nozzle perpendicular to the shaft (Fig. 17, 18).	1.5	74 (100)	85 (115)	67 (91)	133 (180)	207 (281)	103 (140)	140 (190)	273 (370)
	2.5	126 (171)	139 (188)	115 (156)	220 (298)	258 (350)	148 (201)	192 (260)	354 (480)
	4.0	202 (274)	227 (308)	182 (247)	355 (481)	325 (441)	192 (260)	243 (329)	450 (610)
	5.0	254 (344)	281 (381)	227 (308)	443 (601)	420 (569)	258 (350)	325 (441)	590 (800)
	6.0	303 (411)	337 (457)	274 (371)	531 (720)	516 (700)	325 (441)	398 (540)	730 (990)
Horizontal nozzle parallel to the shaft (Fig. 18)	2.5	139 (188)	126 (171)	115 (156)	220 (298)	258 (350)	148 (201)	192 (260)	354 (480)
	4.0	227 (308)	202 (274)	182 (247)	416 (564)	325 (441)	192 (260)	243 (329)	450 (610)
	5.0	281 (381)	254 (344)	227 (308)	443 (601)	420 (569)	258 (350)	325 (441)	590 (800)
	6.0	337 (457)	303 (411)	274 (371)	531 (720)	516 (700)	325 (441)	398 (540)	730 (990)

Recommended minimum flows

CAUTION:

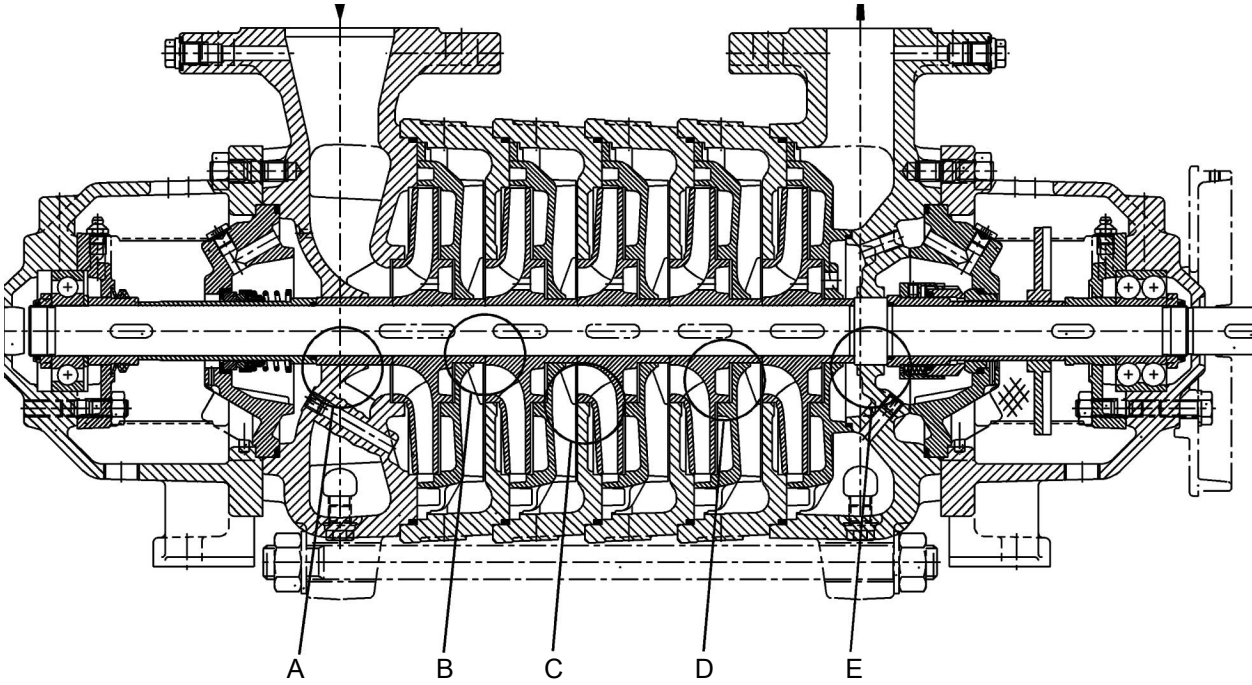
The recommended minimum flow is intended for brief periodic operation. It is not to be used as a design point. Extended operation at the minimum flow can cause pump damage.

Size	60 hertz				50 hertz			
	3600 rpm		1800 rpm		3000 rpm		1500 rpm	
	QMIN operation (gpm)	Q-BEP full diameter (gpm)	QMIN OPERATION (gpm)	Q-BEP full diameter (gpm)	QMIN operation (gpm)	Q-BEP full diameter (gpm)	QMIN operation (gpm)	Q-BEP 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

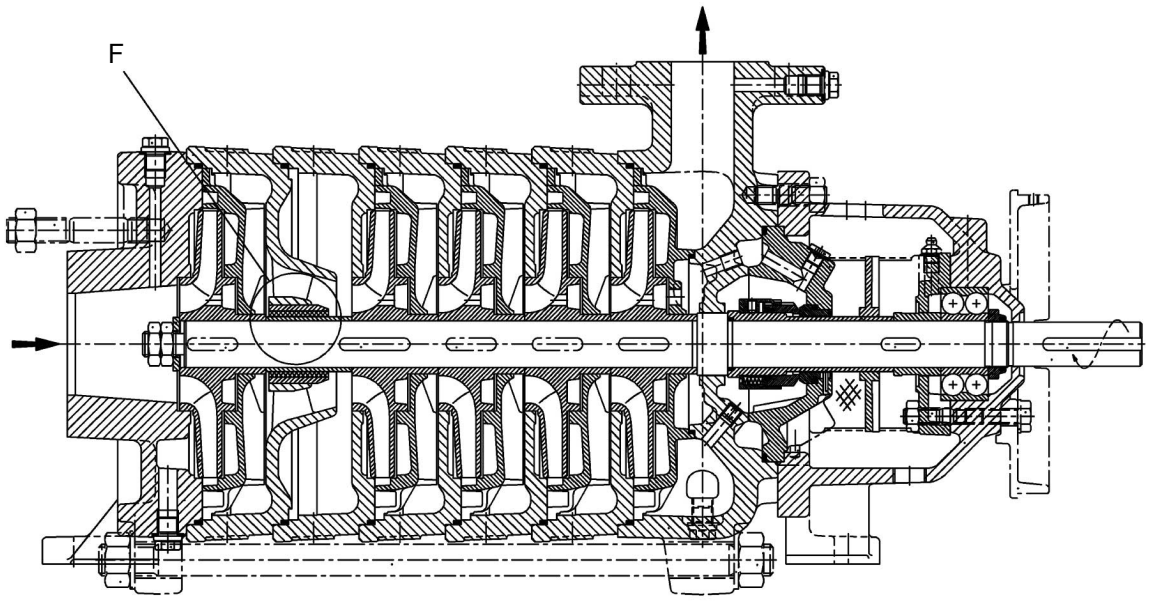
Size	60 hertz				50 hertz			
	3600 rpm		1800 rpm		3000 rpm		1500 rpm	
	QMIN operation (gpm)	Q-BEP full diameter (gpm)	QMIN OPERATION (gpm)	Q-BEP full diameter (gpm)	QMIN operation (gpm)	Q-BEP full diameter (gpm)	QMIN operation (gpm)	Q-BEP full diameter (gpm)
5 x 6- 11A	374	1100	185	595	308	1015	155	480
5 x 6- 11B	589	1470	286	735	485	1235	238	635

Wearing parts and dimensions

Radial suction



End suction



Troubleshooting

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.

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.
		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.

Symptom	Cause	Remedy
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.
		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.

Symptom	Cause	Remedy
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.
	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.

Symptom	Cause	Remedy
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.
		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.

Symptom	Cause	Remedy
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.
		Replace the mechanical seal.

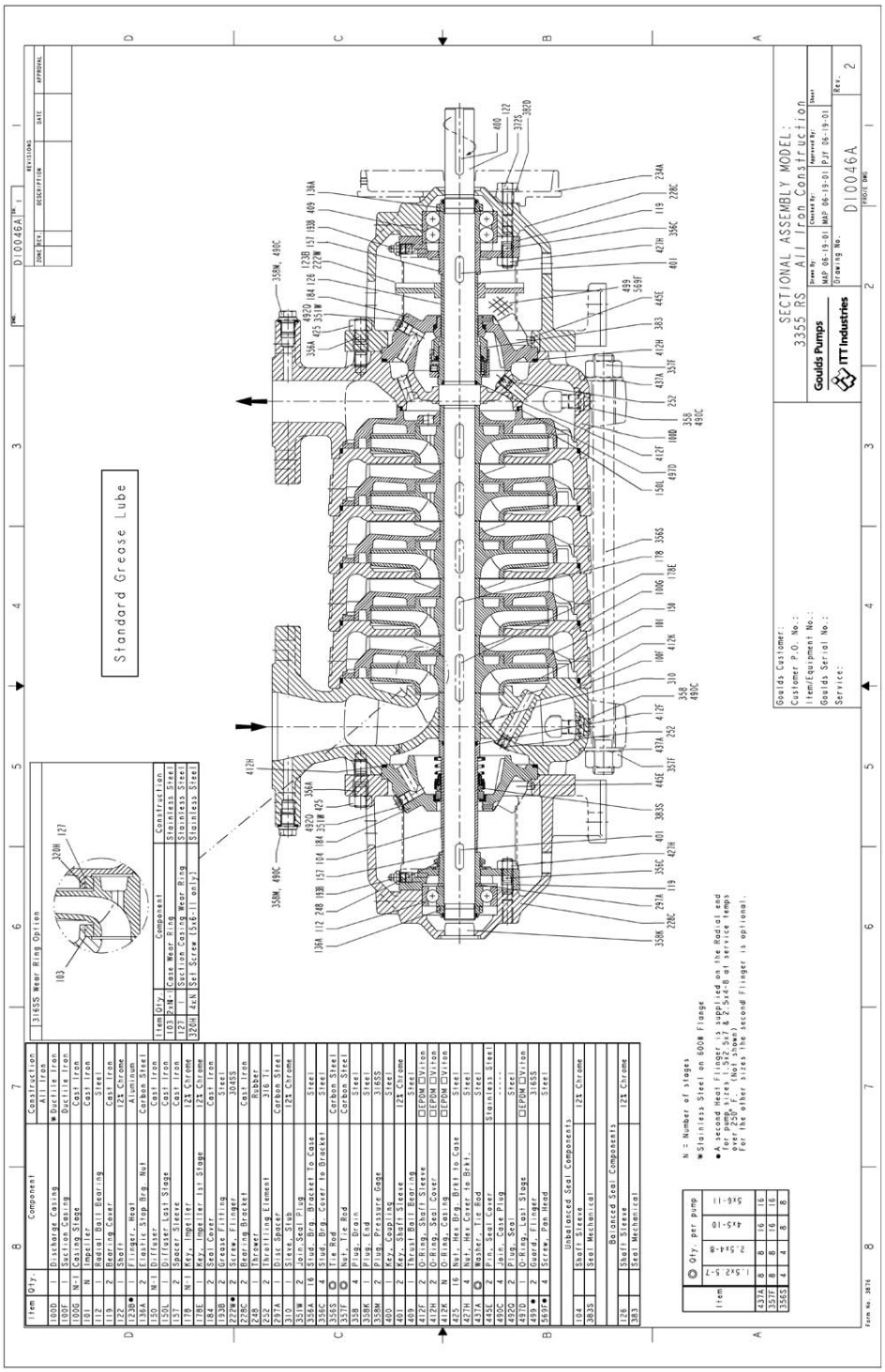
Parts Listings and Cross-sectional Drawings

Recommended spare parts

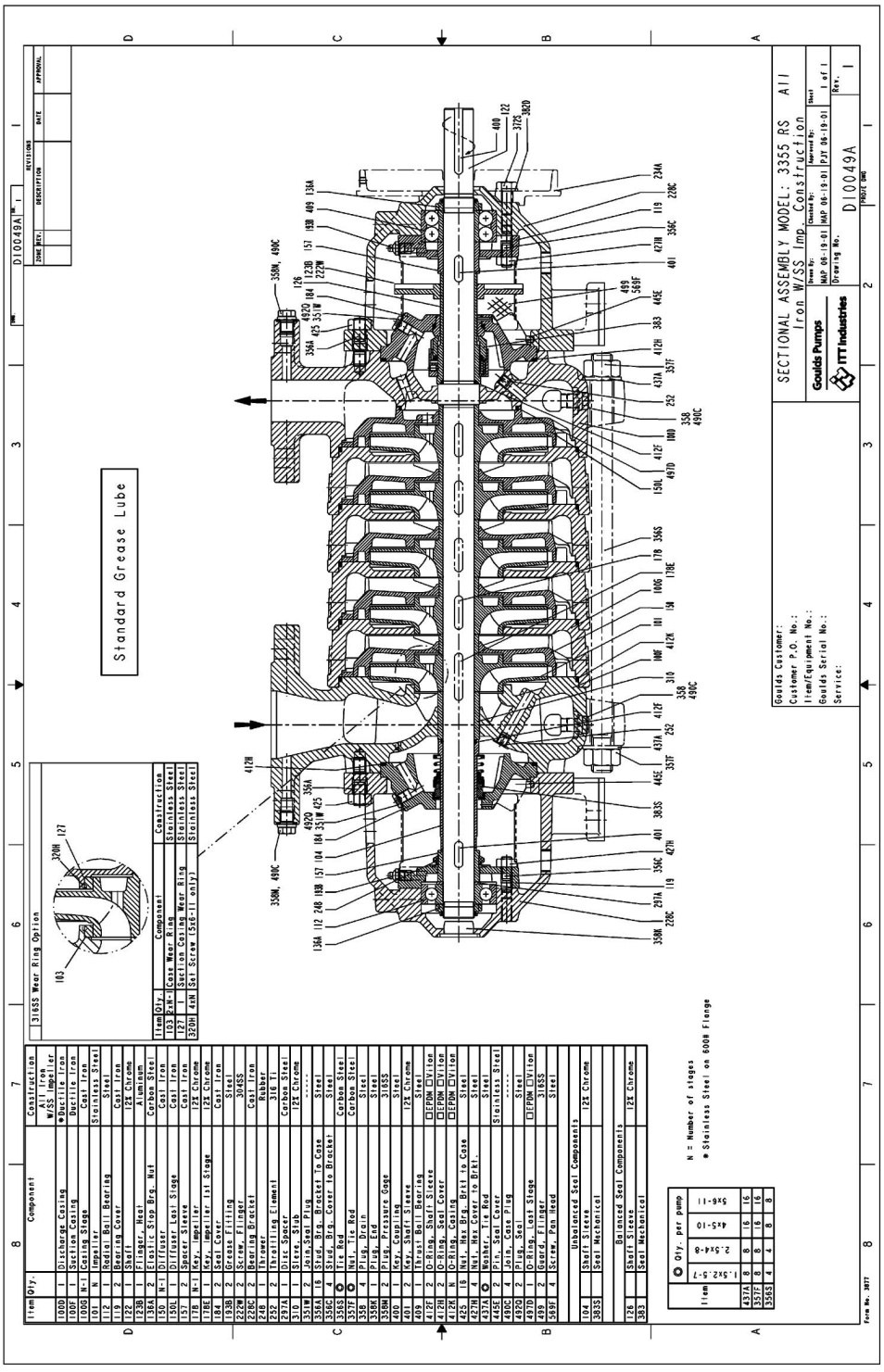
Select spare parts that will last for two years of continuous operation. If no other guidelines are applicable, stock the number of parts listed in this table.

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							

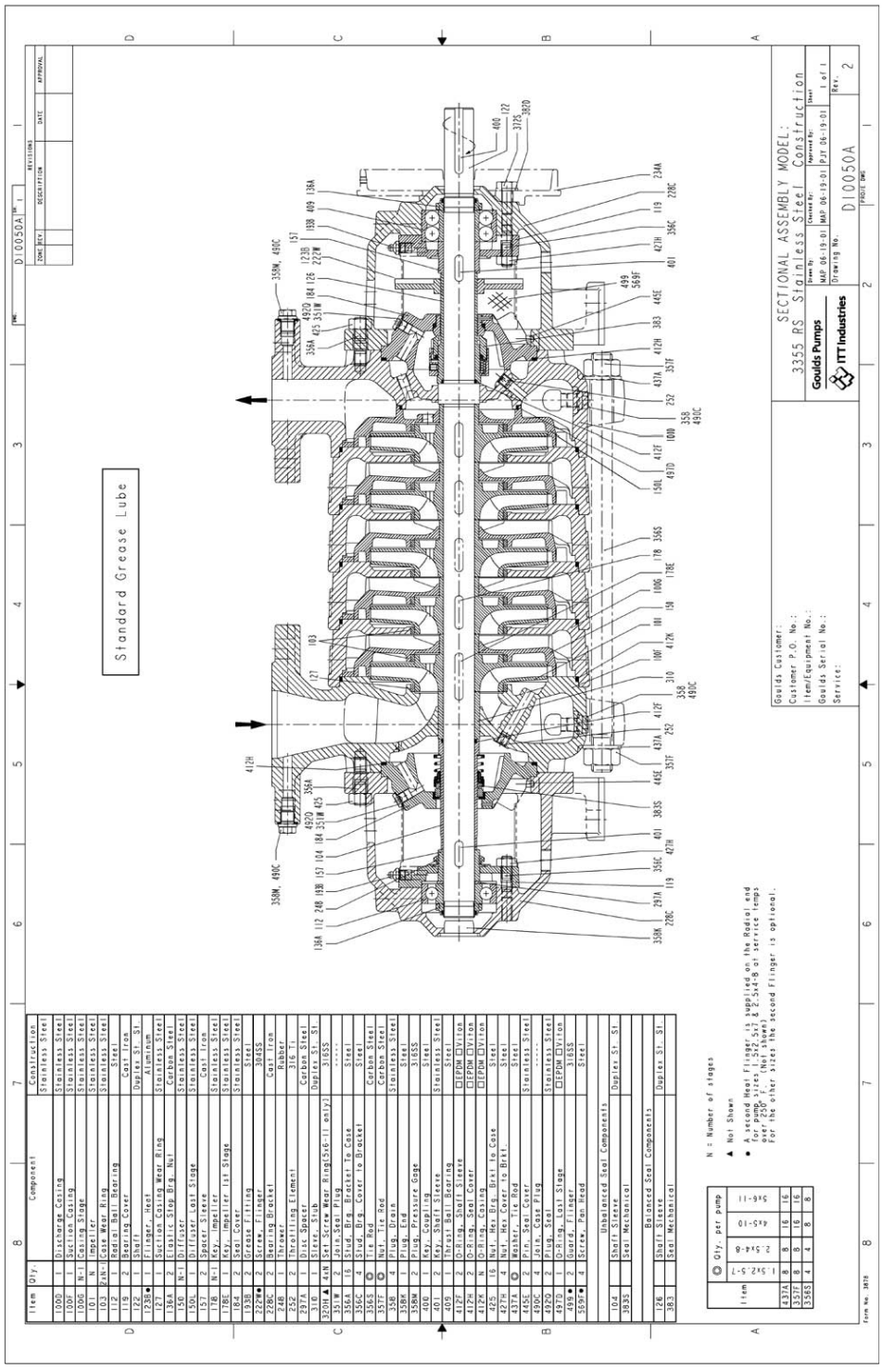
Radial suction all-iron cross-sectional



Radial suction all iron with stainless steel impeller cross sectional



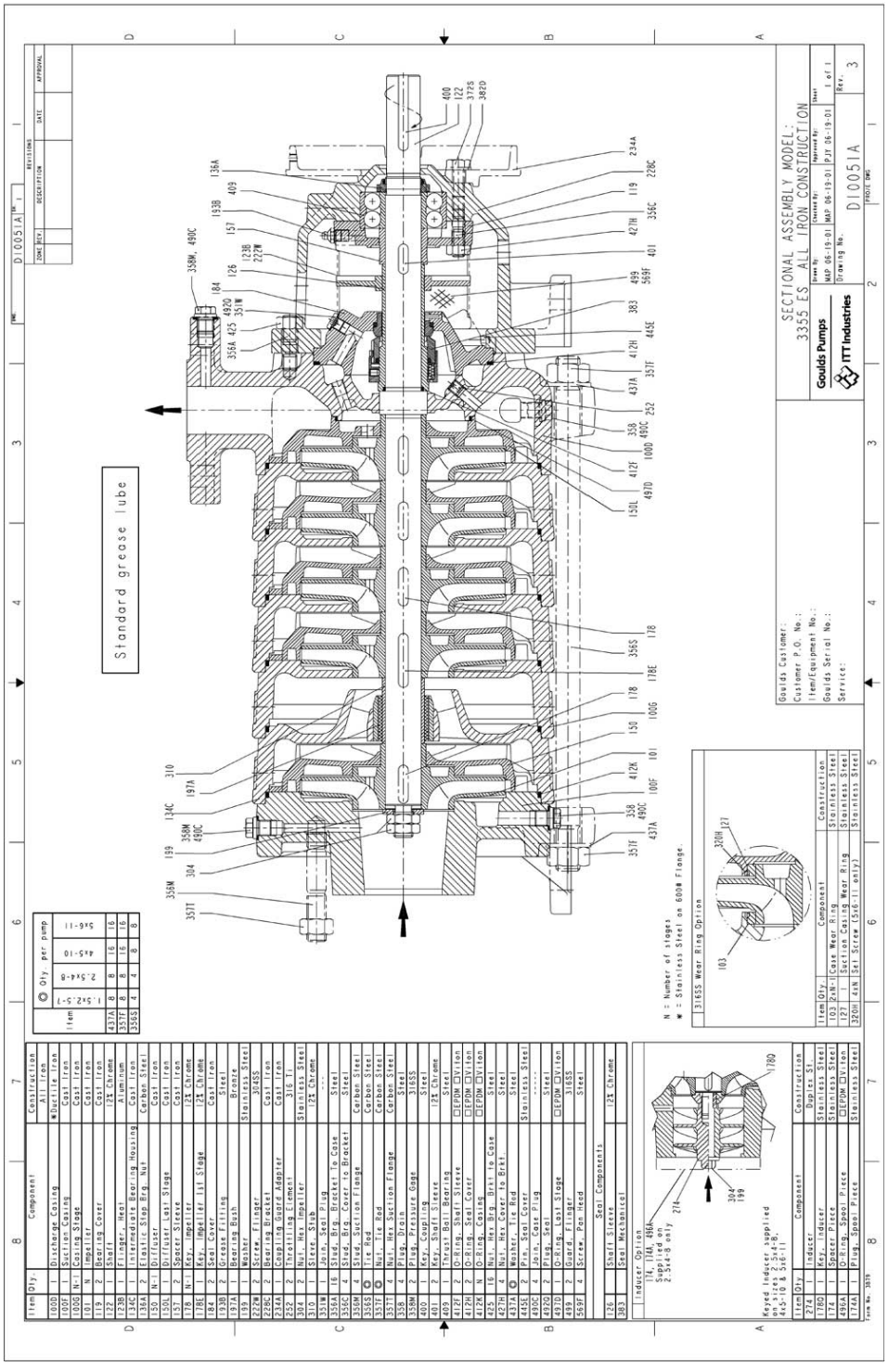
Radial suction stainless steel cross-sectional



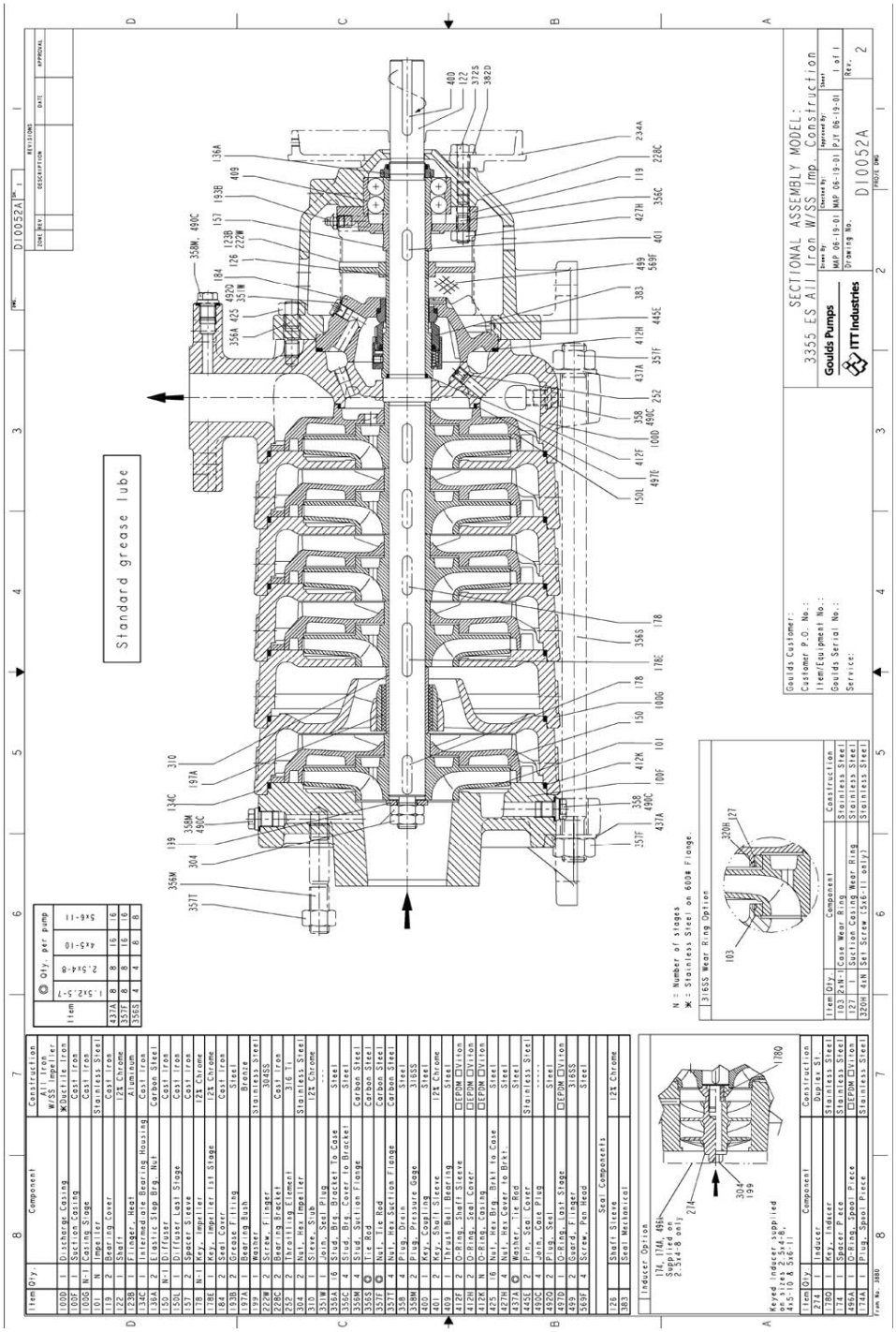
Item	Qty.	Component	Construction
100C	1	Discharge Casing	Stainless Steel
100F	1	Suction Casing	Stainless Steel
100G	N-1	Casing Stage	Stainless Steel
101	N	Impeller	Stainless Steel
103	2or4	Case Wear Ring	Stainless Steel
112	2	Bearing Housing	Cast Iron
118	2	Bearing Cover	Carbon Steel
122	1	Shaft	Duplex SS SS
123B●	1	Flinger, Heat	Aluminum
127	1	Suction Casing Wear Ring	Stainless Steel
136A	2	Elastic Stop Brg. Nut	Carbon Steel
150	N-1	Diffuser	Stainless Steel
151	1	Diffuser, Last Stage	Stainless Steel
163	2	Spacer, Sleeve	Stainless Steel
178	N-1	Key, Impeller	Stainless Steel
178E	1	Key, Impeller 1st Stage	Stainless Steel
184	2	Seal Cover	Stainless Steel
193B	2	Grease Fitting	Steel
222H●	2	Screw, Flinger	304SS
228C	2	Bearing Bracket	Cast Iron
240	2	Flinger	Rubber
252	2	Throttling Element	316 SS
297A	1	Disc Spacer	Carbon Steel
310	1	Sleeve, Stub	Duplex SS SS
320H▲	4oN	Set Screw Wear Ring(5x6-11 only)	316SS
351●▼	2	Jam Seal Plug	-----
356C	16	Stud, Brg. Bracket To Case	Steel
356F	16	Stud, Brg. Cover to Bracket	Steel
356S	O	Tie Rod	Carbon Steel
357F	O	Nut, Tie Rod	Carbon Steel
358	4	Plug, Drain	Stainless Steel
358H	1	Plug, End	Steel
358M	2	Plug, Pressure Gage	316SS
400	2	Key, Coupling	Stainless Steel
400E	1	Key, Stub Sleeve	Stainless Steel
409	1	Thrust Ball Bearing	Steel
412F	2	O-Ring, Shaft Sleeve	□EPDM ○Viton
412H	2	O-Ring, Seal Cover	□EPDM ○Viton
412M	N	O-Ring, Casing	□EPDM ○Viton
425	16	Nut, Hex Brg. Brkt To Case	Steel
427	16	Nut, Hex Cover to Brkt	Steel
437E	O	Washer, Lock	Steel
445E	2	Pin, Seal Cover	Stainless Steel
490C	4	Join. Case Plug	-----
497D	2	Plug, Seal	Stainless Steel
497Q	1	O-Ring, Last Stage	□EPDM ○Viton
499●	2	Guard, Flinger	316SS
559T●	4	Screw, Pan Head	Steel
		Unbalanced Seal Components	
104		Shaft Sleeve	Duplex SS SS
383S		Seal Mechanical	
		Balanced Seal Components	
178		Shaft Sleeve	Duplex SS SS
383		Seal Mechanical	

Item	Qty per pump		
	1.5x2.5x7	2.5x4x8	4x5-10	4x5-11
437A	8	8	16	16
357F	8	8	16	16
356S	4	4	8	8

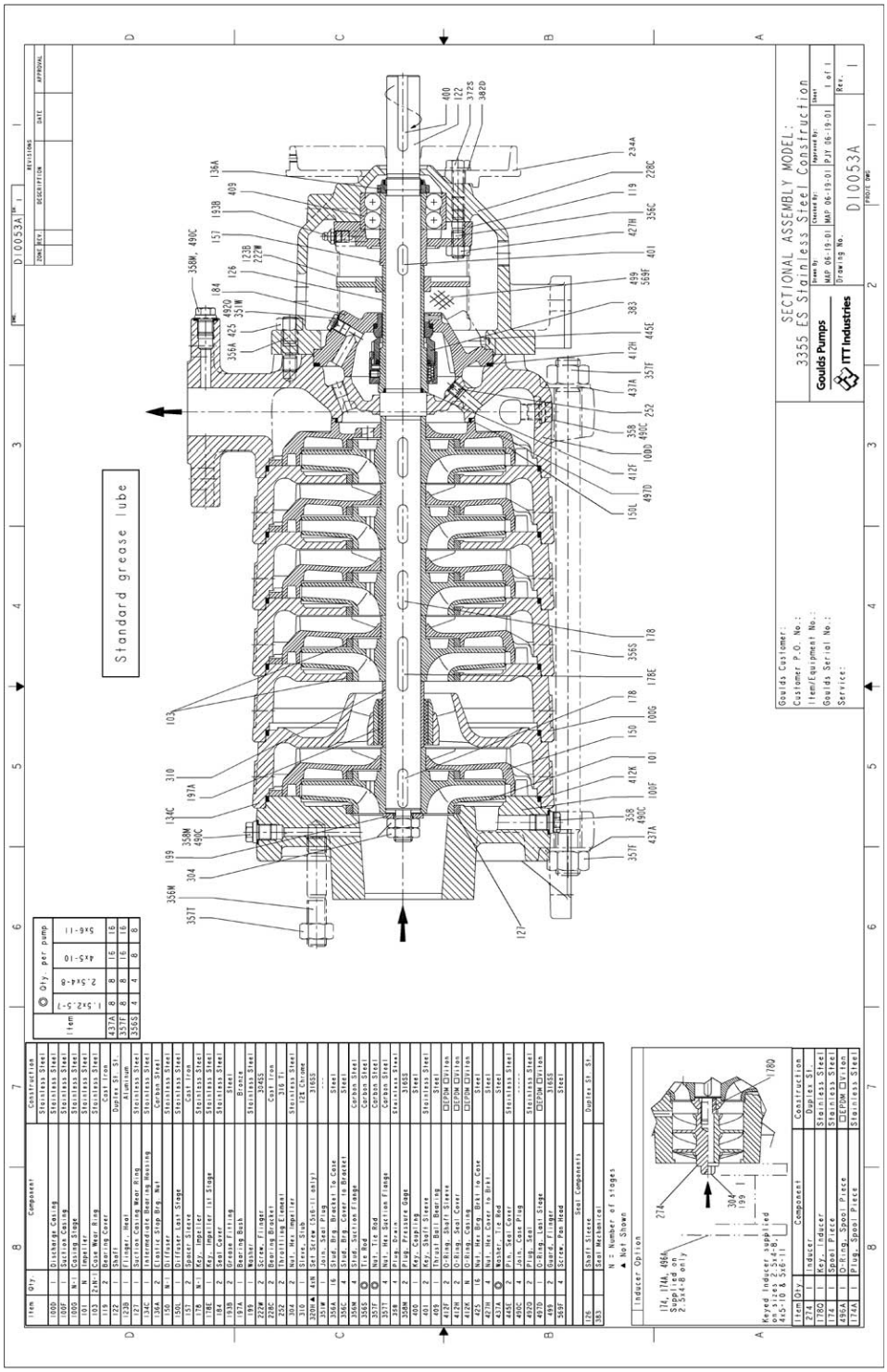
End-suction all-iron cross-sectional



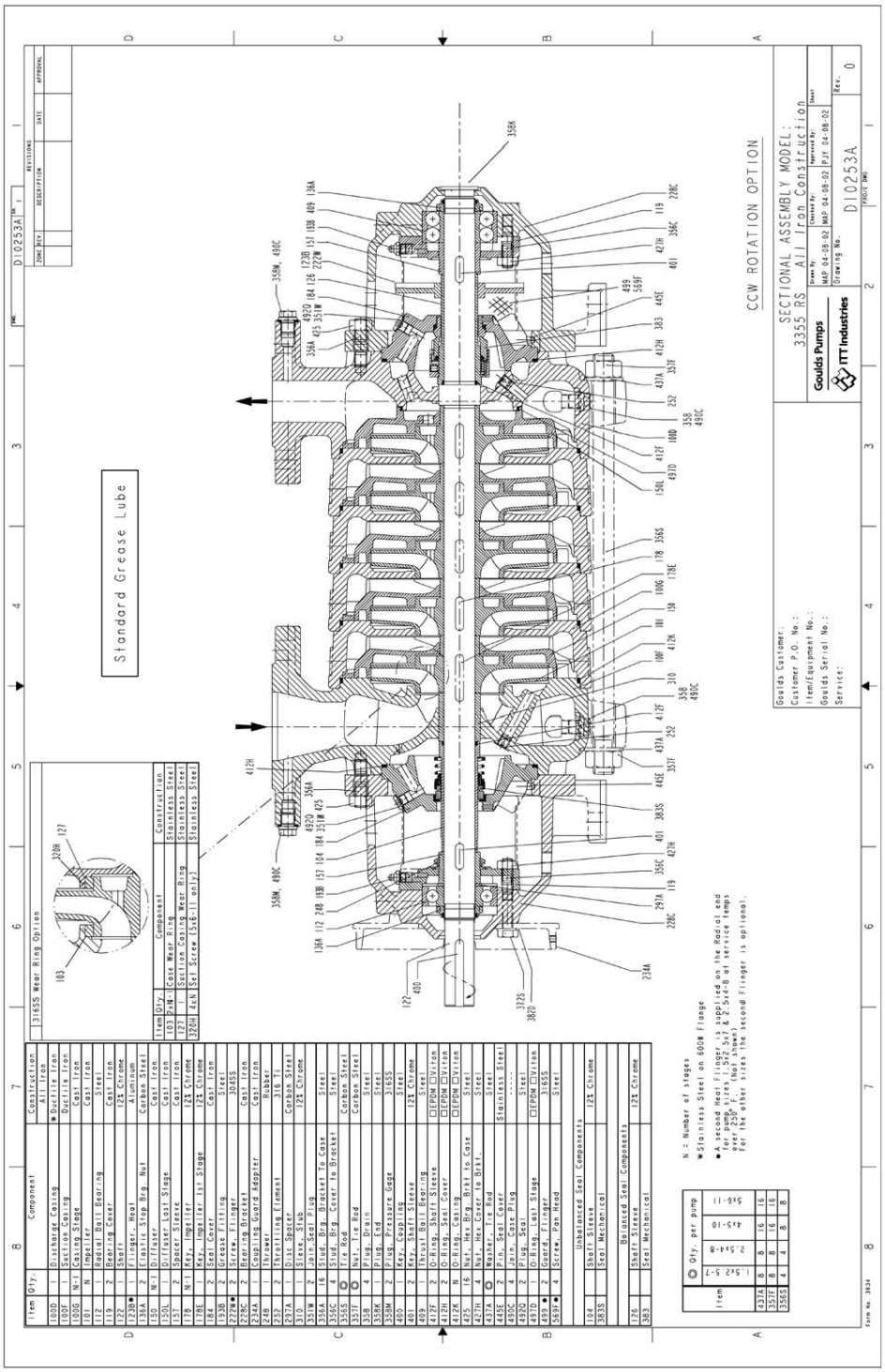
End-suction all-iron with stainless steel impeller cross-sectional



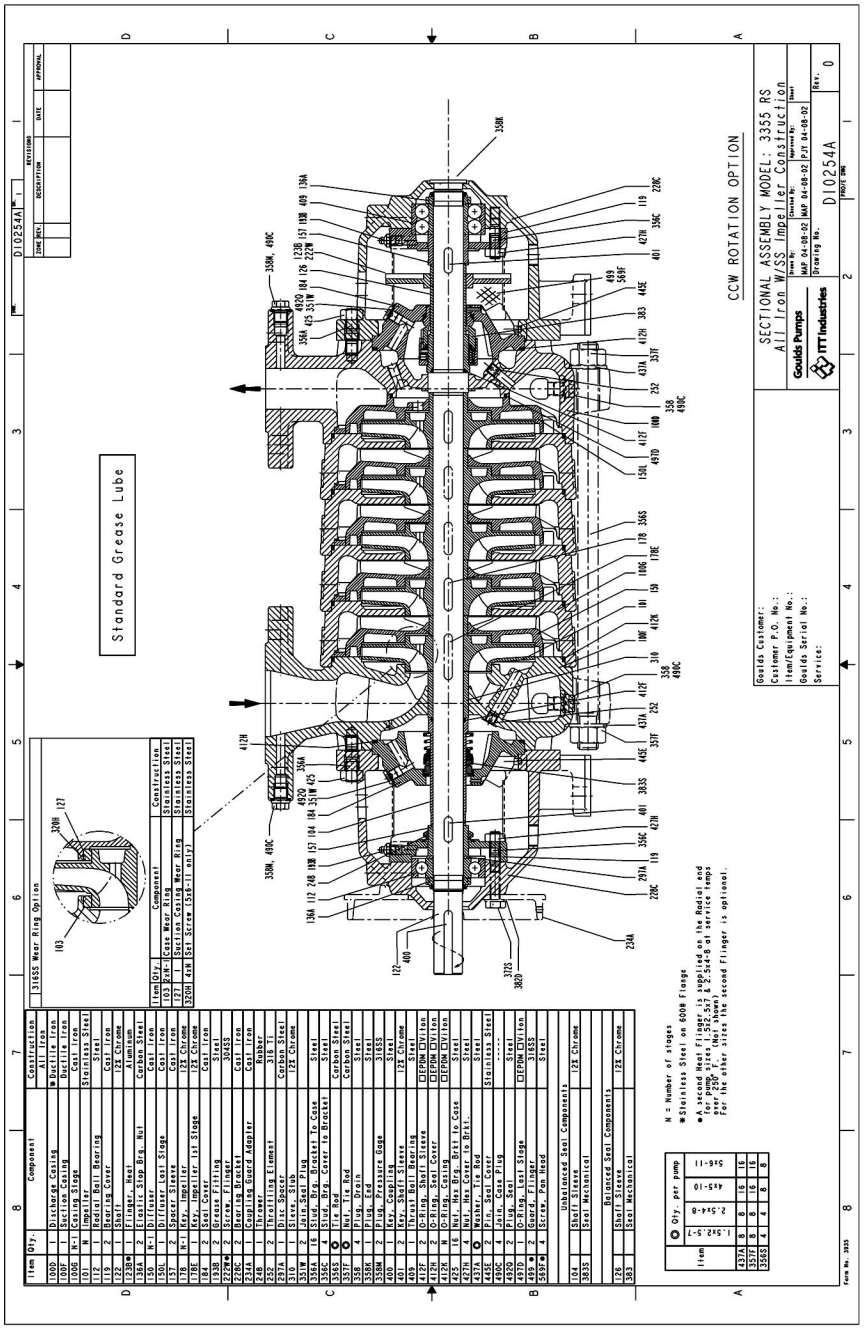
End-suction stainless steel cross-sectional



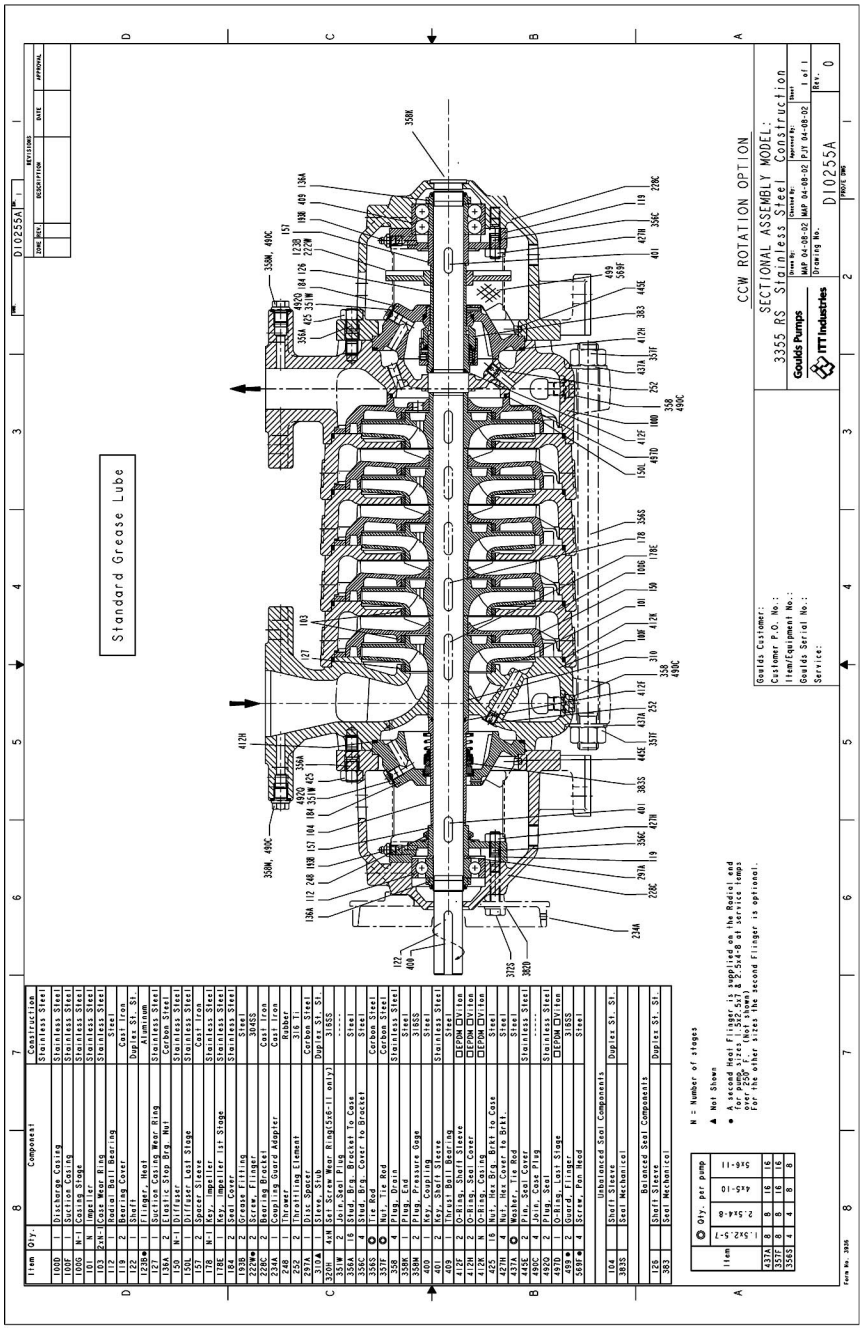
Radial suction (counterclockwise rotation) all-iron cross-sectional



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



Radial suction (counterclockwise rotation) stainless steel cross-sectional



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