# Installation and Maintenance
# SERIES 1120
# Inline Direct Coupled
# Vertical Turbine Pumps

AURORA PUMP
A UNIT OF GENERAL SIGNAL
P O BOX 1500 • CITY OF INDUSTRY, CA • 91749

# RECOMMENDATIONS FOR STORAGE
# AURORA VERTI-LINE PUMPS

Aurora Verti-Line Pumps are carefully prepared for shipment from the factory. Skids and boxes are intended to resist mechanical damage from normal handling and preservatives are used to protect critical surfaces from routine conditions of weather and corrosion in transit. Effective life of factory-applied protection, however, can vary widely under different circumstances and should be considered adequate only to secure the equipment during shipment and installation. If installation and operation cannot be effected within a reasonably short time after delivery to jobsite, the product is assumed to be in storage and subject to precautionary procedures as described below.

With common sense as the best guide, store the equipment off the ground in an indoor location where it will not be exposed to excess moisture or humidity, extreme weather conditions, blowing dust corrosive fumes, or other harmful factors. If storage must be outdoors, provide at least a roof shelter and cover all pieces securely with six mil polyethylene sheet or equivalent.

Inspect pump periodically to assure that factory-applied preventives remain intact. With the first sign of deterioration, renew the protective measure in question. If rust spots appear on machined surfaces, clean with fine emery cloth and apply approved rust preventive.

If pump is assembled, it should remain on skids just as delivered. Packing rings and/or mechanical seals if assembled in place should be removed from the pump and stored in a box. If pump is unassembled, inner column joints should be nested inside eduction column pipe to save space as well as to provide greater protection. All threads must be covered with wrapping and tape or with suitable caps. Never stack anything on top of column joints.

Electric motors and right angle gear drives must be handled vertically at all times. See individual manufacturer's storage instructions for motors, gears, IC engines, universal shafts, other appurtenances and accessories.

For long term storage, but not to exceed 36 months, the following additional precautions should be observed:

- Air dry hydraulic portion of pump to remove any residual liquid.
- Cover and seal with pressure sensitive waterproof tape all openings into flowstream areas.
- Wrap shaft extension with pressure sensitive waterproof tape.
- Coat rabbet fit on driver and pump head with heavy grease, along with any other exposed machined surfaces.
- Completely cover upper part of motor and seal with tape. Consider providing space heaters for motors if stored under damp or humid conditions.
- Fill any external lubrication piping or flush lines with rust preventive.
- Store all parts in a clean dry area with ambient temperature reasonably constant between 40 and 100 degrees F.

Upon removing a pump from any type of storage, proceed as follows:

- Consider contracting with the pump manufacturer for the services of a factory trained field service engineer or technician.
- Remove all covers and tape from openings, drivers, and threads.
- Remove grease and rust preventive from mating fits and running surfaces.
- Clean all threads and mating fits thoroughly.
- Assemble packing and/or mechanical seal if applicable, using appropriate instructions.
- Flush any external lubrication piping to remove rust preventive.
- Follow individual manufacturer's instructions regarding driver and other appurtenances.
- Inspect all visible parts.
- Install pump and start up in accordance with applicable instruction manual.

Occasionally, a pump is stored in its installed position for protracted periods while related equipment is made ready or perhaps simply in seasonal shutdown. In this event, pump and driver shaft must be rotated manually once a week or the unit may be power run every two weeks, using proper startup procedures at each start.

These procedures are offered as a guide to assist users and may not be construed to amend, to extend, or to modify in any way the AURORA Pump warranty.

# Table of Contents

# SECTION 1

## A WORD TO THE OWNER

Efficient performance. Satisfactory operation. Dependable service.

We know these are the things you want from your Aurora Verti-Line vertical turbine pump and we've designed it accordingly. We've prepared this booklet to help you assure continuance of these features by implementing a careful and proper installation and maintenance program. If you want further assistance, you might consider contracting for the services of an experienced Aurora service representative to supervise your installation and/or startup.

Because of variations in jobsite environments and installation requirements, we've had to be somewhat general. However, we have listed what we believe are the most important guidelines. Your installer must still use sound judgement to adapt the methods we've outlined to the specific site circumstances and pump design features in each particular installation. It is in your interest that he does, since failure to comply with recommended procedures may void your warranty.

If any question should arise during the course of the work, we urge you to see your local Aurora representative immediately. Please be able to identify the unit by its serial number. We stamp the number on the nameplate, on the discharge head and on the bowl assembly.

Figures 3 and 4 will show you the relationship of all the parts after installation is complete. The nomenclature we've used here will identify the items throughout the instructions. Before starting the installation procedure, please read through the entire process we've described in this book, omitting material not applicable to your particular pump. Study in detail the precautionary directions emphasized in Section 14.

Then, when you do start the work, refer to the instructions for each individual step. After the equipment is in operation, we suggest you keep a manual available at the site for future use in maintenance programs. It can be used in conjunction with the Aurora disassembly, assembly and troubleshooting manuals.

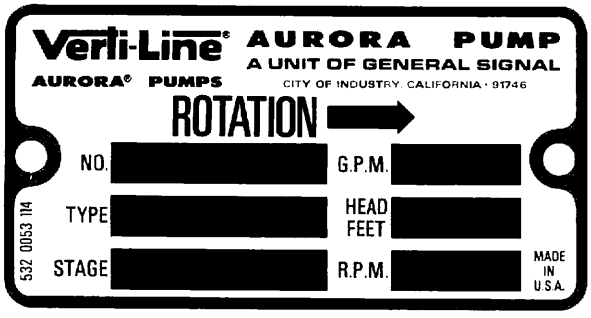



Figure 1. Discharge Head Nameplate

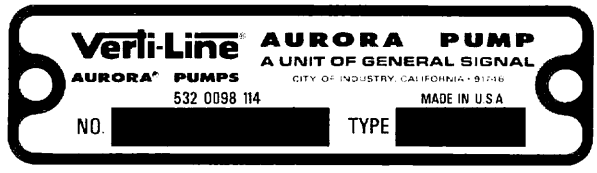



Figure 2. Bowl Assembly Nameplate

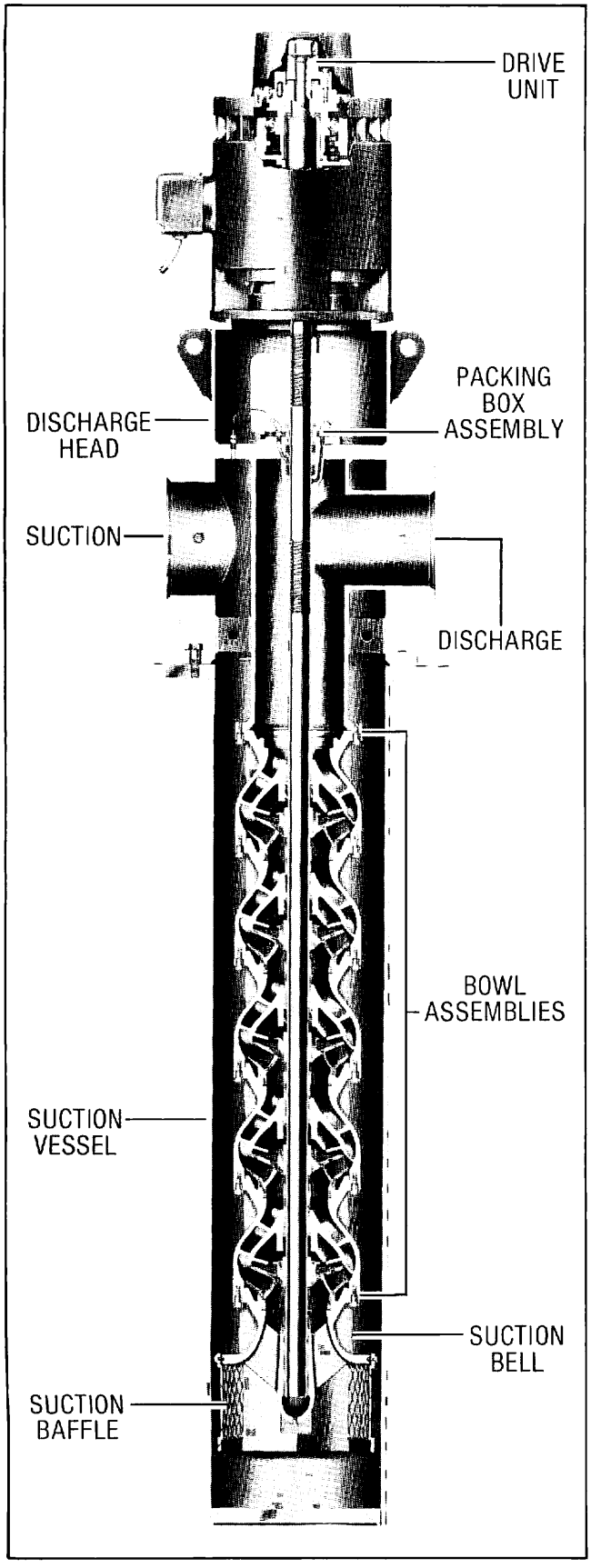



Figure 3. Shallow Set Turbine Pump - Above Surface Suction Vessel

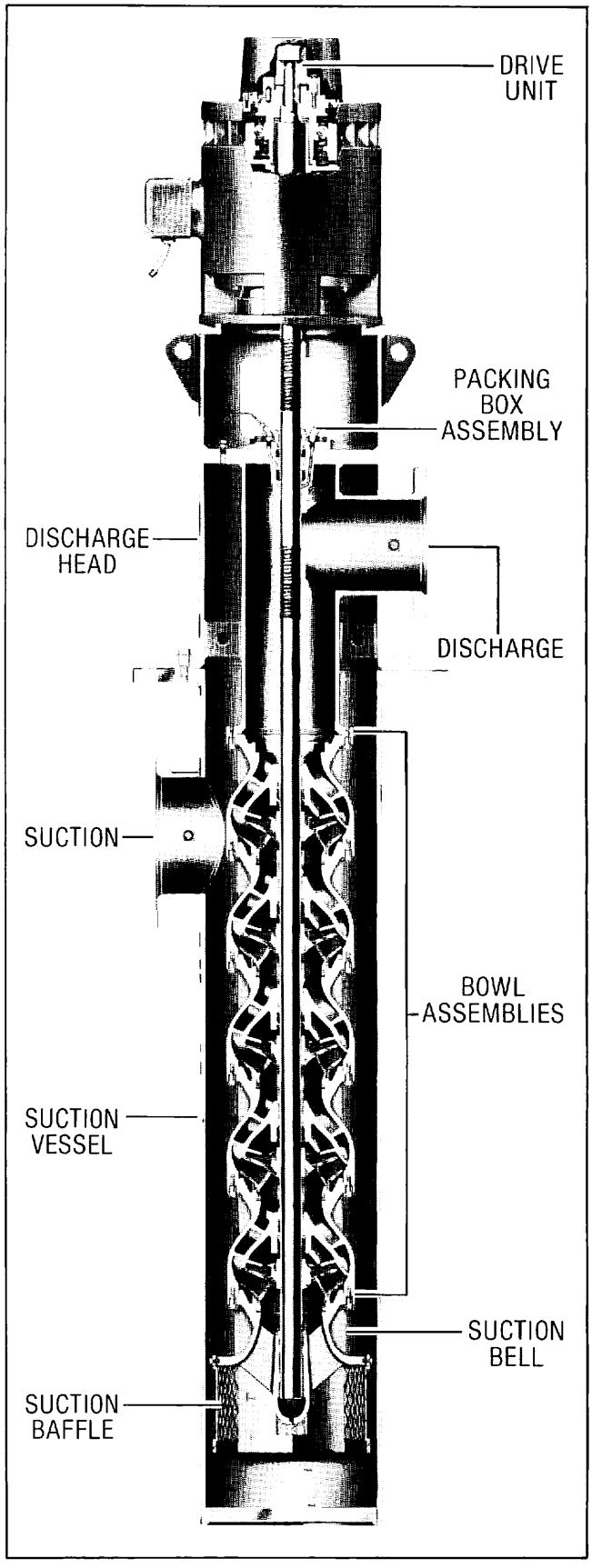



Figure 4. Shallow Set Turbine Pump - Below Surface Suction Vessel

## SECTION 2

## THE SUMP

The sump you provide can influence both the mechanical and hydraulic performance of your pump. The intake configuration should be designed to deliver an evenly distributed flow of water to the pump suction since uneven flow patterns tend to create vortices. Vortexing can be submerged and completely invisible, or, it can appear on the surface. It can introduce air into the pump, can increase or decrease power consumption, can influence submergence requirement, and can produce objectionable noise and vibration, among other things.

It's easy to be misled by low calculated average velocities across an intake channel, but keep in mind these figures can often mean absolutely nothing. It's the localized velocities that start the vortex. Actually, vortices are more easily sustained in flows of lower average velocities where a calm slowly moving surface does nothing to interfere with a gradual buildup in vortex size. A more turbulent surface can tend to break up these disturbances before they grow large enough to cause harm.

The Standards of the Hydraulic Institute offers certain guidelines for good pit design and we subscribe to these general principles. However, we recommend you put your sump design questions in the hands of an experienced sump design engineer who can match intake configuration with pump requirements in the plant design phase and make it possible for you to realize optimum performance from each.

Before starting installation, inspect the completed sump carefully. You'll want to make sure it's dimensionally adequate to receive the pump. You'll also want to see that it has been cleared of all trash and debris. Your inspection should include any pipelines or conduits feeding into the pit. It's a good idea to have the basin screened to prevent future entrance of foreign material which can damage or clog the pump, possibly even rendering it inoperative.

## SECTION 3

## THE MOUNTING BASE

Your Aurora Verti-Line pump requires a foundation suitable for the weight of the entire unit when full of water. While the preferred material is solid reinforced concrete, you can use adequate fabricated steel structures as long as you keep deflections to an absolute minimum. Regardless of material, the mounting structure must be properly engineered, structurally sound and stable, able to withstand and prevent objectionable vibration.

With a suction cased pump, the foundation will be under the suction vessel flange, and the pump head will mount directly to the flange as seen in Figures 6 and 7, Section 4. You'll want to provide anchor bolts to secure the vessel flange to the mounting base. We prefer the sleeve bolt design shown on the right, in Figure 5 and you probably will too, since it's easy to use. Alternate bolt arrangements are illustrated, however, for your information.

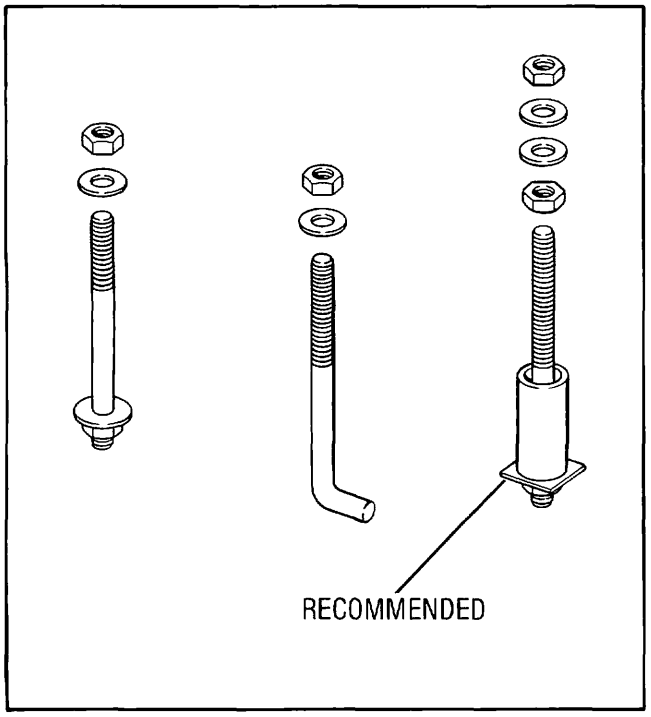



Figure 5. Foundation Anchor Bolts

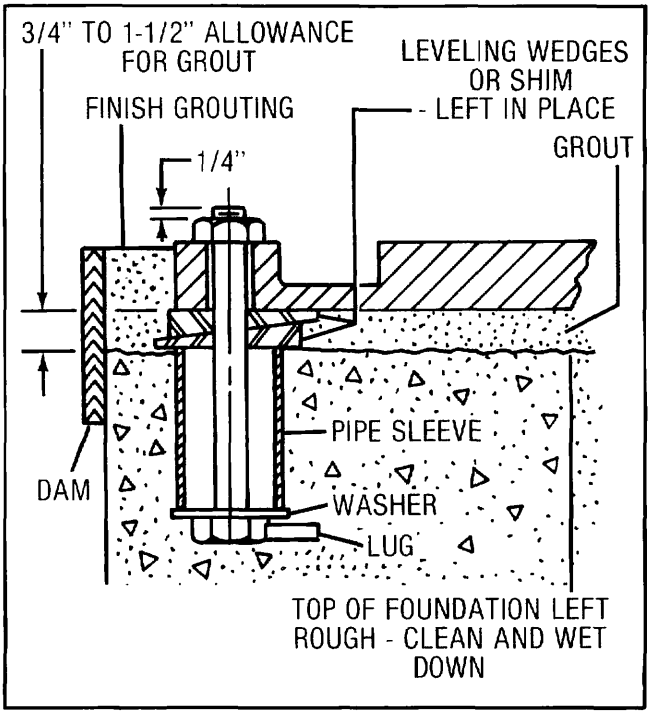



Figure 5a. Typical Foundation Bolt Design

## SECTION 4

## THE SUCTION VESSEL

If your pump is a suction cased booster, your suction vessel may have been furnished with the pump or you may have procured it from another source. In either event, the vessel should be lowered into the pit, levelled, and grouted or otherwise secured in place, after which the nuts may be tightened firmly on the vessel anchor bolts. These bolts may be similar to those discussed in Section 3.

You must set the vessel so that the machined portion of the top flange is level within a maximum of 0.007 inches per linear foot across the flange face. Bolt holes must be located so that the suction and discharge nozzles are in proper orientation for your jobsite piping. See Section 12.

In some installations, concrete is poured around the outside of the vessel after positioning. In other instances, the tank may be set in the ground with a higher water table surrounding. In these or similar situations, you must take proper measures to prevent the barrel from floating out of position. You may use any suitable means, including firm anchoring and bracing, or you may want to fill the vessel itself with water to eliminate its buoyancy.

Velocities and flow patterns in the vessel can be critical to the operation of the pump. If the tank is designed and/or furnished by any source other than Aurora Pump, the configuration must be approved by Aurora Pump engineers before the pump warranty will be validated.

After you've set the vessel, and during the installation of the pump, you must provide protective cover for the machined surface of the barrel flange.

Typical assemblies of this type are illustrated in Figures 6 and 7.

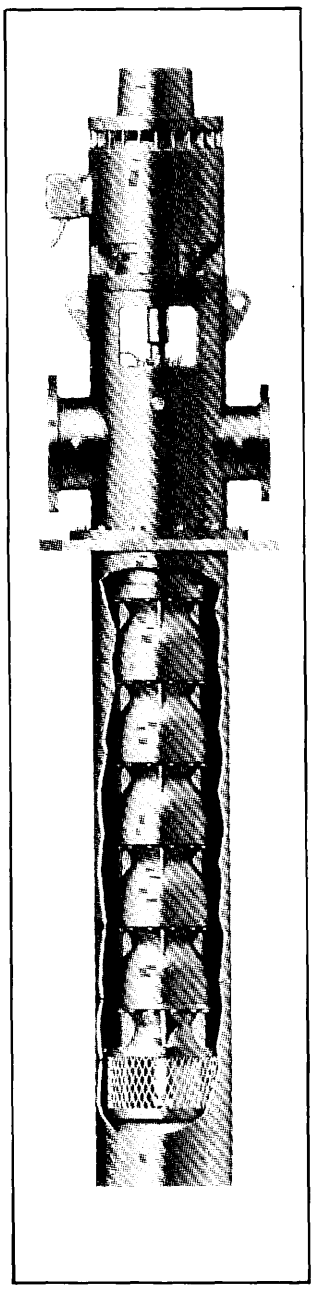


Figure 6. Above Surface Suction Vessel

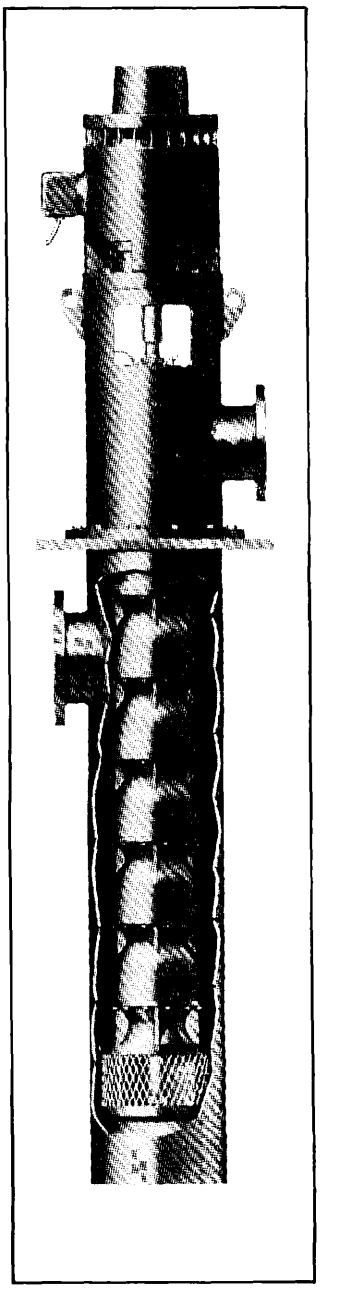


Figure 7. Below Surface Suction Vessel

## SECTION 5

## THE EQUIPMENT

The material and equipment you'll need for installation may vary with the size of pump and the type of job. We'll offer the following suggestions as a guide but you will want to remember the primary tool to be used at all times is SAFETY FIRST.

You can use a portable derrick or tripod, but we recommend either a boom crane of adequate capacity or a properly designed pump setting rig similar to that shown in Figure 8. Whatever you choose, your lifting device must allow the load hook to be raised at least two feet higher than the total length of your assembled pump. Your hook should be of the safety type with a good easy working swivel and you must have sufficient reach to center it over the installation position.

We'll assume your pump has been delivered to you in an assembled condition, which is almost always the case with this type of pumping equipment. If you have elected to receive it unassembled due to its size, jobsite head room limitation, or some other compelling reason, we must refer you here to our SERIES 1110 Manual, Sections 4 through 9, for the initial steps of your installation, after which you may return to this manual at Section 9.

For installation of an assembled unit, we suggest the following miscellaneous tools and material, but you may want to vary them to suit the pecularities of your individual project:

Lifting equipment (See Figure 8)

Cable sling about 10 feet long of adequate size for job (See Figure 9)

Chain tongs

Medium size pipe wrenches

12 foot length 3/4 inch rope

Ordinary set of mechanics tools (see Figure 10)

Wire brush

Assortment of files

Clean rags

Thread compound -- Use anti-galling type for stainless steel parts

Solvent -- Gasoline, distillate, or kerosene in recommended containers

Special lubricants as required

Shims and wedges

Non-shink grouting material

**Note**

All combustible materials must be kept in approved safety containers and handled carefully away from any flame, sparks, exhaust, or any other possible source of ignition.

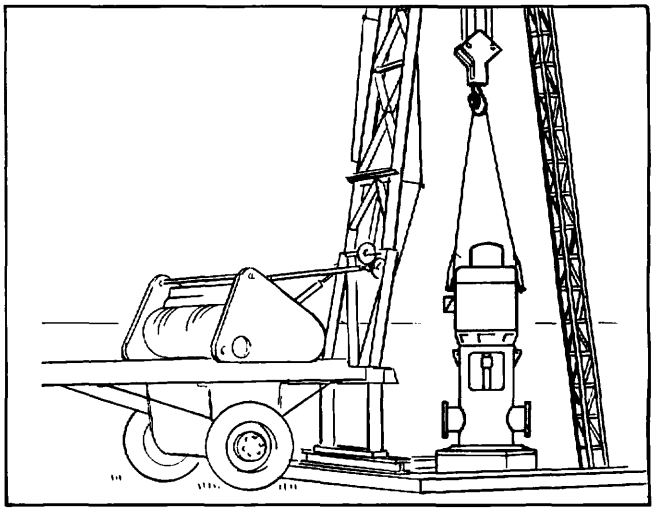


Figure 8. Pump Installation Rig

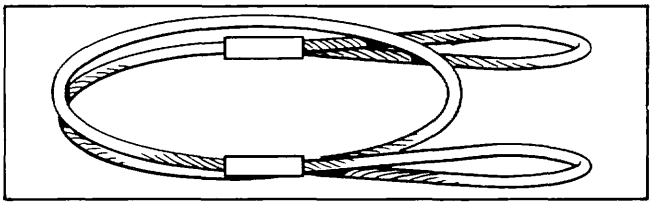


Figure 9. Cable Sling

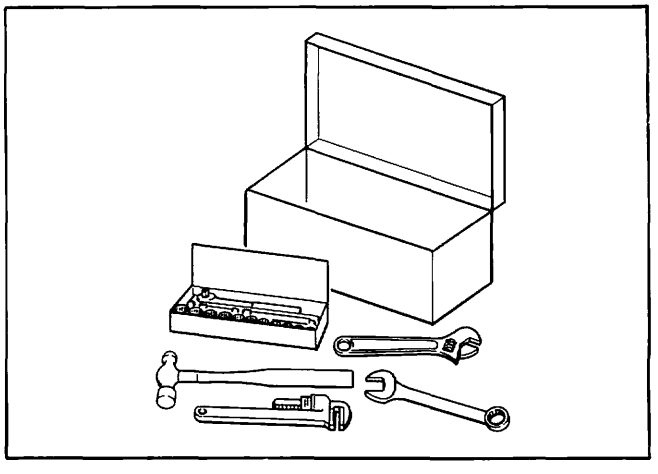


Figure 10. Ordinary Set of Mechanics Tools

## SECTION 6

## RECEIVING THE PUMP

Your Aurora Verti-Line pump was inspected on the carrier just prior to leaving the factory. When you receive it at your job site, look it over carefully for any visible damage to parts, skids, boxes, or dunnage. If shafting is crated, open the crate carefully to inspect and make a count but leave the shaft in the box for protection until ready for installation. Take inventory on the truck or during the unloading process. We don't want you to sign for damaged or incomplete shipments unless you take the appropriate exceptions. Report such instances immediately to the Aurora sales office and to the transportation company involved giving full particulars and confirming all verbal understandings in writing.

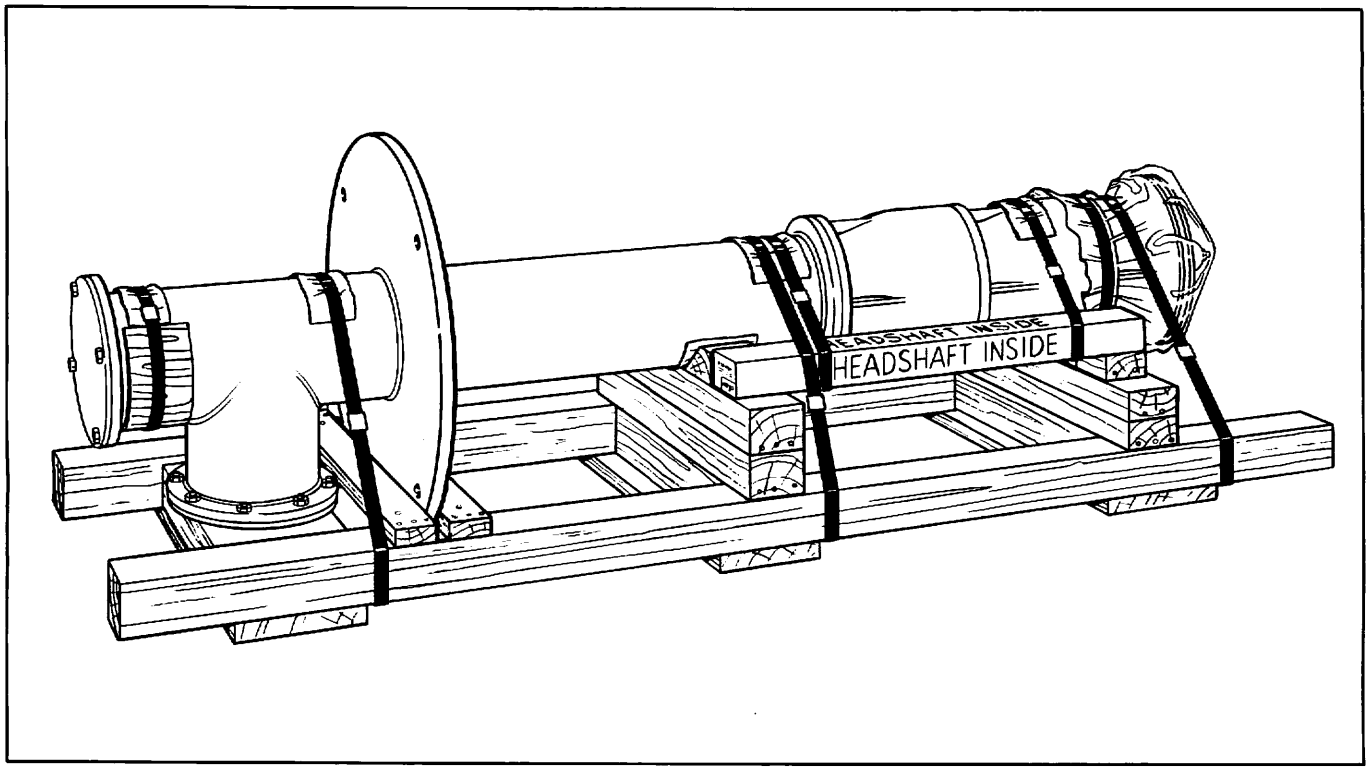



Figure 10a. Typical Close Coupled
Pump Readied For Shipment

## SECTION 7

## UNLOADING THE PUMP

We cannot urge you too strongly to exercise extreme care in handling and installing all parts. All items are precision machined for proper alignment and, if dropped, banged, sprung, or mistreated in any way, misalignment and malfunction will undoubtedly result. Parts which are too heavy to be lifted from the transporting car or truck should be skidded slowly and carefully to the ground so as to prevent injury. We ask you never to unload by dropping parts directly from the carrier to the ground. Never use crates in which parts are shipped for skids.

If your jobsite conditions permit, you may be able to install directly from the truck that brought the pump to you. If not, move the components to the installation area and lay them out in a clean and protected area convenient to the work location.

If installation cannot begin within a very few days after delivery, it is a good idea to segregate and identify all components comprising your Aurora shipment so they will not be lost in the midst of other equipment arriving at the jobsite. Under these conditions, refer to the Recommendations for Storage located on the inside front cover of this publication. Read and follow them carefully because care of the pump during storage and before installation can be as important as maintenance after operation has begun.

Again, check against your packing list to make sure nothing is missing. It's much better to find out now than during the actual installation.

## SECTION 8

## INSTALLING THE PUMP

You're now ready to start actual installation. Clear the work area at and around the mounting position so installers can move freely and with maximum safety. This will also decrease the chances for foreign material or objects to enter the pump as it is lowered into position and secured. If this is a suction cased unit, clean the top flange of the suction vessel and install the gasket or O-ring provided. Examine the vessel and be sure it has been completely cleared of all trash and debris.

During the course of the work, you must never lose sight of the fact that you are handling precision components no matter how awkward they may be to manipulate. All threads should be engaged by hand and checked before tightening. Damage resulting from cross threading or dirt must be repaired with a file before applying force. If not repairable, the part must be replaced so it's clearly worth your while to use the utmost care.

With a sling around the lifting trunnions on the discharge head, raise the entire unit as shipped to a vertical position over its mounting base, as shown in Figure 9. Take care to avoid putting any strain on the column or any exposed shafting. Also be careful not to damage the strainer during the lifting operation. Clean the bottom of the pump base and lower the assembly gently into place in its operating position with full contact, base to mounting surface. Assemble base or flange mounting bolts and/or nuts.

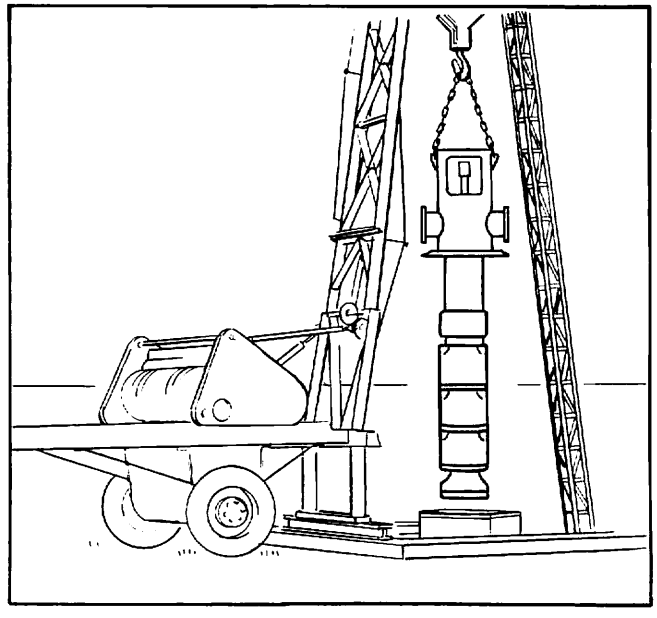


Figure 11. Raising Unit Over Well

Examine the position of the pump. The suction bell must hang the proper distance from the bottom and be unobstructed in any direction. Piping connections must be in the right orientation with respect to jobsite plumbing. When these and all other considerations appear correct, proceed with Section 9.

## SECTION 9

## INSTALLING THE DRIVER

Uncrate the driver but leave it attached to the bottom skid on which it arrived. Move it to a convenient location beside the pump head, keeping it vertical at all times. Set down on firm and level footing.

When ready for installation, raise the driver off its skid to a comfortable working height, lifting it with the lugs provided on the frame.

**WARNING**

Stand beside the load as it hangs in the sling, never under it. Inspect and clean the mounting flange and register. If you find any burrs or nicks, set the driver on two beam supports and repair with a file.

**WARNING**

Don't work under the load while it's hanging from the hoist. Clean the top of the pump head and inspect it also, making any necessary repairs.

If your pump is equipped with a vertical hollowshaft driver, illustrated in Figure 12, continue right on here with subsection 9a. If you have a solid shaft driver as in Figure 13, skip this portion and be guided by subsection 9b.

a. Vertical Hollowshaft

Remove the driver cover capscrews and the canopy itself. as in Figure 13. Remove the drive coupling and any other parts packed in the top for shipment. Place them in a clean, safe place for later use. Cover all openings in the top to prevent anything from dropping into the driver. If this should happen, the object must be retrieved before proceeding.

Lower the driver slowly to the head until the register fit is engaged, but with the weight still on the hoist. In the case of an electric motor, swing it around so the junction box is in the desired orientation. If you have a gear drive, as depicted in Figure 15, your positioning criterion is the horizontal input shaft. Align the mounting holes and start the attaching capscrews in by hand. Transfer the weight gently from hoist to head and secure the capscrews, tightening them uniformly.

Please note that the lifting lugs on the driver are for handling the driver only. Never attempt to use these

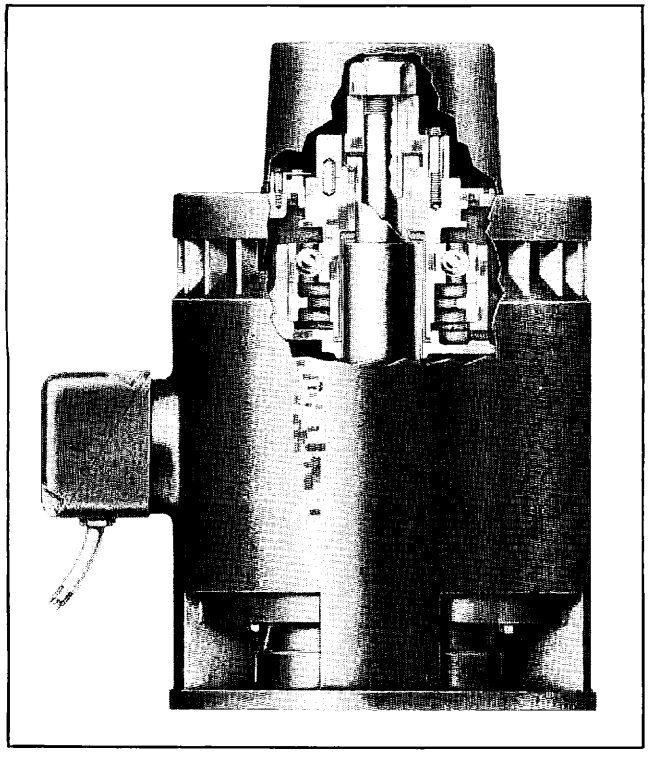


Figure 12. Vertical Hollow Shaft Electric Motor

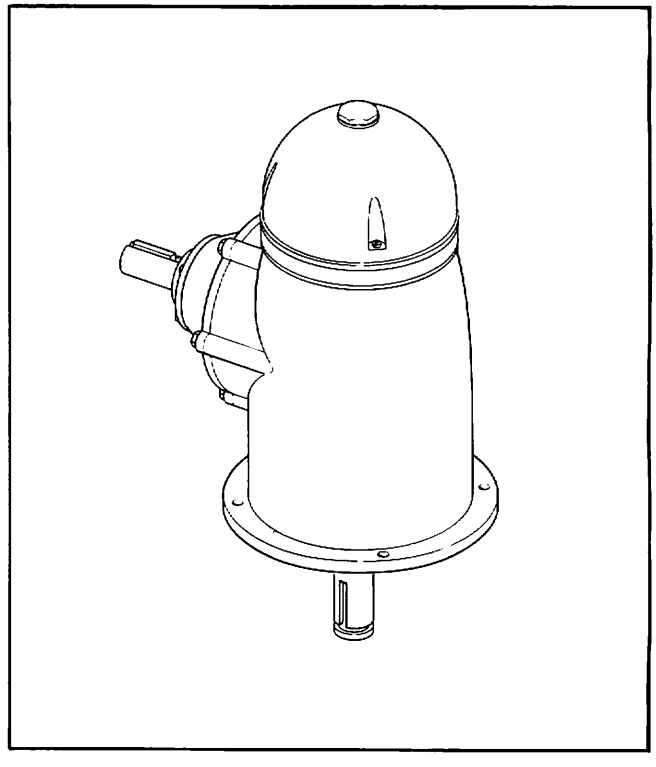


Figure 13. Vertical Solid Shaft Gear Drive

lugs to hoist the pump. The pump must be handled with its own lifting trunnions.

If you have a VHS electric motor, depicted in Figure 12, to deal with, open the main breaker or pump disconnect switch and make a temporary connection between the motor terminals and the leads from the starter panel. Since many electric motors are built as dual voltage machines, it is important that the proper connections be made to suit the voltage of your power source. Therefore, you must check both power characteristic and motor rating for compatibility, then see the motor nameplate for correct wiring hookup.

While scanning the nameplate, determine the type of thrust bearing with which you've been furnished. If it's a spherical roller bearing, proceed with utmost caution as it must never be run at normal speed without an appreciable thrust load. For this reason, when establishing rotation as we're about to do, be very careful to just bump or tap the switch. Never close it fully until the pump is completely operational.

Otherwise, you may now energize the starter panel and buzz start the motor by switching it very quickly on and off, observing for direction of rotation and watching to see that it spins freely and is in apparent balance. Driver shaft must turn counterclockwise when viewed from the top. If rotation is clockwise, kill the power to the starter panel and interchange any two leads on three phase motors. With single phase machines, follow manufacturer's instructions.

After reconnection, energize the starter and again buzz start the motor. When you're sure you have counterclockwise rotation, mark the motor terminals and the leads from the starter box to match. De-energize the starter at the main breaker or pump disconnect switch and make the permanent power connections. Naturally, these connections must be made in accordance with all applicable electrical codes and regulations.

If your pump is equipped with a right angle gear drive, as shown in Figure 15, instead of an electric motor, the rotation check must wait until later when the pump is completely installed and connected to the prime mover. At that time, rotation is verified in a manner similar to that just described with allowances for the type of power equipment. One thing you can do right now is match up the rotation arrows on your gear and your prime mover to determine compatibility, at least as far as the nameplates are concerned.

Your headshaft was probably shipped to you in a separate box. Find it and clean it thoroughly throughout its length, threads, keyway, and end faces. Now, slide it down through the driver hollow shaft without bumping or scraping, keyway end up. If you were furnished with a slinger ring, assemble it to the shaft as the shaft bottom end emerges from the bottom of the driver.

Remove the capscrews securing the packing box or tension nut flange. The shaft coupling may be above or below the packing box/tension nut location. If above, make the connection in the usual manner, mindfull of the left hand threads. If below and in the elbow itself, loosen the packing if any and continue lowering the headshaft through the packing box or tension nut until you encounter the coupling below. If possible, hold the shaft coupling by reaching in through the discharge opening. In any case, start the shaft into the coupling very carefully and snap to a firm butt.

Looking down on the driver, check to see that the headshaft stands in the center of the hollowshaft and that the driver shaft rotates freely by hand. If the shaft stands to one side of the quill, rotate the shaft from below. If the top of the bar moves around the quill, you have a bent shaft or a bad coupling joint. If, however, the shaft remains in the same off center spot during rotation, the problem is with one of the stationary parts, perhaps the column or head assembly or, just as likely, the mounting structure. Wherever it is, it must be rectified before proceeding. If in doubt, call your Aurora representative.

When all is well, replace the packing box or tension nut flange capscrews, tightening them uniformly and securely. Retrieve the drive coupling and other parts you set aside, together with the pump parts shown in Figure 14.

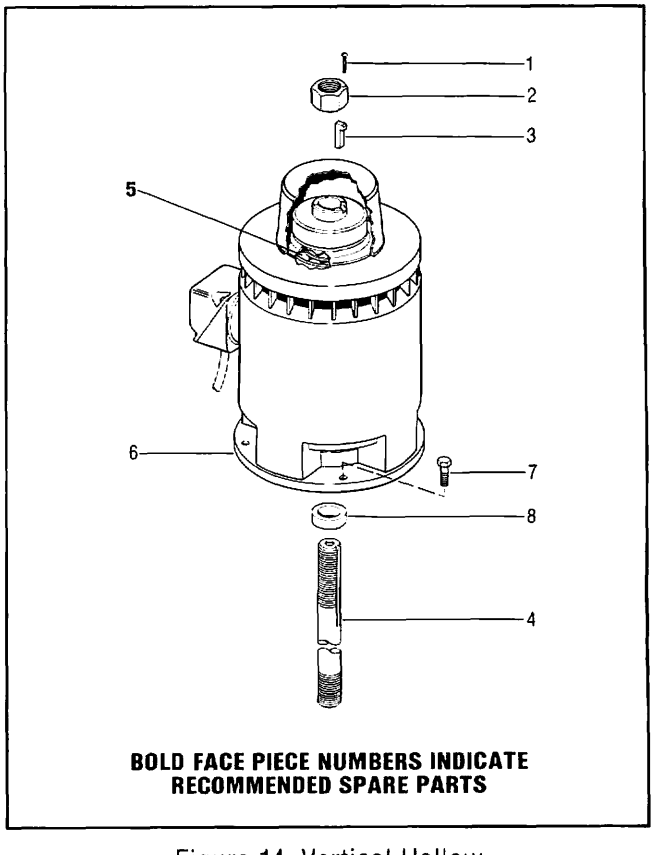



Figure 14. Vertical Hollow Shaft Electric Motor

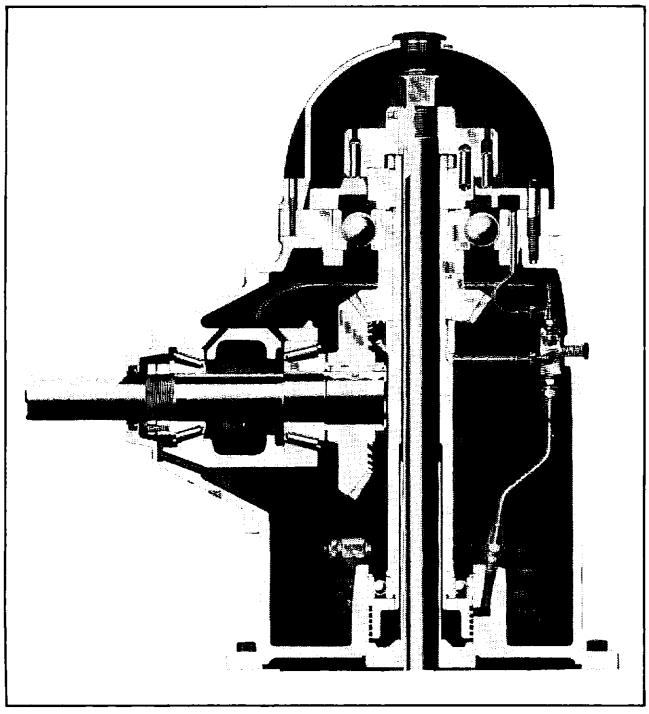


Figure 15. Vertical Hollow Shaft Gear Drive

Try the drive key, Item 3, in both headshaft and drive coupling keyways. They should produce a sliding fit. If necessary, dress the key until a free but not loose fit is obtained. Do not file the keyways. Slide the drive coupling over the headshaft, Item 4, into proper position onto its register, firmly seated perfectly flat without cocking. It should slide easily and smoothly without tendency to drag or hang up when lowered or rotated.

Insert the drive key, Item 3. Again it should be a free, but not loose, fit. If necessary dress the key but never the keyways. The top of the key must be below the adjusting nut seat when in place.

Thread the adjusting nut, Item 2, onto the headshaft remembering the left hand threads, and raise the shaft until all its weight is on the nut. This is the breakfree point and may be recognized as that point at which the impeller can first be turned by hand. With a very slight lowering of the shaft, the impellers are felt to drag on the bowl seal rings. Mark the breakfree point, adjusting nut to driver coupling. Raise the impellers one turn off the nut and assemble the lockscrew, Item 1.

If your pump is equipped with electric drive, energize the starter and just bump the switch very lightly. With an engine or other type of drive, you must go through the entire first startup procedure, then take the unit barely up to speed and immediately release the power. This will firm up all the shaft joints. However, keep in mind our warning regarding a spherical roller thrust bearing. If your driver came equipped with one, omit this step until you can apply the full thrust of the pump to the bearing.

De-energize the starter for electric drives. Remove the adjusting nut lockscrew and lower the impellers to the original breakfree point as marked. Determine that this has not changed or, if it has, establish a new breakfree point, punch marking the nut and driver coupling for permanent reference. For initial operation with your new Aurora Verti-Line pump, we will usually recommend an impeller setting one or two turns of the nut above the breakfree point. This would conclude your adjustment procedure for startup and early period operation of an electrically driven pump. Replace the lockscrew and secure as shown in Figure 16.

Eventually, it may become necessary to readjust to sustain optimum performance. At that time, if you wish, you can make a very precise adjustment by observing the reaction of an ammeter to various settings. If you get a normal power reading at one turn up, you can back the nut off one lockscrew hole at a time, operating the pump and watching the ammeter at each setting. When the impellers just start to drag, the ammeter will fluctuate and/or show increased power requirement. From the setting at which fluctuation first manifests itself, raise the shaft by turning the nut counterclockwise to the next lockscrew hole. This should give you your optimum performance.

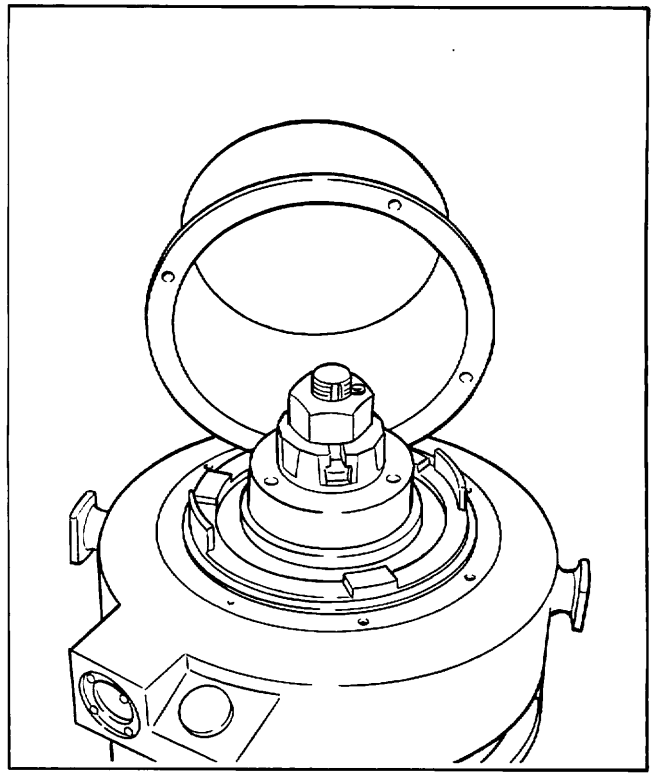


Figure 16. Vertical Hollow Shaft Driver Top

After completing the adjustment procedure, replace the driver canopy and secure the capscrews. Keep it that way all the time that you aren't actually working under the cover. Check driver lubricant and follow directions from manufacturer. If your driver requires provision for coolant flow, take necessary measures as instructed. Do not run equipment until all these considerations have been satisfied. Leave the power circuit open to the starter panel while performing remaining work except when it requires pump operation.

b. Vertical Solid Shaft

Lower your vertical solid shaft driver to a firm and stable position atop a pair of beams or blocks placed on the discharge head to provide ample clearance between driver shaft and pump shaft. If you have an electric motor to deal with, secure it firmly against reactive torque with chain or cable restraints. Open the main breaker or pump disconnect switch and make a temporary connection between the motor terminals and the leads from the starter panel. Since many electric motors are built as dual voltage machines, it is important that proper connections be made to suit the voltage of your power source. Therefore you must check both power characteristic and motor rating for compatibility, then see the motor nameplate for correct wiring hookup.

While scanning the nameplate, determine the type of thrust bearing with which you've been furnished. If it's a spherical roller bearing, proceed with utmost caution as it must never be run at normal speed without an appreciable thrust load. For this reason, when establishing rotation as we're about to do, be very careful to just bump or tap the switch. Never close it fully until the pump is completely operational.

Otherwise, you may now energize the starter panel and buzz start the motor by switching it very quickly on and off, observing for direction of rotation and watching to see that it spins freely and is in apparent balance. Driver shaft must turn counterclockwise when viewed from the top. If rotation is clockwide, kill the power to the starter panel and interchange any two leads on three phase motors. With single phase machines, follow manufacturer's instructions.

After reconnection, energize the starter and again buzz start the motor. When you're sure you have counterclockwise rotation, mark the motor terminals and the leads from the starter box to match. De-energize the starter at the main breaker or pump disconnect switch.

If your pump is equipped with a right angle gear drive, as shown in Figure 17, instead of an electric motor, the rotation check must wait until later when the pump is completely installed and connected to the prime mover. At that time, rotation is verified in a manner similar to that just described with allowances for the type of power equipment involved. One thing you can do right now is match up the rotation arrows on your gear and your prime mover to determine compatibility, at least as far as nameplates are concerned.

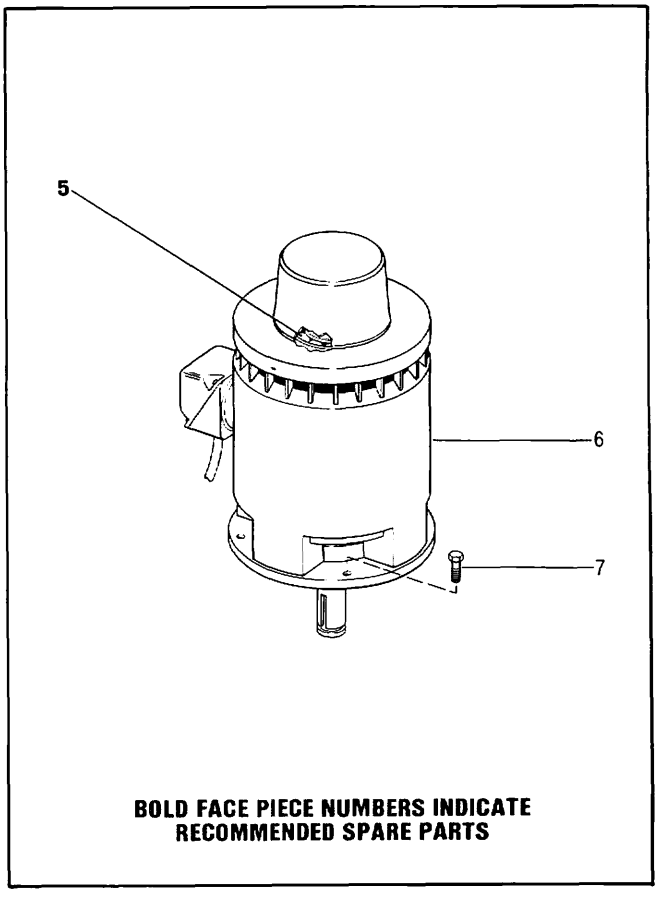
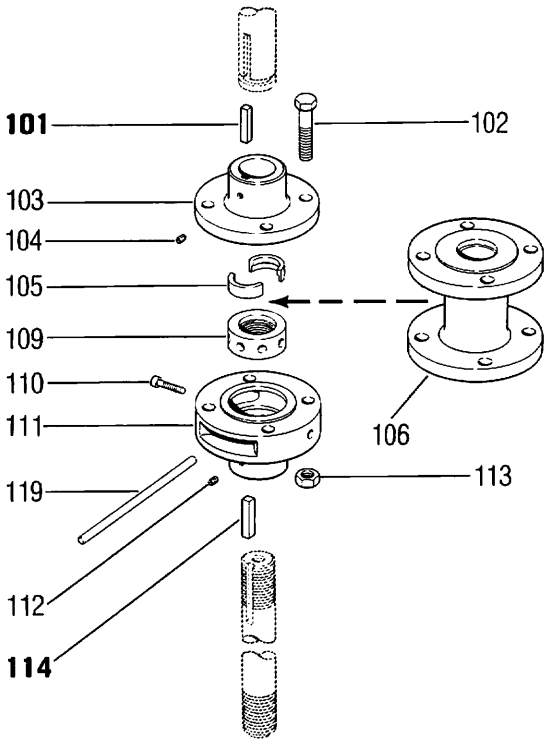



Figure 17. Vertical Solid Shaft Electric Motor

While the driver is still sitting on the blocks, examine the protruding driver shaft for any burrs or nicks. If necessary, repair very cautiously with a small file. Clean the shaft and oil it very lightly. Find the shaft coupling parts, referring to Figure 18, and clean them all thoroughly.

Try the driver shaft key, Item 101, in both driver shaft and upper coupling half, Item 103, keyways. You should find a very close sliding fit. If necessary, dress the key but not the keyways until you obtain a free, but not loose, fit. Now try the thrust collar, Item 105, in the shaft groove. It too, should be a very close fit and may be dressed to obtain this if necessary. Try the coupling half, Item 103, on the shaft.




**BOLD FACE PIECE NUMBERS INDICATE RECOMMENDED SPARE PARTS**

Figure 18. Flanged Adjustable Shaft Coupling

When you have the proper fits and while the driver still sits on the blocks, insert the key, Item 101, in the shaft keyway and slide the coupling half, Item 103, up on the shaft flange face down. With the flange above the drive shaft ring groove, assemble both halves of the thrust collar, Item 105, in the groove and slide the coupling back down until it rests firmly on the thrust collar, retaining the collar halves in place in the coupling recess. Assemble and tighten setscrew, Item 104, securely.

If your coupling is furnished with a spacer spool, Item 106, assemble the spacer to the driver coupling half, Item 103. If parts are matchmarked, install them accordingly. Use only the nuts and bolts shipped with the pump as some couplings are balanced as assemblies. Tighten all flange bolts securely and uniformly throughout the coupling.

Inspect and clean the pump shaft threads, painting lightly with a good thread lubricant. After trying keys and parts as described above, insert key Item 114, in the pump shaft keyway and slip the pump shaft coupling half, Item 111, well down over shaft, flange face up, leaving shaft threads projecting above coupling. Screw adjusting nut, Item 109, onto pump shaft with the rimmed end up, turning counterclockwise until pump shaft protrudes through threaded portion of nut by at least two threads. Remove the capscrews securing the packing box or tension nut flange.

Raise the driver just enough to remove the blocks, then lower it slowly to the head until the register fit is engaged but keeping the weight on the hoist. In the case of an electric motor, swing it around so that the junction box is in the desired orientation. If you have a gear drive, as shown in Figure 16, your positioning criterion is the horizontal input shaft. Align the mounting holes and start the attaching capscrews in by hand. Transfer the weight gently from hoist to head and secure the capscrews, tightening them uniformly.

Please note the lifting lugs on the driver are for handling the driver only. Never attempt to use these lugs to hoist the pump. The pump must be handled with its own lifting trunnions.

With the pumpshaft all the way down so the impellers are firmly seated in the bowls, screw the adjusting nut, Item 109, up by turning it clockwise until its outer shoulder is approximately one tenth of an inch below the face of the driver coupling flange, Item 103, or spacer, Item 106, lower flange, if you have a spacer spool. Pull the pump coupling, Item 111, up and insert flange bolts, Item 108, through both flanges. Assemble the nuts, Item 113, and tighten by hand until they are snug, using a light machine oil on the bolt threads.

Check for shaft alignment at the outer edges of all the flanges. They must meet evenly both at the faces and at the outer circumferences. True alignment can be further verified by using dial indicators on both the driver and the pump shafts. If you cannot obtain an alignment within 0.003 inches T. I. R., call your local Aurora representative.

When satisfactory alignment is achieved, put all bolts under uniform tension, using a torque wrench if available. Five hundred inch pounds should be sufficient torque; i.e., a fifty pound pull on a ten inch wrench or the equivalent. Make sure pump shaft key, Item 114, is flush with coupling hub and tighten setscrew, Item 112, securely to lock the key in place.

Move the adjusting nut, Item 109, very slightly if necessary to line up the nearest hole with the tapped hole in the outer circumference of the pump coupling flange. The nut may be rotated by inserting a bar, Item 119, through the slot in the coupling into one of the holes in the outer surface of the nut. Insert the socket head capscrew, Item 110, making certain it projects into a hole in the adjusting nut, then tighten securely. Now replace the packing box or tension nut flange capscrews. Tighten them uniformly and securely.

You have now adjusted your pump so the impellers are set about one tenth of an inch off their endseal seats.

We recommend this for first start and for initial period of operation. If you have an electric drive and should you want to make a more precise adjustment at anytime in the future, you may do this by observing the reaction of an ammeter to various settings. If you get a normal power reading at your present adjustment, you can back the nut, Item 109, off clockwise one lockscrew hole at a time using the bar wrench, Item 119. Operate the pump and watch the ammeter at each setting. When the impellers just start to drag, the ammeter will fluctuate and/or indicate increased power requirement. From the setting at which fluctuation first manifests itself, raise the shaft by turning the nut counterclockwise to the next lockscrew hole. This should result in optimum performance.

You may now make the permanent power connections to the electric motor, if that's what you have, checking of course to see that the power circuit to the starter panel is still open. Naturally these connections must be made in accordance with all applicable codes and regulations.

Check the driver lubricant and follow manufacturer's directions. If your driver requires provision for coolant flow, take the necessary measures as instructed. Don't attempt to run the equipment until all these considerations have been satisfied. Leave the power circuit open to the starter panel while performing remaining work except when the procedure requires pump operation.

## SECTION 10

## OPTIONAL EQUIPMENT

Your Aurora Verti-Line vertical turbine pump may be furnished with a variety of optional features to your specification. Most of the available options will be described in this manual. Please refer to those sections applicable to the construction of your unit, disregarding those that do not apply. Check your shipment for any drawings and/or special instructions that may have been included to cover items not described in this manual.

a. Packing Box

If a packing box has been furnished, as is the normal case with short coupled open lineshaft industrial pumping equipment, it will usually be shipped assembled in its proper position in the discharge head or driver pedestal. The standard packing box assembly, as shown in Figure 19, will typically include a packing container, Item 244, at the extreme lower end of which is a bushing or throttle sleeve, Item 245. Immediately above this you'll find a sufficient number of packing rings, Item 227, to position the lantern ring, Item 226, opposite the proper drain port. Above the lantern cage you'll see additional packing rings, Item 225, as necessary to achieve proper height of the split gland, Item 224, which can be removed without disturbing the shaft. Ordinarily, a gasket, Item 246, seals the flange to its mounting surface, although an O-ring may sometimes be used. The housing is secured in place with capscrews, Item 234.

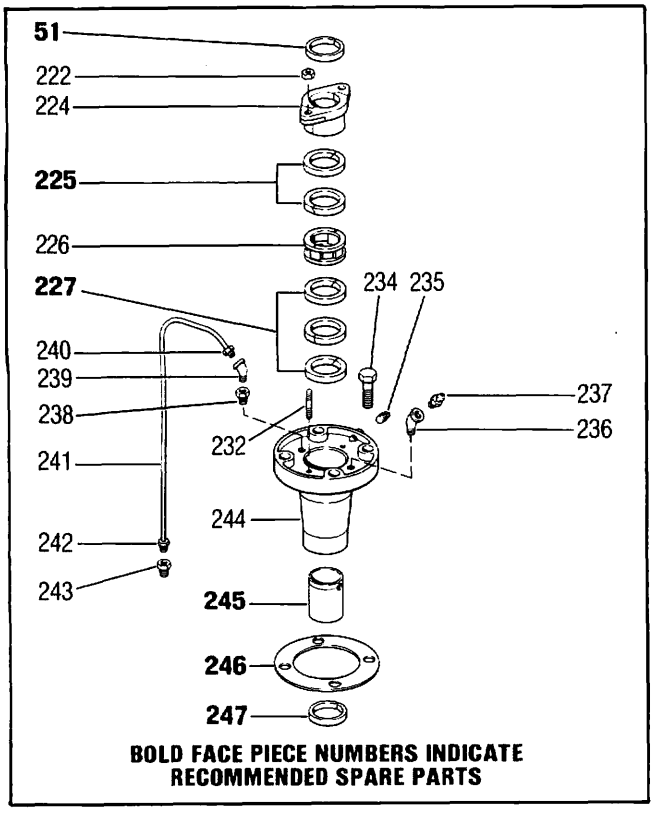



Figure 19. Packing Box Assembly

When assembling the headshaft as described in Section 9a, the packing gland nuts, Item 222, should be loosened so the shaft threads will not drag excessively on the packing rings as the shaft passes through the box. After you've assembled the headshaft, you should tighten the gland nuts initially only finger tight.

The grease fitting, Item 237, channels into the throttle bearing. Only a very small amount of standard water pump grease should be injected for startups only, otherwise not at all. Too much grease can actually interfere with heat transfer in the journal area, producing excessive temperature in the box.

At the time of first operation, start the pump and run it for ten to fifteen minutes. Let the gland leak at least one hundred drops per minute during this period. If the leakage rate slows, loosen the gland nuts to maintain constant flow. Gland temperature should level off and then drop slightly toward the end of the run. You may then draw up the nuts about one sixth turn every five minutes until leakage is minimized. If, during this procedure, the gland heats up so it will vaporize water, back off the nuts and repeat the run-in process as described until temperature stays down after gland is finally adjusted.

During the first four hours of operation, you may find it necessary to tighten the gland gradually as the packing rings are broken in and formed to fill the chamber. You must always allow a small trickle to flow through the top of the gland. During this time, check frequently to see that the box is not overheating. Should this occur, slacking off on the gland nuts may be all you need. If excess heat continues, inspect bypass line from drain port and make sure there is substantial flow through it.

As you repeatedly tighten the gland over long periods of operation, the rings will be compressed in the chamber, lowering the gland into the box. Additional rings are often added as required to compensate but you must never add more than two above the lantern ring since you will block the drain port. After adding any packing, probe the drain port with a wire to see that it has not become plugged.

When you eventually find it necessary to repack the box, you must first remove the remains of the old packing with packing hooks, cleaning the chamber thoroughly. The lantern cage, Item 226, is provided with #10-24 tapped holes in the face so that you can lift it out using appropriate machine screws or similar means. You'll find the gland easy to remove because of its split design. You can secure the lantern ring up out of the way during repacking by tying a couple turns of string around the shart.

At the time of repacking, always check the shaft alignment and surface finish. The finish should be smooth without burrs, grooves, or scratches. Avoid shaft runouts over 0.005 inch. You may use butt or diagonal cut packing, but we recommend the latter. We also recommend you use die cut rings for repacking, of the same size of course as the original. If you cut and fit the rings at the jobsite, be sure to cut them so the ends just meet when formed around the shaft. The ring joints should be located 90° to 180° from the cut in rings immediately above and below.

The packing box described here is a normal design for intermediate pressure service. For higher pressures, we use similar construction except perhaps for more lantern rings, more drain lines, more packing rings, and possibly more throttle sleeves or pressure breakdown bushings. Material of packing may vary with service and pressure and you should check this out before attempting to repack. You must use material for repacking equivalent to that shipped in the original assembly.

b. Tube Tension Assembly

If your pump has been constructed with a shaft enclosing tube, you will find the tubing terminates in a tension nut assembly in the discharge head. See Figure 20. Since this part is assembled at the factory where the proper tension has already been applied to the tube, there is nothing for you to do here except to connect the lubricating system. That will be covered in Section 11.

Meanwhile, if there is ever any reason for you to relieve the tension on the tube, be sure to mark the position of the nut flange with respect to its mounting surface in the head. With this, you can reload the tubing to the same tension when you reassemble.

c. Mechanical Seal

If you ordered your pump with a mechanical seal, it could be furnished in a wide variety of types and sizes, depending on conditions of service. Therefore, we can only give you some general descriptions in this manual, together witn certain procedures common to all seals.

For protection in shipment, your seal is sent to you boxed separately and it will be necessary for you to assemble it in the housing you'll find bolted in place in the discharge head. Please refer to the specific instructions furnished with the shipment before handling the seal or operating the pump. A typical outside seal is shown in Figure 21, while Figure 22 illustrates a typical inside seal. Details of the parts in your pump may vary slightly.

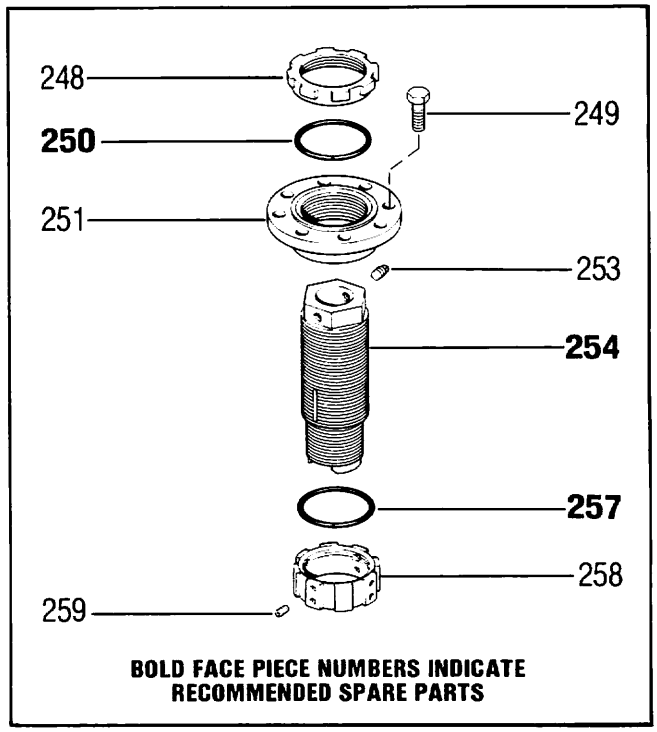



Figure 20. Tension Nut Assembly

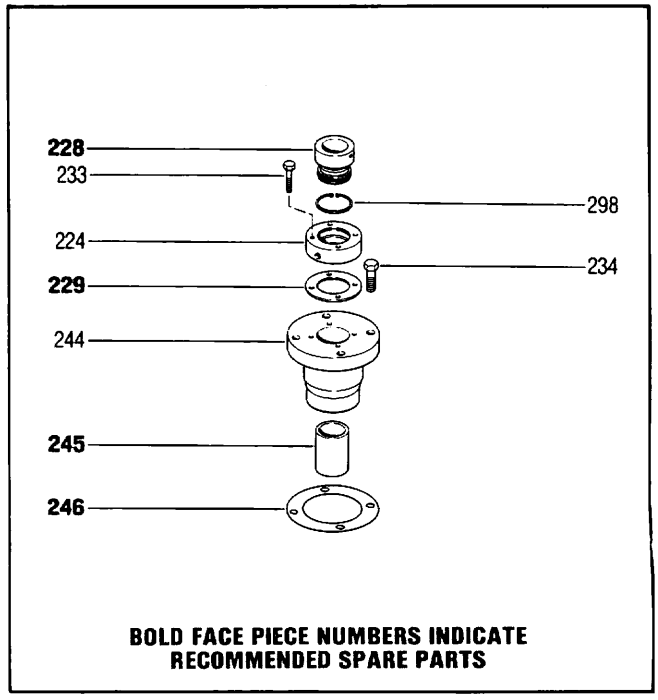



Figure 21. Outside Mechanical Seal

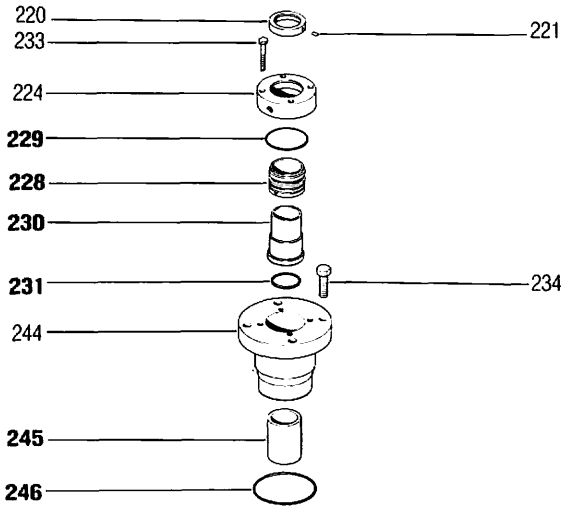



Figure 22. Inside Mechanical Seal

A mechanical seal used in a vertical turbine pump is a face type seal. Regardless of service and rating, it attains its closure between two spring loaded sealing surfaces, one rotating with the shaft and one stationary in the housing. Basic design concepts depend on the presence of a film of liquid on these sealing faces for lubrication, just as is necessary in dealing with plate bearings.

Therefore, before you start up a pump equipped with mechanical seals, you must be sure the seal housing contains liquid so faces won't overheat, wear, or gall. This means you'll have to bleed the air or vapor out of the seal area as well as admit fluid to the pump before startup. In the case of a vessel pump, the suction cavity must be vented of air or vapor and filled with liquid. Starting a seal dry can cause malfunction, even destruction. Liquid supply must be constant to insure complete filling of the critical cavities under all operating conditions. An intermittent flow into the seal area must be avoided, whether resulting from adverse suction conditions, flashing of volatile fluids, or whatever cause.

Your seal assembly, in certain environments, may require external cooling or heating for proper operation. Bypass or recirculating provisions may also be necessary. Where solids in solution may precipitate out, a clean liquid flush will protect the seal. The same thing will assist you in dealing with solids in suspension, through abrasive particles are extremely destructive to almost any arrangement. Under such condition, we must recommend a filter or separator. You must establish and maintain a film of CLEAN liquid between the sealing faces.

You must consider the mechanical seal long before startup. When you check driver rotation, for the pump shaft shouldn't be connected to the driver since the system may be empty of liquid at this time. In addition, you can't adjust the seal until you've adjusted the pump, as discussed in Section 9. This may not take place until immediately before startup. Any time you need to change the pump adjustment, you must first release the seal. After the pump is readjusted, the seal must also be readjusted.

Consideration of the seal must even be carried to conditions that exist when the pump is NOT operating. In some systems, for instance, the pump is subjected at all times to high suction pressure. The shaft then becomes a piston and, with no downward thrust to oppose axial motion, tends to force upward, opening the seal and allowing undesirable leakage. When the pump is started and the hydraulic thrust forces the shaft down again, the seal faces may slam together hard enough to break the liquid film and cause damage. Therefore you can see you will need upthrust protection in such cases and it will be provided at the Aurora factory if the driver is furnished as part of the pump order. If you furnish your own driver, you must make sure this protection is included in the machine you select. Aurora prefers a solid shaft driver for use with mechanical seals. If you use a hollowshaft driver, it must have a centralizing bushing at the bottom of the quill.

We suggest you give a thorough review to any detailed instruction accompanying this shipment, particularly those furnished by the seal manufacturer. We also recommend that pumps equipped with these seals be started or turned over once a day if not in continuous operation.

d. Flanged NonAdjustable Shaft Coupling

In Section 9b, we described for you the installation of a Flanged Adjustable Shaft Coupling to couple a solid shaft driver to the pump shaft. The Flanged Non-Adjustable Shaft Coupling is used almost exclusively to connect a hollowshaft electric motor with a hollow-shaft gear drive in a combination drive assembly.

In such an assembly, the gear is mounted on the pump head and carries a yoke on its top. The electric motor sits atop the yoke and thus we attain a combination electric and internal combustion drive, usually for insurance against loss of operation due to power failure. The Flanged Non-Adjustable Shaft Coupling is loacted in the gear drive yoke and couples the gear drive shaft to the motor drive shaft. See Figure 23.

If your pump is equipped with a combination drive, assemble it complete up to and including the gear drive with its shaft and adjusting nut. The shaft will protrude upward out of the gear drive coupling with threads and a keyway exposed. Clean all the parts and paint the threads with lubricant. If the parts are stainless steel,

use only an approved anti-galling compound. Thread the lower coupling half, Item 16, onto the gear shaft so that the end face of the shaft terminates about one thread below the flange face. Note: that's the flange face, not the register face. Line up the keyways and insert the key, Item 15. If necessary dress the key but not the keyways to a free but not loose fit. Tighten the setscrew, Item 17, securely.

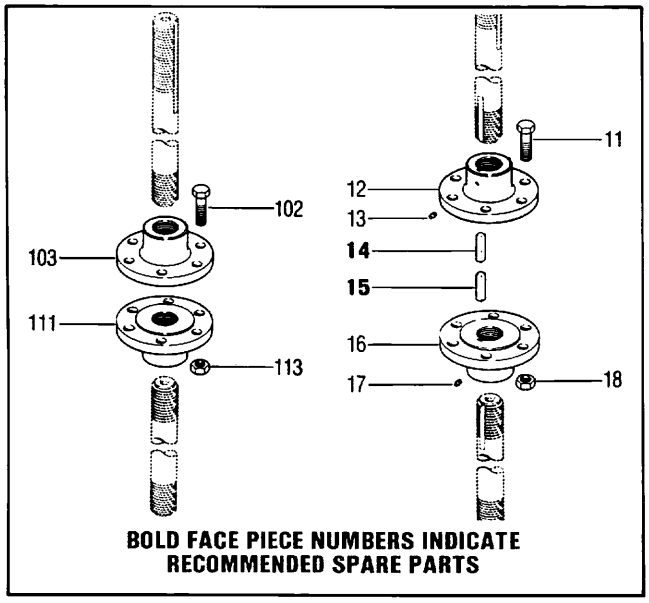



Figure 23. Flanged Non-Adjustable Shaft Coupling

In a similar manner, assemble the upper coupling half, Item 12, to the motor drive shaft, leaving the endface of the shaft about one thread below the flange face as before. Again, assemble the key, Item 14, and the setscrew, Item 13.

Now raise the electric motor and insert the motor shaft into the motor hollowshaft from the bottom with the shaft coupling flange facing down. Thread the adjusting nut on the top of the motor shaft to support the shaft weight while you lower the motor carefully into place atop the gear yoke. Orient the motor properly with respect to the junction box and secure the attaching capscrews.

Insert the bolts, Item 11, through the flanges and run the nuts, Item 18, up by hand until they're snug against the flange, using a light weight machine oil on the bolt threads. After all the nuts are drawn up and you're satisfied the flanges meet evenly, put all the bolts under uniform tension with a torque wrench if you have one.

Assembly of the motor shaft adjusting nut, the adjustment of impellers, and other procedures may now be completed as described in Section 9a.

e. Below Base Suction

Although most pumps are so constructed that the suction inlet elbow is above the mounting surface and is usually an integral part of the driver pedestal, we can design for your specific requirements to locate the suction inlet at a position below the mounting base. This type of construction is illustrated in Figure 24.

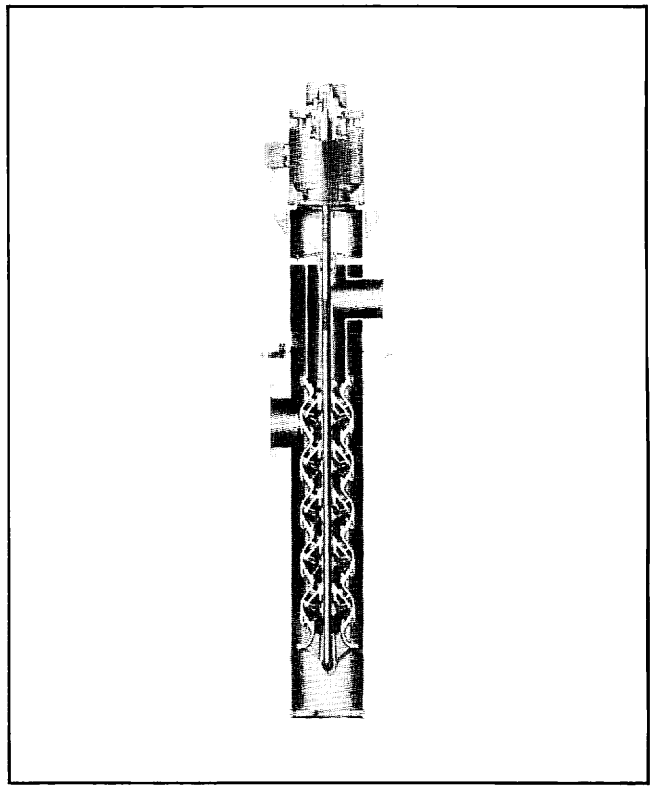


Figure 24. Below Base Suction Assembly

f. Pump Upthrust Provisions

Any close coupled vertical turbine pump may be vulnerable to axial thrust in an upward direction, particularly upon startup. While this force can't be prevented, it can be opposed and nullified. Without going into the several sources of upthrust, we can simply recommend that any pump of short setting should be protected since it has relatively little weight in the rotating elements to hold them down.

As long as upthrust forces are normal, the easiest expedient is to bolt the driver coupling down so the self release feature is eliminated. This is accomplished by inserting the two or three bolts furnished with any hollow shaft driver and securing the coupling We recommend you do this on your unit as part of the procedures outlined in Section 9a.

However, upthrust magnitudes may not always succumb to the above solution, in which case it may be necessary to order your driver with a special thrust bearing oriented to oppose upward loading. This is most often the case in pipeline boosters or similar applications.

If for some reason the load can't be taken in the driver, Aurora is able, in most instances, to furnish an upthrust bearing mounted on the shaft under the driver but external to it. In any case, these forces must be considered in plenty of time to neutralize them before they can damage your pump. The best time is the time of purchase.

## SECTION 11

## LUBRICATING THE PUMP

a. Pumped Liquid

Most close coupled pumps for industrial and commercial applications are designed to be lubricated by the pumped liquid. If your unit is of this type, there is little if anything for you to do since the pump is, in effect, self lubricating. All it requires is an adequate supply of cool, non-aerated liquid, free from suspended solids or gases in solution. All you need do before installation is to make sure the bypass ports in the discharge case are plugged as shown in Figure 25.

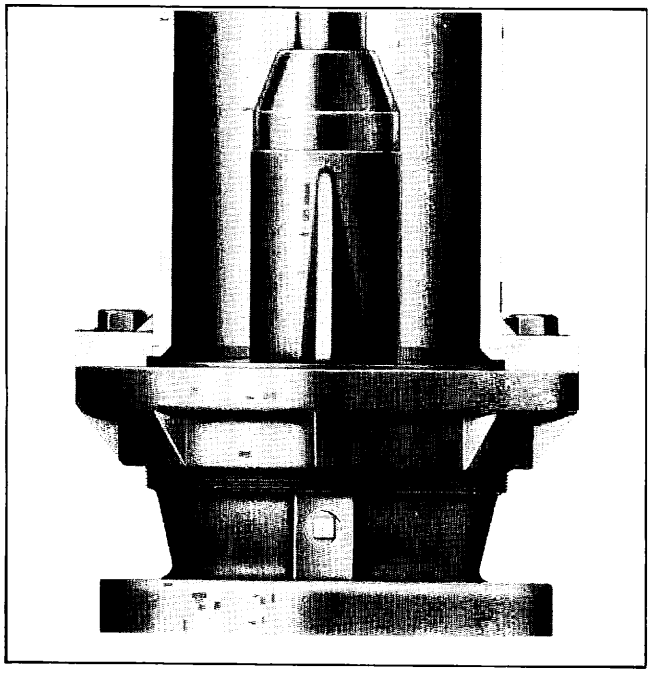


Figure 25. By-Pass Port

If your pump must be idle for any prolonged period, the shaft should be rotated by hand once a week. If you prefer, you can instead spin the shaft under power once a week provided you have adequate liquid over the pump suction.

If the fluid you are to handle is something other than water, or if you expect temperatures to be higher than normal, we will have furnished bearings suited specifically to that kind of service. However, if your pump has been designed for a given application, we can't recommend your switching it to a different environment without first checking with the sales office or your Aurora representative.

b. Gravity Flow Oil

If your pump is of the oil lubricated design, examine the oil reservoir and the oil feed line, making sure they are clean and without obstruction. Figure 25 will show you the parts involved. Attach the reservoir assembly, Item 204, to the driver pedestal by its bracket, using capscrews, Item 218, and placing dampener gasket, Item 219, between bracket and mounting surface. It may be necessary to interchange the sight gauge assembly with the oil line fittings to make the routing to the tube connector in the most convenient way.

If your lubrication system is automatic, you will have a solenoid valve, Item 294, as shown in Figure 26; If system is manual, this part is not needed. Keep the cover assembly on the reservoir at all times to prevent the entrance of foreign material.

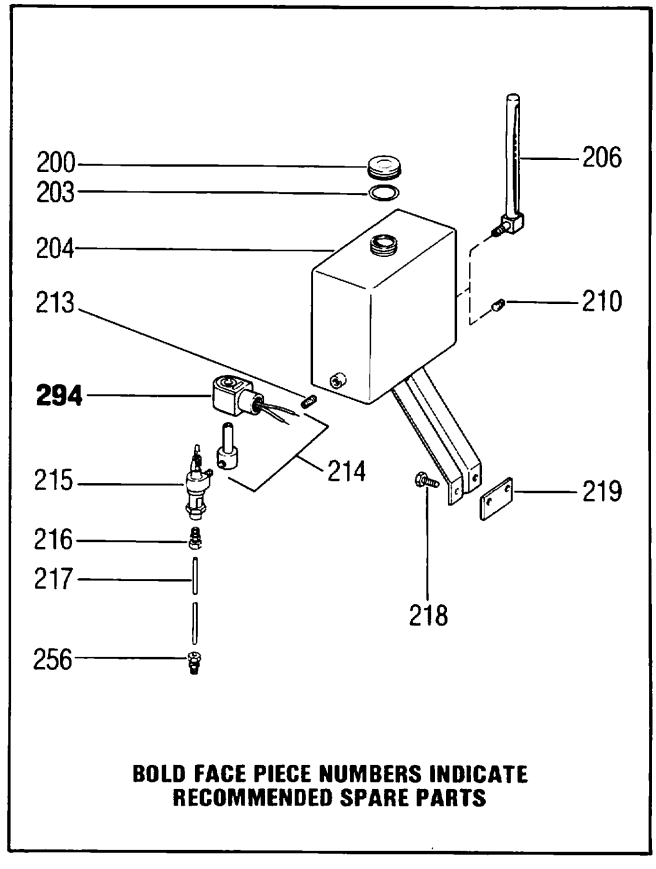



Figure 26. Oil Reservoir Assembly

Connect up the lubrication system as illustrated in Figure 27 using the parts depicted in Figure 26. Adjust lubricator valve, Item 215, to permit oil to drip at the

rate of approximately one drop per-second. With automatic lubricators, complete the electrical connections to the solenoid valve, Item 294, so it can be operated to allow flow of oil to the lubricator valve, Item 215.

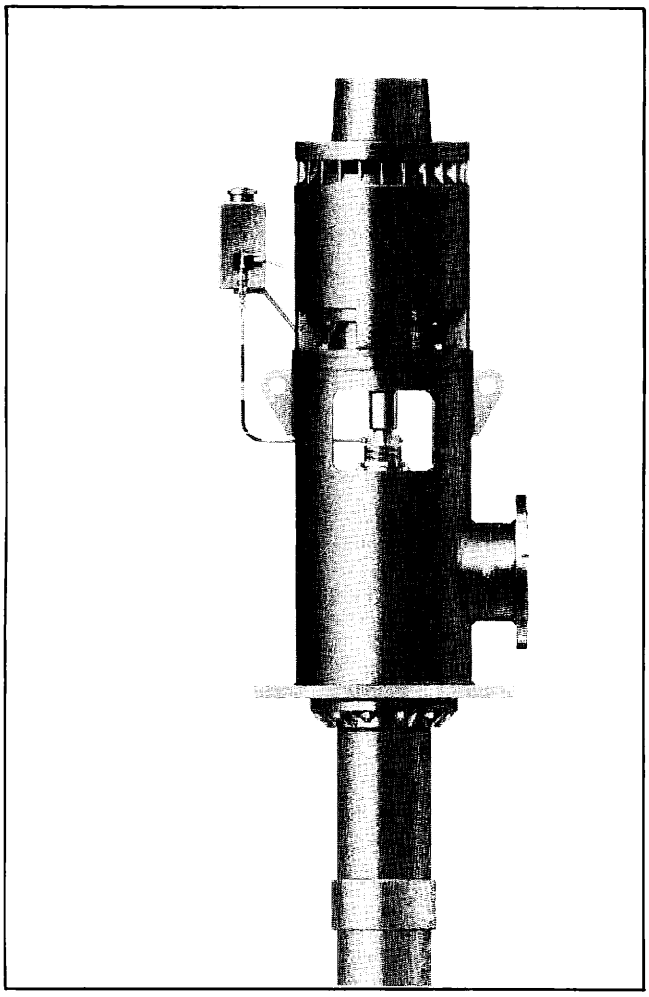


Figure 27. Lubricator Location

If it isn't practical to energize the solenoid at this time, it will be necessary to prelubricate the pump manually. Remove the pipe plug in the top of the tube connector in the head and fill the upper cavity with turbine oil a number of times so that oil will run down into the enclosing tube.

Before first start, verify that the oil reservoir is full and that the lubricant can flow freely into the enclosing tube. Allow the oil to drip for fifteen minutes while checking all related procedures to be sure all is ready for startup. After starting, be sure the oil continues to drip into the pump during operation. You may find it necessary to apply a small amount of oil from a can to the point where the shaft emerges from the tubing in the discharge head. This should only be required during the first few minutes of operation.

After logging about one-half hour running time, adjust the flow on the manual lubricator to about thirty drops per minute and run at this rate for the first ten operating hours. When a solenoid control is not furnished, shut off the manual lubricator during idle periods. After running successfully about ten hours, reduce the oil flow rate to eight drops per minute maximum for permanent operation.

c. External Source Pressure Lubrication

You may have ordered your Aurora Verti-Line pump equipped for connection to an external source of pressurized lubricating liquid. If so, refer to this subsection and Figure 27. In our description here, we'll deal with water as the lubricant, through any suitable lubricating fluid will do so long as it's compatible with your bearing material. Be sure to use the lubricant for which your pump was originally designed.

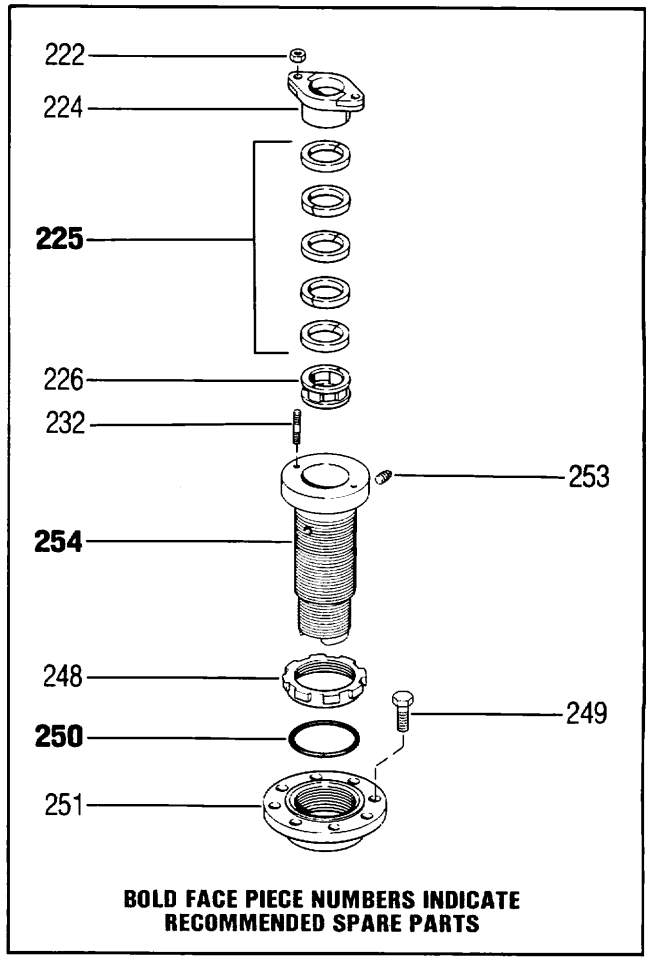



Figure 28. Packed Tube Tension Nut Assembly

This construction usually features a shaft enclosing tube terminating in a tension nut assembly in the discharge head. Like a similar part described in subsection 10b, this assembly is installed at the factory where the proper tension has already been applied to the tube for you. However, as you can see in Figure 27,

the tube connector, Item 254, has a packing chamber at the bottom of which is placed a lantern ring, Item 236, ported to receive the lubricating water and direct it down the tube to the lineshaft bearings. Above the lantern cage are rings of packing, Item 225, in sufficient number to locate the gland, Item 224, properly in the top of the container.

As a tension nut, this assembly is treated the same as we suggested in subsection 10b. If there is ever any reason for you to relieve the tension on the tube, be sure to mark the position of the nut, Item 251, with respect to its mounting surface in the head. With this, you can reload the tubing to the same tension magnitude when you reassemble. As a packing box, the connector will respond to the same general treatment we discussed in subsection 10a.

If your external lubrication system is of the low pressure variety, make sure the bypass ports in the discharge bowl are open before you install the pump. For most applications, you'll need to furnish three to five gallons per minute of lubricating water at 40 to 50 PSIG source pressure to lubricate and cool the lineshaft bearings. This flow is injected into a port on the side of the connector, Item 254. A pressure gauge on your source will only indicate system backpressure so it may not show the forty pound value we've mentioned. We recommend you have this much available should you need it.

If your system is a high pressure design, the bypass ports in the discharge case will be plugged. You should verify this before installation of the pump. In this design, lubricating water must be admitted to the tubing under heads greater than that generated in the bowl assembly. Higher pressures will of course necessitate more frequent maintenance of packing. Do not exceed 125 PSIG injection pressures without first checking with the factory.

In either the low or the high pressure systems, we recommend you incorporate a positive indicating flowmeter and an alarm arrangement to warn of any interruption in flow of lubricating water. If flow stops, the pump must be shut down immediatley until the malfunction is cleared. Otherwise, serious damage will result.

d. Fresh Water Flush

If you're going to pump fluids containing abrasive particles, you'd be well advised to inject clean liquid directly into the journal areas to provide lubrication and cooling as well as to prevent entrance of abrading material into bearing zones. If you ordered your pump equipped for this service, we will have provided means for you to flush bearings continuously with clean or filtered water.

As in subsection 11c, we recommend very strongly you incorporate a positive indicating flowmeter and an alarm arrangement to warn of any interruption in flow anywhere in the lubricating system. If flow to any journal area stops, the pump must be shut down immediately until the malfunction is cleared. Otherwise serious damage may result.

Although this option is referred to as a fresh water flush system, you can use any approved lubricant that is compatible with the pumped liquid and with your bearing material, and so long as flow and pressure conditions permit. In general, for water, you should be prepared to furnish about one gallon per minute for each journal to be served up through one inch shaft diameter; you'll need two GPM for each journal from one through two inch, nearly 5 GPM per journal through three inch. Above these sizes, it's best to consult the factory.

Figures 29 and 30 will give you an idea what to expect in the way of external piping for this system. Figure 29 illustrates the bowl assembly in which the suction case is provided with a port in the bottom of the hub through which flush water may be injected. The bowls themselves may be cast with a port leading from the outside through a flow directing vane into the bearing area. At the discharge case, if you have one, fluid is usually injected into one of the bypass ports. Obviously such bowl assemblies must be ordered in this condition so the necessary porting will be provided. Close coupled pumps are usually shipped with the piping in place as in Figure 30 but occasionally it may be required for you to install at the jobsite. When you handle these units with external piping, take care to avoid damage to pipe or tubing. Pinching or perforating a line could render the lubrication system inoperative.

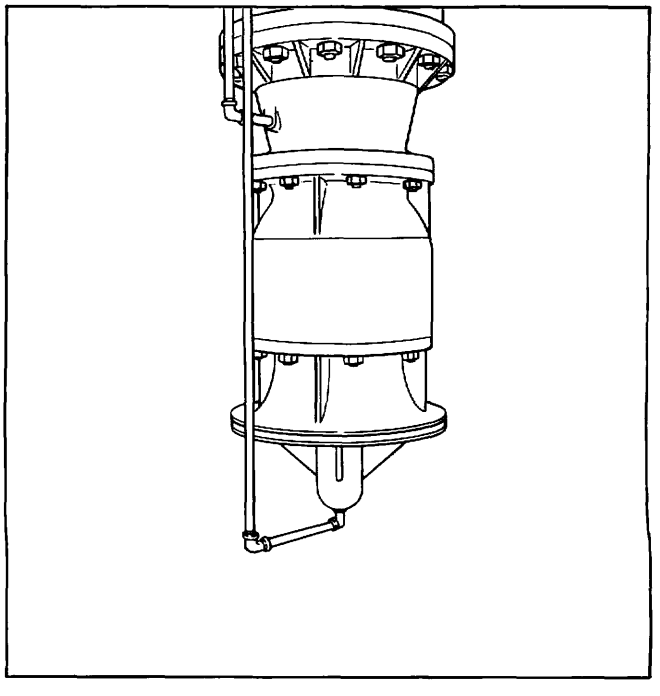


Figure 29. Lubricant Flush Piping

The flushing liquid must be free from abrasives and other foreign particles, must have adequate lubricating properties to do the job, and should be kept below 85° F in temperature. The liquid must be injected at a pressure in excess of that existing across the journal area to which it is ported. This usually means something greater than the total discharge head against the pump.

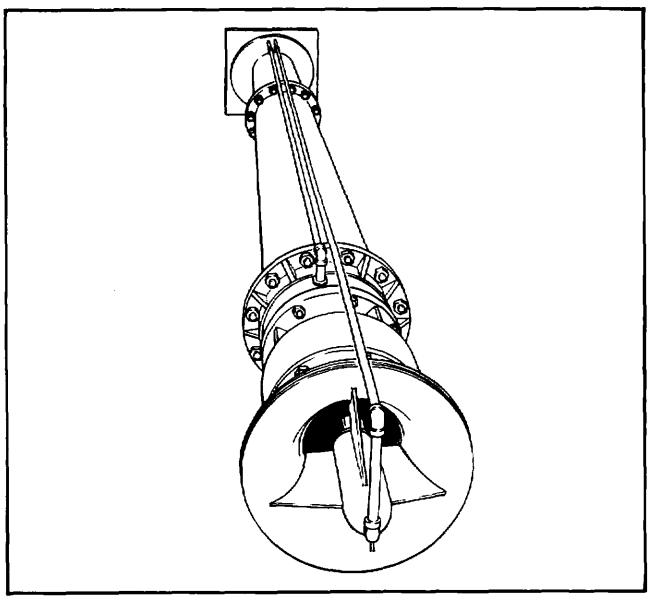


Figure 30. Lubricant Flush Piping

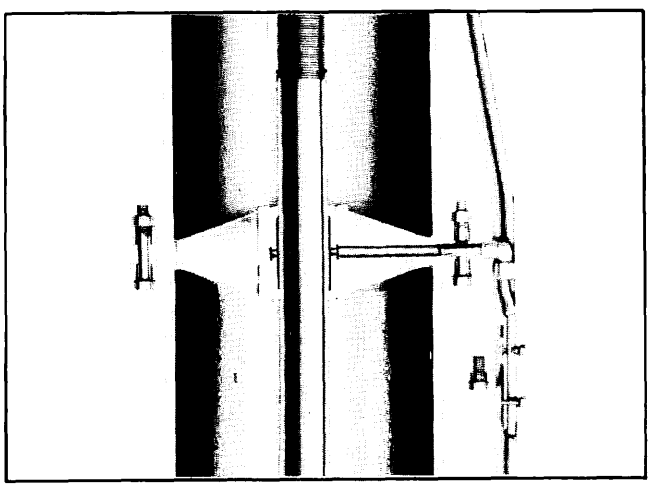


Figure 31. Open Lineshaft Bearing Flush Provision

Open lineshaft bearings, if necessary, may be protected in much the same way as illustrated in Figure 31. Again piping is connected as shown and run to bearing from surface source of supply. Flush water must be injected into bearing at a pressure in excess of that existing in the column pipe at that point.

Flushing at the packing box may be accomplished in a manner as depicted in Figure 32. You can make similar arrangements for mechanical seals, Figure 33. Occasionally, you may want to use a water flush design in connection with tube enclosed construction and you may accomplish this by an extension of the system described in subsection 11c.

If you choose oil as your lubricant, you can reduce the recommended capacities or flow rates slightly. If you use this type of system to feed grease to your bearings, it is only necessary to keep the piping full and under adequate pressure at all times during operation. Here again, an alarm system may save you much trouble.

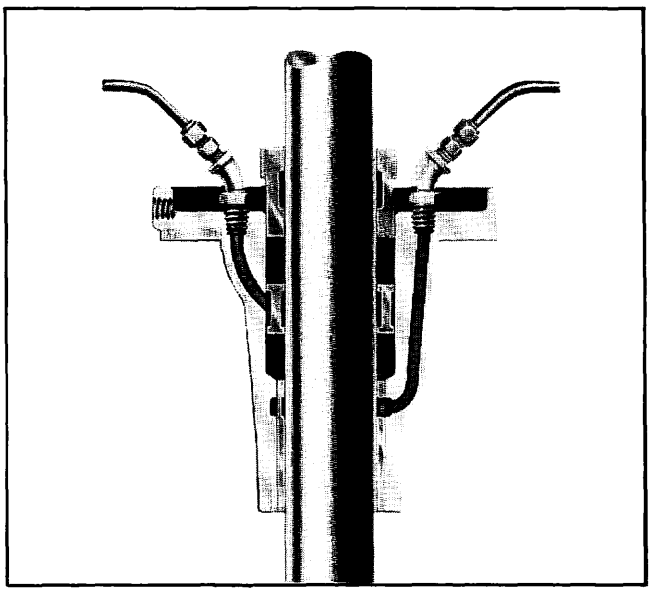


Figure 32. Packing Box Flush Provision

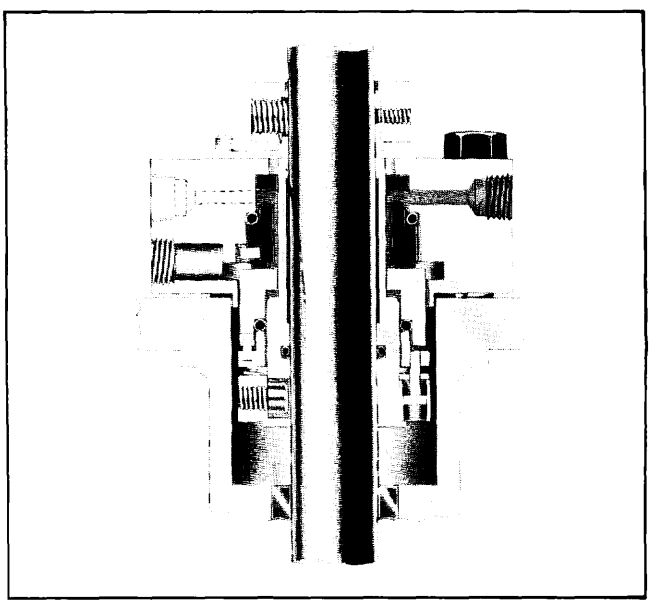


Figure 33. Mechanical Seal Flush Provision

## SECTION 12

## CONNECTING THE PIPING

You will be connecting your Aurora Verti-Line pump to your piping of course, since the pump is there to energize your system. Depending on details of installation, you will certainly be joining at the discharge flange and there may be a connecction at the suction also. Whatever your particular system is, it must be independently supported. It must not be allowed to impose stresses on the discharge head due to weight, thermal expansion, misalignment, or any other condition.

When bolting the system flange to the pump head discharge flange, determine that the flanges fit face to face and hole to hole before inserting bolts. Do not draw the flanges together with the flange bolts.

You may have some small pipes or tubes to accommodate if you are supplying coolant to the driver, for example. In such cases, it is well to protect the small lines from vibration by using a hose connection in strategic locations.

## SECTION 13

## STARTING THE PUMP

Before starting a new pump for the first time, you must establish the status of the following items:

* Driver lubrication levels must be adequate.

* Driver cooling system, if used, must be operative.

* Driver wiring has been carefully checked.

* Driver connection to power source is complete and adequately guarded.

* Pump lubrication system is operative with adequate levels.

* Pump has been through a proper prelubrication cycle as, previously described.

* All accessible connection are tight.

* Pump is properly adjusted.

* Pump rotation is counterclockwise when viewed from top.

* System is in condition to deliver and accept full flow.

* All covers and guards are in place.

* All personnel are clear of equipment.

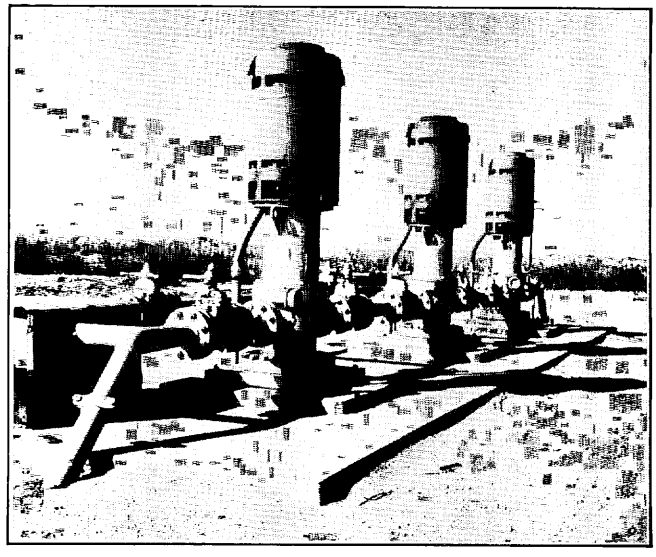
When all these conditions are satisfied, start the pump and observe the operation closely. If there is excessive vibration, unusual or excessive noise, or if the driver draws noticeably more power than expected, stop the pump. Research the cause and correct the problem before attempting a restart.

With an open lineshaft pump, observe the packing box. The gland should be adjusted to allow a very slight leakage at the top of cooling purposes. The drain line should show a positive flow from the lantern ring. Neither shaft nor box should exhibit excess heat. The packing will normally require a run in period for standard packing as we described earlier. Under normal operation, it is not necessary to use the grease fitting on the top of the box at all.

If your pump is tube enclosed and leaks at the tension nut, check the locknut and packing ring at the top. If this isn't the cause, it may be necessary to apply more tension on the tube. Stop the pump and move the tension nut flange around to the next capscrew hole, working through the access openings in the discharge head.

If your pump has been repaired or if it has been shut down for several days or more, follow the same procedures for restarting as above. Refer to our Recommendations for Storage located on the inside front cover of this publication.

If you have any questions, Aurora Pump will be glad to help you. We wish you the best of service from your pumping equipment.



## SECTION 14

## PRECAUTIONARY INFORMATION

a. Responsibilities

There are certain areas in which Aurora Pump has no control and can therefore accept no liability. For instance, unless supervised by an Aurora Pump service engineer, responsibility for installation, start-up and maintenance rightfully belongs to the Owner and his authorized agents. Similarly, the following shall be the Owner's obligation and responsibility:

Suitability of foundation or mounting structure

Suitability of power characteristics

Security and safety of jobsite and site conditions

Placement and maintenance of all appropriate guards and safety devices

Suitability and performance of system to which pump is applied

Aurora Pump cannot be responsible for damages, lost time, or injury resulting from failure to comply with these instructions. Aurora Pump's obligations do not cover damage to the pump due to abrasives, gas, or corrosives in the water. They do not cover harm due to starting pump in a reverse rotation mode; neither do they cover performance when parts not furnished by Aurora are used in the pump.

If you have any question, please call your Aurora representative.

b. General Cautionary Notes

Your Aurora Verti-Line pump is an engineered assembly of precision parts and must be treated accordingly even though sometimes the components are heavy and awkward to manipulate. Also, because they may be heavy, they must never be handled carelessly. Normal rules of safety and approved methods of practice as associated with the erection of heavy equipment must be observed in any activity related to your pump.

In addition to general acceptable industrial practice, we emphasize the following twenty precautions:

Don't work on pumps, wiring, or any pump or system components without opening energizing circuits such as at main breaker or pump disconnect switch. This will prevent damage or injury due to "surprise" starts actuated by automatic control systems. It will also help prevent other possibilities of injury.

Don't work under a suspended load. Rest the load on positive supports when it's necessary to be underneath.

Don't run a spherical roller thrust bearing except under full thrust load. It can fly apart and cause damage to equipment and injury to personnel.

Don't forget that this equipment contains rotating parts. Use CAUTION when working near such parts to avoid injury. Always replace all guards, covers, shields, and other safety devices before startup.

Don't permit smoking in the vicinity of petroleum base solvents. Store solvents in approved containers.

Don't use lubricants that can contaminate your system and cause damage or injury.

Don't start pump while it is still rotating in reverse direction after having shut down. It is advisable to install a time delay relay on electric drives to prevent this. Non-reverse protection in the driver could also be a solution.

Don't put heavier than recommended heaters in your starter if the pump load begins to trip those furnished originally. These are protective devices. Call your Aurora representative for assistance.

Don't add oil to driver while running; check levels only when idle. Don't add grease to grease lubricated driver without removing the relief plug.

Don't drop parts into pump during installation or disassembly. Don't drop parts into driver when canopy is off and top is open. Parts must be recovered immediately.

Don't run pump backward. Clockwise operation (looking down at top of pump) under power can unscrew threaded shaft joints. Power requirements of some designs increase when driven backward and can thus create undesirable overloads. In certain areas of the country prone to phase reversal problems, consider phase protection in your power circuit. Note: these problems do not apply to pumps coasting backward due to return flow from system; overspeed is the circumstance to question then.

Don't allow oil, grease, or thread lubricant to contact rubber bearings or tube stabilizers.

Don't pump anything but water unless your pump has been designed for it

Don't start the pump without proper adjustment.

Don't start a pump in which the shaft appears frozen or locked up. Free the shaft and rotate by hand first.

Don't pull system piping to pump flanges with bolts or capscrews. Install pipelines so that fasteners are used to prevent leakage only.

Don't hang the weight of suction or discharge lines and fittings on pump. Support pipe runs with blocking or concrete saddles according to best piping practice. Use dresser type couplings with thrust ties if necessary whenever possible to eliminate piping strains imposed on pump.

Don't throttle or obstruct the suction of any pump.

Don't tighten shaft packing except in increments. For example, take gland nuts up part of a turn and let pump run five or ten minutes before tightening further. If leakage water is too hot to put on your hand, back gland nuts off a little until water cools, then tighten again. Gland nuts must be adjusted evenly so as to prevent gland from cocking and forcing against shaft.

Don't change pump speed without first checking effect on power, internal pressure, and other conditions. Don't forget that your pump is guaranteed for design conditions only as purchased.

And let us add one more DON'T for the benefit of your pump and your peace of mind:

Don't hesitate to call your Aurora representative or the Aurora factory when you need help or have a question.

c. Operation at Shutoff Head

In the usual application of Aurora Verti-Line vertical turbine pumps, no harm will result from operation at conditions of static flow heads. However, not all installations are "usual" and for this reason consideration should be given to any unit which may be subjected to this usage. The following points should therefore be checked and resolved before putting the equipment into operation at or near shutoff heads.

Thrust bearing must be adequate.

Impeller adjustment must allow for much greater thrust load.

If prolonged operation at no flow is contemplated, the problem of heat dissipation may become acute since most of the shutoff horsepower is converted to heat in the available liquid. This can be reduced with an adequate recirculation system.

For high pressure units, stresses at shutoff heads should be investigated. This information may be obtained from your Aurora representative upon request.

Certain impeller designs have critical horsepower characteristics at low flow rates. Shutoff horsepower requirements should be reviewed for possible driver overload.

It must be remembered that open lineshaft units depend upon pumped liquid for lubrication. Fluid temperatures, if raised excessively due to lack of flow, may impair lubrication efficiency even to the point of destroying the pump.

To summarize, normal designs will easily accommodate most of the considerations listed above. However, to obtain the best possible application, you must notify the factory at the time of purchase if operation at static flow heads will be a possibility. This precaution must be observed to validate any warranty.

d. Maintenance Hints

For pump oil lubrication, use a light turbine oil equivalent to Standard Oil O. C. Turbine Oil #32 or a good grade of mineral oil with proper additives having a viscosity equal to SAE #10. Always be sure your lubrication system has plenty of oil and is operating any time the pump is running.

Remove the old oil from your driver at least once a year or according to the driver manufacturer's instructions. Flush with kerosene and refill. Follow manufacturer's directions carefully as to method and type of lubricant. Replace self lubricated driver ball bearings in about five years. It is generally less expensive to replace these before they fail.

Replace all shaft packing on open lineshaft pumps after maintenance has required the addition of no more than two rings. Always let packing box leak slightly at top of gland to protect the shaft and add life to your packing.

Be aware of changing conditions in your system. Any change from the original condition or any variation in the system can create an undesirable reaction in the pump as the energizer of the system. If your system head has increased, for example, check your performance curve, your thrust bearing capacity, and other details for the new conditions.

We recommend you consult your Aurora representative before attempting to remove or repair your pump. If it becomes necessary to work on your equipment, be sure to review all instructions for operation and maintenance. You may want to consider contracting for the services of a trained Aurora service engineer to guide you.

# NOTES

# TERMS AND CONDITIONS OF SALE

**NOT INTENDED FOR SALE OR USE FOR PERSONAL, FAMILY, OR HOUSEHOLD PURPOSES.** 1-79 *Printed in U.S.A.*

All orders shall be made out to Aurora Pump at North Aurora, Illinois, and shall be subject to acceptance by us at North Aurora.

**1. CONSTRUCTION AND LEGAL EFFECT.** Our sale to you will be solely upon the terms and conditions set forth herein. They supersede and reject any conflicting terms and conditions of yours, any statement in yours to the contrary notwithstanding. Exceptions to any of our terms and conditions must be contained in a written or typed (not printed) statement received from you; we shall not be deemed to have waived any of our terms and conditions or to have assented to any modification or alteration of such terms and conditions unless such waiver or assent is in writing and signed by an authorized officer. No representation of any kind has been made by us except as set forth herein; this agreement conclusively supersedes all prior writings and negotiations with respect thereto and we will furnish only the quantities and items specifically listed on the face hereof; we assume no responsibility for furnishing other equipment or material shown in any plans and/or specifications for a project to which the goods ordered herein pertain. Any action for breach of contract must be commenced within one year after the cause of action has accrued. Our published or quoted prices, discounts, terms and conditions are subject to change without notice.

**2. PRICES.** Unless otherwise noted on the face hereof, prices are net F.O.B. our producing factory, and include standard catalogue literature only. Service time of a factory-trained service man is not included and may be charged extra. The amount of any applicable present or future tax or other government charge upon the production, sale, shipment or use of goods ordered or sold will be added to billing unless you provide us with an appropriate exemption certificate. We may adjust prices to our prices in effect at time of shipment. Purchased equipment such as motors, controls, gasoline engines, etc., will be invoiced at prices in effect at time of shipment in accordance with pricing policy of manufacturer.

**3. DEFECTIVE EQUIPMENT.** Providing Purchaser notifies us promptly, if within one year from date of shipment equipment or parts manufactured by us fail to function properly under normal, proper and rated use and service because of defects in material or workmanship demonstrated to our satisfaction to have existed at the time of delivery, the Company reserving the right to either inspect them in your hands or request their return to us will at our option repair or replace at our expense F.O.B. our producing factory, or give you proper credit for such equipment or parts determined by us to be defective, if returned transportation prepaid by Purchaser. The foregoing shall not apply to equipment that shall have been altered or repaired after shipment to you by anyone except our authorized employees, and the Company will not be liable in any event for alterations or repair except those made with its written consent. Purchaser shall be solely responsible for determining suitability for use and the Company shall in no event be liable in this respect. The equipment or parts manufactured by others but furnished by us will be repaired or replaced only to the extent of the original manufacturer's guarantee. Our obligations and liabilities hereunder shall not be enforceable until such equipment has been fully paid for. Purchaser agrees that if the products sold hereunder are resold by purchaser, he will include in the contract for resale, provisions which limit recoveries against us in accordance with this section. In case of our failure to fulfill any performance representation, it is agreed that we may at our option remove and reclaim the equipment covered by this agreement at our own expense and discharge all liability by repayment to the purchaser of all sums received on account of the purchase price. (THE FOREGOING OBLIGATIONS ARE IN LIEU OF ALL OTHER OBLIGATIONS AND LIABILITIES INCLUDING NEGLIGENCE AND ALL WARRANTIES, OF MERCHANTABILITY OR OTHERWISE, EXPRESS OR IMPLIED BY FACT OR BY LAW, AND STATE OUR ENTIRE AND EXCLUSIVE LIABILITY AND BUYER'S EXCLUSIVE REMEDY FOR ANY CLAIM OF DAMAGES IN CONNECTION WITH THE SALE OR FURNISHING OF GOODS OR PARTS, THEIR DESIGN, SUITABILITY FOR USE, INSTALLATION OR OPERATION.) WE WILL IN NO EVENT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL OR CONSEQUENTIAL DAMAGES OR DELAY RESULTING FROM ANY DEFECT WHATSOEVER, AND OUR LIABILITY UNDER NO CIRCUMSTANCES WILL EXCEED THE CONTRACT PRICE FOR THE GOODS FOR WHICH LIABILITY IS CLAIMED.

**4. DELIVERY.** Delivery, shipment and installation dates are estimated dates only, and unless otherwise specified, are figured from date of receipt of complete technical data and approved drawings as such may be necessary. In estimating such dates, no allowance has been made, nor shall we be liable directly or indirectly for, delays of carriers or delays from labor difficulties, shortages, strikes or stoppages of any sort, fires, accidents, failure or delay in obtaining materials or manufacturing facilities, acts of government affecting us directly or indirectly, bad weather, or any causes beyond our control or causes designated Acts of God or force majeure by any court of law, and the estimated delivery date shall be extended accordingly. We will not be liable for any damages or penalties whatsoever, whether direct, indirect, special or consequential, resulting from our failure to perform or delay in performing unless otherwise agreed in writing by an authorized officer.

**5. OPERATING CONDITIONS AND ACCEPTANCE.** Recommendations and quotations are made upon the basis of operating conditions specified by the Purchaser. If actual conditions are different than those specified and performance of the equipment is adversely affected thereby, Purchaser will be responsible for the cost of all changes in the equipment required to accommodate such conditions, and we reserve the right to cancel this order and Purchaser shall reimburse us for all costs and expenses incurred in, and reasonable profit for, performance hereunder. We reserve the right to refuse any order based upon a quotation containing an error. The provisions in any specification or chart are descriptive only and are not warranties or representations; we will certify to a rated capacity in any particular product upon request. Capacity, head and efficiency certifications are based on shop tests and when handling clear, fresh water at a temperature of not over 85°F. Certifications are at this specified rating only and do not cover sustained performance over any period of time nor under conditions varying from these .

**6. SHIPPING.** Unless you specify otherwise in writing, (a) goods will be boxed or crated as we may deem proper for protection against normal handling, and extra charge will be made for preservation, waterproofing, export boxing and similar added protection of goods; (b) routing and manner of shipment will be at our discretion, and may be insured at your expense, value to be stated at order price. On all shipments F.O.B. our producing factory, delivery of goods to the initial carrier will constitute delivery to you and all goods will be shipped at your risk. A claim for loss or damage in transit must be entered with the carrier and prosecuted by you. Acceptance of material from a common carrier constitutes a waiver of any claims against us for delay or damage or loss.

**7. PATENT INFRINGEMENT.** We will not be liable for any claim of infringement unless due to infringement by goods manufactured by us in the form in which we supply such goods to you and without regard to their use by you. If you notify us promptly of any such claim of infringement and, if we so request, authorize us to defend or settle any suit or controversy involving such claim, we will indemnify you against the reasonable expenses of any such suit and will satisfy any judgment or settlement in which we acquiesce, but only to an amount not exceeding the price paid to us for the allegedly infringing goods. If an injunction is issued against the further use of allegedly infringing goods we shall have the option of procuring for you the right to use the goods, or replacing them with non-infringing goods, or modifying them so that they become non-infringing, or of removing them and refunding the purchase price. The foregoing expresses our entire and exclusive warranty and liability as to patents, and we will not be liable for any damages whatsoever, suffered by reason of any infringement claimed, except as provided herein. You will hold us harmless and indemnified against any and all claims, demands, liabilities, damages, costs and expenses resulting from or connected with any claim of patent infringement arising out of the manufacture by us of goods in accordance with a design or specifications which you furnish us.

**8. CANCELLATION AND RETURNED EQUIPMENT.** Orders may be cancelled only with our written consent and upon payment of reasonable and proper cancellation charges. Goods may be returned only when specifically authorized and you will be charged for placing returned goods in saleable condition, any sales expenses then incurred by us, plus a restocking charge and any outgoing and incoming transportation costs which we pay.

**9. CREDIT AND PAYMENT.** Payment for products shall be 30 days net. Pro-rata payments shall become due with partial shipments. A late charge of 1½ percent per month or the maximum permitted by law, whichever is less, will be imposed on all pastdue invoices. We reserve the right at any time to alter, suspend, credit, or to change credit terms provided herein, when in its sole opinion your financial condition so warrants. In such a case, in addition to any other remedies herein or by law provided, cash payment or satisfactory security from you may be required by us before shipment; or, the due date of payment by you under this contract may be accelerated by us. Failure to pay invoices at maturity date at our election makes all subsequent invoices immediately due and payable irrespective of terms, and we may withhold all subsequent deliveries until the full account is settled, and we may terminate this agreement. Acceptance by us of less than full payment shall not be a waiver of any of our rights. You represent by sending each purchase order to us that you are not insolvent as that term is defined in applicable state or federal statutes. In the event you become insolvent before delivery of any products purchased hereunder, you will notify us in writing. A failure to notify us of insolvency at the time of delivery shall be construed as a reaffirmation of your solvency at that time. Irrespective of whether the products purchased hereunder are delivered directly to you, or to a customer of yours, and irrespective of the size of the shipment, we shall have the right to stop delivery of the goods by a bailee if you become insolvent, repudiate, or fail to make a payment due before delivery, or if for any other reason we have a right to withhold or reclaim goods under the applicable state and federal statutes. Where you are responsible for any delay in shipment the date of completion of goods may be treated by us as the date of shipment for purposes of payment. Completed goods shall be held at your cost and risk and we shall have the right to bill you for reasonable storage and insurance expenses.

**10. SPECIAL JIGS, FIXTURES AND PATTERNS.** Any jigs, fixtures, patterns and like items which may be included in an order will remain our property without credit to you. We will assume the maintenance and replacement expenses of such items, but shall have the right to discard and scrap them after they have been inactive for one year without credit to you.

**11. INSPECTION.** Inspection of goods in our plant by you or your representative will be permitted insofar as this does not unduly interfere with our production workflow, provided that complete details of the inspection you desire are submitted to us in writing in advance.

**12. RECORDS, AUDITS AND PROPRIETARY DATA.** Unless otherwise specifically agreed in writing signed by an authorized officer, neither you nor any representative of yours, nor any other person, shall have any right to examine or audit our cost accounts, books or records of any kind or on any matter, or be entitled to, or have control over, any engineering or production prints, drawings or technical data which we, in our sole discretion, may consider in whole or in part proprietary to ourselves.



AURORA PUMP
A UNIT OF GENERAL SIGNAL
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