INSTALLATION, OPERATION AND MAINTENANCE INSTRUCTIONS AND PARTS LISTS FOR VERTICAL TURBINE PUMPS

CUSTOMER: _______________________________________________________
PUMP SERIAL NUMBER: _____________________________________________
DATE SHIPPED: ___________________________________________________

DELIVERING VERTICAL TURBINE PUMP RELIABILITY, QUALITY AND SERVICE SINCE 1969.
Subject to the terms and conditions set forth below, NATIONAL PUMP COMPANY (“National”) warrants that its manufactured equipment is free from defects in workmanship and materials USING ITS SPECIFICATIONS AS A STANDARD. This warranty does not extend to anyone except the first purchaser to whom the goods are shipped from National.

National’s obligation under this warranty is expressly limited to replacing or repairing, free of charge, F.O.B. point of manufacture, any defective part or parts of its manufactured equipment; however, NATIONAL SHALL HAVE NO SUCH LIABILITY EXCEPT WHERE IT IS SHOWN TO THE SATISFACTION OF NATIONAL THAT THE DAMAGE OR CLAIM RESULTED FROM BREACH OF THIS WARRANTY. All parts claimed defective must be delivered to National at its factory or any factory branch, freight or express thereon PREPAID.

Every claim under this warranty SHALL BE DEEMED WAIVED UNLESS MADE IN WRITING AND RECEIVED BY NATIONAL WITHIN THIRTY (30) DAYS OF THE DATE THE DEFECT WAS DISCOVERED OR SHALL HAVE BEEN DISCOVERED, and within one year of the date of installation. The installation date must be within six months of the date the pump was purchased from National.

This Warranty does not cover those parts of the manufactured equipment which are not manufactured by National except to extend to the purchaser the same warranty, if any, which is given to National by the manufacturers of said parts.

National makes no other representation of warranty of any kind, express or implied, in fact or in law, including without limitation, the warranty of merchantability or the warranty of fitness for a particular purchase, other than the limited warranty set forth herein. In no event shall National be liable for any consequential or incidental damages resulting directly or indirectly from the use or loss of use of the manufactured equipment. National shall not be liable for any alleged negligence, breach of warranty, strict liability, or any other theory other than the limited liability set forth herein.

THIS WARRANTY CONTAINS THE ENTIRE WARRANTY RELATING TO THE MANUFACTURED GOODS OF NATIONAL, AND NO CONDUCT, ORAL STATEMENTS OR REPRESENTATIONS NOT CONTAINED IN THIS WARRANTY SHALL HAVE ANY FORCE OR EFFECT OR BE DEEMED A WAIVER THEREOF, THIS WARRANTY SHALL NOT BE MODIFIED IN ANY WAY EXCEPT IF IN WRITING AND SIGNED BY AN AUTHORIZED REPRESENTATIVE OF NATIONAL.

This Warranty, and any liability of National hereunder, shall be governed by, construed, and enforced in accordance with the laws of the State of Ohio.
1. **GENERAL.** These Terms, together with any quotation, proposal, acknowledgement or invoice from Seller, constitute the complete and exclusive statement of the terms of the agreement governing the sale of Goods by Seller to Buyer, unless otherwise agreed by Seller in writing. These Terms supersede all other communications, negotiations, and all prior oral or written statements, regarding the subject matter hereof.

If an order for Goods (“Order”) is deemed to be an offer by Buyer, then Seller’s acceptance of such offer is expressly conditioned on Buyer’s assent to the Terms. Any additional, different or conflicting terms proposed by Buyer in any Order, acceptance, confirmation, specifications or otherwise are hereby rejected and objected to by Seller and will not be binding in any way on Seller. Seller reserves the right in its sole discretion to refuse Orders.

2. **WARRANTY; LIMITATION OF REMEDY.** Seller warrants that its manufactured Goods are free from defects in workmanship and meet Seller’s specifications at the time of shipment (under the conditions of proper storage, installation by a licensed well-driller or contractor, normal use, and regular service and maintenance) for a period of 12 months from the date of shipment of the goods by Seller or 18 months from the date of manufacture of the goods by Seller, whichever occurs sooner. All claims under this warranty with respect to any Goods must be made in writing and delivered to Seller within 30 days after the defect is discovered (or should have been discovered).

Seller’s obligation under this warranty is expressly limited to replacing or repairing, free of charge, F.O.B. point of manufacture, any defective part of its manufactured Goods; however, Seller shall have no liability except where it is shown to the satisfaction of Seller that the defect resulted from breach of this warranty. All parts claimed defective must be delivered to Seller, freight or express prepaid, unless otherwise agreed by Seller in writing.

Seller’s warranty does not cover those parts of its manufactured Goods that are not manufactured by Seller except to the extent that the seller of such parts extended its warranty to Seller as the purchaser of such parts.

**SELLER MAKES NO OTHER REPRESENTATION OR WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, IN FACT OR IN LAW, INCLUDING WITHOUT LIMITATION, ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR ANY OTHER WARRANTY OF NOT THE PURPOSE OR USE HAS BEEN DISCLAIMED TO SELLER IN SPECIFICATIONS, DRAWINGS OR OTHERWISE, AND WHETHER OR NOT SELLER’S PRODUCTS ARE SPECIFICALLY DESIGNED AND/OR MANUFACTURED BY SELLER FOR BUYER’S PURPOSE OR USE.**

**IT IS EXPRESSLY AGREED THAT THE ABOVE STATES BUYER’S EXCLUSIVE REMEDY FOR ANY BREACH OF WARRANTY AND FOR ANY CLAIM FOR PERSONAL INJURY, PROPERTY DAMAGE OR COMMERCIAL LOSS, WHETHER SOUNDING IN CONTRACT, TORT, STRICT LIABILITY OR NEGLIGENCE BASED ON ANY DEFECT IN SUCH GOODS.**

3. **LIMITATION OF LIABILITY.** NO EVENT SHALL SELLER BE LIABLE, WHETHER BY WAY OF INDEMNITY OR BREACH OF CONTRACT OR STATUTORY OR MORAL OR REASON OF TORT, FOR ANY LIQUIDATED, DIRECT, INDIRECT, SPECIAL, CONSEQUENTIAL, INCIDENTAL, PUNITIVE OR EXEMPLARY DAMAGES OR LOSS OF PROFIT, SAVINGS, REVENUE, INCOME, BUSINESS, PRODUCTION, OPPORTUNITY OR REPUTATION ARISING OUT OF OR RELATING TO THE ORDER OR THE GOODS WHETHER FORESEEABLE OR UNFORESEEABLE OR KNOWN OR UNKNOWN. The foregoing limitation of liability shall be effective without regard to Seller’s acts or omissions or negligence or strict liability in performance or non-performance hereunder.

Except as otherwise provided by law, in no event shall Seller’s liability under any Order or these Terms exceed the amount paid by Buyer under such related Order.

4. **DELIVERY; LIMITATION AND REMEDY.** Unless otherwise specified on any Order or as agreed by Seller in writing, all shipments are F.O.B. Seller’s plant and all risk of loss with respect to any Goods shipped shall pass to Buyer when such Goods are delivered to the carrier at Seller’s plant. Shipping dates are approximate and are based upon the prompt receipt of all necessary information. Seller shall not be liable for damages or delays in delivery or failure to manufacture or deliver due, directly or indirectly, to (a) causes beyond its reasonable control; (b) acts of God, acts of Buyer, acts of any civil or military authority, fires, labor disputes, earthquakes, floods or other weather conditions, accidents, epidemics, wars, riots or other civil disturbances, or delays in transshipment; or (c) delays or defaults by Seller’s suppliers or subcontractors or other inability to obtain necessary labor, fuel, materials, components or manufacturing facilities. In the event of any such delay, the date of delivery shall be extended for a period equal to the time lost by reason of the delay.

Delivery dates cannot be altered by Buyer without Seller’s written consent. Any extension of the delivery date by Buyer will be subject to storage charges as determined by Seller, interest charges as set forth below, and any applicable price increases.

Goods produced by Seller in compliance with the Order requirements which cannot be shipped solely due to missing information from Buyer, including but not limited to carrier arrangements, will be charged an additional 10% of the Order value within 5 business days after Seller notifies Buyer of same.

5. **PRICE AND PAYMENT.** The price of Goods sold shall be Seller’s price in effect for such Goods on the date of shipment of such Goods. Unless otherwise agreed by Seller in writing, prices quoted do not include freight, Insurance, installation costs, special packaging or any sales, use, excise, VAT or similar taxes. Taxes imposed by any federal, state, county, city or municipal law on the Goods will be added to the invoice unless a fully completed and executed tax exemption certificate is received by Seller with the Order. Unless otherwise agreed by Seller in writing, payment terms are net thirty (30) days from the date of Seller’s invoice in U.S. dollars.

**BUYER SHALL PAY A LATE CHARGE OF ONE AND ONE-HALF PERCENT (1.5%) PER MONTH ON ALL AMOUNTS NOT PAID WHEN DUE.** Buyer waives its right to set-off against claims it may have against Seller and acknowledges that it may not suspend its payment obligations to Seller.

Seller reserves the right to withhold shipment or to require other adequate assurances of performance of Buyer’s payment obligations as Seller in its discretion may require, notwithstanding any Order confirmation issued by Seller. Buyer shall be liable for all expenses, including attorneys’ fees, relating to the collection of past due amounts.

6. **SECURITY INTEREST.** Buyer hereby grants Seller a security interest in and a lien upon all Goods sold to Buyer by Seller and the proceeds therefor (including any insurance proceeds), which security interest shall continue until all such Goods are fully paid for in immediately available funds. Buyer, upon Seller’s demand, will execute and deliver to Seller such instruments as Seller shall require to protect and perfect such security interest. Buyer shall have no right to sell, encumber or dispose of the Goods until Seller receives full payment for such Goods.

7. **CANCELLATION; RETURN OF GOODS.** Buyer may not cancel any Order except upon reasonable advance written notice and upon payment to Seller of Seller’s cancellation fee, which shall include all costs and expenses incurred by Seller prior to the receipt of the cancellation notice including, but not limited to, all commitments to its suppliers and subcontractors, all fully burdened labor and overhead expended by Seller, and a reasonable profit charge. Such cancellation fee could equal the quoted total price of the Order. Seller’s determination of such cancellation fee shall be conclusive. Return of Goods shall be in accordance with Seller’s most current return authorization process and shall be subject to a minimum fifteen percent (15%) restocking fee.

8. **SUBSTITUTION.** Seller reserves the right to substitute materials and/or modify specifications of an Order to the extent required to comply with any governmental law or regulation.

9. **AMENDMENTS; CHANGES.** The Terms may be amended, modified or waived only as agreed by Seller and Buyer in writing. No changes to an Order may be made by Buyer unless approved by Seller in writing.

10. **FAIR LABOR STANDARDS.** Seller represents that any Goods to be delivered hereunder will be produced in compliance with the requirements of the Fair Labor Standards Act of 1938, as amended.

11. **EXPORT REGULATIONS.** The marketing, sale, use, export and release of the Goods are subject to applicable export laws and regulations of the United States and other countries. Buyer agrees to comply with all such applicable laws and regulations, including without limitation, U.S. Export Administration Regulations, regulations of the U.S. Office of Foreign Asset Control, the U.S. Foreign Corrupt Practices Act and comparable laws and regulations of other countries. Buyer shall be responsible for any breach of this Section.

12. **GOVERNING LAW.** These Terms and any Order hereunder shall be construed in accordance with the laws of the State of Ohio, without regard to conflicts of law principles. Any dispute arising hereunder shall be resolved in the federal or state courts of the State of Ohio, as applicable. The rights and obligations of Seller and Buyer shall not be governed by the U.N. Convention on Contracts for the International Sale of Goods.

13. **WAIVER OF JURY TRIAL.** EACH OF SELLER AND BUYER IRREVOCABLY WAIVES ANY AND ALL RIGHT TO TRIAL BY JURY IN ANY LEGAL PROCEEDING ARISING OUT OF OR RELATED TO THESE TERMS OR ANY OTHER ORDER HEREUNDER.

14. **MISCELLANEOUS.** The section titles in these Terms are for reference only and shall not limit or restrict the interpretation or construction of the Terms. Seller’s failure to insist, in any one or more instances, upon Buyer’s performance of any of the Terms, or to exercise any rights conferred by the Terms, shall not constitute a waiver of any such right to insist upon such performance or exercise such rights in the future. The partial or complete invalidity of any one or more provisions of these Terms shall not affect the validity or continuing force and effect of any other provision.
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SECTION I
GENERAL INFORMATION

I-1. GENERAL INFORMATION

The length of the satisfactory service obtained from the equipment will, in part, depend on proper installation and maintenance. This instruction manual is provided to present the basic information for operating, maintenance and management personnel. Due to the many variations and custom designed units, it is impossible to cover every design variation or contingency which may arise. However, the basic information contained herein will cover most questions.

I-2. IDENTIFICATION

Should questions arise concerning the pump, the factory will require the complete serial number to be of assistance. The serial number is stamped on a metal nameplate affixed to the discharge head assembly and/or bowl assembly. The driver will have a separate nameplate attached to it. When requesting information on the driver both the driver serial number and pump serial number will be required.

I-3. GENERAL DESCRIPTION

The basic components of Close Coupled Pumps are the driver, discharge head assembly, column assembly (when used), and bowl assembly. The pumps are normally shipped assembled and ready for installation. The drivers, couplings and strainers (when used) are shipped unassembled to prevent damage.

I-4. DRIVERS

A variety of drivers may be used, however, electric motors are most common. For the purposes of this manual, all types of drivers can be grouped into two categories:

1. Hollow shaft drivers where the pump shaft extends through a tube in the center of the rotor and is connected to the driver by a clutch assembly at the top of the driver.

2. Solid shaft drivers where the rotor shaft is solid and projects below the driver mounting base. This type of driver requires an adjustable flanged coupling for connecting to the pump.

I-5. DISCHARGE HEAD ASSEMBLY

The discharge head supports the driver and bowl assembly as well as supplying a discharge connection (except for the “NUF” type discharge connection which will be located on one of the column pipe sections below the discharge head). A shaft sealing arrangement is located in the discharge head to seal the shaft where it leaves the liquid chamber.

The shaft seal will usually be either a mechanical seal assembly or stuffing box.

Figure I-1. “N260” Type Unit

I-6. COLUMN ASSEMBLY

Column assembly is of two basic types, either of which may be used:

1. Open lineshaft construction utilizes the fluid being pumped to lubricate the lineshaft bearings.

2. Enclosed lineshaft construction has an enclosing tube around the lineshaft and utilizes oil, grease or injected liquid (usually clean water) to lubricate the lineshaft bearings.
Column assembly will consist of: 1) column pipe, which connects the bowl assembly to the discharge head, 2) shaft, connecting the bowl shaft to the driver and, 3) may contain bearings, if required, for the particular unit. Column pipe may be either threaded or flanged.

Note: Some units will not require column assembly, having the bowl assembly connected directly to the discharge head instead.

I-7. BOWL ASSEMBLIES
The bowl consists of: 1) impellers rigidly mounted on the bowl shaft which rotate and impart energy to the fluid, 2) bowls to contain the increased pressure and direct the fluid, 3) suction bell or case which directs the fluid into the first impeller, and 4) bearings located in the suction bell (or case) and in each bowl.

SECTION II
PRE-INSTALLATION

II-1. RECEIVING
When shipment is received extreme care should be exercised when unloading. Heavy parts should be carefully skidded to the ground if lifting equipment is not available. Do not drop the unit, or any parts, as damage may cause trouble in assembly and operation of the units.

Inspect unit for signs of transit damage before beginning to uncrate or put into storage. If damage is evident the local transporting company agent should be notified before uncrating and a claim filed with the agent.

II-2. STORAGE
If the unit is to be stored prior to installation, carefully select a storage space so the unit will not be subjected to excess moisture, extreme weather conditions, corrosive fumes, or other harmful conditions. Carefully inspect the unit and clean any rust spots on machined surfaces with fine emery cloth or scotchbrite pad and coat with a rust preventive. If the unit is stored for a long period it should be inspected from time to time, cleaned, and shafting rotated as required.

II-3. UNCRATING & CLEANING
If unit appears undamaged proceed to uncrate. The pump is shipped as a unit from the factory and is advisable to lift into the vertical position before uncrating. If this is not possible the longer units must be supported at more than one place to avoid putting undue strain on the unit when raising to the vertical position.

Clean all parts of all dirt, packing materials and other foreign matter. Flush the pump inside and outside with clean water. Clean all machined surfaces. These are coated with a rust preventive before shipment which must be removed. Remove any rust spots found on the machined surfaces with a fine emery cloth or scotchbrite pad. Clean all threaded connections and any accessory equipment.

NOTE: Parts and accessories may be placed inside shipping containers or attached to skids in individual packages. Inspect all containers, crates and skids for attached parts before discarding.

II-4. EQUIPMENT AND TOOLS
No installation should be attempted without equipment adequate for the job. The following list covers the principal items required for an installation.

1. Mobile crane capable of hoisting and lowering the weight of the pump or motor.
2. Cable sling for attaching to the pump and motor lifting eyes.
3. Ordinary hand tools—end wrenches, socket set, screw drivers, allen wrenches, collet hammer, etc.
4. Wire brush, scraper and fine emery cloth or scotchbrite pad.
5. Thread compound and light machinery oil.

II-5. PRE-INSTALLATION CHECK LIST
The following checks should be made before starting actual installation to assure proper installation and prevent delays:

1. Where more than one unit is received, check the pump serial number against the packing slip to be sure the correct unit is being installed.
2. Check the driver horsepower and speed indicated on the driver nameplate, and the horsepower and speed indicated on the pump nameplate (located on the discharge head) to be sure they agree.

NOTE: A slight difference between the speeds (RPM) shown on the driver and pump nameplates is O.K., however, the difference should not be more than 2%.
3. With motor driven units be sure the voltage and frequency on the motor nameplate agree with the service available. Also make sure the horsepower and voltage rating of the control box or starter agree with the horsepower and voltage rating of the motor.
4. Check the depth of the sump against the pump length to be sure there will be no interference.
5. Check the proposed liquid level in the sump against the pump length. The bottom stage of the pump must be submerged at all times.

6. Clean the sump and piping system before installing the pump.

7. Check the installation equipment to be sure it will safely handle the equipment.

8. Check all pump connections (bolts, nuts, etc.) for tightness. These have been properly tightened before leaving the factory, however, some connections may have worked loose in transit.

9. On the hollow shaft drivers, check the clutch size and drive key against the shaft size which must go through the clutch. Sometimes the shaft size coming through the discharge head is different from the shaft size going through the driver. Be sure you check against the shaft which will go through the driver.

10. On solid shaft drivers check the motor shaft size against the coupling bore size.

SECTION III
INSTALLATION

III-1. GENERAL

This is a precision piece of equipment and should be treated as such. Proper installation is necessary to provide maximum service from the pump. To insure proper alignment three items are very important during installation:

1. All machined mating surfaces (such as the mating flanges of pump and driver) must be clean and free of burrs and nicks. These surfaces should be cleaned thoroughly with a scraper, wire brush and emery cloth if necessary and any nicks or burrs removed with a fine file.

2. Exterior strain must not be transmitted to the pump. The most common cause of trouble in this respect is forcing the piping to mate with the pump. It is recommended that flexible connectors be installed in the piping adjacent to the pump. This is especially critical on “NUF” type units where the discharge may be several feet below the supporting structure, and a relatively small strain can cause misalignment.

3. All threads should be checked for damage and repaired if necessary. If filing is necessary, remove the part from the pump if possible, or arrange a rag to catch all filings so they do not fall into other parts of the pump. Clean all threads with wire brush and cleaning solvent. Ends of shafts must be cleaned and any burrs removed since alignment depends on the shaft ends butting squarely. Lubricate all screwed connections with a thread lubricant – an anti-galling threading compound such as “Never-Seez” should be used on stainless and monel mating threads.

CAUTION: Apply thread lubricant sparingly to male shaft threads only when making up shaft connection. Excess lubricant should not be allowed to get between the ends of the shaft.

III-2. FOUNDATION

The foundation may consist of any material that will afford permanent, rigid support to the discharge head and will absorb expected stresses that may be encountered in service.

Concrete foundations should have anchor bolts installed in sleeves twice the diameter of the bolt to allow alignment with the holes in the mounting plate as illustrated in Figure III-1.

III-3. INSTALLING PUMP

1. Position lifting equipment so it will center over the foundation opening.

NOTE: Sump and piping should be thoroughly cleaned of all loose debris before starting installation.

2. If a base plate is used, level the mounting surface grout and anchor in place.

3. Clean pump discharge flange.

NOTE: All machined surfaces are coated with rust preventive prior to shipment. This must be completely removed along with any paint overspray.
or rust which might be on the machined faces. The surfaces should be scraped and wire brushed and then a fine emery cloth used to remove any stubborn spots.

4. Lift pump, mount strainer if required, and lower slowly into sump. Hand guide the pump as it is lowered and watch for any obstructions or binding of the pump which can be felt through the hands. Stop lowering unit when still a few inches off foundation.

NOTE: Be particularly careful not to damage any piping which may extend down along the column and/or bowl assembly. This piping (when used) must remain open. Should it be damaged, it should be removed and replaced.

5. Rotate pump until discharge flange faces proper direction for alignment with piping, and align anchor bolt holes.


7. Install anchor bolts or nuts, but do not tighten.

8. Shift the pump slightly on the foundation, if required, to facilitate alignment.

9. Check level of discharge head once sitting on grout plate.

CAUTION: Exterior stresses should not be transferred to the pump. All piping must be carefully aligned and supported to prevent this.

NOTE: It is strongly recommended that flexible connectors (Dresser Couplings, or equal) be installed in the piping immediately adjacent to the pump.

10. Tighten discharge flange bolting using proper torque sequence. Be sure the flanges mate without forcing.

11. Tighten anchor bolting.

12. Mechanical seal should be installed at this time if the pump is so equipped. If the mechanical seal was shipped not installed, see paragraph III-9 for further details.

III-4. INSTALLING HOLLOWSHAFT DRIVE

1. Clean the driver mounting flange on the discharge head and flange. Check for burrs or nicks on the register and mounting face. Oil lightly.

2. Remove driver clutch.

3. Lift the driver and clean the mounting flange, checking for burrs and nicks.

4. Some electric motors will be supplied with a "lowerguide bushing" (steady bushing) which is installed at the bottom of the motor to stabilize the shaft at this point. Some motor manufacturers mount this guide bushing before shipping while others will ship the guide bushing with instructions for field mounting. Check the packing slip to see if a guide bushing is required. If so, determine if the bushing is already mounted or not and proceed accordingly. See Fig. III-2.

5. Raise and center driver over pump.

6. Lower carefully until about 1/4" above mounting flange. Rotate driver until junction box on motor or input shaft on gear drive is in correct position. Align bolt holes and insert bolts.

7. Lower carefully into place making certain that the female register on the driver mates over the male register on the pump.

8. Tighten mounting bolts.

9. Check driver manufacturer's instruction manual for special instructions including lubrication instructions and follow all "start up" directions.

10. Electric drivers should be checked for rotation at this time. Make electrical connections and jog motor momentarily to check rotation. DRIVER MUST ROTATE COUNTER-CLOCKWISE when looking down at top end of motor. To change the direction of rotation on a three-phase motor, interchange any two line leads. To change direction of rotation on a two-phase motor, interchange the leads of either phase.

CAUTION: Reverse rotation with the pump connected can cause extensive damage to the pump – ALWAYS check rotation before connecting driver to pump.

NOTE: On units equipped with one piece headshaft (no lineshaft coupling between driver and pump) Steps 11, 12 and 13 will not be applicable.
11. Clean all shaft threads (both ends of head shaft and on top shaft). Try the lineshaft coupling and headshaft nut on their respective threads. These should thread on by hand. If not, clean up threads with fine three cornered file. Check ends of shaft where they will butt inside lineshaft coupling. Ends must be square and clean. Fit gib key so it slides smoothly.

12. Lubricate top shaft threads and thread (LEFT OR RIGHT HAND threads) headshaft nut half way onto top shaft.

**CAUTION:** Apply thread lubricant only to male shaft threads. Apply sparingly to avoid build-up between ends of shaft which could cause misalignment.

13. Lower headshaft carefully down through driver. Clean and lubricate threads and thread into lineshaft coupling. Shafts must butt against each other.

**NOTE:** Headshaft should stand centered (long shafts may lean slightly from own weight, however, they can be centered without effort) in the driver hollow shaft. If not, check driver mounting flange for improper mounting and re-clean ends of shaft where coupled inside discharge head.

14. Remove headshaft nut and install clutch on driver being careful that it fits down properly.

15. Install gib key in clutch and shaft. Gib key should be a slip fit. Do not force.

16. Thread adjusting nut down (RIGHT OR LEFT HAND threads) on shaft until it bears against clutch.

**III-5 INSTALLING SOLID SHAFT DRIVER**

1. Clean driver mounting flange on discharge head and check for burrs or nicks on the register and mounting face.

2. Clean pump half of AFS coupling and fit key to shaft, and install. Clean headshaft threads. Lubricate and try adjusting nut. The adjusting nut should run down on the threads by hand, until flush with top of threads on headshaft.

3. Lift driver and clean mounting flange, checking for burrs and nicks.

4. Install driver half-coupling on driver shaft (See Figure III-4 and III-6 for coupling illustrations):
   a. Place straight key into keyway, be sure the key is up far enough to clear the groove cut around the shaft near the end.
   b. Slide driver half-coupling onto shaft far enough to insert the circular thrust rings into the shaft groove.
   c. Install circular thrust ring in shaft groove. When properly positioned, the half-coupling will slip down over the circular key and hold it in position (see Figure III-4.)

5. Mechanical seal should be installed at this time if the pump is so equipped. If the mechanical seal was shipped not installed, see paragraph III-9 for further details.

6. Install pump half-coupling on head shaft:
   a. Slide pump half-coupling onto shaft.
   b. Install key and push down to clear threads.

![Figure III-3. Hollow Shaft Driver Clutch](image)

![Figure III-4. Driver Half-Coupling Correctly Positioned](image)

17. See paragraph III-6 for impeller adjustment.

18. Adjust mechanical seal AFTER adjusting impellers.
c. Thread adjusting nut (RIGHT OR LEFT HAND threads) onto shaft until end of shaft is even with top of adjusting nut.

7. Center motor over pump and rotate to align mounting holes.

   **Electric Motors** — rotate junction box into desired position.

   **Gear Drives** — rotate input shaft into desired position.

8. Lower driver carefully into place making certain that the female register on the driver mates over the male register on the discharge head.

9. Bolt driver to discharge head.

10. Check driver manufacturer’s instructions for special instructions including lubrication instructions and follow all “start up” instructions.

11. Electric drivers should be checked for rotation at this time. Make electrical connections and jog motor briefly to check rotation. **DRIVER MUST ROTATE COUNTER CLOCKWISE** when looking down at the top end of motor. To change the direction of rotation on a three-phase motor, interchange any two line leads. To change direction of rotation on a two-phase motor, interchange the leads of either phase.

**CAUTION:** Before jogging the motor make sure the coupling halves are not touching and that the driver can rotate freely without rotating the pump. Driver half-coupling must be in proper position as shown in Figure III-4 so the circular thrust ring will not come out.

**CAUTION:** Reverse rotation with the pump connected can cause extensive damage to the pump. ALWAYS check rotation before connecting driver pump.

12. On pumps using the spacer-type coupling, bolt the spacer to the driver half-coupling.

13. On adjustable flanged couplings — thread the adjusting nut up the shaft until there is a proper gap between nut and spacer or driver half-coupling. (See paragraph III-6 for impeller adjustment.)

**NOTE:** Adjusting Nuts on all sizes have drilled holes inside inserting handle of hex wrench or round bar to facilitate adjustment.


### III-6. IMPELLER ADJUSTMENT — GENERAL

Proper impeller adjustment positions the impeller inside the bowl assembly for maximum performance. The impellers must be raised slightly to prevent dragging on the bowls. Impellers are of two basic types: “enclosed” and “semi-open” (sometimes called “semi-enclosed”). The type of impeller will determine proper adjustment. The type of impellers installed in the pump can be determined from the pump nameplate or packing slip. The second letter of the pump type indicated enclosed impellers by “C” and semi-open “O”, thus “MO” would indicate semi-open impellers while “MC” would indicate enclosed impellers.

**ENCLOSED IMPELLERS** — Enclosed impellers should be raised 1-1/2 to 2 turns of the adjusting nut or approximately 1/8”.

**SEMI-OPEN IMPELLERS** — The adjustment of semi-open impellers is more critical than for enclosed impellers. The performance of the pump will vary considerably (see Figure V-2) for a small change in the impeller setting. For maximum performance, the impeller must run within a few thousandths of the bowl seat — exact shaft adjustment will vary according to variables of each installation; however, for close-coupled units as covered by this manual a general rule of .015” plus .005” for each 100 feet of discharge head produced by the pump plus .005” for each 10 feet of column assembly will provide near ideal adjustment. The highest discharge head the unit will be expected to operate against should be used for this adjustment. As an example — a pump designed to operate at 400’ discharge head but will also be operated against a closed valve for short period at which time it will produce 500’, therefore $5 \times .005” = .025”$. If the unit has 20’ of column assembly — $2 \times .005” = .010$”. The initial adjustment would be .025" + .010" + .015" = .050”.

**CAUTION:** The impellers must be down against the bowl seat when starting impeller adjustment. All dimensions and instructions given above assume the impellers are initially all the way down. When pumps are subjected to suction pressure the pressure acting against the shaft ends, raise them. If the suction pressure is great enough it can raise the shaft. Make sure the shaft is down when starting to adjust the impellers.
If, after making the above adjustment, the pump does not deliver its rated capacity, the impellers can be lowered one step at a time until the lowest possible adjustment is achieved without the impellers dragging. On the other hand, if the impellers appear to be dragging after the initial adjustment, the unit should be stopped and the impellers raised one step. Dragging impellers will increase the load markedly and can usually be heard and felt as increased vibration.

NOTE: If semi-open impellers are raised and then adjusted down, a slight increase in power required will be noted due to the increased delivery of the pump. Do not confuse this with the marked increase when the impellers are lowered enough to drag.

III-7 IMPeller ADJUSTMENT – HOLLOW SHAFT DRIVER

Impeller adjustment, when using a hollow shaft driver is accomplished at the top of the driver by the following procedure. The driver canopy will have to be removed before beginning.

1. Install headshaft as outlined in paragraph III-4 if not already in place.

2. Install driver clutch in accordance with the driver instruction manual and bolt into place.

3. Install gib key, making sure top of gib key slides easily down below top of clutch.

4. Check shaft position — raise shaft slightly by hand and lower until there is a definite feel of metal contacting metal. This indicates the impellers are “on bottom” and is the correct starting position for impeller adjustment.

5. Thread headshaft nut down (RIGHT OR LEFT HAND threads) until impellers are just lifted off their seat and the shaft will rotate freely. When semi-open impellers are used the correct determination of the point where the impellers just barely clear their seat is very important for proper adjustment.

6. Adjust impellers as outlined in paragraph III-6.

7. Lock the headshaft nut with lock screws inserted down through holes in headshaft nut and threaded into driver clutch.

CAUTION: Always lock headshaft nut before starting driver. Failure to do so could result in damage to the pump and driver.

III-8. IMPeller ADJUSTMENT – SOLID SHAFT DRIVER

Impeller adjustment when using solid shaft drivers is accomplished in the adjustable flanged coupling located below the driver.

III-8a. ADJUSTABLE FLANGED SPACER COUPLINGS

1. Assemble coupling on pump and driver as outlined in paragraph III-5.

2. Rotate adjusting nut up shaft (threads are RIGHT OR LEFT HAND) until the nut bears firmly against spacer or driver shaft and headshaft will not move down. This will insure that the impellers are all the way down against their seat and in proper position for adjustment.

3. Thread adjusting nut down until the proper impeller adjustment as outlined in paragraph III-6 can be measured between the adjusting nut and spacer or driver half-coupling as shown in Figure III-6.

CAUTION: Always lock headshaft nut before starting driver. Failure to do so could result in damage to the pump and driver.

Figure III-6. Adjustable Flanged Coupling (Illustrated with Spacer)

4. Slide pump half-coupling up shaft and align adjusting nut bolt holes with those in pump half-coupling. Rotate driver shaft until bolts can be inserted and tightened.

5. Tighten all bolts which will raise impellers to correct for any operating position.
III-9. MECHANICAL SEAL

Because of the numerous mechanical seal arrangements available, separate instruction manuals are written covering installation and operation of these seals. There are, however, comments which apply to all seals.

1. The seal cavity must be clean before installing seal.
2. The faces and register of the seal housing and gland plate or cap must be clean and free of burrs.
3. The shaft seal is a precision product. Treat it with care. Take particular care not to scratch or chip the lapped faces of the runner or seat.
4. Circulation lines must remain in place and open. Do not remove.
5. Impeller adjustment must be made PRIOR to seal adjustment.

READ THE MECHANICAL SEAL INSTRUCTION MANUAL FURNISHED WITH THIS UNIT.

III-10. STUFFING BOXES

Stuffing boxes are pre-packed at the factory and will be factory installed. Do not tighten the packing gland. See Section V for further information.

III-11. ENCLOSING TUBE TENSION

The enclosing tube (enclosed lineshaft design) tension is pre-adjusted at the factory before shipping on short set pumps: additional adjustment will not be required. See assembly instructions (Section VI) if assembly or adjustment is required for any reason.

SECTION IV
OPERATION

IV-1. PRE-STARTING CHECKS

Before starting the pump, the following checks should be made:

1. Rotate the pump shaft by hand to make sure the pump is free and the impellers are correctly positioned.
2. Is the head shaft adjusting nut properly locked into position?
3. Has the driver been properly lubricated in accordance with the instructions furnished with the driver?
4. Has the driver been checked for proper rotation? If not, the pump must be disconnected from the driver before checking. The driver must rotate COUNTER CLOCKWISE when looking down at the top of the driver.
5. Check all connections to the driver and control equipment.
6. Check that all piping connections are tight.
7. Check all anchor bolts for tightness.
8. Check all bolting and tubing connections for tightness (driver mounting bolts, flanged coupling bolts, gland plate bolts, seal piping, etc.).
9. On pumps equipped with stuffing box, make sure the gland nuts are only finger tight — DO NOT TIGHTEN packing gland before starting.
10. On pumps equipped with mechanical seals, clean fluid should be put into the seal chamber. With pumps under suction pressure this can be accomplished by bleeding all air and vapor out of the seal chamber and allowing the fluid to enter. With pumps not under suction pressure, the seal chamber should be flushed liberally with clean fluid to provide initial lubrication. Make sure the mechanical seal is properly adjusted and locked into place.

NOTE: After initial start-up, pre-lubrication of the mechanical seal will usually not be required as enough liquid will remain in the seal chamber for subsequent start-up lubrication.

IV-2. INITIAL STARTING

1. If the discharge line has a valve in it, it should be partially open for initial starting — Min. 10%.
2. Start lubrication liquid flow on enclosed lineshaft units.
3. Start the pump and observe the operation. If there is any difficulty, excess noise or vibration, stop the pump immediately and refer to Section V for probable cause.
4. Open the discharge valve as desired.
5. Check complete pump and driver for leaks, loose connections or improper operation.

6. If possible, the pump should be left running for approximately ½ hour on the initial start-up. This will allow the bearings, packing or seals, and other parts to “run-in” and reduce the possibility of trouble on future starts.

NOTE: If abrasives or debris are present upon start-up, the pump should be allowed to run until the pumpage is clean. Stopping the pump when handling large amounts of abrasives (as sometimes present on initial starting) may lock the pump and cause more damage than if the pump is allowed to continue operation.

CAUTION: Every effort should be made to keep abrasives out of lines, sumps, etc. so that abrasives will not enter the pump.

IV-3. STUFFING BOX ADJUSTMENT

On the initial starting it is very important that the packing gland not be tightened too much. New packing must be “run in” properly to prevent damage to the shaft and shortening of the packing life. See paragraph V-3c, page 10 for further information.

The stuffing box must be allowed to leak for proper operation. The proper amount of leakage can be determined by checking the temperature of the leakage, this should be cool or just lukewarm — NOT HOT.

When adjusting the packing gland bring both nuts down evenly and in small steps until the leakage is reduced as required. The nuts should only be tightened about ½ turn at a time at 20 to 30 minute intervals to allow the packing to “run in.”

Under proper operation, a set of packing will last a long time. Occasionally a new ring of packing will need to be added to keep the box full. After adding two or three rings of packing, or when proper adjustment cannot be achieved, the stuffing box should be cleaned completely of all old packing and re-packed.

IV-4. LINESHAFT LUBRICATION

Open lineshaft bearings are lubricated by the pumped fluid and on close coupled units (less than 30’ long) will usually not require pre or post lubrication.

Enclosed lineshaft bearings are lubricated by extraneous liquid (usually oil or clean water) which is fed to the tension nut by either a gravity flow system or pressure injection system. The gravity flow system utilizing oil is the most common arrangement. The oil reservoir must be kept filled with a good quality light turbine oil (about 150 SSU at operating temperature) and adjusted to feed 10 to 12 drops per minute plus one (1) drop per 100’ of setting.

Injection systems are designed for each installation — injection pressure and quantity of lubricating liquid will vary. Refer to packing slip or separate instruction sheet for requirements when unit is designed for injection lubrication.

<table>
<thead>
<tr>
<th>MANUFACTURER</th>
<th>TRADE NAME OF OIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continental Oil Company</td>
<td>Conoco Turbine Oil, Light</td>
</tr>
<tr>
<td>Exxon Company</td>
<td>Teresstic - 32</td>
</tr>
<tr>
<td>Mobil Oil Company</td>
<td>Mobile DTE - 797</td>
</tr>
<tr>
<td>Shell Oil Company</td>
<td>Tellus 32</td>
</tr>
<tr>
<td>Standard Oil Co. of Calif.</td>
<td>Chevron OC Turbine 9</td>
</tr>
<tr>
<td>Texaco, Inc.</td>
<td>Texaco Regal 32 R &amp; O</td>
</tr>
</tbody>
</table>

If none of the above oils are available, an oil with the following specifications should be obtained: Turbine type oil with rust and oxidation inhibitors added. Viscosity 145-175 SUS at 100°F with a 90 minimum viscosity index.

It is recommended that detergent type oils not be used.

Figure IV-1. Recommended Lineshaft Oil

SECTION V
MAINTENANCE

V-1. GENERAL

A periodic inspection is recommended as the best means of preventing breakdown and keeping maintenance costs to a minimum. Maintenance personnel should look over the whole installation with a critical eye each time the pump is inspected — a change in noise level, amplitude or vibration, or performance can be an indication of impending trouble.

Any deviation in performance or operation from what is expected can be traced to some specific cause. Determination of the cause of any misperformance or improper operation is essential to the correction of the trouble — whether the correction is done by the user, the dealer or reported back to the factory.

Variances from initial performance will indicate changing system conditions or wear or impending breakdown of unit.
V-2. PERIODIC INSPECTION

A periodic, once-a-month inspection is suggested for all units. During this inspection, the pump and driver should be checked for performance and change in noise or vibration level, loose bolts or piping, dirt and corrosion. Clean and re-paint all areas that are rusted or corroded.

V-3. STUFFING BOX MAINTENANCE

Maintenance of the stuffing box will consist of greasing the box when required, tightening the packing gland occasionally as the leakage becomes excessive, and installing new packing rings or sets as required.

V-3a. GREASING THE STUFFING BOX

Under ordinary operation, once-a-month greasing of the stuffing box will be adequate. A good grade of grease such as Standard of California No. TB-medium or Texaco Multi-fax No. 2-medium should be used.

V-3b. REPLACING PACKING

Remove gland and all old packing. If the box contains a lantern ring remove this and all packing below it. Inspect shaft or sleeve for score marks or rough spot. Be sure bypass holes (if required) are not plugged. Repair or replace badly worn shaft or sleeve. If wear is minor, dress down until smooth and concentric. Clean box bore.

Oil inside and outside of replacement rings lightly and install box, staggering joints 90 degrees. Be sure to replace lantern ring in proper position when used.

Replace gland and tighten nuts, making sure gland enters box squarely. Keep the packing under moderate pressure for one minute to allow it to cold flow and adjust itself. Back off on the gland until loose before starting the pump.

V-3c. START UP WITH NEW PACKING

Check that the bypass line (if used) is connected and packing gland nuts are finger tight only. Start pump and allow to run for 20 to 30 minutes. Do not tighten the gland during this “run-in” period even if leakage is excessive. If the leakage continues to be more than normal, adjust as outlined in paragraph IV-3. Should the new packing cause excess heating during “run-in,” flush the shaft and packing box area with cold water or shut the pump down and allow to cool if necessary.

V-3d. AUXILIARY STUFFING BOX MAINTENANCE

Pumps equipped with mechanical seals may also be provided with an auxiliary stuffing box to restrict leakage should the mechanical seal fail. This packing gland must be left loose since, under normal operation, the packing will not be cooled and lubricated by the pumpage. This stuffing box arrangement is designed to help contain leakage past the mechanical seal. It is not designed as a primary seal and should not be used as such.

V-4. MECHANICAL SEAL MAINTENANCE

Mechanical seals should not be readjusted unless there is a reason. Best results will be obtained if the seal is properly set on start-up and left that way. If the seal starts to leak after an extended operating period, some extra service may be obtained by readjusting. However, it is usually best to plan on replacing the seal at the next maintenance period.

After impeller readjustment, seal leakage may occur due to improper seal adjustment or improper seating of the seal parts. If readjustment of the seal will not correct the problem, refer to the Mechanical Seal Instruction Manual for further information.

V-5. IMPELLER RE-ADJUSTMENT

Ordinarily, impellers will not require readjustment if properly set at initial installation. Almost no change in performance...
can be obtained by minor adjustment of enclosed impellers. However, the positioning of semi-open impellers has a definite effect on the performance of the pump. This fact is sometimes used to adjust the output of the pump without valving. Figure V-2 illustrates the general effect of raising semi-open impellers.

After extended operation under abrasive conditions the sealing faces between semi-open impellers and the bowl will wear, causing a reduction in performance. The pump performance can be brought back up to almost “as new” by proper readjustment of the impellers. See paragraph III-6 for proper adjustment procedure.

NOTE: All adjustments of the impellers will change the mechanical seal setting. Unless the adjustment is to be very minor, it is recommended that the seal be loosened from the shaft until the adjustment is complete and then reset.

V-6. PUMP LUBRICATION

Other than the stuffing box lubrication outlined in paragraph V-3a and lineshaft lubrication outlined in paragraph IV-4, the pump will not require further periodic lubrication. The suction bearing on the bowl assembly should be repacked when repairs are made. However, no attempt should be made to repack until repairs to the bowl assembly are necessary.

V-7. DRIVER LUBRICATION

Drivers will require periodic attention. Refer to the driver instruction manual for recommendations.

The above chart indicates the approximate effect of raising semi-open impellers from their ideal (A) operating position. Raising the impellers increases the clearance between impeller and bowl seat and reduces the performance accordingly. The chart is general and will not be exactly correct for any particular pump model since each model will react differently. 100% head and capacity are to be taken as the head and capacity of the pump at peak efficiency. Example: If a particular pump delivers 250 GPM at 50' head at peak efficiency when the impellers are properly adjusted, raising the impellers .080" would reduce the capacity to approximately 181 GPM (72 1/2% of 250 GPM) while maintaining the 50' head. Conversely, the pump would deliver 250 GPM at 37 1/2' head (75% of 50'). The horsepower would be about 91 1/2% of the previous horsepower.

Figure V-2. Effect of Raising Semi-Open Impellers
<table>
<thead>
<tr>
<th>CONDITION</th>
<th>PROBABLE CAUSE</th>
<th>REMEDY</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>a. Incorrect control box.</td>
<td>b. Check wiring diagram furnished with starter.</td>
</tr>
<tr>
<td></td>
<td>b. Incorrect connections.</td>
<td>c. Replace.</td>
</tr>
<tr>
<td></td>
<td>c. Faulty overloads.</td>
<td>d. Check voltage at pump side of control box.</td>
</tr>
<tr>
<td></td>
<td>d. Low voltage.</td>
<td>e. Use ambient compensated relays.</td>
</tr>
<tr>
<td></td>
<td>e. Ambient temperature of control box or starter too high.</td>
<td>2. Check fuses, relays or heater elements for correct size and all electrical connections.</td>
</tr>
<tr>
<td></td>
<td>2. Blown fuse, broken or loose electric connections.</td>
<td>3. Repair or replace.</td>
</tr>
<tr>
<td></td>
<td>3. Defective motor.</td>
<td>4. Check all circuits and repair.</td>
</tr>
<tr>
<td></td>
<td>4. Faulty control equipment.</td>
<td>5. Repair or replace.</td>
</tr>
<tr>
<td></td>
<td>5. Faulty switch.</td>
<td>6. Pull master switch, rotate pump by hand to check.</td>
</tr>
<tr>
<td></td>
<td>6. Pump binding.</td>
<td>Check impeller adjustment or disassemble unit to determine cause.</td>
</tr>
<tr>
<td></td>
<td>1. Line check valve backward.</td>
<td>4. Lift too high for pump.</td>
</tr>
<tr>
<td></td>
<td>2. Line check valve stuck.</td>
<td>5. Pump not submerged.</td>
</tr>
<tr>
<td></td>
<td>3. Unit running backwards.</td>
<td>6. Excessive amounts of air or gas.</td>
</tr>
<tr>
<td></td>
<td>4. Lift too high for pump.</td>
<td>7. Intake strainer or impeller plugged, or pump in mud or sand.</td>
</tr>
<tr>
<td>Reduced Capacity</td>
<td>5. Pump not submerged.</td>
<td>8. Impeller loose on shaft.</td>
</tr>
<tr>
<td></td>
<td>2. Lift too high for pump.</td>
<td>2. Check performance curve.</td>
</tr>
<tr>
<td></td>
<td>3. Motor not coming up to speed.</td>
<td>3. Check voltage while unit is running.</td>
</tr>
<tr>
<td></td>
<td>4. Strainer or impellers partly plugged.</td>
<td>4. Start &amp; stop pump several times or use the line pressure if available to back flush. Pull pump and clean.</td>
</tr>
<tr>
<td></td>
<td>5. Scaled or corroded discharge pipe or leaks anywhere in system.</td>
<td>5. Replace pipe or repair leaks.</td>
</tr>
<tr>
<td></td>
<td>6. Excessive amounts of air or gas.</td>
<td>6. Correct conditions.</td>
</tr>
<tr>
<td></td>
<td>7. Excessive water due to abrasives.</td>
<td>7. Remove worn parts.</td>
</tr>
<tr>
<td></td>
<td>8. Impellers not properly adjusted.</td>
<td>8. See Section III.</td>
</tr>
<tr>
<td>Motor Over-loaded</td>
<td>1. Line voltage not correct.</td>
<td>1. Check and correct.</td>
</tr>
<tr>
<td></td>
<td>2. Faulty equipment used to check.</td>
<td>2. Check equipment.</td>
</tr>
<tr>
<td></td>
<td>3. Specific gravity higher than design.</td>
<td>3. Correct specific gravity or re-evaluate system.</td>
</tr>
<tr>
<td></td>
<td>4. Operation at point on pump curve other than design.</td>
<td>4. Check performance curve.</td>
</tr>
<tr>
<td></td>
<td>5. Motor speed too high.</td>
<td>5. Line voltage too high or incorrect frequency.</td>
</tr>
<tr>
<td></td>
<td>7. Pump in bind.</td>
<td>7. Pull master switch, rotate pump by hand to check.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Disassemble unit to determine cause.</td>
</tr>
<tr>
<td>Pump Noisy and Vibrating</td>
<td>1. Unit running backwards.</td>
<td>1. See “Initial Starting of Unit”</td>
</tr>
<tr>
<td>Excessively</td>
<td>2. Pump breaking suction and pumping air.</td>
<td>2. Lower pump or reduce capacity.</td>
</tr>
<tr>
<td></td>
<td>3. Loose fasteners.</td>
<td>3. Check all bolts, nuts, etc.</td>
</tr>
<tr>
<td></td>
<td>4. Badly worn motor or pump bearings.</td>
<td>4. Pull unit and repair.</td>
</tr>
<tr>
<td></td>
<td>5. Impeller loose on shaft.</td>
<td>5. Pull unit and repair.</td>
</tr>
<tr>
<td></td>
<td>7. Stress due to piping misalignment.</td>
<td>7. Correct.</td>
</tr>
<tr>
<td></td>
<td>2. Pump in bind.</td>
<td>2. Pull master switch, rotate pump by hand to check.</td>
</tr>
<tr>
<td>Corrosion</td>
<td>1. Impurities.</td>
<td>3. Determine cause and correct.</td>
</tr>
<tr>
<td></td>
<td>2. Corrosive Liquid.</td>
<td></td>
</tr>
</tbody>
</table>

**Fig. V-3 Troubleshooting Chart**
SECTION VI
REPAIRS

VI-1. GENERAL

It must be borne in mind that eventually repairs have to be made, either to the pump or to the motor. When regular maintenance checks indicate that an overhaul is required, it should not be delayed.

Repairs will consist of removal of the unit and disassembly to the point necessary for replacement of worn parts.

Disassembly should be performed in a clean area with sufficient space to lay out the parts in order of disassembly. Cleanliness throughout repairs is important. Remember this is a close tolerance, high speed machine and should be handled as such.

CAUTION: Protect machined surfaces from burrs and scrapes which will cause mis-alignment on reassembly.

VI-2. EQUIPMENT AND TOOLS

Required equipment and tools will be listed in Section II of this manual.

CAUTION: Always pull and lock the driver master switch before doing any work on the pump or driver.

VI-3. STUFFING BOX REPAIRS

Stuffing box repairs can be affected without removing the complete unit. Packing replacement, as outlined in Section V, can be accomplished without disturbing the pump driver. The stuffing box bearing can be replaced if necessary by removing the driver and sliding the stuffing box off the shaft.

VI-4. MECHANICAL SEAL REPAIRS

Mechanical seal repairs can be affected without removing the complete unit. The mechanical seal assembly can be replaced by removing the spacer and lowering half coupling on solid shaft units. On hollow shaft units, the driver shaft and shaft coupling inside the discharge head must be removed or lifted out of the way. Replacement of the bearing located at the bottom of the seal housing will usually require removal of the driver in order to obtain sufficient headroom.

VI-5. DISASSEMBLY

NOTE: Refer to Section VII for parts drawings and identification.

1. Disconnect electrical leads from motor.
2. Loosen mechanical seal from shaft.
3. Disconnect pumpshaft from driver:
   a. Hollow Shaft—Remove headshaft nut lock screw (132), headshaft nut (131), gib key (133) and driver clutch. Un screw head shaft (130) from shaft coupling (270) inside discharge head and remove.
   b. Solid Shaft—Lower shaft and un bolt driver half coupling.
4. Remove bolts (123) which attach driver to discharge head.
5. Lift driver off pump and set on wooden supports. With solid shaft drivers be sure supports are high enough to clear shaft and coupling half.
6. Disconnect discharge piping from pump.
7. Remove anchor bolts (or nuts).
8. Lift pump vertically until pump suction clears foundation or base plate.
9. Cover opening in foundation.
10. Lower pump into a horizontal position on suitable support and in a suitable area for disassembly.

NOTE: If more than minor repairs are anticipated it is recommended that the unit be taken to a shop or other clear area with a smooth floor and overhead lifting equipment.

11a. Stuffing box construction — remove slinger (199) and packing gland (185).
11b. Mechanical seal construction — loosen seal cover cap screws (156) and remove gland plate (151).

NOTE: With sleeve mounted mechanical seals the seal and sleeve assembly should be removed with the gland plate. See Seal Instruction Manual for further details.

11c. Enclosed lineshaft construction — remove lock screw (173) and lubrication line (149) and unscrew tension nut assembly (171). Threads are LEFT HAND.

12. Remove cap screws (178) which attach the stuffing box, tube adapter or seal housing to discharge head.
13. Remove stuffing box (175), tube adapter (170) or seal housing (150).
NOTE: If non-sleeve mounted mechanical seal is used the set screws which lock the seal assembly to the shaft must be loosened before removing seal housing.

NOTE: Before proceeding further, make sure the discharge head and bowl assembly are supported independently of each other.

14. Disconnect bowl assembly or top column from discharge head. This connection may be flanged or the column pipe or bowl assembly may be threaded into the discharge head. If threaded, the threads will be **RIGHT HAND**.

15. Remove discharge (101) being careful not to damage or bend shaft.

16. Disconnect column pipe (251) (if present) at first joint below top and remove from shaft.

17. (a) Open Lineshaft Construction — Each time a lineshaft coupling (270) is exposed by removing length of column pipe the lineshaft (272) and coupling should be removed by holding the lower lineshaft and turning the coupling in a **RIGHT HAND** direction (lineshaft threads are **LEFT HAND**). Bearing retainers (280) should be removed after the lineshaft coupling. Before lifting the bearing retainer out of the pipe coupling or register in flanged column — any nicks or burrs on the shaft should be removed.

**CAUTION:** When using wrenches on shafting always place the wrenches on the same side of the shaft to avoid excess side strain on the shafting. Care should always be taken so that exposed lengths of shafting are not damaged or bent.

17. (b) Enclosed lineshaft construction — Each time a length of column pipe is removed the enclosing tube (241) and lineshaft (235) must also be disassembled. Locate the joint (See Figure VI-2) and unscrew (RIGHT OR LEFT HAND threads) the enclosing tube (241) from the lineshaft bearing (240) (which acts as a bearing for the shaft and also as an enclosing tube coupling). Leave the lineshaft bearing threaded into the enclosing tube not being removed (to support the lineshaft). Slide the enclosing tube up to expose the lineshaft coupling and uncouple as outlined in step 17(a) above.

18. Disconnect each section of column pipe one at a time and remove along with shaft and enclosing tube as applicable until all are removed.

19. Remove bowl assembly to clear area and continue disassembly.

**VI-6 INSPECTION AND CLEANING**

After disassembly, all components should be thoroughly cleaned and examined for physical defects, wear, corrosion and damage.

Check all bearings for total clearance over the shaft diameter. It is recommended that all bearings indicating wear be replaced. The following indicates the maximum allowable diametrical clearance over existing shaft diameter:

- 1" through 1-3/4" shaft — .020" clearance.
- 1-15/16" through 2-7/16" shaft — .025" clearance.
- 2-11/16" through 3-15/16" shaft — .030" clearance.

All bearings are pressed into their respective bores and can be either pressed out or machined on the inside diameter until the wall is thin enough to collapse.

**VI-7. REPLACEMENT PARTS**

Parts showing signs of damage, cracks or excessive wear should be replaced.

**CAUTION:** When repairing a pump that has been in service for several years, the physical condition or strength of all parts such as cap screws, bowls, threads, etc., must be carefully checked to be sure that these parts can continue to perform their function without failure.

**VI-8. LUBRICATION**

Lubricate all bearings and impeller skirts with clean grease or oil. Thoroughly clean all threaded connections and flanges and paint with threading compound and oil or pipe joint compound.
VI-9. ASSEMBLY

Assembly of the unit is basically the reverse of disassembly. Before proceeding with assembly, clean thoroughly and check all threads, registers and mating faces for burrs. Clean up with file where required. Lubricate as outlined above. Oil all shafts lightly.

Proceed with assembly in reverse order of disassembly as outlined in paragraph VI-5 above. Figure VI-2 indicates recommended torque values for standard fasteners.

<table>
<thead>
<tr>
<th>Fastener Size</th>
<th>1/4</th>
<th>5/16</th>
<th>3/8</th>
<th>7/16</th>
<th>1/2</th>
<th>9/16</th>
<th>5/8</th>
<th>3/4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Torque (Fl.-Lb.)</td>
<td>5.4</td>
<td>10</td>
<td>17</td>
<td>27</td>
<td>40</td>
<td>60</td>
<td>84</td>
<td>135</td>
</tr>
</tbody>
</table>

Figure VI-2. Torque Values for Standard Fasteners

CAUTION: Cleanliness and proper lubrication are very important since one small chip, burr or one dry bearing can be a cause for re-doing the whole job.

VI-10. TENSION NUT ASSEMBLY AND ADJUSTMENT

Enclosed lineshaft (oil lubricated) units use a tube tension assembly which must be properly tightened for proper operation. General construction is shown in Figure VI-3.

1. Clean all machined surfaces thoroughly before assembly.
2. Assemble tube tension bearing into top tube and tighten properly before placing discharge head on top column nipple.
3. Thread discharge head with top column flange on to top column nipple.
4. Place “O” ring on tension nut and thread tension nut on to tube tension bearing until nut is snug against discharge head. Continue to tighten tension nut until bolt holes in discharge head line up with tension nut holes (1/4 – 1/2 turn should be sufficient). Install four (4) tension nut capscrews.

CAUTION: It is necessary that the enclosing tube have tension on it which is accomplished by tightening the tension nut. However, excess tightening will distort or break the tube tension bearing. Do not tighten more than 1-1/4 turns on close-coupled pumps.

5. Place “O” ring over tube tension bearing and proceed to thread lock nut onto the tube tension bearing. Tighten as required.
6. Install lock nut set, screw, and tighten.
7. Install lubrication line and fittings as shown in Figure VI-3.
8. Proceed with remainder of installation.

VII

PARTS LIST

VII-1. ORDERING PARTS

When ordering spare or replacement parts the pump serial number and size and type of pump must be given. This can be found on the nameplate furnished with the unit. Give the complete name and reference number of each part as indicated on the applicable sectional drawing (Fig. VII-2 or VII-3) and the quantity required.

VII-2. STOCKING SPARE PARTS

Spare parts to be kept in inventory will vary according to service, field maintenance anticipated, allowable down time and number of units. A minimum inventory of one complete set of bearings, gaskets, “O” rings, and packing (or mechanical seal) and one spare of each moving part is suggested.
PARTS LIST

Illustrated with Spacer

<table>
<thead>
<tr>
<th>REF. NO.</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>450</td>
<td>Assembly - With Spacer</td>
</tr>
<tr>
<td>451*</td>
<td>Assembly - Less Spacer</td>
</tr>
<tr>
<td>450A</td>
<td>Spacer</td>
</tr>
<tr>
<td>450B</td>
<td>Spacer Bolts</td>
</tr>
<tr>
<td>450C</td>
<td>Lock Nuts</td>
</tr>
<tr>
<td>451A</td>
<td>Driver - Half Coupling</td>
</tr>
<tr>
<td>451B</td>
<td>Driver Key</td>
</tr>
<tr>
<td>451C</td>
<td>Split Thrust Ring</td>
</tr>
<tr>
<td>451D</td>
<td>Coupling Bolts</td>
</tr>
<tr>
<td>451E</td>
<td>Lock Nuts</td>
</tr>
<tr>
<td>451F</td>
<td>Adjusting Nut</td>
</tr>
<tr>
<td>451G</td>
<td>Pump Half Coupling</td>
</tr>
<tr>
<td>451H</td>
<td>Pump Key</td>
</tr>
<tr>
<td>451K</td>
<td>Dowel Pin</td>
</tr>
</tbody>
</table>

*Construction for coupling assembly less spacer will be identical to that shown, except parts 450A, 450B and 450C will be omitted.

Figure VII-1. Adjustable Flanged Coupling Parts List
PARTS LIST
“NF” TYPE

<table>
<thead>
<tr>
<th>REF. NO.</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>101</td>
<td>Discharge Head</td>
</tr>
<tr>
<td>116</td>
<td>Top Column Flange Capscrews</td>
</tr>
<tr>
<td>117</td>
<td>Top Column Flange Gasket</td>
</tr>
<tr>
<td>151</td>
<td>Gland Plate</td>
</tr>
<tr>
<td>154</td>
<td>By-pass Line with Fittings</td>
</tr>
<tr>
<td>155</td>
<td>Mechanical Seal Assembly</td>
</tr>
<tr>
<td>156</td>
<td>Packing Gland Capscrews</td>
</tr>
<tr>
<td>166</td>
<td>Top Lineshaft</td>
</tr>
<tr>
<td>175</td>
<td>Stuffing Box</td>
</tr>
<tr>
<td>177</td>
<td>Stuffing Box Bearings</td>
</tr>
<tr>
<td>250</td>
<td>Top Column Pipe</td>
</tr>
<tr>
<td>251</td>
<td>Intermediate Column Pipe</td>
</tr>
<tr>
<td>252</td>
<td>Bottom Column Pipe</td>
</tr>
<tr>
<td>270</td>
<td>Shaft Coupling</td>
</tr>
<tr>
<td>272</td>
<td>Intermediate Lineshaft</td>
</tr>
<tr>
<td>280</td>
<td>Bearing Retainer</td>
</tr>
<tr>
<td>283</td>
<td>Open Lineshaft Bearing</td>
</tr>
<tr>
<td>450</td>
<td>See Figure VII-1</td>
</tr>
</tbody>
</table>
PARTS LIST

“HI-PRO” AND “N260” TYPE
Illustrated with adjustable flanged spacer coupling, motor stand and mechanical seal.

“HI-PRO” AND “N260” TYPE
Illustrated with solenoid operated lubricator assembly for enclosed lineshaft.

Note: Lineshaft sleeve (274) may be omitted when special material is used for lineshaft bearings (283) and/or lineshafts (272).

Fig. VII-2b. Pump Parts List
PARTS LIST

"NUF" TYPE

Illustrated with hi-pressure stuffing box and flanged column pipe.

<table>
<thead>
<tr>
<th>REF. NO.</th>
<th>DESCRIPTION</th>
</tr>
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<tbody>
<tr>
<td>101</td>
<td>Discharge Head</td>
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<tr>
<td>107</td>
<td>Snap Plug</td>
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<tr>
<td>113</td>
<td>Pipe Plug</td>
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<tr>
<td>115</td>
<td>Top Column Flange</td>
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<tr>
<td>116</td>
<td>Top Column Flange Capscrews</td>
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<tr>
<td>117</td>
<td>Top Column Flange Gasket</td>
</tr>
<tr>
<td>119</td>
<td>Underground Discharge Assembly</td>
</tr>
<tr>
<td>121</td>
<td>Motor Stand</td>
</tr>
<tr>
<td>123</td>
<td>Driver Bolts and Nuts</td>
</tr>
<tr>
<td>130</td>
<td>Headshaft</td>
</tr>
<tr>
<td>131</td>
<td>Headshaft Nut</td>
</tr>
<tr>
<td>132</td>
<td>Headshaft Nut Lock Screw</td>
</tr>
<tr>
<td>133</td>
<td>Gib Key</td>
</tr>
<tr>
<td>145</td>
<td>Lubricator Assembly</td>
</tr>
<tr>
<td>146</td>
<td>Lubricator Mounting Bracket</td>
</tr>
<tr>
<td>147</td>
<td>Solenoid Valve</td>
</tr>
<tr>
<td>148A</td>
<td>Sight Feed Valve (Auto)</td>
</tr>
<tr>
<td>148M</td>
<td>Sight Feed Valve (Man) - not shown</td>
</tr>
<tr>
<td>149</td>
<td>Lubrication Line with Fittings</td>
</tr>
<tr>
<td>150</td>
<td>Seal By-Pass with Fittings</td>
</tr>
<tr>
<td>154</td>
<td>By-Pass with Fittings</td>
</tr>
<tr>
<td>155</td>
<td>Mechanical Seal Assembly</td>
</tr>
<tr>
<td>166</td>
<td>Top Line Shaft</td>
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<tr>
<td>170</td>
<td>Tube Tension Nut</td>
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<tr>
<td>171</td>
<td>Lock Nut</td>
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<tr>
<td>173</td>
<td>Lock Nut Set Screw</td>
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<tr>
<td>175</td>
<td>Stuffing Box</td>
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<tr>
<td>176</td>
<td>Stuffing Box &quot;O&quot; Ring</td>
</tr>
<tr>
<td>177</td>
<td>Stuffing Box Bearing</td>
</tr>
<tr>
<td>178</td>
<td>Stuffing Box Cap Screws</td>
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<tr>
<td>180</td>
<td>Packing Rings</td>
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<tr>
<td>181</td>
<td>Lantern Rings</td>
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<tr>
<td>185</td>
<td>Packing Gland</td>
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<tr>
<td>186</td>
<td>Pacing Gland Studs &amp; Nuts</td>
</tr>
<tr>
<td>192</td>
<td>Tension Nut &quot;O&quot; Rings</td>
</tr>
<tr>
<td>193</td>
<td>Top Tube</td>
</tr>
<tr>
<td>199</td>
<td>Slinger</td>
</tr>
<tr>
<td>240</td>
<td>Lineshaft Bearing</td>
</tr>
<tr>
<td>250</td>
<td>Top Column Pipe</td>
</tr>
<tr>
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<td>Intermediate Column Pipe</td>
</tr>
<tr>
<td>252</td>
<td>Bottom Column Pipe</td>
</tr>
<tr>
<td>253</td>
<td>Column Pipe Coupling</td>
</tr>
<tr>
<td>256</td>
<td>Column Flange Bolts</td>
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<td>257</td>
<td>Column Flange Nuts</td>
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<tr>
<td>270</td>
<td>Shaft Coupling</td>
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<tr>
<td>272</td>
<td>Intermediate Lineshaft</td>
</tr>
<tr>
<td>274</td>
<td>Lineshaft Sleeve</td>
</tr>
<tr>
<td>280</td>
<td>Bearing Retainer</td>
</tr>
<tr>
<td>283</td>
<td>Open Lineshaft Bearing</td>
</tr>
<tr>
<td>450</td>
<td>See Fig. VII-1</td>
</tr>
</tbody>
</table>

Note: Complete pump description with serial number must be supplied when ordering parts.

Fig. VII-2c. Pump Parts List
PARTS LIST

BOWL ASSEMBLY

BRONZE BEARING OIL LUBRICATED (BZL)
ENCLOSED LINESHAFT CONSTRUCTION

Figure VII-3a.

ALTERNATE MATERIALS AVAILABLE UPON REQUEST
PARTS LIST

BOWL ASSEMBLY

PRODUCT LUBRICATED (PRL)

OPEN LINESHAFT CONSTRUCTION

Figure VII-3b.

ALTERNATE MATERIALS AVAILABLE UPON REQUEST
**CORPORATE OFFICE**

**ARIZONA**
7706 N. 71st Avenue  
Glendale, AZ  85303  
623-979-3560  
Toll Free: 800-966-5240  
Fax:  623-979-2177

**FACTORY BRANCH LOCATIONS**

<table>
<thead>
<tr>
<th>Location</th>
<th>Address</th>
<th>Phone</th>
<th>Toll Free</th>
<th>Fax</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CALIFORNIA</strong></td>
<td>2830 San Antonio Drive</td>
<td>559-497-5071</td>
<td>800-868-9755</td>
<td>559-497-8816</td>
</tr>
<tr>
<td></td>
<td>Fowler, CA  93625</td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>195 E. Third Street</td>
<td>863-735-8222</td>
<td>800-994-3045</td>
<td>863-735-8202</td>
</tr>
<tr>
<td></td>
<td>Zolfo Springs, FL  33890</td>
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<tr>
<td></td>
<td>11176 Green Valley Drive</td>
<td>662-895-1110</td>
<td>866-668-4914</td>
<td>662-895-5083</td>
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<td>Olive Branch, MS  38654</td>
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<tr>
<td></td>
<td>109 Richey Street</td>
<td>713-641-6818</td>
<td>800-231-0590</td>
<td>713-641-4569</td>
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<td>4229 Adrian Street</td>
<td>806-745-5396</td>
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Email: info@natlpump.com  
Website: www.nationalpumpcompany.com