GOULDS PUMPS

Installation, Operation, and Maintenance Manual

Model 3196 i-FRAME

ITT

4 Installation

4.1 Pre-installation

Precautions

WARNING:

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

NOTICE:

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

4.1.1 Pump location guidelines

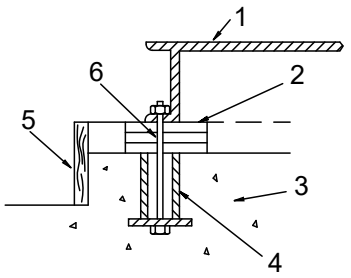
Guideline	Explanation/comment
Keep the pump as close to the liquid source as practically possible.	This minimizes the friction loss and keeps the suction piping as short as possible.
Make sure that the space around the pump is sufficient.	This facilitates ventilation, inspection, maintenance, and service.
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.
If the pump location is overhead, undertake special precautions to reduce possible noise transmission.	Consider a consultation with a noise specialist.

4.1.2 Foundation requirements

Requirements

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

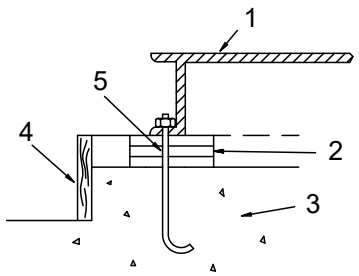
Sleeve-type bolts



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

Figure 16: Sleeve type bolts

J-type bolts



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

Figure 17: J-type bolts

4.2 Baseplate-mounting procedures

4.2.1 Prepare the baseplate for mounting

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

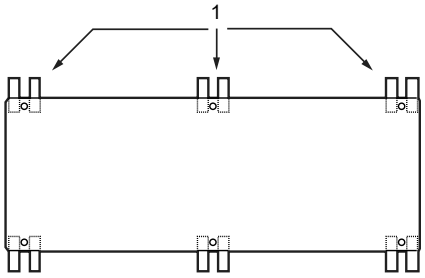
4.2.2 Install the baseplate using shims or wedges

Required tools:

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

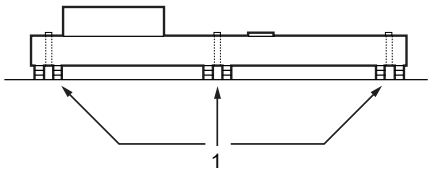
This procedure is applicable to cast iron and fabricated steel baseplates.

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.
   The sets of wedges should have a height of between 19 mm | 0.75 in. and 38 mm | 1.50 in.



1. Shims or wedges

Figure 18: Top view



1. Shims or wedges

Figure 19: Side view

3. Lower the baseplate carefully onto the foundation bolts.
4. Put the machinist's levels across the mounting pads of the driver and the mounting pads of the pump.

NOTICE:

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

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

   These are the leveling tolerances:

   - A maximum difference of 3.2 mm | 0.125 in. lengthwise
   - A maximum difference of 1.5 mm | 0.059 in. across

   You can use the 4.2.6 Baseplate-leveling worksheet on page 36 when you take the readings.
6. Hand-tighten the nuts for the foundation.

4.2.3 Install the baseplate using jackscrews

Tools required:

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

This procedure is applicable to the feature-fabricated steel baseplate and the advantage base baseplate.

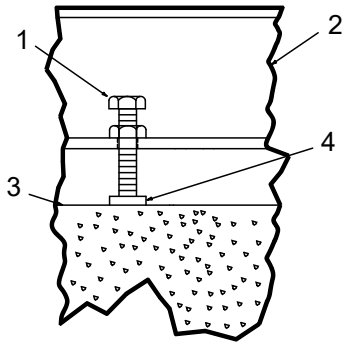
1. Apply an anti-seize compound on the jackscrews.
   The compound makes it easier to remove the screws after you grout.
2. Lower the baseplate carefully onto the foundation bolts and perform these steps:

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

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

   c) Use the four jackscrews in the corners in order to raise the baseplate above the foundation.
   Make sure that the distance between the baseplate and the foundation surface is between 19 mm | 0.75 in. and 38 mm | 1.50 in.

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



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

Figure 20: Jackscrews

3. Level the driver mounting pads:

NOTICE:

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

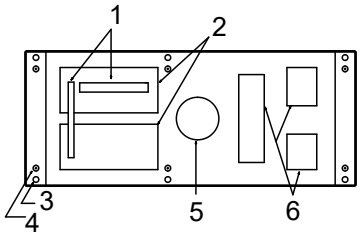
a) Put one machinist's level lengthwise on one of the two pads.

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

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

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

Use the baseplate-leveling worksheet when you take the readings.



Item	Description
1.	Machinist's levels
2.	Driver's mounting pads
3.	Foundation bolts
4.	Jackscrews
5.	Grout hole
6.	Pump's mounting pads

Figure 21: Level driver mounting pads

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

NOTICE:

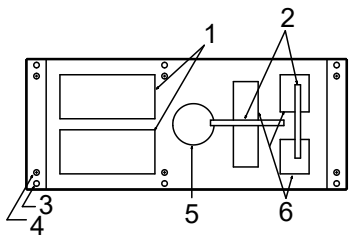
Remove all dirt from the mounting pads in order to ensure that the correct leveling is achieved. Failure to do so can result in equipment damage or decreased performance.

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

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

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

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



Item	Description
1.	Driver's mounting pads
2.	Machinist's levels
3.	Foundation bolts
4.	Jackscrews
5.	Grout hole
6.	Pump's mounting pads

Figure 22: Level pump mounting pads

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

   The correct level measurement is a maximum of 0.167 mm/m | 0.002 in./ft .

4.2.4 Install the baseplate using spring mounting

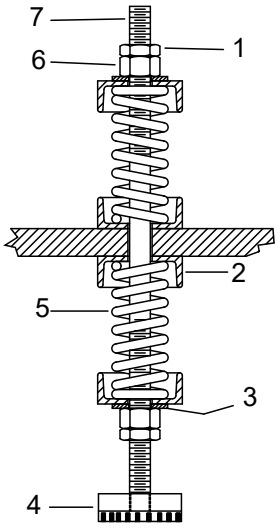
NOTICE:
The spring-mounted baseplate is designed only to support piping loads from thermal expansion. Ensure that the suction and discharge piping are supported individually. Failure to do so may result in equipment damage.

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

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

1. Put the baseplate on a support above the foundation/floor.
   Make sure that there is enough space between the baseplate and the foundation/floor in order to install the spring assemblies.
2. Install the lower part of the spring assembly:
   a) Screw the lower jam nut onto the spring stud.
   b) Screw the lower adjusting nut onto the spring-stud, on top of the jam nut.
   c) Set the lower adjusting nut to the correct height.
   The correct height depends on the required distance between the foundation/floor and the baseplate.
   d) Put a washer, a follower, a spring, and one more follower onto the lower adjusting nut.
3. Install the spring assembly on the baseplate:
   a) Insert the spring assembly into the baseplate's anchorage hole from below.
   b) Put a follower, a spring, another follower, and a washer onto the spring stud.
   c) Fasten the spring assembly with the upper adjusting nut by hand.

4. Thread the upper jam nut onto the spring stud by hand.
5. Repeat steps 2 through 4 for all the spring assemblies.
6. Lower the baseplate so that the spring assemblies fit into the foundation pads.
7. Level the baseplate and make the final height adjustments:
   a) Loosen the upper jam nuts and adjusting nuts.
   b) Adjust the height and level the baseplate by moving the lower adjusting nuts.
   c) When the baseplate is level, tighten the top adjusting nuts so that the top springs are not loose in their followers.
8. Fasten the lower and upper jam nuts on each spring assembly.



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

Figure 23: Example of an installed spring assembly

4.2.5 Install the baseplate using stilt mounting

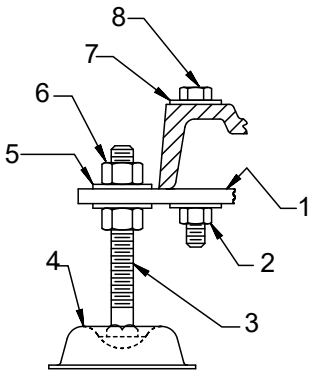
NOTICE:
The stilt-mounted baseplate is not designed to support static piping loads. Ensure that the suction and discharge piping are supported individually. Failure to do so may result in equipment damage.

1. Put the baseplate on a support above the foundation/floor.
   Make sure that there is enough space between the baseplate and the foundation/floor to install the stilts.
2. Install the lower part of the stilt assembly:
   a) Screw the lower jam nut and adjusting nut onto the stilt.
   b) Set the lower adjusting nut to the correct height.

The correct height depends on the required distance between the foundation/floor and the baseplate.

c) Put a washer onto the lower adjusting- nut.

3. Install the stilt assembly on the baseplate:
   a) Insert the stilt assembly into the baseplate's anchorage hole from below.
   b) Put a washer onto the stilt.
   c) Fasten the stilt assembly with the upper adjusting nut by hand.
4. Screw the upper jam nut onto the stilt by hand.
5. Repeat steps 2 through 4 for all the stilt assemblies.
6. Lower the baseplate so that the stilts fit into the foundation cups.
7. Level the baseplate and make the final height adjustments:
   a) Loosen the upper jam nuts and adjusting nuts.
   b) Adjust the height and level the baseplate by moving the lower adjusting nuts.
   c) When the baseplate is level, tighten the top adjusting nuts.
8. Fasten the lower and upper jam nuts on each stilt.

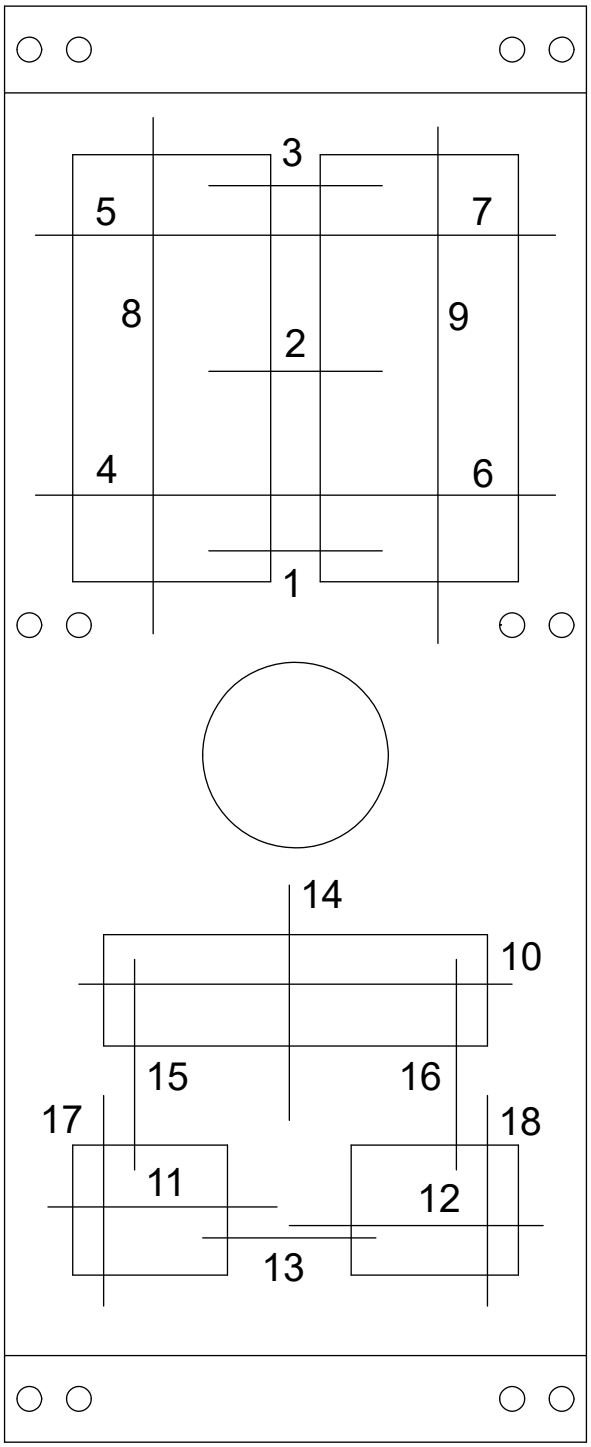


1. Mounting plate
2. Mounting nut
3. Stilt bolt
4. Foundation cups
5. Washer
6. Upper adjustment nut
7. Mounting washer
8. Mounting bolt

Figure 24: Example of an installed stilt assembly

4.2.6 Baseplate-leveling worksheet

Level measurements



1)_____

2)_____

3)_____

4)_____

5)_____

6)_____

7)_____

8)_____

9)_____

10)_____

11)_____

12)_____

13)_____

14)_____

15)_____

16)_____

17)_____

18)_____

4.3 Install the pump, driver, and coupling

1. Mount and fasten the pump on the baseplate. Use applicable bolts.
2. Mount the driver on the baseplate. Use applicable bolts and hand tighten.
3. Install the coupling.
   See the installation instructions from the coupling manufacturer.

4.4 Pump-to-driver alignment

Precautions

WARNING:

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

4.4.1 Alignment checks

When to perform alignment checks

You must perform alignment checks under these circumstances:

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

Types of alignment checks

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

Initial alignment (cold alignment) checks

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

Final alignment (hot alignment) checks

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

4.4.2 Permitted indicator values for alignment checks

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

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

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

4.4.2.1 Cold settings for parallel vertical alignment

Introduction

This section shows the recommended preliminary (cold) settings for electric motor-driven pumps based on different temperatures of pumped fluid. Consult driver manufacturers for recommended cold settings for other types of drivers such as steam turbines and engines.

Recommended settings for models 3196, CV 3196, and LF 3196

Pumpage temperature	Recommended setting
10°C | 50°F	0.05 mm | 0.002 in., low
65°C | 150°F	0.03 mm | 0.001 in., high
120°C | 250°F	0.12 mm | 0.005 in., high
175°C | 350°F	0.23 mm | 0.009 in., high
232°C | 450°F	0.33 mm | 0.013 in., high
288°C | 550°F	0.43 mm | 0.017 in., high
343°C | 650°F	Not applicable
371°C | 700°F	Not applicable

4.4.3 Alignment measurement guidelines

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

Guideline	Explanation
Check the alignment again after any mechanical adjustments.	This corrects any misalignments that an adjustment may have caused.

4.4.4 Attach the dial indicators for alignment

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

1. Attach two dial indicators on the pump coupling half (X):
   a) Attach one indicator (P) so that the indicator rod comes into contact with the perimeter of the driver coupling half (Y).
   This indicator is used to measure parallel misalignment.
   b) Attach the other indicator (A) so that the indicator rod comes into contact with the inner end of the driver coupling half.
   This indicator is used to measure angular misalignment.

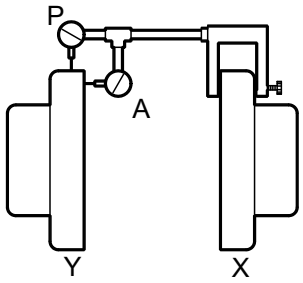


Figure 25: Dial indicator attachment

2. Rotate the pump coupling half (X) in order to check that the indicators are in contact with the driver coupling half (Y) but do not bottom out.
3. Adjust the indicators if necessary.

4.4.5 Pump-to-driver alignment instructions

4.4.5.1 Perform angular alignment for a vertical correction

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

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

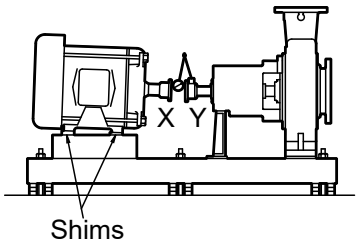


Figure 26: Side view of an incorrect vertical alignment

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

4.4.5.2 Perform angular alignment for a horizontal correction

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

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

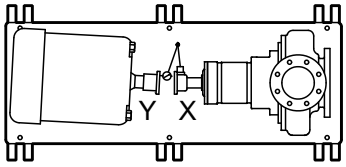


Figure 27: Top view of an incorrect horizontal alignment

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

   Maximum permitted value for angular alignment:

4.4.5.3 Perform parallel alignment for a vertical correction

Refer to the alignment table in "Permitted indicator values for alignment checks" (see Table of Contents for location of table) for the proper cold alignment value based on the motor temperature rise and the pump operating temperature.

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 0.05 mm | 0.002 in. as measured at four points 90° apart at the operating temperature.

Recommended settings

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

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

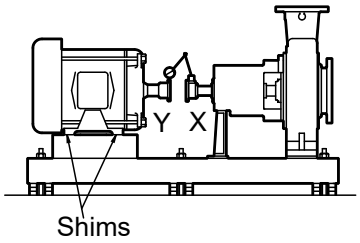


Figure 28: Side view of an incorrect vertical alignment

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

NOTICE:

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

4.4.5.4 Perform parallel alignment for a horizontal correction

Refer to the alignment table in "Permitted indicator values for alignment checks" (see Table of Contents for location of table) for the proper cold alignment value based on the motor temperature rise and the pump operating temperature.

A unit is in parallel alignment when the parallel indicator (P) does not vary by more than 0.05 mm | 0.002 in. as measured at four points 90° apart at the operating temperature.

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

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

4. Slide the driver carefully in the appropriate direction.

NOTICE:

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

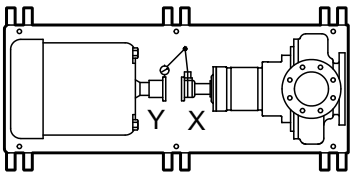


Figure 29: Top view of an incorrect horizontal alignment

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

NOTICE:

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

4.4.5.5 Perform complete alignment for a vertical correction

A unit is in complete alignment when both the angular indicator (A) and the parallel indicator (P) do not vary by more than 0.05 mm | 0.002 in. as measured at four points 90° apart.

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

4.4.5.6 Perform complete alignment for a horizontal correction

A unit is in complete alignment when both the angular indicator (A) and the parallel indicator (P) do not vary by more than 0.05 mm | 0.002 in. as measured at four points 90° apart.

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

4.4.6 C-face adapter

Intended use

The C-face adapter is a device that attaches the pump to the drive unit to minimize the axial and radial play between the two coupling halves.

Illustration

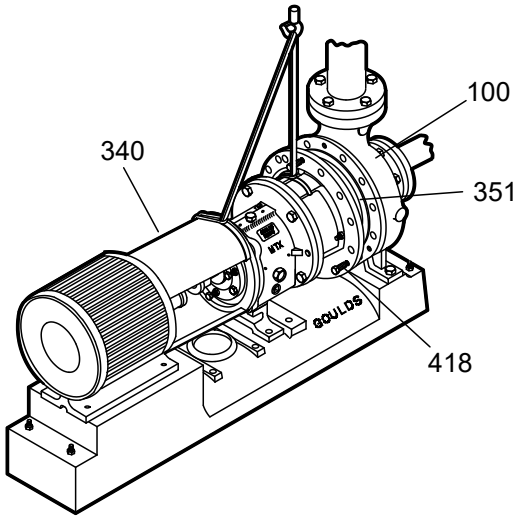


Figure 30: Example of the C-face adapter (340)

Alignment requirements

When you use a C-face adapter, you do not have to align the shaft. The rabbeted fittings of the drive unit to the adapter and the adapter to the bearing frame automatically align the shaft to within the specified limits.

Specified limits

A C-face adapter can attain a nominal alignment of 0.18mm | 0.007 in. Total Indicated Runout (T.I.R.). However, because of the stack-up of the machining tolerances of the various parts, the alignment can be as high as 0.38mm | 0.015 inches TIR.

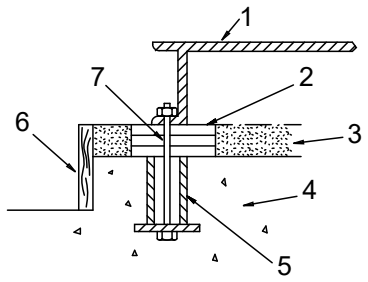
If high reliability (with shaft alignments of less than 0.05mm | 0.002 in.) is required for the pump, use a foot-mounted drive unit on a precision-machined baseplate and perform a conventional alignment.

4.5 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.
- Grout: Non-shrink grout is recommended.

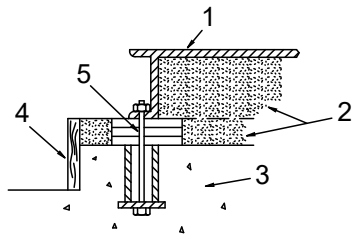
1. Clean all the areas of the baseplate that will come into contact with the grout.
2. Build a dam around the foundation.
3. Thoroughly wet the foundation that will come into contact with the grout.
4. Pour grout through the grout hole into the baseplate up to the level of the dam.
   When you pour the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



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

Figure 31: Pour grout into baseplate

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



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

Figure 32: Fill remainder of baseplate with grout

7. Tighten the foundation bolts.

4.6 Piping checklists

4.6.1 General piping checklist

Precautions

WARNING:

- Risk of premature failure. Casing deformation can result in misalignment and contact with rotating parts, causing excess heat generation and sparks. Flange loads from the piping

system, including those from the thermal expansion of the piping, must not exceed the limits of the pump.

- Risk of serious personal injury or property damage. Fasteners such as bolts and nuts are critical to the safe and reliable operation of the product. Ensure appropriate use of fasteners during installation or reassembly of the unit.
  - Use fasteners of the proper size and material only.
  - Replace all corroded fasteners.
  - Ensure that all fasteners are properly tightened and that there are no missing fasteners.

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

Piping guidelines

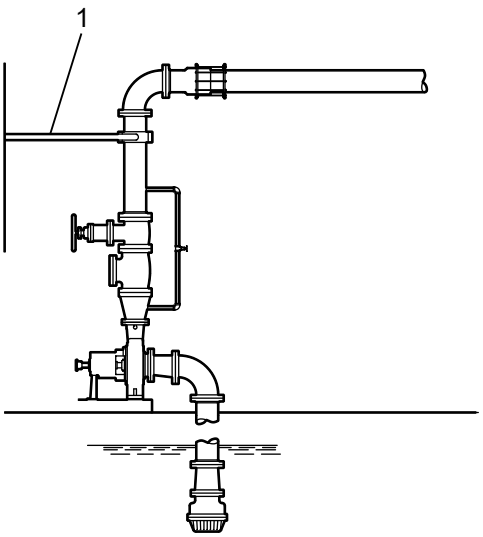
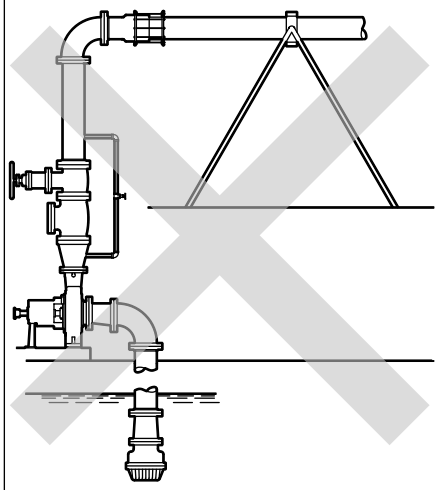
Guidelines for piping are given in the Hydraulic Institute Standards available from the Hydraulic Institute at 9 Sylvan Way, Parsippany, NJ 07054-3802. You must review this document before you install the pump.

Checklist

Check	Explanation/comment	Checked
Check that all piping is supported independently of, and lined up naturally with, the pump flange.	• Strain on the pump • Misalignment between the pump and the drive unit • Wear on the pump bearings and the coupling	
Keep the piping as short as possible.	This helps to minimize friction losses.	
Keep the piping as straight as possible. Avoid unnecessary bends. Use 45° or long radius 90° fittings where necessary.	This helps to minimize friction losses.	
Check that only necessary fittings are used.	This helps to minimize friction losses.	
Make sure that the inside diameters match properly when you use flange joints.	—	
Do not connect the piping to the pump until: • The grout for the baseplate or sub-base becomes hard. • The grout for the pit cover becomes hard. • The hold-down bolts for the pump and the driver are tightened.	—	
Make sure that all the piping joints and fittings are airtight.		
If the pump handles corrosive fluids, make sure that the piping allows you to flush out the liquid before you remove the pump.		

Check	Explanation/comment	Checked
If the pump handles liquids at elevated temperatures, make sure that the expansion loops and joints are properly installed.	This helps to prevent misalignment due to linear expansion of the piping.	
Make sure that all piping components, valves and fittings, and pump branches are clean prior to assembly.	—	
Make sure that the isolation and check valves are installed in the discharge line.	Locate the check valve between the isolation valve and the pump. This will permit inspection of the check valve. The isolation valve is required for regulation of flow, and for inspection and maintenance of the pump. The check valve prevents pump or seal damage due to reverse flow through the pump when the driver is turned off.	
Use cushioning devices.	This protects the pump from surges and water hammer if quick-closing valves are installed in the system.	
In no case should loads on the pump flanges exceed the limits stated in API Standard 610, 11th Edition (ISO 13709).	Bottom of casing should be supported by a solid foundation or casing feet should be used.	

Example: Installation for expansion

Correct	Incorrect
This illustration shows a correct installation for expansion:  1. Expansion loop/joint	This illustration shows an incorrect installation for expansion: 

4.6.1.1 Fastening

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

- Use fasteners of the proper size and material only.
- Replace all corroded fasteners.

- Ensure that all fasteners are properly tightened and that there are no missing fasteners.

4.6.2 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 five pipe diameters.	This minimizes the risk of cavitation in the suction inlet of the pump due to turbulence. See the Example sections for illustrations.	
Check that elbows in general do not have sharp bends.	See the Example sections for illustrations. —	
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. See the Example sections for illustrations.	
Check that the eccentric reducer at the suction flange of the pump has the following properties: • Sloping side down • Horizontal side at the top	See the example illustrations.	
Suggested suction strainers are used. Check that they are at least three times the area of the suction piping. Monitor the pressure drop across the suction strainer. An increased pressure drop across the strainer of 34.5 kPa | 5 psi indicates that the strainer should be removed and cleaned. After a period of time (24 hours minimum) system flushing should be complete and the suction strainer can be removed.	Suction strainers help to prevent debris from entering the pump. Mesh holes with a minimum diameter of 1.6 mm | 1/16 in. are recommended. Liquids with specific gravity less than 0.60 a pressure drop across the suction strainer may be due to ice buildup. Ice buildup can cause turbulence, low pressure areas and pumpage vaporization.	
If more than one pump operates from the same liquid source, check that separate suction-piping lines are used for each pump.	This recommendation helps you to achieve a higher pump performance and prevent vapor locking especially with specific gravity of liquid less than 0.60.	
If necessary, make sure that the suction piping includes a drain valve and that it is correctly installed.	—	
Assure adequate insulation is applied for liquids with specific gravity less than 0.60.	To assure sufficient NPSHa.	

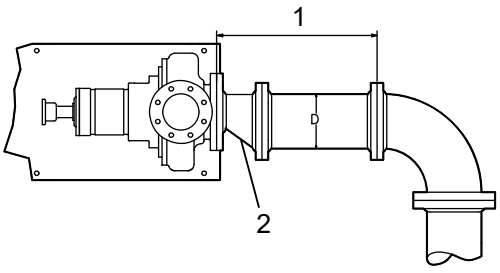
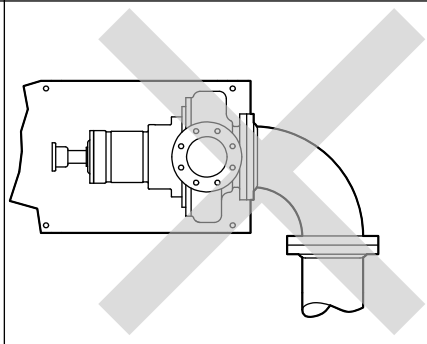
Liquid source below the pump

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

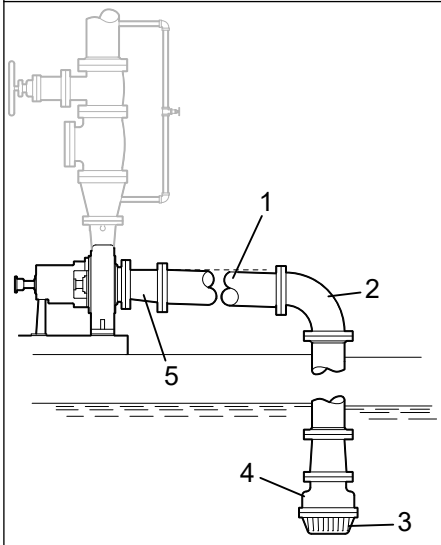
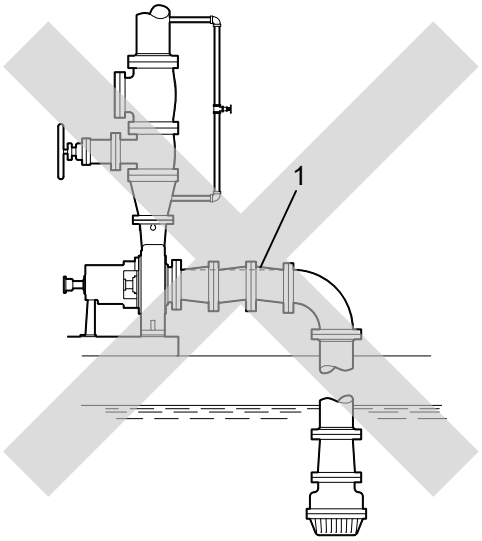
Liquid source above the pump

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

Example: Elbow close to the pump suction inlet

Correct	Incorrect
The correct distance between the inlet flange of the pump and the closest elbow must be at least five pipe diameters.  1. Enough distance to prevent cavitation 2. Eccentric reducer with a level top	

Example: Suction piping equipment

Correct	Incorrect
	
1. Suction pipe sloping upwards from liquid source 2. Long-radius elbow 3. Strainer 4. Foot valve 5. Eccentric reducer with a level top	1. Air pocket, because the eccentric reducer is not used and because the suction piping does not slope gradually upward from the liquid source

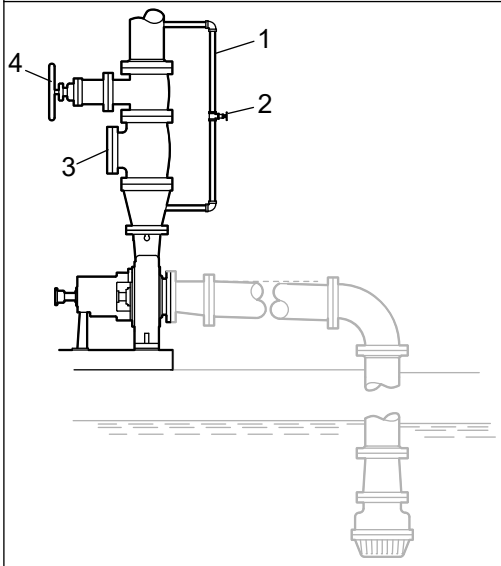
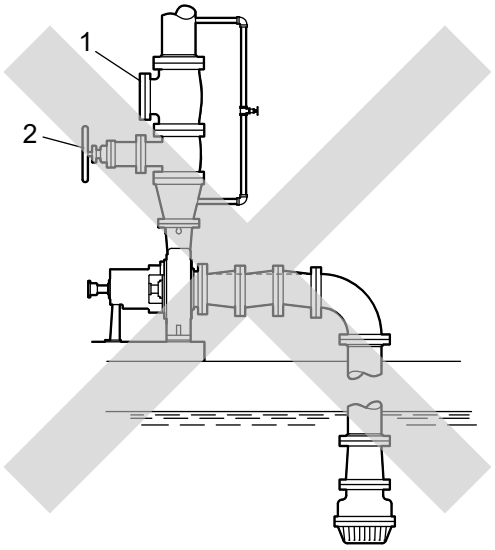
4.6.3 Discharge piping checklist

Checklist

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

Check	Explanation/comment	Checked
If quick-closing valves are installed in the system, check that cushioning devices are used.	This protects the pump from surges and water hammer.	

Example: Discharge piping equipment

Correct	Incorrect
	
1. Bypass line 2. Shut-off valve 3. Check valve 4. Discharge isolation valve	1. Check valve (incorrect position) 2. The isolation valve should not be positioned between the check valve and the pump.