SIMFLO®

PERFORMANCE BEYOND THE PUMP®

VERTICAL TURBINE MANUAL

INSTALLATION, OPERATION & MAINTENANCE

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SIMFLO, LLC. Terms and Conditions

SIMFLO, LLC. is herein referred to as the "**Seller**" and the customer purchasing goods ("**Goods**") from the Seller is referred to as the "**Buyer**." The Terms and Conditions as set forth herein, and the Seller's quotation, estimate or bid to Buyer, shall collectively and exclusively govern all of the rights, duties and obligations of Seller and Buyer related to Buyer's purchase order for the Goods Seller is agreeing to sell to Buyer. Any terms and conditions set forth in Buyer's purchase order which are different or inconsistent with Seller's Terms and Conditions and/or Seller's quotation, estimate or bid, shall be null and void. Buyer's receipt of the Goods, and/or payment, or partial payment, to Seller for the Goods being sold to Buyer, shall evidence Buyer's acceptance of the terms and conditions of the sale as set forth herein. Seller reserves the right, in its sole discretion, to refuse any purchase order.

1. PRICES: Prices for Goods shall apply to the specific quantities stated in Seller's quotation, estimate or bid. Prices shall include standard packing according to Seller's specification for packing and delivery. All costs and taxes for special packing requests by Buyer, including packing for exports, shall be paid by Buyer as an additional charge. Prices for Goods are subject to change without notice based on any subsequent changes in the cost to Seller for sub-supplier materials, supplies or other related increases, and the adjusted price will be based on the cost to Seller in effect at the time of the requested shipment date, and each shipment will be invoiced at such increased price. All prices for Goods are exclusive of, and do not include, any applicable sales, use, excise, GST, VAT or similar taxes, duties or levies, or transportation or insurance costs, and all such costs are the sole responsibility of, and shall be paid by, Buyer.

2. TAXES: Any current or future tax or government charge, or increase in same, affecting Seller's costs of production, sales, delivery or shipment, or which Seller is otherwise required to pay or collect in connection with the sale, purchase, delivery, storage, processing, use of consumption of Goods, shall be paid by Buyer and shall either be added to the purchase price of the Goods or billed to Buyer separately, at Seller's election.

3. ARBITRATION: Seller and Buyer agree that any controversy or claim, excluding collections and past due accounts, arising out of or relating to the agreed terms as provided herein to sell Goods, or the breach thereof, shall be submitted to mandatory arbitration in accordance with the Texas Arbitration Act, and the arbitration award or dispositive order, shall be final and binding and may be entered in any court of competent jurisdiction in the State of Texas. The exclusive place of arbitration shall be within Lubbock County, Texas, and the parties hereby submit to such jurisdiction and venue. Collections and past due accounts may be filed in the appropriate court located in Lubbock County, Texas, and Buyer hereby submits to the exclusive jurisdiction and venue in Lubbock County, Texas.

4. TERMS OF PAYMENT: Seller reserves the right to require payment in advance or C.O.D., and otherwise modify credit terms should Buyer's credit standing not meet Seller's credit requirements. Unless otherwise specified in writing by Seller, the terms of payment are net thirty (30) days from the date of Seller's invoice to be paid in U.S. currency. All credit sales are subject to prior approval by Seller. Seller may, at its option, require copies of pertinent contracts, financial statements and other documents relative to any given sale of Goods in order to evaluate and determine, in its sole discretion, Buyer's credit status or the credit status of any third party with whom Buyer has a contractual relationship concerning the Goods to be furnished to Buyer. Failure or delay in delivery of this information will postpone production and delivery of Goods, and may result in a price increase. In the event payment is not made when due, Buyer agrees to pay Seller a service or finance charge of the lessor of: (i) one and one-half percent (1.5%) per month (18% per annum); or (ii) the highest rate permitted by applicable law, on the unpaid balance of the invoice from and after the invoice due date. Buyer shall be responsible for all costs and expenses associated with any checks returned due to insufficient funds. If, during the performance hereunder with Buyer, the financial responsibility or condition of Buyer is such that Seller in good faith deems itself insecure, or if Buyer becomes insolvent, or if a material change in the ownership of Buyer occurs, or if Buyer fails to make any payments in accordance with the terms as provided herein, then, in any such event, Seller is not obligated to continue performance under the agreed terms as provided herein, and may stop Goods in transit and defer or decline to make delivery of Goods, except upon receipt of satisfactory security or cash payments in advance, or Seller may terminate Buyer's purchase order upon written notice to Buyer without further obligation to Buyer whatsoever. Payment by Buyer to Seller shall not be conditioned upon Buyer receiving payment from any third party.

5. Quotation, (Estimate or Bid), Withdrawal, Expiration. Quotations, estimates or bids are valid for thirty (30) calendar days from the date of issuance, unless otherwise provided therein. Seller reserves the right to cancel or withdraw any quotation, estimate or bid at any time, with or without notice or cause, prior to acceptance by Buyer. There is no agreement if any conditions specified within the quotation, estimate or bid are not completed by Buyer to Seller's satisfaction within thirty (30) calendar days of Seller's written acknowledgement of a purchase order by Buyer. Seller, nevertheless, reserves its right to accept any contractual documents received from Buyer after this 30-day period.

6. SELLER'S RIGHTS IN DEFAULT: In the event Buyer fails to make any payment when due, Seller shall have the right, among other remedies, either to terminate its agreement with Buyer, or suspend further performances under the agreed terms as provided herein and/or any other agreements with Buyer. Buyer shall be liable for all expenses, including attorneys' fees, relating to the collection of past due amounts. Additionally, upon any payment default by Buyer, Buyer shall immediately pay to Seller the entire unpaid amounts for any and all shipments made to Buyer irrespective of the terms of said shipment and whether said shipments are made pursuant to the agreed terms as provided herein, or any other agreement between Seller and Buyer, and Seller may also withhold all subsequent shipments until the full amount due is paid by Buyer. Acceptance by Seller of less than full payment shall not be a waiver of any of its rights hereunder. Buyer shall not assign or transfer its rights, duties or obligations, or any interest in it, or monies payable under it, without the written consent of Seller, and any assignment made without such written consent shall be null and void.

7. SHIPMENT AND DELIVERY: While Seller will use all responsible commercial efforts to maintain the delivery date(s) acknowledged or quoted by Seller, all shipping dates are proximate and not guaranteed. Shipment dates are best, estimates only at the time of the proposal, and are subject to change based on manufacturing load and sub-supplier schedules at Seller's date of order and/or full release to manufacture. Seller reserves the right to make partial shipments. Seller, at its option, shall not be bound to tender delivery of any Goods postponed or delayed by Buyer for any reason. Buyer agrees to reimburse Seller for any and all storage costs and other additional expenses resulting therefrom. Risk of loss and legal title to the Goods shall transfer to Buyer for sales in which the end destination of the Goods is outside the United States immediately after the Goods have passed beyond the territorial limits of the United States. For all other shipments, risk of loss for damage and responsibility shall pass from Seller to Buyer upon delivery to and receipt by a carrier at Seller's shipping point. All shipments are F.O.B. Seller's shipping point. Any claims for shortages or damages suffered in transit are the responsibility of the Buyer and shall be submitted by Buyer directly to the carrier. Shortages or damages must be identified and signed for at the time of delivery. Seller is not responsible for any such shortages or loss. Seller shall not be responsible to Buyer for any loss, whether direct, indirect, incidental or consequential in nature, including without limitation loss of profits or liquidated damages, arising out of or relating to any failure of the Goods to be delivered by the specified delivery date. In the absence of specific instructions, Seller will select the carrier. Buyer shall reimburse Seller for the additional cost of its performance resulting from inaccurate or lack of delivery instructions, or by any act or omission on Buyer's part. Any such additional cost may include, but is not limited to, storage, insurance, protection, re-inspection and delivery expenses. Buyer further agrees that any payment due on delivery shall also be made if the Goods are delivered into storage as though the Goods had been delivered in accordance with the purchase order. Buyer grants to Seller a continuing security interest in and a lien upon the Goods and the proceeds thereof (including insurance proceeds), as security for the payment of all such amounts and the performance by Buyer of all of its obligations to Seller pursuant to this the agreed terms as provided herein and all such other sales, and Buyer shall have no right to sell, encumber or dispose of the Goods. Buyer shall execute any and all financing statements and other documents and instruments and do and perform any and all other acts and things which Seller may consider necessary, desirable or appropriate to establish, perfect or protect Seller's title, security interest and lien. In addition, Buyer authorizes Seller and its agents and employees to execute any and all such documents and instruments, and do and perform any and all such acts and things, at Buyer's expense, in Buyer's name and on its behalf related to its security interest in the Goods. Such documents and instruments may also be filed without the signature of Buyer to the extent permitted by law.

8. LIMITED WARRANTY: Subject to the limitations of Section 9, below, Seller warrants that the Goods manufactured by Seller will be free from defects in material and workmanship at the time of shipment under normal use and regular service and maintenance, for a period of eighteen (18) months from the date of shipment of the Goods by Seller, or one year from start-up, whichever occurs first, unless otherwise specified by Seller in writing. Products and Special Coating Applications purchased by the Seller from a third party for resale to Buyer ("**Resale Products**") shall carry only the warranty extended by the original manufacturer or supplier. ANY ITEM OF THE PRODUCT(S) WHICH IS NOT MANUFACTURED OR APPLIED BY SELLER IS NOT WARRANTED BY SELLER and shall be covered only by the express warranty, if any, of the manufacturer or applicator thereof. **THE WARRRANTY SET FORTH IN THIS SECTION 8 AND THE WARRANTY SET FORTH IN SECTION 9, BELOW, ARE THE SOLE AND EXCLUSIVE WARRANTIES GIVEN BY SELLER WITH RESPECT TO THE GOODS, AND ARE IN LIEU OF AND EXCLUDE ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, ARISING BY OPERATION OF LAW OR OTHERWISE, INCLUDING WITHOUT LIMITATION, MERCHANTABLITY AND FITNESS FOR A PARTICULAR PURPOSE, WHETHER OR NOT THE PURPOSE OR USE HAD BEEN DISCLOSED TO SELLER IN SPECIFICATIONS, DRAWINGS OR OTHERWISE, AND WHETHER OR NOT SELLER'S GOODS ARE SPECIFICALLY DESIGNED AND/OR MANUFACTURED BY SELLER FOR BUYER'S USE OR PURPOSE.** This warranty does not extend to any losses or damages due to misuse, accident, abuse, neglect, normal wear and tear, negligence (other than Seller's), unauthorized modification or alteration, use beyond rated capacity, unsuitable power sources or environmental conditions, improper installation, repair, handling, maintenance or application or any other cause not the fault of the Seller. To the extent that Buyer, or its agents, has supplied specifications, information, representation of operating conditions or other conditions or other data to Seller in the selection or design of the Goods and the preparation of Seller's quotation, estimate or bid, or in the event that actual operating conditions or other conditions differ from those represented by Buyer, any warranties or other provisions contained herein which are affected by such conditions shall be null and void. Equipment performance is not warranted unless separately agreed to in writing by the Seller. Seller manufactures engineered-to-order Goods based on the design point specified by the Buyer. Warranty on performance results will be based on laboratory tests performed at Sellers location. Due to the inaccuracies of field testing, if there are any conflicts between the results of field testing conducted and laboratory testing conducted, the laboratory tests results will control. Seller will not provide or furnish any equipment for field testing. (See Section 16) If within thirty (30) days after Buyer's discovery of any claimed warranty defects within the warranty period, and Buyer notifies Seller thereof in writing; Seller shall, at its option and as Buyer's exclusive remedy, repair, correct, replace or refund the purchase price for that portion of the Goods found by Seller to be defective. Failure by Buyer to give such written notice within the applicable time period shall be deemed absolute and unconditional waiver of Buyer's claims for such defects. Seller shall have the right to require the Buyer to deliver the Goods to Seller's designated repair center or manufacturing facility. All responsibility and expenses associated with removal, dismantling, reinstallation and transportation to and from Seller's designated repair center or manufacturing facility, and the time and expense of Seller's personnel and representatives for site travel and diagnosis under this warranty, shall be paid by Buyer. Goods repaired or replaced during the warranty period shall be covered by the foregoing warranty for the remainder of the original warranty period, or ninety (90) days from the shipment date that the Goods are returned to Buyer, whichever is longer. Buyer assumes all other responsibility for any loss, damage, or injury to persons or property arising out of, connected with, or resulting from the use of the Goods, whether alone or in combination with other products/components.

Buyer agrees to provide any subsequent transferee of the Goods conspicuous, written notice of Section 8 and 9 herein. Sections 8 and 9 shall apply to any entity or person who may buy, acquire or use the Goods, including any entity or person who obtains Goods from Buyer, and such entity or person shall be bound by the limitations as provided herein.

9. LIMITATION OF REMEDY AND LIABLITY: BUYER'S SOLE AND EXCLUSIVE REMEDY FOR BREACH OF ANY WARRANTY HEREUNDER SHALL BE LIMITED TO REPAIR, CORRECTION, REPLACEMENT OR REFUND OF THE PURCHASE PRICE UNDER SECTION 8. SELLER SHALL NOT BE LIABLE FOR DAMAGES CAUSED BY DELAY IN PERFORMANCE, AND THE REMEDIES OF BUYER UNDER THE AGREED TERMS AS PROVIDED HEREIN ARE EXCLUSIVE. IN NO EVENT, REGARDLESS OF THE FORM OF THE CLAIM OR CAUSE OF ACTION (WHETHER BASED IN CONTRACT, INFRINGEMENT, NEGLIGENCE, STRICT LIABLITY, ANY OTHER TORT OR OTHERWISE), SHALL SELLER'S LIABLITY TO BUYER AND/OR ITS CUSTOMERS EXCEED THE PRICE PAID BY BUYER FOR THE SPECIFIC GOODS PROVIDED BY SELLER GIVING RISE TO THE CLAIM OR CAUSE OF ACTION. BUYER AGREES THAT IN NO EVENT SHALL SELLER'S LIABILTY TO BUYER AND/OR ITS CUSTOMERS EXTEND TO INCLUDE LIQUIDATED, INCIDENTAL, CONSEQUENTIAL, PUNITIVE, EXEMPLARY OR SPECIAL DAMAGES, INCLUDING BUT NOT LIMITED TO, LOSS OF PROFITS OR ANTICIPATED PROFITS, LOSS OF ANTICIPATED SAVINGS OR REVENUE, LOSS OF INCOME, LOSS OF BUSINESS AND BUSINESS INTERUPTION, LOSS OF USE, LOSS OF PRODUCTION, LOSS OF OPPORTUNITY, LOSS OF REPUTATION, AND/OR LOSS OR DAMAGE TO PROPERTY OR EQUIPMENT. THE FOREGOING LIMITATIONS OF LIABILITY SHALL BE EFFECTIVE WITHOUT REGARD TO SELLER'S ACTS OR OMISSIONS OR NEGLIGENCE OR STRICT LIABILITY IN THE PERFORMANCE OR NON-PERFORMANCE HEREUNDER. It is expressly understood that any technical advice furnished by Seller with respect to the use of the Goods is given without charge, and Seller assumes no obligation or liability for the advice given, or result obtained, and all such advice being given is accepted at Buyer's risk.

10. Buyer Warranty: Buyer warrants the accuracy of any and all information relating to the details of its operating conditions, including temperatures, pressures, and where applicable, the nature of all hazardous materials. Seller can justifiably rely upon the accuracy of Buyer's information in its performance. Should Buyer's information prove inaccurate, Buyer agrees to reimburse Seller for any losses, liabilities, damages and expenses that Seller may have incurred as a result of any inaccurate information provided by Buyer to Seller.

11. EXCUSE OF PERFORMANCE/FORCE MAJEURE: Seller shall not be liable for delays in performance or for non-performance due to acts of God; acts of Buyer; war; fire; flood; weather; natural disasters; terrorism; sabotage; strikes; labor disputes; civil disturbances or riots; currency restrictions; pandemics; disease; governmental requests, restrictions, allocations, laws, regulations, orders or actions; unavailability of or delays in transportation or in obtaining materials, fuel, power and energy; default of suppliers; or unforeseen circumstances or any events or causes beyond Seller's reasonable control. Deliveries or other performances may be suspended for an appropriate period of time or canceled by Seller upon notice to Buyer in the event of any occurrence of the foregoing, but the balance of the agreement shall otherwise remain unaffected as a result of the foregoing. If Seller determines that its ability to supply the total demand for the Goods, or to obtain material used directly or indirectly in the manufacture of the Goods, is hindered, limited or made impracticable due to causes set forth hereinabove, Seller may allocate its available supply of the Goods or such material (without obligation to acquire other supplies of any such Goods or material) among itself and its buyers on such a basis as Seller determines to be equitable, in its sole discretion, without liability for any failure of performance which may result therefrom.

12. CANCELLATION:. Except as otherwise provided herein, no order may be cancelled on special or made-to-order Goods unless requested in writing by either party and accepted in writing by the other party. In the event of a cancellation by Buyer, Buyer shall, within thirty (30) days of such cancellation, pay Seller a cancellation fee, which shall include all costs and expenses incurred by Seller prior to the receipt of the request for cancellation, including but not limited to, all commitments to its suppliers, subcontractors and others, all fully burdened labor and overhead expended by Seller, plus a reasonable profit charge. Return of Goods shall be in accordance with Seller's most current return policy and subject to a minimum thirty percent (30%) restocking fee, unless otherwise agreed to by the parties in writing. Notwithstanding anything to the contrary herein, in the event that: (i) there is a commencement by or against Buyer of any voluntary or involuntary proceedings in bankruptcy or insolvency; (ii) it is determined Buyer is insolvent; (iii) Buyer makes a general assignment for the benefit of its creditors; (iv) a receiver is appointed on account of Buyer's insolvency; (v) Buyer fails to make payment when due under the agreed terms as provided herein; or (vi) Buyer does not correct or, if immediate correction is not possible, commence and diligently continue action to correct any default of Buyer to comply with any of the provisions or requirements of the agreed terms as provided herein within ten (10) calendar

days after being notified in writing of such default by Seller, Seller may, by written notice to Buyer, without prejudice to any other rights or remedies which Seller may have, terminate its further performance hereunder. In the event of such termination, Seller shall be entitled to receive payment as if Buyer has cancelled its purchase order pursuant to this paragraph. Seller may nevertheless elect to complete its performance of under the agreed terms provided herein by any means it chooses. Buyer agrees to be responsible for any additional costs incurred by Seller in so doing. Upon termination of the agreed terms as provided herein, the rights, obligations and liabilities of the parties, which shall have arisen or been incurred hereunder prior to its termination, shall survive such termination.

13. CHANGES: Buyer may request changes or additions to the Goods consistent with the Seller's specifications and criteria. In the event Seller accepts such changes or additions, Seller may revise the price and dates of delivery. Seller reserves the right to change the design and specifications for the Goods without prior notice to the Buyer, except with respect to Goods being made-to-order for Buyer. Seller shall have no obligation to install or make such change in any Goods manufactured prior to the date of notification of such change.

14. NUCLEAR/FIRE/MEDICAL: GOODS SOLD HEREUNDER ARE NOT FOR USE IN CONNECTION WITH ANY NUCLEAR, FIRE SYSTEMS, MEDICAL, LIFE-SUPPORT AND RELATED APPLICATIONS. Buyer accepts Goods with the foregoing understanding, and agrees to communicate same in writing to any subsequent purchasers or users, and to defend, indemnify and hold harmless Seller for any claims, losses, suits, judgments and damages, including incidental and consequential damages, arising from such use, whether the cause be based in tort, contract or otherwise, including allegations that the Seller's liability is based on negligence or strict liability.

15. ASSIGNMENT: Buyer shall not assign its rights or delegate its duties hereunder, or any interest herein, without the prior written consent of Seller, and any such assignment, without such consent, shall be null and void.

16. INSPECTION/TESTING: Buyer shall have the right to inspect the Goods upon their receipt. When delivery is to Buyer's site or to a project site ("**Site**"), Buyer shall notify Seller in writing of any nonconformity of the Goods with the quotation, estimate or bid, or the agreed terms as provided herein, within three (3) days from receipt of the Goods by Buyer, unless a shorter period is required in Seller's quotation, estimate or bid. For all other deliveries, Buyer shall notify Seller in writing of any nonconformity of the Goods with the quotation, estimate or bid, or the agreed terms as provided herein, within fourteen (14) days from receipt of the Goods by Buyer. Failure to give such applicable notice shall constitute a waiver of Buyer's right to inspect and/or reject the Goods for nonconformity, and shall be equivalent to an irrevocable acceptance of the Goods by Buyer. Claims for loss of or damage to Goods in transit must be made to the carrier, and not to Seller. Buyer, at its option and sole expense, may inspect and observe the testing by Seller of the Goods for compliance with Seller's standard test procedures prior to shipment, which inspection and testing shall be conducted at Seller's plant at such reasonable time as is determined by Seller. Any rejection of the Goods must be made promptly by Buyer before shipment. Tests shall be deemed to be satisfactorily completed, and the test fully met, when the Goods meet Seller's criteria for such procedures. Acceptance by Buyer, or Buyer's representative, of any witnessed testing or coatings will preclude any future rejection.

17. STANDARD, TOLERANCE: Except for made-to-order Goods specified by the Buyer in writing and expressly agreed to in writing by Seller, all Goods furnished hereunder are produced in accordance with the standard manufacturing practices in the country of origin of the Goods. All materials incorporated into the Goods are subject to mill tolerances and variations consistent with normal manufacturing practices for dimension, weight, straightness, section, composition and mechanical properties, normal surface and internal conditions, and deviations in quality resulting from practical testing. Seller is not responsible for any deterioration in quality as a result of the foregoing tolerances and variations.

18. DRAWINGS: Seller's prints and drawings (including without limitation, the underlying technology) furnished by Seller to Buyer in connection with Seller's quotation, estimate or bid are the property of Seller, and Seller retains all rights, including without limitation, exclusive rights of use and license. Buyer shall return all copies (in whatever medium) of such prints or drawings to Seller immediately upon request by Seller. Seller does not supply detailed or shop working drawings of the Goods; however, Seller will supply necessary installation drawings. The drawings and bulletin illustrations submitted with Seller's quotation, estimate or bid, show general type, arrangement and approximate dimensions of the Goods to be furnished for Buyer's information only, and Seller makes no representation or warranty regarding their accuracy. Unless expressly stated to the contrary within the quotation, estimate or bid, all drawings, illustrations, specifications or diagrams form no part of the agreed terms as provided herein. Seller reserves the right to alter such details in design or arrangement of its Goods which, in its sole discretion, constitute an improvement in construction, application or operation of the Goods. All engineering information necessary for installation of the Goods shall be forwarded by Seller to Buyer at the time the Goods are shipped. After Buyer's acceptance of Seller's quotation, estimate or bid, any changes requested by Buyer in the type of Goods, the arrangement of the Goods, or the application of the Goods will be made at Buyer's expense. Instructions necessary for installation, operating and maintenance will be supplied when the Goods are shipped.

19. EXPORT/IMPORT: Buyer agrees that all applicable import and export control laws, regulations, orders and requirements, including without limitation those of the United States and the European Union, and the jurisdictions in which the Seller and Buyer are established, or from which the Goods may be supplied, will apply to the Goods receipt and use. In no event shall Buyer use, transfer, release, import or export any Goods in violation of such applicable laws, regulations, orders or requirements. The Buyer shall not, and shall not permit any third parties to, directly or indirectly, export, re-export or release any Goods to any jurisdiction or country to which, or any party to whom, the export, re-export or release of any Goods is prohibited by applicable law, regulation or rule. The Buyer shall be solely responsible for any breach of this Section 19.

20. Proprietary Information, Injunction: Seller's designs, illustrations, drawings, specifications, technical data, catalogues, "know-how", economic or other business or manufacturing information (collectively "**Proprietary Information**") disclosed to Buyer shall be deemed proprietary and confidential to Seller. Buyer agrees not to disclose, use or reproduce any Proprietary Information without first having obtained Seller's express written consent. Buyer's agreement to refrain from disclosing, using or reproducing Proprietary Information shall survive completion of the work and delivery of the Goods under the agreed terms as provided herein. Buyer acknowledges that its improper disclosure of Proprietary Information to any third party will result in Seller's suffering irreparable harm. Seller may seek injunctive or equitable relief to prevent Buyer's unauthorized disclosure of Proprietary Information.

21. Installation and Start-up: Unless otherwise agreed to in writing by Seller, installation of the Goods shall be the sole responsibility of Buyer. In the event Buyer has engaged Seller to provide an engineer for start-up supervision, such engineer will function in a supervisory capacity only, and Seller shall have no responsibility for the quality of workmanship of the installation. Buyer understands and agrees that it shall furnish, at Buyer's sole expense, all necessary foundations, supplies, labor and facilities that might be required to install and operate the Goods.

22. INSURANCE: Buyer agrees to do all acts necessary to protect Seller's interest by adequately insuring the Goods against loss or damage from any external cause, with Seller named as insured, additional insured or co-insured. Seller and Buyer agree to maintain liability insurance in commercially reasonable amounts covering claims of any kind or nature for damage to property or personal injury, including death, made by anyone that may arise from activities performed or facilitated related to the Goods, whether these activities are performed by that company, its employees, agents, or anyone directly engaged or employed by that party or its agents.

23. GENERAL PROVISIONS: These terms and conditions herein supersede all other communications, negotiations, and prior oral or written statements regarding the subject matter of the agreed terms as provided herein. No change, modification, rescission, discharge, abandonment, or waiver of these terms and conditions shall be binding upon the Seller, unless made in writing and signed on its behalf by a duly authorized officer of Seller. No conditions, usage of trade, course of dealing or performance, understanding or agreement purporting to modify, vary, explain, or supplement these terms and conditions shall be binding unless hereafter made in writing and signed by the party to be bound, and no modification or additional terms shall be applicable to the agreed terms as provided herein by Seller's receipt, acknowledgement, or acceptance of purchase orders, shipping instruction forms, or other documentation containing terms at variance with or in addition to those set forth herein. Any such modifications or additional terms are specifically rejected and deemed a material alteration hereof. If this document shall be deemed an acceptance of a prior offer by Buyer, such acceptance is expressly conditional upon Buyer's assent to any additional or different term set forth herein. There is no waiver by either party with respect to any other breach or default of any other right or remedy, unless such waiver be expressed in writing and signed by the party to be bound. All typographical or clerical errors made by Seller in any quotation, estimate or bid, acknowledgement or publication are subject to correction. No action, regardless of form, arising out of transactions relating to this contract, may be brought by either party more than two years after the cause of action has accrued.

24. GOVERNING LAW: THE AGREED TERMS AS PROVIDED HEREIN, AND THE VALIDITY, PERFORMANCE, AND ALL OTHER MATTERS RELATING TO THE INTERPRETATION AND EFFECT OF AND ALL RIGHTS AND OBLIGATIONS HEREUNDER, SHALL BE GOVERNED BY THE LAWS OF THE STATE OF TEXAS, WITHOUT REFERENCE TO PRINCIPLES OF CONFLICTS OF LAW. SUBJECT TO THE ARBITRATION PROVISION AS PROVIDED HEREINABOVE, THE JURISDICTION OF ANY PROCEEDING RELATED TO THE GOODS SHALL BE IN THE STATE OF TEXAS AND VENUE SHALL BE LUBBOCK COUNTY, TEXAS. THE RIGHTS AND OBLIGATIONS OF THE PARTIES HEREUNDER SHALL NOT BE GOVERNED BY THE 1980 U.N. CONVENTION ON CONTRACTS FOR THE INTERNATIONAL SALE OF GOODS.

25. Titles: The section titles herein are for reference only, and shall not limit or restrict the interpretation or construction of this Agreement.

26. Waiver: Seller's failure to insist, in any one or more instances, upon Buyer's performance of this Agreement, or to exercise any rights conferred, shall not constitute a waiver or relinquishment of any such right or right to insist upon Buyer's performance in any other regard.

27. Severability: The partial or complete invalidity of any one or more provisions of this Agreement shall not affect the validity or continuing force and effect of any other provision

SIMFLO®

WE SEE WATER DIFFERENTLY®

SIMQUAL® CERTIFIED

SEVEN MORE WAYS WE DELIVER PERFORMANCE BEYOND THE PUMP.®

Our SIMQUAL quality control program codifies our decades-long dedication to ensuring every SIMFLO product meets specifications and surpasses performance expectations – fostering trust, confidence, brand reputation as an industry leader and exceptional customer loyalty. SIMQUAL is comprised of a meticulous seven-stage process. Each stage scrutinizes key project aspects. From raw materials to final assembly and shipping, SIMFLO leaves no detail unchecked.

1. PROJECT APPLICATION REVIEW
2. ENGINEERING & TECHNICAL (E&T) AUDIT
3. MANUFACTURING REVIEW & VERIFICATION (MR&R)
4. PERFORMANCE TESTING
5. ASSEMBLY TESTING
6. FINAL COATING PROCESS (FCP)
7. TRANSPORTATION PREPARATION

ONCE ALL SEVEN STEPS ARE VERIFIED, A FINAL SIMQUAL STICKER IS ATTACHED TO THE PUMP (SYSTEM) AND SIGNED, CERTIFIED, DATED AND SENT ON ITS WAY!

SIMFLO®
WE SEE WATER DIFFERENTLY®

SIMQUAL® CERTIFIED

7-STEP SIMQUAL® PROCESS EXPLAINED

1. **Project Application Review:**
   Starting with a detailed review to confirm all requests align with project scope is critical. Our sales and engineering team work to carefully develop accurate quotes you can rely on for budgeting and approval.

2. **Engineering and Technical (E&T) Audit:**
   Approved project application requests are given a pre-production audit to ensure that all products being developed meet the final submitted parameters before beginning production including MTRs verifications. SIMFLO designs customized pumps and specs for final system components. MTRs verification to meet project requirements.

3. **Manufacturing Review and Verification (MR&V)**
   All designed and produced base piping and components are inspected for correct sizing, tolerances, or defects. Parts are then moved into final machining and finishing processes. Then each part is inspected a second time before moving on to testing.

4. **Performance Testing:**
   All parts, both custom designed and manufactured, as well as sourced system parts are performance tested to ensure they meet E&T audit and approved project scope.

5. **Assembly Testing:**
   Approved parts are combined for system assembly and are put through a series of physical and computer testing to match exact output and pressure specifications.

6. **Final Coating Process (FCP):**
   Specific coatings to meet technical requirements like ASME are applied. Formulated coatings also provide added performance and longevity to the pumps through abatement of various environmental conditions.

7. **Transportation Preparation:**
   Completed, tested and approved products/systems are weighed and properly fitted into appropriate custom-built packaging to ensure the final product is shipped safely, securely and ready for installation.

ONCE ALL SEVEN STEPS ARE VERIFIED, A FINAL SIMQUAL STICKER IS ATTACHED TO THE PUMP (SYSTEM) AND SIGNED, CERTIFIED, DATED AND SENT ON ITS WAY!

1.0 SAFETY CONSIDERATIONS

1.1 SAFETY INSTRUCTIONS

There is a multitude of potential dangers when installing, operating and/or maintaining pumping equipment (rotating assemblies, high pressure, high heat, high voltage, chemicals, lifting and handling hazard) just to mention a few. Paying attention to safety is important. Follow OSHA guidance for safety awareness and compliance as well as the safety instructions outlined in this manual. Failure to follow the instructions can cause serious personal injury, death, or property damage.

Information in these user instructions is believed to be reliable. Despite all the efforts to provide correct and necessary information, the content of this manual may appear insufficient and is not guaranteed as to its completeness or accuracy.

Safety Apparel is encouraged, some examples are as follows:

- Insulated Work Gloves
- Heavy Work Gloves
- Safety Glasses
- Steel Toe Boots
- Hard Hats
- Ear Plugs/Covers
- Other Personal Protective Equipment – as may be required to protect against other hazardous conditions, such as electrical shock, toxic fumes and/or fluids.

All personnel involved in the operation, installation, inspection, and maintenance of the unit must be qualified to carry out the work involved. If the personnel in question do not already possess the necessary knowledge and skill, appropriate training and instruction must be provided.

If needed, the operator may commission the manufacturer/representative to provide applicable training.

Always coordinate repair activity with operations and health and safety personnel and follow all plant safety requirements and applicable safety and health laws and regulations.

Additionally, there can be situations that require special attention. These situations are highlighted throughout this manual by the following symbols.

SAFETY ALERT SYMBOL – *When you see this symbol on the pump or in the manual, look for one of the following signal words and be alert to the potential for personal injury or property damage,*

DANGER

Immediate hazards which WILL result in severe personal injury or death if procedures in this manual are not followed.

WARNING

Hazards or unsafe practices which COULD result in severe personal injury or death if procedures in this manual are not followed.

CAUTION

Hazards or unsafe practices which COULD result in minor personal injury or product or property damage if procedures in this manual are not followed.

NOTICE: INDICATES SPECIAL INSTRUCTIONS WHICH ARE VERY IMPORTANT AND MUST BE FOLLOWED.

(NOTE: Notes points of instruction which require specific considerations.)

1.2 SAFETY ACTIONS

WIRE SIZING - Install, ground and wire according to local and national electrical code requirements.

DISCONNECT SWITCH - Install a disconnect switch near the pump.

POWER LOCKOUT - Disconnect and lockout electrical power before installing or servicing the pump.

ELCTRICAL SUPPLY - Electrical supply must match motor's nameplate specifications. Incorrect voltage can cause fire, motor damage and void warranty.

THERMAL CIRCUITS - Single phase pump motors are equipped with an automatic thermal protector, which opens the motor's electrical circuit when an overload condition occurs. This can cause the pump to start unexpectedly when the circuit cools and closes allowing voltage to the motor circuit.

⚠ PUMP ISOLATION - Ensure pump is isolated from the system and the pressure is relieved before disassembling the pump, removing plugs, or disconnecting the piping.

⚠ LIFTING AND HANDLING - Use proper lifting and supporting equipment to prevent serious injury. Do not work under a heavy suspended object unless there is positive support and safeguards, which will protect personnel, should a hoist or sling fail.

⚠ DECONTAMINATION - Observe all decontamination procedures.

⚠ SAFETY GUARDS - Safety Guards must not be removed or missing while the pump is operational.

⚠ THERMAL SHOCK - Rapid changes in the temperature of the liquid within the pump can cause thermal shock that can result in damage or breakage of components and should be avoided.

⚠ APPLYING HEAT – Great care shall be taken if heat is used to disassemble a pump. Some parts may have been shrunk to fit on the pump shaft and may require heat for removal. Special care should be taken to ensure that all gas toxins and or flammables are not present which could cause a fire and/or explosion.

⚠ HOT/COLD PARTS – If hot or freezing part and/or components can present a hazard to operators and/or persons entering the immediate area, then actions must be taken to avoid accidental contact. If complete protection is not possible, then access must be limited to maintenance personnel only, with clear visual warnings and indicators to those entering the immediate area.

⚠ HAZARDOUS LIQUIDS – if a pump is handling hazardous liquids, care must be taken to avoid exposure to the liquid by appropriate setting of the pump, limiting personnel access, and by operator training. If the liquid is flammable and/or explosive, strict safety procedures must be applied.

NOTICE: PACKING TYPE SEALS MUST NOT BE USED WHEN PUMPING HAZARDOUS LIQUIDS.

⚠ EXPLOSIVE ATMOSPHERES - Prior to installing any equipment, determine the hazardous area classification and any other requirements applicable to the specific location and confirm all equipment has the required certifications.

⚠ EXTERNAL PIPE LOAD - Do not use pump as a support for piping. Do not mount expansion joints, unless allowed by the pump manufacturer in writing, so that their force, due to internal pressure, acts on the pump flange.

⚠ ENSURE CORRECT LUBRICATION – *(See Section 5, Pump Startup and Operation, and Section 6.5, Recommended Lubricants).*

⚠ PUMP STARTUP – (Unless otherwise stated at a specific point in the user instructions), Start the pump at reduced speed or with the outlet valve partly opened. This is recommended to minimize the risk of overloading and damaging the pump motor at full or zero flow. Pumps may be started with the valve further open only on installations where a partly opened valve cannot occur. The pump outlet valve may need to be adjusted to comply with the duty following the run-up process*. (See Section 5, Pump Startup, Operation and Shutdown.)*

⚠ NEVER RUN THE PUMP DRY

⚠ SUCTION VALVES TO BE FULLY OPEN WHEN PUMP IS RUNNING

⚠ DO NOT RUN THE PUMP CONTINUOUSLY OUTSIDE THE ALLOWABLE OPERATING RANGE – Operating at a flow rate outside the pumps design parameters with no back pressure on the pump may overload the motor and cause cavitation/vibration. Running the pump at a flow rate below the pumps design parameters can cause damage due to reduction in pump bearing life, inter-bowl recirculation of fluids, overheating of pump, instability, and cavitation/vibration.

⚠ EXCESSIVE PUMP NOISE OR VIBRATION – may indicate a dangerous operating condition. The pump(s) must be shut down immediately.

⚠ ALL EQUIPMENT USED FOR LIFTING MUST BE MAINTAINED AND INSPECTED TO BE IN GOOD CONDITION AND APPROPRIATE FOR THE WEIGHT.

⚠ DO NOT ATTEMPT TO LIFT BOWL ASSEMBLY BY THE PUMP SHAFT. THIS MAY RESULT IN DAMAGE TO THE PUMP SHAFT.

1.3 EMERGENCY PROCEDURES

Several possible emissions or leakage of hazardous substances may be possible depending on the product being pumped. Ensure you are familiar with site and local procedures and requirements.

2.0 GENERAL INSTRUCTIONS

2.1 RECEIVING THE PUMP

When receiving the shipment, extreme care must be taken while unloading not to drop or damage the pump or packaging. Handle all components carefully. Inspect the shipping crate for transit damage prior to unpacking the pump. After unpacking, visually inspect the pump and check the following:

- Contents of the pump assembly against the packing list.
- All components against damage.
- All shafting for damage, should the crate be broken or show careless handling.

Any shortages or damages should be immediately called to the attention of the freight carrier or agent by which the shipment arrived, and proper notation made on the bill. This will prevent any controversy when claim is made and facilitate prompt and satisfactory adjustment. Pictures are always an advantageous form of added documentation for any signs of damage prior to and/or promptly after removal from the freight carrier. Pictures of any damaged components/parts after opening a damaged package is also highly suggested.

NOTICE: Damaged pumps, components and/or parts are the responsibility of the freight carrier and not the shipper (manufacturer). Any claims for shortages and/or damages must be filed by the receiver with the freight carrier. Prompt notification and filing is highly suggested to facilitate a prompt and satisfactory adjustment.

2.2 HANDLING & TRANSPORTATION

⚠ WARNING

ALL LIFTING AND RIGGING must be performed by qualified and experienced personnel who are familiar with safe lifting practices and requirements. A lifting plan should be established and followed to ensure safe lifting of all equipment.

When practical, standard practice is to ship close coupled short-set vertical turbine pumps assembled. For longer pump lengths where shipping limitations, handling limitations and headroom limitations prevent complete assembly, we will ship the pump sub-assembled. It is the responsibility of the installer to ask for assistance should it be required to properly assemble and install the pump.

The pump and additional equipment have been prepared for shipment at the factory in such a way to minimize potential damage from handling and transport. It is important to exercise extreme care in handling all parts. Certain items are precision machined for proper alignment and, if dropped, banged, sprung, or mistreated in any way, misalignment and malfunction will result.

The pump must be transported in the horizontal position. If the bowl assembly is strapped to an I-beam for support, do not remove the bowl assembly from the I-beam support until the bowl assembly is in the vertical position. 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. Components should be unsecured and removed from shipping containers only when necessary for installation.

All components must be handled and transported securely by using suitable slings and tie-down devices. Handling must be carried out by specialized personnel to avoid damage to the pump and persons. The lifting rings attached to various components should be used exclusively to lift the components for which they have been supplied.

Parts which are too heavy to be manually lifted from the transporting vehicle and appropriate lifting equipment is not available, should be skidded slowly and carefully to the ground to prevent damage. Never unload by dropping parts directly from the carrier to the ground and never use shipping crates for skids. Best practice for safe loading and unloading of all equipment is to make sure the proper personnel and equipment are available.

Other components, such as the electrical cable, may be vulnerable to gouging or scuffing. Special care and protection should be given to ensure the jacket and insulation on the power cable and motor leads are not damaged in any way.

⚠ WARNING

DAMAGED POWER CABLES MAY CAUSE EQUIPMENT FAILURE AND PERSONAL INJURY OR DEATH.

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

2.3 SHORT-TERM STORAGE

SIMFLO defines short-term storage as three months or less. The storage time is considered to start from the time the pump is delivered and awaiting installation.

This section is intended to be of general assistance to users of SIMFLO VT pumps. It shall not modify, amend and/or otherwise alter the scope of SIMFLO VT pumps warranty responsibilities to the purchaser in any way whatsoever. Specific procedures for storing motors, gearheads, and engines should be obtained from the equipment manufacturer.

SIMFLO uses approved protective preservatives with an effective life of 3-18 months or less depending on the storage environment.

Normal packaging is designed to protect the pump during shipment and for dry, indoor storage for up to three months or less. The pump shall be considered in storage when it has been delivered to the job site and waiting to be installed. Steps should be taken to protect the pump against moisture, dirt, and foreign particulate intrusion.

Indoor storage is preferred. If indoor storage is not available, then it is preferred that the storage area is paved, well drained and free from flooding. Pumps and/or component parts shall be sorted to permit ready access for inspection and/or maintenance without excessive handling.

Minimum requirements for short-term storage is as follows:

- Loose unmounted items. This packaging will provide protection for up to twelve months without damage to mechanical seals, bearings, lip seals, etc. due to humidity, salt laden air, dust, etc.
- After unpacking, protection will be the responsibility of the user. Addition of oil to the bearing housing will remove the inhibitor. If units are to be idle for extended periods after the addition of lubricants, inhibitor oils and greases should be used.
- Re-greaseable bearings are packed with grease.
- All uncoated surfaces require rust preventative monthly.
- Exposed threads are taped with polywrap.
- Flange faces are protected with covers.
- All assemblies are attached to a wood skid which confines the assembly within the perimeter of the skid, at least 6" above grade.
- Added protection is provided to assemblies with special paint.
- All assemblies having external piping (seal flush and cooling water plans), etc. are packaged and braced to withstand normal handling during shipment. In some cases, components may be disassembled for shipment. The pump must be stored in a covered, dry location.
- Enclose the unit with black polyethylene with a minimum thickness of 0.15mm and seal it with tape.
- Rotating assembly should not be left in one position for more than one month at minimum without rotating the pump shafting counterclockwise. Shaft should rotate freely.

2.4 LONG-TERM STORAGE

SIMFLO defines long-term storage as more than three months. The storage time is considered to start from the original time the pump is delivered and awaiting installation.

In addition to the short-term storage procedures above, the recommended procedures for long-term storage of pumps are as follows:

- Remove split rings, packing and lantern rings from the packing box and place in a clean plastic bag for storage.
- Inspect the lube oil piping and either fill the piping with rust preventative oil, or re-coat the piping periodically to prevent corrosion.
- Place 5 pounds of vapor phase inhibitor crystals or 10 pounds of moisture absorbing desiccant near the center of the pump. If the pump is assembled, place an additional one pound in the discharge opening securely fastened to the discharge elbow.
- Install a moisture indicator near the perimeter of the pump. Provide a small ventilation hole approximately ½ inch diameter.
- Provide a roof or warehouse shelter to protect from direct exposure to the elements.

2.5 MATERIALS & EQUIPMENT REQUIRED

The materials and equipment required for the installation of the pump will vary depending on the type and size of the pump, and the type of installation. The following list of supplies and tools is provided only as a guide.

Hand Tools

- Pipe wrenches
- Mechanics tools
- Clean rags
- Feeler gauges
- Dial indicator to assist with equipment alignment
- Machinist level
- Taperlock driver

Rigging Equipment

- Mobile power hoist, traveling crane or derrick.
- Drag line and blocks.
- Lifting bell for threaded column.
- Lifting slings, cables, and chains (properly sized and inspected for good condition).
- Elevator clamps if unit is unassembled.
- Clevises for use with eyebolts.
- Timbers: size, length, and quantity to support long pump parts on the floor.
- I-Beams to support pump over installation.

Materials – (See section 6.5 for specifications)

- Thread compound
- Anti-Galling lubricant
- Grease
- Lubricating Oil
- Turbine Oil

2.6 GENERAL DESCRIPTION

PUMP NAME PLATE IDENTIFICATION

All pumps are identified by serial number, model number and size. This information is stamped on a stainless-steel identification plate which is permanently attached to the Discharge Head and Bowl Assembly. The pumps serial number is critical information regarding spare parts and duplicates when contacting factory.

COMPONENT DESCRIPTIONS

Pump unit's less than 20 feet in overall length are normally shipped assembled and ready for installation as approved by customer. All pump units greater than 20 feet in overall length are shipped unassembled as individual components.

DRIVER

Drivers can be placed into two categories, Solid-shaft, and Hollow-shaft.

Vertical Hollow Shaft (VHS) motors or Right-angle gear drives are often used with a separate head shaft through the driver and connected to the pump by a clutch assembly at the top of the driver.

Vertical Solid Shaft (VSS) motors are connected to the pump by an adjustable flanged coupling on the driver shaft which protrudes from the bottom of the motor.

Submersible motors are considered a solid-shaft driver and are connected directly to the bottom of the pump by a splined and/or keyed coupling.

DISCHARGE HEAD ASSEMBLY

The discharge head supports the driver and bowl assembly. It typically is used as a discharge connections.

Ports are provided for connecting the pressure gauge, seal bypass return and lubricator connections. The shaft seal will typically be a mechanical seal assembly, packing box, or tension assembly.

OPEN LINE-SHAFT COLUMN ASSEMBLY

Open lineshaft allows the pumping fluid to lubricate the line-shaft bearings (See Figure 1). Components are as follows:

COLUMN PIPE - connects the bowl assembly to the discharge head. The column may be threaded or flanged to ensure proper shaft and bearing alignment.
LINE-SHAFT – connects the bowlshaft to the driver.
BEARINGS – spaced along the shaft to provide line-shaft support below the discharge head down to the bowl assembly.
BEARING RETAINERS - center the bearings within the column pipe.

ENCLOSED LINE-SHAFT COLUMN ASSEMBLY

Enclosed lineshaft has tube around the lineshaft and filled with oil, grease, or injected liquid to lubricate the line-shaft bearings (See Figure 2). Components are as follows:

COLUMN PIPE - connects the bowl assembly to the discharge head. Column may be threaded or flanged.
LINESHAFT – connects the bowl shaft to the driver.
ENCLOSING TUBE – encloses the line-shaft and connected via tube bearings.
TUBE BEARINGS – shaft bearings centering the bearing within the enclosing tube
TUBE RETAINERS – center the enclosing tube within the column assembly. Typically, either integral to the column or rubber inserts.

BOWL ASSEMBLY

The bowl assembly main components:
BOWLSHAFT – connects the impellers to a driver.
IMPELLERS – pressure generating hydraulic components.
IMPELLER ATTACHMENTS

- Taperlocks are used to fasten the Impellers to the bowl shaft in fluid temperatures up to 180°F Max. and shaft sizes up to 2.19".
- Keyed Impellers are used for fluid temperatures over 180°F and bowl sizes over 16".

BOWLS – reorient flow produced via impellers and contain pressure. They generally have flanged connections.
SUCTION –directs the fluid into the first impeller.
DISCHARGE ADAPTER –used to adapt bowls to a flange or threaded column. It may also adapt enclosed tube.
BEARINGS –placed in the suction and in each bowl.
STRAINER – to strain large foreign objects from entering the eye of the impeller.

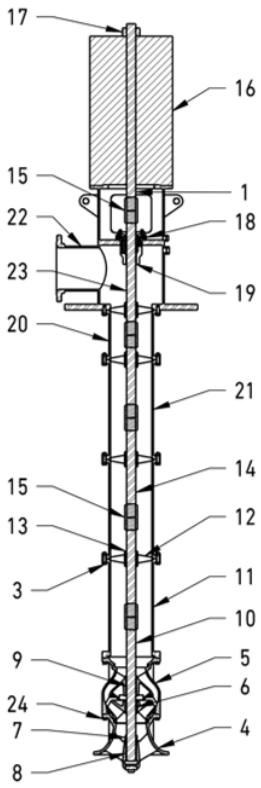


Figure 1

HEAD ASSEMBLY	
ITEM	DESCRIPTION
22	DISCHARGE HEAD
19	SEAL BEARING
18	SEAL HOUSING
15	MOTOR CONNECTION
23	TOPSHAFT
1	MOTORSHAFT
16	MOTOR
17	ADJUSTING NUT

COLUMN ASSEMBLY	
ITEM	DESCRIPTION
20	TOP COLUMN
21	INTERMEDIATE COLUMN
11	BOTTOM COLUMN
12	BEARING RETAINER
13	LINESHAFT BEARING
14	LINESHAFT
15	LINESHAFT CONNECTION
3	COLUMN CONNECTION

BOWL ASSEMBLY	
ITEM	DESCRIPTION
4	SUCTION
5	BOWL
6	IMPELLER ATTACHMENT
7	SAND COLLAR
8	SUCTION BEARING
9	BOWL BEARING
10	BOWLSHAFT
24	BOWL CONNECTION

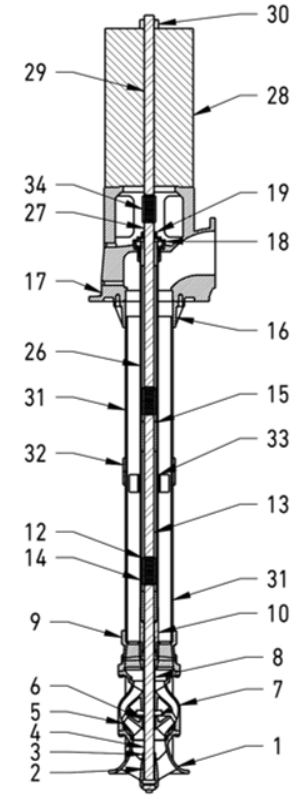


Figure 2

HEAD ASSEMBLY	
ITEM	DESCRIPTION
17	DISCHARGE HEAD
19	TENSION NUT
18	TENSION PLATE
34	MOTOR CONNECTION
27	TOPSHAFT
29	MOTORSHAFT
28	MOTOR
30	ADJUSTING NUT

COLUMN ASSEMBLY	
ITEM	DESCRIPTION
31	COLUMN
33	SPIDER
15	TUBE BEARING
13	LINESHAFT
12	LINESHAFT CONNECTION
32	COLUMN CONNECTION
14	TUBE
26	TOP TUBE
16	HEAD ATTACHMENT

BOWL ASSEMBLY	
ITEM	DESCRIPTION
1	SUCTION
7	BOWL
6	IMPELLER ATTACHMENT
3	SAND COLLAR
2	SUCTION BEARING
8	BOWL BEARING
4	BOWLSHAFT
9	DISCHARGE
8	THROTTLE BEARING
10	OIL TUBE ADAPTER KIT

3.0 INSTALLATION & ALIGNMENT

WARNING

WARNING – PERSONAL INJURY

The pump must be installed, operated, and maintained only by personnel who are trained and have sufficient knowledge about the hazards that may occur during such work.

3.1 PREPARATION

Review Safety Procedures and look for any safety hazards that require attention prior to beginning installation. Make sure the work area is clean and clear of any debris or objects which are not needed as a part of each progressive step of installation.

Turbines are precision equipment and must be treated as such. Proper installation is necessary to obtain maximum service life from the pump.

All machined mating surfaces must be clean and free of burrs and nicks. These surfaces must be cleaned thoroughly with scraper, wire brush and cloth if necessary, and any nicks or burrs must be removed with a fine file.

All threads must be checked for damage and repaired if necessary. If filing is required, remove the part from the pump if possible, or arrange a rag to catch all the filings so that 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 suitable for steel. Use an anti-galling compound on stainless and Monel mating threads.

3.2 WELL OR SUMP CONDITIONS

WELL CONDITIONS

Make sure that the well complies with applicable local codes. Ensure the well casing I.D. is large enough to accommodate the O.D. of the bowl and column assemblies. If a submersible pump is being used, be sure the casing I.D. is large enough to accommodate the motor flow sleeve, power cable and cable guard without scrapping or damaging the cable during installation and operation.

Ensure the pumps inlet of the bell is located below the water according to manufacturer's minimum submergence, while complying with ANSI/HI 9.8 for distance to the bottom of sump.

The pump unit must be operated in a straight well. Installing a pump unit in a crooked well may bind and distort the pump column causing premature failure. When the straightness of the well is not known, the well should be gauged prior to installation by lowering a dummy assembly, slightly longer and larger diameter than the bowl assembly to ensure the pump unit can be set at the proper depth to meet the service condition requirements.

Some benefits for wells developed with a test pump prior to installation. Test pumps remove excess sand, and can help determine capacity and draw down.

SUMP CONDITIONS

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 as uneven flow patterns can create surface and sub-surface vortices. Vortexing can introduce air into the pump, can increase power consumption, can influence submergence requirements, and can produce objectionable noise and vibration.

For these reasons, 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.

3.3 FOUNDATION PLATE OR BARREL PLATE

The foundation must be located to allow adequate space for operation, maintenance, and inspection. The foundation must be able to absorb any vibration and form a permanent, rigid support for the pumping unit. Additionally, the foundation must be strong enough to support the total weight of the pump and the liquid passing through it.

CONCRETE FOUNDATION

Though foundations can be formed of steel structures, they are typically formed of concrete that is poured on a solid footing. The recommended mass of a concrete foundation is three times that of the pump, motor, and base. A typical installation will have bolts with a pipe sleeve 2 to 2-1/2 times the bolt diameter embedded in the concrete. Bolts should be sized and located according to the dimensions on the certified pump outline drawing and/or the foundation plate to be used. The pipe sleeve allows movement for the final positioning of the foundation bolts to align with the holes in the plate. (See Figure 3)

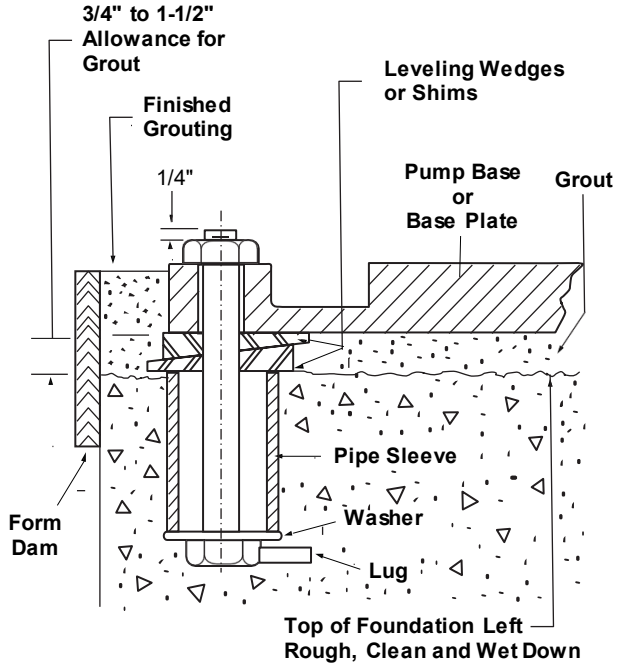


Figure 3

FOUNDATION PLATE OR BARREL PLATE

Foundation plate is a term used to describe a solid steel plate mounted in grout or bolted to steel structures at the interface of the pump discharge head to the foundation, completing the load path into the foundation. These plates help provide a uniform distribution of the pumps total weight load to the foundation, and therefore conform to the shape of the foundation, typically a square or a rectangle.

⚠ CAUTION

Once the foundation plate is grouted, the plate cannot be adjusted so it is extremely important that all alignment procedures be completed prior to grouting.

NEW FOUNDATION PLATE OR BARREL INSTALLS

If the pump is equipped with a foundation plate, it should be installed separately.

Make sure that the pump will pass through the opening in the plate. If the pump will not pass through the plate, it will complicate service and maintenance operations.

Thoroughly clean both sides of the plate with an appropriate solution. It is sometimes necessary to coat the underside of the plate with an epoxy primer.

Leveling the plate may be done by several methods.

- Leveling Wedges and Shims.
- Leveling Nuts on the anchor bolts.
- Jack Screws mounted through the plate.

Shims and metal wedges are not recommended for leveling because they are difficult to remove before or after grouting. On large units, small leveling screws (jack screws) made of cap screws and nuts under the sole plate may be used. If used, the leveling screw threads should be covered with a nonbinding material, such as grease, putty, or tape, before grouting, to facilitate their removal. A gap of about ¾" to 1-½" inches should be allowed between the plate and the foundation for grouting.

Regardless of the method, a machinist level should be used for leveling. To ensure an accurate reading the surface should be free of all contaminants, such as dust. Level the plate in two directions at 90 degrees on the machined surface. The levelness tolerance is 0.005 inches per foot for commercial, and 0.001 inches per foot for API, regardless of machined face or not.

If the plate has machine planed mounting surfaces, these machined surfaces are to be referenced when leveling the plate. If the plate is without machine planed mounting surfaces, the pump and motor are to be left on the plate. The proper surfaces to reference when leveling the plate assembly are the pump suction and discharge flanges. Do not stress the plate, and do not bolt the discharge flanges of the pump to the piping until the plate foundation is completely installed. Use leveling jackscrews to level the plate. Check for levelness both inline direction with the discharge and 90° direction to the discharge. Do not rely on the bottom of the plate to be flat. Standard plate bottoms are not machined, and it is not likely that the field mounting surface is flat.

After leveling the plate, tighten the anchor bolts. If shims were used, make sure that the plate was shimmed near each anchor bolt before tightening. Failure to do this may result in a twist of the plate,

which could make it impossible to obtain final alignment. Check the level of the plate to make sure that tightening the anchor bolts did not disturb the level of the plate. If the anchor bolts did change the level, adjust the jackscrews or shims as needed to level the plate. Continue adjusting the jackscrews or shims and tightening the anchor bolts until the plate is level.

Grouting the plate. Provisions to properly fill and vent the plate grout must be made prior to installation. Inspect foundation for dust, dirt, oil, chips, water, etc. and remove any contaminants. Do not use oil-based cleaners as grout will not bond to it. Refer to grout manufacturer's instructions.

Form a dam around foundation (See Figure 3). Thoroughly wet foundation. If the elevation of the plate is critical, this should be considered prior to and during leveling. Pour grout between plate and concrete foundation, up to level of formed dam. A gap of about 1 to 2 inches should be allowed between the plate and the foundation for grouting. Remove air bubbles from grout as it is poured by puddling, using vibrator, or pumping the grout into place. Non- shrink grout is recommended.

Allow grout to set for 48 to 72 hours before tightening the foundation bolts.

EXISTING GROUTED FOUNDATION PLATES OR BARREL INSTALLS

Installation will vary when installing a pump on an existing grouted plate. Mount the pump on the existing plate. Level the pump by putting a level on the discharge flange. If not level, the plate will have to be removed and then realigned and re-grouted or add or delete shims between the pump discharge head and the plate.

3.4 PIPING

Refer to Hydraulic Institute Standards guidelines for piping and must be reviewed prior to pump installation.

⚠ WARNING

Never draw piping into place by forcing the flange connections of the pump. Pipe strain will adversely affect the operation of the pump resulting in damage to the equipment and possible physical injury.

Exterior strain must not be transmitted to the pump. The most common cause of trouble is forcing the discharge piping to mate with the pump. It is recommended that flexible connectors are installed in the piping adjacent to the pump, when possible. This is especially critical for the underground discharge units where the discharge could be several feet below the supporting structure and a relatively small strain can cause misalignment. All piping must be independently supported and accurately aligned so that undue pipe strain is not imposed on the pump. It should be possible to install suction and discharge bolts through mating flanges without pulling or prying on either of the flanges.

Carefully clean all pipe parts, valves and fittings, and pump branches prior to assembly.

Exercise special care when handling parts which have special coatings. If the coating is damaged (nicks, scrapes, wrench marks, etc.), the damaged spots should be repaired before the installation is completed

All piping must be tight. Pumps may vapor- lock if air is allowed to leak into the piping.

Isolation and check valves should be installed in the discharge line. Locate the check valve between isolation valve and pump, this will allow inspection of the check valve. The isolation valve is required for regulation of flow, and for inspection and maintenance of pump. The check valve prevents pump or seal damage due to reverse flow through the pump when the driver is turned off.

If used, Increasers should be placed between pump and check valves. Hydraulic cushioning devices should be used to protect the pump from surges and water hammer if quick- closing valves are installed in the system.

3.5 SUCTION

SUCTION PIPING REQUIREMENTS

A vertical pump in a suction barrel or a vertical multistage pump performs properly when supplied with a steady flow of liquid with a uniform velocity profile and with sufficient pressure to provide adequate net positive suction head available.

Failure of the suction pipe to deliver the liquid to the pump in this condition can lead to noisy operation, swirling of liquid around the suspended pump assembly, premature bearing failure, and cavitation damage.

For pumps operating with suction pressure below atmospheric pressure, or handling fluids near their vapor pressure, the suction line should slope constantly upwards toward the pump to avoid

trapping vapor using eccentric reducers where necessary.

In systems where the suction line is not always kept full of liquid, there is a possibility that a large slug of air or vapor may be swept into the pump during a restart, causing a partial or complete loss of pump prime. Any high point in a suction line will accumulate gas with similar results.

Entrained air reduces pump total head and rate of flow, with amounts as small as 1% by volume affecting radial flow pumps, and 3% to 5% affecting axial flow pumps. Cascading water causing air entrainment should therefore be avoided. For well pumps, the perforated casing should be located below the pump suction.

Return lines into sumps or tanks should terminate a minimum of two pipe diameters below the low liquid level. Undersized or partially blocked intake screens and trash racks result in similar problems, caused by excess pit velocity. Adequate provisions for cleaning rotating screens and trash racks should be made.

Reference ANSI/HI 9.8 Pump Intake Design for suction piping recommendations.

SUCTION PIPE REDUCERS

Reducers are installed just ahead of the pump suction when the pipe is larger than the pump nozzle. Reducers used at the pump suction should be of the conical type and sufficiently long to prevent liquid turbulence.

With the liquid source below the pump, the reducer should be eccentric and installed with the level side up. Eccentric or concentric reducers may be used when the liquid source is above the pump and the suction piping is sloping upward towards the source.

SUCTION VALVES & MANIFOLDS

Block valves should be installed to isolate the pump for safe maintenance.

⚠ CAUTION

Suction Valves must be Fully Open when pump is running.

Foot valves are specially designed check valves sometimes used at the inlet-to-bowl assemblies for well pumps to keep the column water filled and to prevent backspin and well disturbance caused by rapidly draining water.

ELBOW AT PUMP SUCTION

When a straight run of pipe at the pump suction cannot be provided, certain arrangements of fittings should be avoided for vertical pumps installed in suction barrels and for vertical multistage pumps. When liquid flows through an elbow or makes a turn through a tee, the exit velocity will be strongly nonuniform. Elbows positioned with their plane of curvature perpendicular to the pump shaft should therefore not be used since a strong vortex motion can be set up in the liquid in the pump barrel. This could lead to a swirling motion in the suspended pump and result in bearing failure, noisy operation, and cavitation damage in the first stage of the pump assembly. Splitters inside the suction barrel can be used to break up the liquid swirl.

Ninety-degree suction elbows should be designed to include guide vanes.

CHECK VALVES

Check valves may be used in the discharge to prevent backflow but should not be used in the suction line. They are sometimes used in series-parallel connections to reduce the number of valves that should be operated when changing from one type of operation to the other. In some applications, check valves may be provided with dashpots to mitigate the slamming effect of the valve during closing.

In a submersible pump application, excessive backspin speed and hydraulic shock can cause severe damage to the pump and motor. Install at least one check valve to help prevent this. Install check valve in discharge pipe 5-20 ft above pump.

The bottom check valve must be installed at a level that will ensure that the check valve is always below water level. Failure to do so will cause water hammer during start-up and cause severe damage to the submersible motor and system components.

SUCTION STRAINERS

Strainers may be attached at the point of the suction on a pump to keep out unwanted solids or large debris. Clean strainers have a minimal pressure drop, but the pressure drop may increase as debris accumulates and block the strainer openings. Pressure taps can be installed to monitor the pressure drop caused by the strainer. Strainers attached to the suction of the pump usually clean themselves by backflow when the pump is stopped,

however depending on the debris accumulated they may require manual cleaning.

INSTALLING SUCTION PIPE IN A DEEP WELL

If the overall length of the assembled strainer, suction pipe and bowl assembly does not exceed the maximum hook height of the derrick or hoist, the suction pipe can be assembled to the bowl while they are on the ground. The bowls and suction pipe can then be installed as one unit per the instructions given in Section 4.6 If the travel of the derrick or hoist being used is not sufficient, it will be necessary to install the suction pipe and bowl assembly separately, as follows

1. Attach a pipe clamp or elevator clamp to the upper end of the first piece of suction pipe (with strainer attached if strainer is required).
2. Attach a sling to the elevator clamp and hoist the pipe and strainer assembly to the vertical position taking care not to damage the strainer. Push the bottom of the pipe away from the well opening and tap the side of the pipe to remove any loose matter.
3. Center the suction pipe and strainer assembly over the well opening and carefully lower it until the clamp ears are resting squarely on the setting beams and slip plate. Remove the sling.
4. Apply thread compound to the exposed threads.
5. If there are no additional sections of suction pipe, proceed with the installation of the bowl assembly as described in the following section. If there are additional sections, install the elevator clamp to the next section to be installed, hoist it to the vertical position, then slowly lower the hoist and screw the pipe into the coupling. Using chain tongs, tighten the pipe connection securely. Remove the chain tongs, raise the hoist slightly, remove the elevator clamp from the lower piece of pipe, secure the airline (if required) to the upper piece of pipe and slowly lower the assembly until the upper elevator clamp is resting on the setting beams and slip plate. Repeat the above until all the suction pipe has been installed.

3.6 BOWL ASSEMBLY INSTALLATION

Use a protective covering over open well, sump, column and or discharge piping when appropriate to decrease the chances for foreign material or objects to enter. Should a foreign object enter any openings, they must be removed before proceeding.

⚠ WARNING

Do not work under a heavy suspended object unless there is positive support and safe guards, which will protect personnel, should a hoist or sling fail.

⚠ CAUTION

Do not lift or handle the pump or bowl by the shaft.

1. Inspect the Bowl Assembly as follows:
   - Make sure all bolting is tight.
   - Turn the pump shaft by hand and make sure it turns freely.
   - Make sure no rags, wood or other foreign material are in the nozzles
   - If the discharge nozzle has bleed ports (used if enclosed line shaft type column is to be used), make sure that these ports are free of obstructions.
2. If pump setting exceeds 200 ft., measure the available bowl assembly lateral (shaft end play) by pushing shaft toward suction bowl, mark shaft, pull shaft out and mark again. Measure the distance between the marks and record. This will later aid in adjusting the final impeller position. This measurement must be completed before proceeding.
3. Place two I-beam supports across the foundation plate opening, strong enough to safely support the weight of the entire pump assembly. Use protective plywood between the beams and the plate to prevent plate surface damage. These I-beams should be connected by threaded rods and nuts to firmly clamp them together around the portion to be supported.

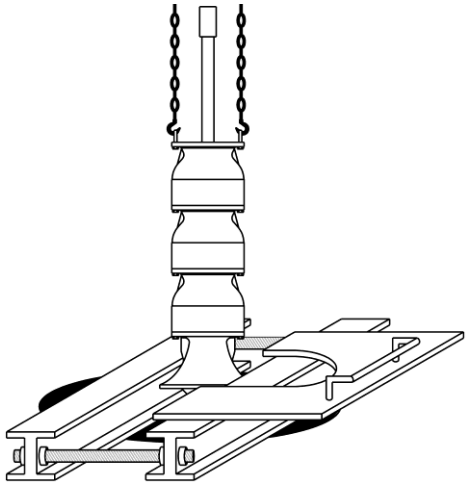


Figure 4

4. Place a properly sized hoist or derrick over the foundation plate opening with the hook hanging in the center.
5. Place the elevator clamps just below the discharge bowl, and utilize a lifting bail sized to handle the weight of the bowl assembly and suction apparatus. For flanged column install

two threaded eyebolts through the discharge bowl bolt holes 180° apart.

6. Attach a sling to the elevator clamps, eyebolts, or lifting bail. Make sure that the sling is long enough for the load hook to clear the shaft.

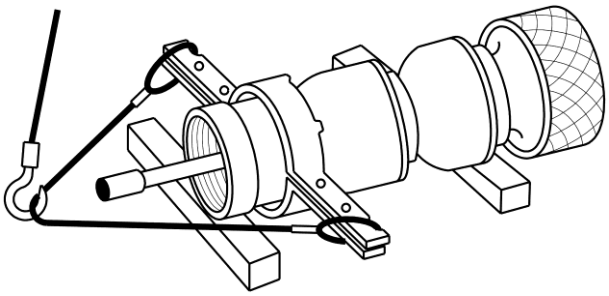


Figure 5

7. Hoist the bowl assembly to a vertical position being careful not to damage the pump suction or strainer. Use a rope to tail in the bowl assembly preventing it from swinging.
8. If suction pipe is provided, lower the bowl assembly until the bottom end of the suction meets the top end of the suction pipe. Apply thread compound and screw together.
9. Carefully lower bowl assembly, guiding the unit so it does not strike the sides of the opening. Continue to lower bowl assembly until the elevator clamps or discharge bowl flange rests firmly on the I-beam supports.
10. Place a cover over the discharge bowl opening to prevent entrance of foreign matter until ready for installation of the column assembly.

⚠ CAUTION

Do not drop any foreign object into the bowl assembly. Any foreign object dropped into the bowl assembly must be retrieved prior to continuing.

3.7 COLUMN ASSEMBLY INSTALLATION

⚠ CAUTION

If at any point the pump is observed to bind or will not rotate freely on the hook swivel, then either there is an obstruction in the well or the well is crooked. Either way, the well is not acceptable for a proper pump installation and continuing with the installation will void the warranty.

OPEN LINESHAFT COLUMN INSTALLATION

Lineshafts are coupled with either keyed or threaded couplings. Column Pipe is either threaded or flanged. The top and bottom sections may be special lengths.

1. Determine the correct sequence of installation of the column sections and organize them accordingly.
2. Secure a friction clamp or elevator clamp immediately beneath the column coupling on the first section of column to be installed. If column is flanged, secure the clamp about 6" below the bottom of the flange.

⚠ WARNING

Slip Plates should be manufactured and maintained to tight tolerances to ensure a safe fit for each column and flange size.

3. Check the lineshaft for straightness. Average total runout should be less than 0.0005" TIR (Total Indicator Reading) per foot, not to exceed 0.005" TIR for every 10 feet of shafting.
4. Screw a shaft coupling onto the lower end of the shaft to protect the shaft threads and face while sliding it into the column pipe, until it protrudes approximately 12" past the bottom end of the column pipe.
5. Tie a series of half hitches to the column pipe and shaft with a 3/4" rope, preventing the shaft from sliding out of the column pipe when the assembly is hoisted to the vertical position.

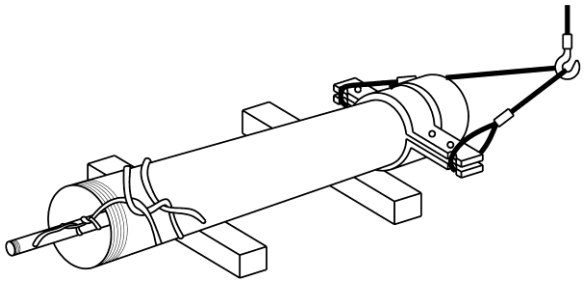


Figure 6

6. Hoist the column assembly to the vertical position taking care not to strain the shaft or damage the shaft or pipe threads.
7. Before centering the column pipe over the bowl assembly, hit the sides of the column pipe with a hammer to ensure that any loose debris is cleared from within the column pipe.
8. Center the column pipe over the bowl assembly and lower the lineshaft until the bottom end is properly aligned with the coupling of the pump shaft. Remove the protective shaft coupling and apply a thin coat of oil on the threads of the lineshaft and the pumpshaft coupling for non-galling material.

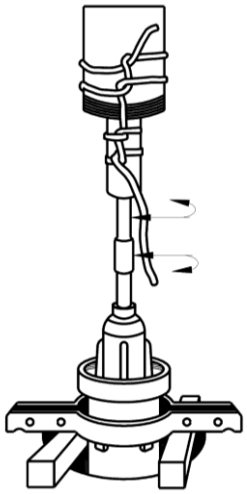


Figure 7

9. For threaded couplings, lower lineshaft until it touched the pump shaft coupling. With lineshaft in the proper position on the coupling, screw lineshaft into the coupling manually by hand until resistance is felt. If the shaft will not screw into the coupling by hand, the threads are either damaged or dirty or the shafts are not properly aligned. This problem must be corrected before proceeding. A fine wire inserted in the hole at the center of the coupling can be used as a gage to determine when the coupling is correctly positioned on the shaft. Remove the wire before tightening the shaft. The shafts should show equal amounts of threads above and below the coupling, indicating that the shaft butt is centered in the coupling. Completely tighten the joint by using a pair of pipe wrenches. Use care not to damage the bearings.
10. For keyed couplings, insert the key into the pump shaft. Lower the sleeve over the pump shaft, to approximately 1.0 in below the top of the shaft. Then lower the lineshaft until it touches the pump shaft. Insert the split ring into the grooves of the pump shaft and lineshaft. Raise the sleeve until it covers the split ring, then insert the key into the lineshaft. Raise the sleeve to the top of the key and secure the sleeve to the split ring with a lock screw and lock wire if applicable.
11. For threaded column connections, apply thread compound to the discharge threads and to the column pipe threads. Lower the column ensuring the shaft feeds smoothly through the bearing in the spider until the column engages the bowl adapter. Using chain tongs, tighten the pipe into the bowl while slowly lowering the derrick hoist. Tighten the pipe into the bowl so that it seats securely against the mating shoulder in the bowl.
12. For flanged column connections, spread a thin even film of thread compound on the bowl discharge flange. Lower the pipe, align the studs in the bowl with the holes in flanges, seat the column flange against the bowl flange and then install and tighten the hex nuts evenly.
13. If a lubrication line is being installed, secure the line to the column pipe just above the column pipe joint.
14. Hoist the unit slightly, remove the bowl clamp and slide the setting beams out enough to allow passage of the unit.
15. If the bowl and column are coated with any special application, any required touch up work should be done before lowering the unit.
16. Lower the unit, slide the setting beams in close to the column and continue lowering the unit until the clamp ears rest on the setting beams. Remove the sling. If an airline is being installed, be careful not to crush it during install.
17. If a separate lineshaft bearing retainer is used, clean the flange recess and the bearing retainer ring O.D. and faces thoroughly, slip the bearing retainer assembly over the shaft and seat it in the flange recess or coupling I.D. Thread compound dries fairly quickly, wait until the next column section is in the vertical position and the shaft connection is made, then apply thread compound.
18. Check that the shaft is approximately centered in the bearing. Center the shaft it in its bearing. If an excessive amount of force is required, the pipe or shaft may not be butted properly or the shaft may be bent. If so, the problem must be corrected prior to proceeding.
19. Remove the exposed shaft coupling, clean the coupling threads and the shaft threads and face thoroughly. Thread the coupling on for half its length. Cover the coupling with a rag to prevent entrance of foreign matter.
20. Repeat the above outlined procedure for each additional section of column until all the column has been assembled. Clean the top column flange face or threads, and the shaft projection thoroughly.
21. Install the top shaft.

⚠ CAUTION

Do not drop any foreign object into the column assembly. Any foreign object dropped into the column assembly must be retrieved prior to continuing.

1. Determine the correct sequence of installation of the column sections and organize them accordingly.
2. Insert tube & shaft assembly sections into column pipe sections.
3. Secure a friction clamp immediately beneath the column coupling or 6" under the flange on the first section of column to be installed.
4. Attach the bottom of shaft to column by tying a tail rope to a deep- throated clamp attached to bottom column. Tie a clove hitch or double half hitch around the enclosing tube and then around the shaft in threaded area.
5. Hoist column section over pump, keeping tension on tail rope. With column in a vertical position, remove dragline and traveling block, lower column until bottom line shaft is properly aligned with pump shaft coupling.
6. Apply a thin coat of oil on the threads of the lineshaft and the pump shaft coupling.
7. With lineshaft in proper position on the pump shaft coupling, remove tail rope and screw lineshaft into the coupling manually by hand until resistance is felt. If the shaft will not screw into the coupling by hand, the threads are either damaged or dirty or the shafts are not properly aligned. This problem must be corrected before proceeding. A fine wire inserted in the hole at the center of the coupling can be used as a gage to determine when the coupling is correctly positioned on the shaft. Remove the wire after installing the shaft. The shafts should show equal amounts of threads above and below the coupling, indicating that the shaft butt is centered in the coupling. Completely tighten the joint by using a pair of pipe wrenches. Use care not to damage any bearing journal areas on the shaft.
8. Carefully lower column section until lower end of the tube section rests on the adapter bearing. The end faces of the tube should be clean and free of nicks. Remove tail rope, clean outside of the adapter bearing and lubricate with thread compound. Screw tube section onto adapter bushing manually, until resistance is felt. Complete tube joint by utilizing a pair of pipe wrenches or chain tongs, butting the end of tube against the upper end of the tube adapter bearing.
9. Clean column threads and lubricate with thread compound.
10. Lower column until column pipe engages in the discharge bowl. Manually thread the column into discharge bowl. Complete joint by tightening column, utilizing chain tongs until the end of the column butts firmly against discharge bowl.
11. Lift the pump assembly and remove elevator clamp secured to discharge bowl. Slowly lower assembly into well or sump until elevator clamp gently comes to rest on timbers or I-beam supports and remove the sling.
12. Remove the exposed lineshaft bearing, pour oil into the tubing and reinstall the bearing. The amount of oil to be poured is given in Table 1.

TABLE 1 – Tube Installation Oil

Tube Size (inches)	Amount of Oil Per Section	
	10 ft. Sections	20 ft. Sections
1¼, 1½, 2	½ Cup	1 Cup
2½, 3, 3½	1 Cup	½ Qt.
4 and larger	½ Qt.	1 Qt.
Note: Mineral, ISO Viscosity Grade 32, SAE Grade 10W. Section 6.5		

13. If the column is threaded, clean the tubing O.D. and force slip the spider over the tubing approximately 2" into the pipe. The spiders should be located approximately 20' from the bowl and head, with 40' spans in between. The spiders should fit snugly in the column pipe and tubing. Soapy water can be used as lubricant when sliding the spiders in. If the column is flanged, clean the flange recess and O.D. with a file to remove any foreign matter, nicks, and burrs. Since thread compound dries quickly, wait until the next column section is in the vertical position and the tubing connection has been made before applying to column coupling threads or flange.
14. Repeat the above outlined procedure for each additional section of column until all the column has been assembled. Clean the top column flange face or threads, and the shaft projection thoroughly.
15. Install the top shaft.

3.8 DISCHARGE HEAD INSTALLATION

The bottom of the discharge head will either be a threaded or flanged column mounting configuration. Install the discharge head as follows:

1. If the packing box or tension nut is assembled in the head, remove it and all the attached piping.
2. If a steel foundation plate is provided for use under the discharge head and this plate is not already attached to the head, attached the plate as described below.
    - Clean the mating surfaces of the head and the plate.
    - Place the head on the foundation plate. Orient the head so that the holes in the head, line up with the holes in the plate.

- Bolt the head to the plate by installing two bolts in diagonally opposite holes in the base of the head.
- Install studs in the threaded holes near the large hole in the plate. Tighten the studs into the plate as deep as the threads will allow. Also assure that the stud protrudes from the same side of the lifting plate as the female register.
- Clean the mating surfaces of the head and the lifting plate and install the O-ring and/or gasket if required.
- Place the discharge head on the lifting plate. Orient the head to the desired position, making sure that the auxiliary holes in the head, lines up with the auxiliary holes in the plate.
- Install the socket head cap screws provided to secure the plate to the head.

3. If a top column flange is to be used and it is not already installed, install it on the top section of column pipe as follows:
   - Clean the pipe and flange threads and butt surfaces and apply a thin coat of thread compound.
   - Screw the flange onto the pipe and tighten securely.
4. Remove the coupling guard if provided. Attach a sling to the lifting lugs on the side of the discharge head through windows and hoist discharge head over the protruding topshaft.
5. Attach slings to the head using lifting devices, and if not present, use the window opening.
6. Lift the head, remove the hex nuts from the studs and clean the mating surfaces on the bottom of the head and on the column pipe. Apply a thin coat of thread compound to all the head-to-column mating surfaces.
7. If the head-to-column pipe connection is flanged, align the head with flange holes, lower the head until it is seated squarely on the flange, and then install and tighten the fasteners. If a butt type flange is used, orient the head so that its outlet is as close as possible to its final position.
8. If the head-to-column pipe connection is threaded, lower the head until it contacts the pipe, apply a set of chain tongs to the pipe and turn the head until the pipe seats. To tighten the head further, place a long pipe through the head windows or into the discharge being careful not to damage the shaft.
9. If the head-to-column pipe connection is flanged to thread, check to be sure that the threaded column flange adapter is securely attached to the bottom of the discharge head. Check and tighten the cap screws gradually in diametrically opposite pairs. lower the head until it contacts the pipe, apply a set of chain tongs to the pipe and turn the head until the pipe seats. To tighten the head further, place a long pipe through the head windows or into the discharge being careful not to damage the shaft.

⚠ CAUTION

Do not bump or scrape the shaft protruding above the column. This could result in bending or damaging the shaft.

⚠ DANGER

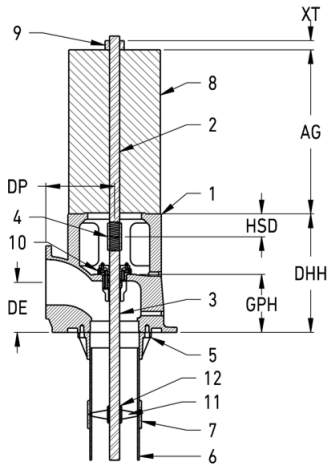
Sling should be rated to handle more than the total pump weight.

10. Hoist the discharge head by lifting lugs and remove the elevator clamp attached to column.
11. Remove the support timbers or I-beams and clean the top of the foundation plate. Orient the discharge head in the required position.
12. Lower bowl, column, and head assembly until discharge head mounting flange engages the foundation plate. Secure discharge head to the foundation plate. Check the levelness of the discharge head in all directions, utilizing a machinist level across the driver's mounting surface of the discharge head.
13. Check whether the topshaft is in the center of the packing box bore. If not, the shaft must be centered by shimming the head base and the plate.
14. Rotate the shaft approximately 90 degrees. Check again whether the shaft is at the center of the packing box bore or not. If not, either the top shaft is bent or the first shaft below it did not butt properly. This must be corrected before installation can proceed.

⚠ CAUTION

It may be necessary to connect a lifting device to the upper end of the shaft and then carefully raise the shaft and impellers using a hoist with a swivel. A wrench can then be used to turn the shaft. Lower the hoist and remove the lifting device prior to doing any alignment checks.

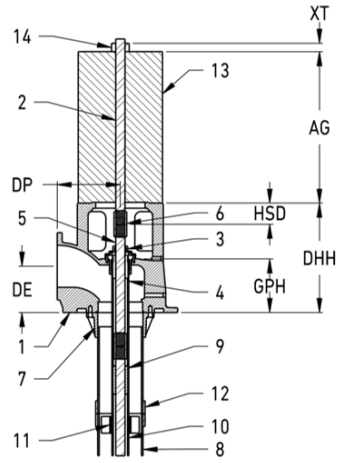
OPEN LINESHAFT, TYPICAL SET-UP



ITEM	DESCRIPTION
1	HEAD
2	MOTORSHAFT
3	TOPSHAFT
4	LINESHAFT COUPLING
5	HANGER FLANGE
6	COLUMN
7	COLUMN COUPLING
8	MOTORSHAFT
9	ADJ NUT ASSEMBLY
10	PACKING ASSEMBLY
11	BEARING RETAINER
12	LINESHAFT BEARING

Figure 8

ENCLOSED LINESHAFT, TYPICAL SET-UP

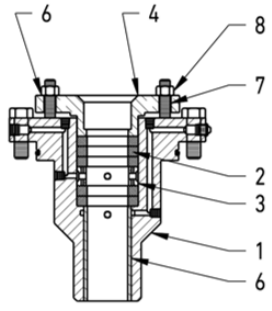


ITEM	DESCRIPTION
1	HEAD
2	MOTORSHAFT
3	TENSION ASSEMBLY
4	TOP TUBE
5	TOPSHAFT
6	LINESHAFT COUPLING
7	HANGER FLANGE
8	COLUMN
9	OIL TUBE BEARING
10	TUBE
11	RUBBER SPIDER
12	COLUMN COUPLING
13	MOTORSHAFT
14	ADJ NUT ASSEMBLY

Figure 9

3.9 PACKING BOX INSTALLATION

PACKING SEAL



ITEM	DESCRIPTION
1	HOUSING
2	PACKING
3	LANTERN RINGS
4	SPLIT RINGS
5	STUD NUT
6	BEARING
7	STUDS

Figure 10

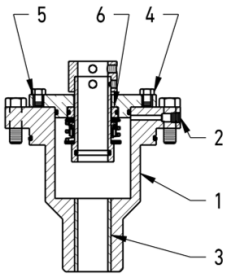
1. Clean the matting surfaces of both the discharge head and the packing box, ensuring that there are no nicks or burrs. position gasket on the surface, then slide packing box down over the topshaft and into position on the gasket. Evenly tighten packing box with cap screws.
2. Start the first ring into the packing box. Using your fingers, work the entire packing ring into the packing box, tamp it down using a split ring and push the packing ring down firmly. It must seal on the shaft and bore of the packing box. Install the others in this manner, staggering the joints 90°.
3. Insert lantern ring into packing box. Be sure it is properly positioned so that it aligns with the lubrication passage in the packing box.

⚠ CAUTION

Check that the split ring is square in the packing box. Cocking can cause uneven compression of packing and damage to the shaft or sleeve and heat up the shaft and packing box.

4. Insert remaining rings of packing, staggering joints 90 degrees apart. The split ring may be used as a tamper for the top ring.
5. Install the split ring and screw nuts on the split ring studs. Tighten nuts then relieve the nuts and tighten finger tight. If discharge pressure is over 100 PSI, attach bypass line “L” to the packing box bypass.
6. The packing box is shipped with it’s port plugged. If the discharge pressure is over 150 psi, remove the plug on Bypass “U” and attach a bypass line.
7. Final adjustment of the packing box must be made at pump start up.

MECHANICAL SEAL



ITEM	DESCRIPTION
1	HOUSING
2	SEAL PORT
3	BEARING
4	SEAL BOLTS
5	WASHER
6	SEAL

Figure 11

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

- The seal cavity must be clean before install.

- The faces and register of the seal housing and gland plate or cap must be clean and burr free.
- The shaft seal is a precision product. Treat it with care. Take particular care not to scratch or chip the lapped faces of the rotor runner or stator seat.
- Circulation lines must remain in place and open. Do not remove.
- Impeller adjustment must be made prior to seal adjustment.

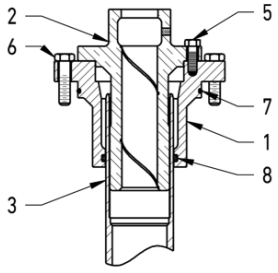
Read and follow the mechanical seal instruction manual furnished with this unit.

3.10 TENSION PLATE INSTALLATION

Assemble Tension Plate Assembly as follows:

1. Remove the lock screw and O-ring. Thoroughly clean the tension plate including the O-ring groove. Lightly grease the O-ring and reinstall it.
2. Clean the matting surfaces of both the discharge head and the tension plate, ensuring that there are no nicks or burrs. Clean the I.D. of the top tube. Position gasket on the surface, then slide tension plate down over the topshaft and into position on the gasket. Evenly tighten tension plate with cap screws.

TENSION ASSEMBLY



ITEM	DESCRIPTION
1	TENSION SLIP PLATE
2	TENSION NUT
3	TOP TUBE
5	BOLT
6	SEAL BOLT
7	UPPER ORING
8	LOWER ORING

Figure 12

1. Pour one pint of recommended oil down the tube nipple. Factory assembled units have no oil. Oil must be added in the field.
2. Clean the tension nut before oiling it's O.D. and the threads. Screw the tension nut into the top tube until the flange face of the tension nut contacts the tension plate.
3. Tighten the tension nut and back off the tension nut until a slot aligns with the lock screw threads. Install the lock screw.
4. For setting less than 100 ft., tighten to the nearest locking position. Check the "HSD" dimension, be sure it is correct.
5. Connect the lubrication line to the tension nut. Fill the oil container with the recommended oil. Check the lubricator feed and see that the oil is flowing freely.

3.11 DRIVER INSTALLATION

INSTALLING VHS DRIVER

The motorshaft extends through the VHS driver and is held in place by the adjusting nut, which carries all the static and hydraulic thrust of rotating assembly, but is also used for impeller adjustment. The motorshaft is connected to the topshaft by a threaded coupling or a rigid flange coupling.

Install the hollow shaft driver as follows:

1. Clean the driver mounting flange on the discharge head and flange. Check for burrs or nicks on the register and mounting face.
2. Remove the driver cover and cap screws.
3. 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

Do not work under a heavy suspended object unless there is a positive support and safeguards which will protect personnel should a hoist or sling fail.

⚠ WARNING

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.

4. Inspect the drivers mounting surface, register and clean these surfaces thoroughly. If any burrs are found, remove burrs with a smooth mill file, cleaning thoroughly afterward.
5. Hoist the motor stand, inspect the mounting surfaces, register, and clean these surfaces thoroughly. Install the motor stand on discharge head and secure with cap screws provided. Follow motor OEM instruction manual.
6. Lower the driver slowly to the discharge 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, position the horizontal input shaft. Align the mounting holes and start the attaching cap screws in by hand. Transfer the weight gently from hoist to head and secure the cap screws, tightening them uniformly.

7. Check driver manufacturer's instruction manual for special instructions including lubrication instructions and follow all "startup" directions.

⚠ CAUTION

Ensure Correct Lubrication Is Used

8. If you have a VHS electric motor 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.
9. While viewing the nameplate, determine the type of thrust bearing you have been furnished. If it is a spherical roller bearing, proceed with caution as it must never be run at normal speed without an appreciable thrust load. When establishing rotation be very careful to just bump or tap the switch. Never fully close until the pump is completely operational.
10. Otherwise, you may now energize the starter panel and bump start the motor by switching it very quickly on and off, observing the direction of rotation and watching to see that it spins freely and is in apparent balance. Motorshaft 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 the manufacturer's instructions.

⚠ DANGER

POWER LOCKOUT - Disconnect and lockout electrical power before installing or servicing the pump.

11. After reconnection, energize the starter and again bump start the motor. When you are sure you have counter-clockwise 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 in accordance with all applicable electrical codes and regulations.
12. If your pump is equipped with a right-angle gear drive instead of an electric motor, the rotation check must wait until the pump is completely installed and connected to the prime mover. At that time, rotation is verified in a manner like that just described with allowances for the type of power equipment. Match up the rotation arrows on your gear and your prime mover to determine compatibility.
13. Find the motorshaft and clean it thoroughly throughout its length, threads, keyway, and end faces. Now, slide it down through the driver without bumping or scraping.
14. Start the motorshaft into the topshaft coupling using shaft coupling procedure outlined in section 3.7.
15. Looking down on the driver, check to see that the head-shaft stands in the center of the hollow shaft and that the motorshaft 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, possibly 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 factory representative.
16. When all is correct, replace the packing box or tension nut flange cap screws, tightening them uniformly and securely.
17. Try the drive gib key in both motorshaft and clutch keyways. They should produce a sliding fit. If necessary, dress the gib key until a free but not loose fit is obtained. Do not file the keyways.
18. Install adjusting Head Nut to hand tight.

COMBINATION ENGINE AND MOTOR DRIVES

On combination drivers, the motor is invariably on top with a projecting head shaft extension.

Follow all previously defined procedures, except that the motor must be lowered over this extended head shaft and great care must be taken to center it exactly so as not to bump or miss-align the shaft while the motor is being lowered into place.

There are several methods of running engines without electric motors and vice versa, requiring simple adjustment to the combination drive, but they are too numerous to mention here and can be obtained from the gear manufacturer's instructions included with the shipment.

ADJUSTING NUT AND CLUTCH INTERACTION

Shaft adjustment up or down is accomplished by turning the adjusting head nut. There are five holes in the adjusting head nut and only four in the motor clutch.

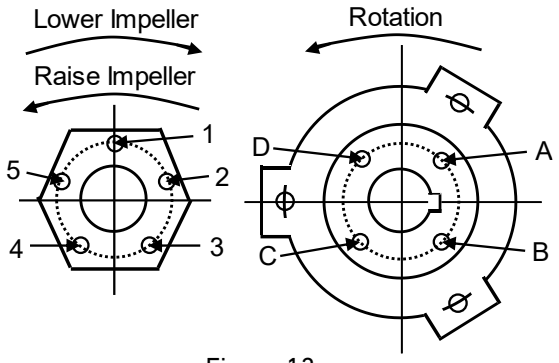


Figure 13

Refer to factory for impeller settings greater than 200 ft.

With shafting all the way down and the impellers resting on their seats, turn the adjusting nut in the counterclockwise direction, lifting the shaft, until the impellers just clear their seats, and the shaft/motor turns free by hand. This removes all deflection from the shaft.

TABLE 2
Adjusting Nut Distance Per Turn by TPI

TPI	Turns	Distance
12	1	0.084
10	1	0.100
8	1	0.125

ENCLOSED IMPELLER SETTING

Refer to factory provided laterals. If pump setting is 200 ft. or less, and factory information is not present, a good rule of thumb is to make two turns on the adjusting nut for the first 100 ft. (3 turns for 12 TPI shaft), and one additional turn for each additional 50 ft. Line up one of the holes in the adjusting nut with the nearest hole in the driver coupling. Insert the cap screw in the hole and tighten it.

If the lateral measured at the adjusting nut is less than that recorded previously, check the topshaft to make sure that the adjusting nut has not run out of threads and that the keyway is long enough. Also, check the shaft coupling or water slinger to make sure that neither are being pulled against the bottom of the driver base.

OPEN IMPELLERS SETTING

- The aim to achieve 0.030" impeller setting.
- Align hole "5" in the adjusting nut and hole "D" in the driver clutch, (See Figure 13) or similar holes are in like position. If care is exercised, this will give an initial impeller clearance of 0.001" to 0.003" depending on shaft size or the pitch of the thread.
- Insert cap screw into hole "4" provided these are the nearest matching holes for counterclockwise rotation of adjusting nut, turn adjusting nut counterclockwise until holes "5" and "C" line up. This gives 1/20 of a turn which is 0.004" on 12 TPI or 0.005" on 10 TPI shaft.
- Normal impeller clearance for the open impeller is approximately 0.015" for the first 10 ft. of the column length and 0.010" additional clearance for each 10 ft. of length thereafter. This can be reduced in some instances where it is necessary but should not be attempted without consulting the factory or a factory field service representative if present.

After completing the adjustment procedure, replace the driver cover and secure the cap screws.

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.

INSTALLING VSS DRIVER

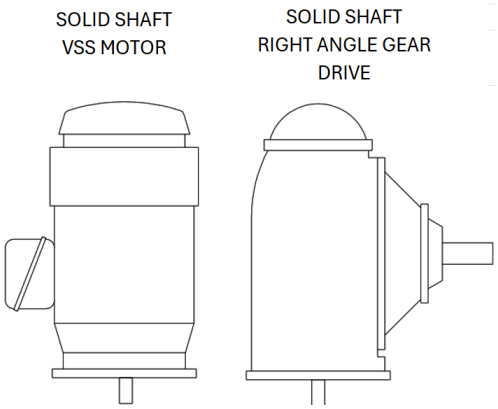


Figure 14

1. 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 are using an electric motor, secure it against re-active torque with chain or cable restraints.
2. 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. You must check

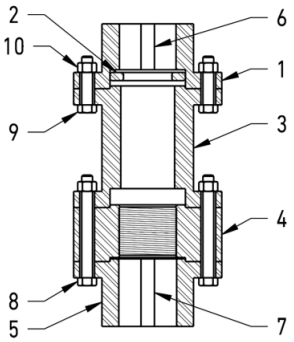
both power characteristics and motor rating for compatibility, then see the motor nameplate for correct wiring hookup.

3. While viewing the nameplate, determine the type of thrust bearing you have been furnished. If it is a spherical roller bearing, proceed with 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.
4. Otherwise, you may now energize the starter panel and bump start the motor by switching it very quickly on and off, observing direction of rotation and watching to see that it spins freely and is in apparent balance. Motorshaft 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.

⚠ DANGER

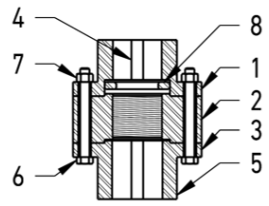
POWER LOCKOUT - Disconnect and lockout electrical power before installing or servicing the pump.

5. After reconnection, energize the starter and again bump start the motor. When you are sure you have counter-clockwise 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 in accordance with all electrical codes and regulations.
6. If your pump is equipped with a right-angle Gear Drive instead of an electric motor, the rotation check must wait until the pump is completely installed and connected to the prime mover. At that time, rotation is verified in a manner like that just described with allowances for the type of power equipment. Match up the rotation arrows on your gear and your prime mover to determine compatibility.
7. While the driver is still sitting on the blocks, examine the protruding driver shaft for any burrs or nicks. If necessary, repair precisely with a small file. Clean the shaft and oil it very lightly. Find the shaft flanged-coupling parts and clean them all thoroughly.



ITEM	DESCRIPTION
1	MOTOR HUB
2	SPLIT RING
3	SPACER
4	ADJUSTING NUT
5	PUMP HUB
6	MOTOR KEY
7	PUMP KEY
8	ADJ BOLT
9	MOTOR BOLT
10	LOCK NUT

Figure 15



ITEM	DESCRIPTION
1	MOTOR HUB
2	ADJUSTING NUT
3	PUMP HUB
4	MOTOR KEY
5	PUMP KEY
6	BOLT
7	LOCK NUT
8	SPLIT RING

Figure 16

8. Try the driver shaft key, in both driver shaft and upper coupling half 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 in the shaft groove. It too, should be a very close fit and may be dressed to obtain this if necessary. Try the top half coupling on the shaft.
9. When you have the proper fits and while the driver still sits on the blocks, insert the key in the shaft keyway and slide the coupling half up on the shaft flange face down. With the flange above the drive shaft ring groove, assemble both halves of the thrust collar 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 securely.
10. If your coupling is furnished with a spacer, assemble the spacer to the driver coupling half. If parts are match marked, 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.
11. Inspect and clean the pump shaft threads, painting lightly with a good thread lubricant. After trying keys and parts as described above, insert key in the pump shaft keyway and slip the pump shaft coupling half well down over shaft, flange face up, leaving shaft threads projecting above coupling. Screw adjusting nut onto pump

shaft with the rimmed end up, turning counterclockwise until pump shaft protrudes through threaded portion of nut by at least two threads.

12. 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 your positioning criterion is the horizontal input shaft. Align the mounting holes and start the attaching cap screws in by hand. Transfer the weight gently from hoist to head and secure the cap screws, tightening them uniformly.

⚠ WARNING

Do not work under a heavy suspended object unless there is positive support and safeguards which will protect personnel should a hoist or sling fail.

⚠ WARNING

Lifting lugs on the driver is for handling the driver only. Never attempt to use these lugs to hoist the pump. The pump must be handled with its own lifting device.

13. With the pump shaft all the way down so the impellers are firmly seated in the bowls, screw the adjusting nut up or down until the predetermined impeller adjustment can be measured between the adjusting nut and pump shaft half-coupling. Slide pump half-coupling up shaft and rotate driver half-coupling until bolts can be inserted. Assemble the nuts and carefully tighten by hand, lifting the impellers, until all adjusting bolts are equally snug, using a light machine oil on the bolt threads.
14. 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 factory representative.
15. When satisfactory alignment is achieved, put all bolts under uniform tension, using a torque wrench. Five-hundred-inch pounds should be sufficient torque, i.e., a 50lb. pull on a 10" wrench or the equivalent. Make sure pump shaft key is flush with coupling hub and tighten setscrew securely to lock the key in place.

4.0 MISCELLANEOUS EQUIPMENT

4.1 LUBRICATING DEVICES

OIL LUBRICATED PUMPS

Fill the lubrication tank with recommended oil. (6.5)

Manually open the lubricator valve and allow oil to run into the lube supply line to the tension nut for at least 2 minutes for each 100 feet (30 meters) of setting prior to start up. Then, adjust the lubricator for the proper drops per minute according to Table 3.

TABLE 3

Lineshaft Diameter	Rate (drops per minute)
up to 1"	8 to 10
1-3/16" to 1-15/16"	16 to 18
2-3/16" to 2-11/16"	20 to 22

On the system equipped with a solenoid operated lubricator valve that cannot be energized independently, it will be necessary to remove the valve stem to allow the oil to flow into the tube. If the start-up is delayed or the pump has been shut down for over 150 hours, the lubrication procedure must be repeated just prior to actual start up.

WATER LUBRICATED PUMPS

For open lineshaft pumps, when a static water level exceeds 30 feet, pre-lubrication is necessary. Install the pre-lubrication system in accordance with the drawings in the pre-lube plan. Some systems may require automated pre-lube controls and are touched on in these instructions.

The following items should be taken into consideration for the pre-lube system.

- Place the system as close as possible to minimize the total length of the supply line.
- Do not use pipe that is smaller than the pre-lube connection furnished in the packing box.
- If the system is to be subjected to low temperatures, adequate precautions must be taken to prevent freezing.

Connect the line from the pre-lube system to the pre-lube connections on the packing box. Simflo heads have a pre-lube connection at the back of the head.

If pump is equipped with a pre-lube system supplied from a pressurized header, open the supply valve, and allow the pre-lube water to flow.

If it is equipped with a tank type pre-lube system, open the valve between the pre-lube tank and the pump and allow approximately half of the water in the tank to run into the pump before starting the pump. The pre-lube valve should remain open during the start up.

Pumps operating at a static water level of greater than 100 ft. and are not equipped with a non-reverse mechanism must be post- lubricated during the time that the pump is spinning backward after it is shut down. The post lubrication should start immediately when the pump is shut down and should continue for as long as the shaft is turning. It is desirable that the post-lube be initiated automatically, so that loss of power to an unattended pump will not result in damage due to lack of post lubrication.

4.2 AIR RELEASE VALVES

The air release valve prevents a large volume of air from being compressed and then setting up a severe shock wave when suddenly released, with potential for serious equipment damage. The air release valve also prevents air from entering a pressurized system.

The air release valve also relieves the vacuum that might otherwise be generated in the discharge during shutdown when the liquid recedes in the column pipe to the sump or well standing level. Vacuum release valves may be critically important to prevent equipment damage on restarting flow into an evacuated column.

An air release valve is required on water lubricated pumps with underground outlets. It eliminates trapped air in the column above the underground outlet which would cause the bearings and packing box to run dry.

For medium and large-size vertical wet-pit pumps discharging into a pressurized system, an automatic air and vacuum release valve is recommended. The valve should be located on the pump discharge nozzle or between the pump discharge nozzle and the discharge valve or check valve, whichever is closest.

Install the air release valve to the pump head or just beyond the head flange on the discharge piping. It is recommended that a throttling device be used on the discharge side of the air release valve to restrict the discharge of air ensuring that a cushion of air is available in the discharge head during start up.

Open the air release system isolation valve. Adjusting the air release system throttling device so that is partially open, it should not be closed or fully open.

Not exhausting the air or releasing it too fast can damage the pump.

4.3 MISCELLANEOUS ACCESSORIES

PRESSURE GAUGES

Connect the pressure gauge, and/or gauge cock, if furnished to the tapped hole at the top of the discharge flange on the head. Position the dial face to facilitate reading.

DISCHARGE VALVES

A check valve and an isolation valve should be installed in the discharge line. The check valve serves to protect the pump from reverse flow and excessive backpressure. The isolation valve is used in priming, starting, and when shutting down the pump. Except on axial flow, mixed flow, and high energy pumps, it is advisable to close the isolation valve before stopping or starting the pump. Operating pumps of specific speed over 100 (5000) at shutoff may cause a dangerous increase in pressure or power.

⚠ CAUTION

Start the pump at Reduced Speed or with the Isolation Valve partly opened.

⚠ CAUTION

Do not run the pump continuously outside the allowable operating region.

PIPE REDUCERS / INCREASERS

If increasers are used on the discharge side of the pump to increase the size of piping, they should be placed between the check valve and the pump.

EXPANSION JOINTS

If expansion joints are used, they should be placed between the pipe anchor and the check valve.

4.4 ELECTRICAL CONNECTIONS

All connections to the motor such as main leads, space heater leads, thermocouple leads, etc. should be made in accordance with motor manufacturer's recommendations and local codes.

All control, monitoring, and alarm equipment should be installed in accordance with the installation instruction provided by the manufacturer of that equipment.
Ensure that all control equipment is supplied with the proper voltage and that they are functioning normally prior to running the pump the first time. Check with the factory before installing anti-reverse rotation devices as their application is not always desirable.

Electrical boxes and conduit should be installed in accordance with industry standards, local ordinances, and in unison with specific factory recommendations for a certain pump (if any). Ensure that the guards installed on the discharge head can still be opened with electrical conduit and boxes installed so normal maintenance and inspections can be completed.

⚠ DANGER
WIRE SIZING - Install, ground and wire according to local and national electrical code requirements.

⚠ DANGER
DISCONNECT SWITCH - Install an all leg disconnect switch near the pump.

⚠ DANGER
POWER LOCKOUT - Disconnect and lockout electrical power before installing or servicing the pump.

⚠ DANGER
ELCTRICAL SUPPLY - Electrical supply must match motor's nameplate specifications. Incorrect voltage can cause fire, damage motor and void warranty.

⚠ DANGER
NEVER DO MAINTENANCE WORK WHEN THE UNIT IS CONNECTED TO POWER.

⚠ WARNING
GUARDS MUST NOT BE REMOVED WHILE THE PUMP IS OPERATIONAL.

4.5 AIR LINE

When required, the water level in the well can be determined by installing an open-ended airline from just above the pump, up along the column pipe to the surface and through the inspection port of the discharge head. At the surface, attach an air valve (snifter valve) and a pressure gauge to the air line. Attach a bicycle tire pump or other source of compressed air to the air valve and force air into the air line until the pressure gauge reading is constant. This pressure reading is then converted to feet of water (1 PSI = 2.31 Ft.) indicates the number of feet of submergence of the end of the air line. The water level in the well is determined by subtracting the amount of submergence from the known length of the air line and the known length of the pump.

4.6 CONNECTING THE PIPING

Whatever your system is, all piping 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 discharge head 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.

Above the floor piping should be installed in such a manner as to eliminate the possibility of the discharge head being placed in a strain or being thrown out of alignment.

Below ground discharge connection should be made in such a manner that no strain or misalignment is imposed on the column pipe. Alignment between the pump discharge and the outside should have already been achieved as instructed. The above procedure can also be used. However, it might be more convenient to construct a simple brace from directly behind the discharge outlet to the pit wall to counteract any forces created by discharge pressure.

If a flexible joint such as a dresser coupling is to be used, sufficiently strong tie bolts and lugs should be used to span the flexible joint capable of resisting the force created by the discharge pressure at the pump head. None of this force should be imposed on the head. Tension should be taken carefully on these tie bolts so that any amount of forward movement induced to the head will be counteracted during operation so that alignment is maintained during operation.

Flange faces should be thoroughly clean and free of all nicks or burrs and should be in perfect alignment before tightening 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 or forming a downward coil loop in the tubing to absorb vibration from the tubing connections.

5.0 STARTING THE PUMP

5.1 INITIAL PUMP STARTUP

PRE-START CHECK LIST

Before starting the pump, the following checks should be made to ensure that all pump installations as described in preceding sections of this manual are complete and correct.

Rotate the pump shaft by hand to make sure the pump is free, and the impellers are correctly positioned.

Ensure motorshaft adjusting nut properly locked into position.

Has the driver been properly lubricated in accordance with the instructions furnished with the driver?

Are pre-lube or oiling systems properly filled and ready for use as described in the preceding procedures outlined in section 4.1.
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.

Check the connections to the driver and control equipment.

Check that all automatic control systems have been checked prior to making the driver-to-drive shaft connection.

⚠ CAUTION

Automatic controls that do not function properly can cause severe damage to the pump.

Check that all auxiliary equipment has been installed, serviced, and is ready for operation.

Check that all piping connections are secure.
Check that the anchor bolts are properly torqued.

Check all bolting and tubing connections are properly torqued (driver mounting bolts, flanged coupling bolts, gland plate bolts, seal piping, etc.).

On pumps equipped with packing box, make sure the split ring nuts are only finger tight.

Mechanical seals should have clean fluid in 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 no 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.

Enclosed lineshaft pumps, lubricating liquid must be available and should be allowed to run into the enclosing tube in sufficient quantity to thoroughly lubricate all line shaft bearings.

PRE-START OPERATING NOTES

Special consideration must be given to the following conditions:

If the pump is to discharge into a system that is already pressurized, ensure that the system pressure will not cause reverse flow through the pump during start-up. This can be accomplished by installing a check valve between the pump and the system, or by starting the pump with the discharge valve shut and then opening the valve after all the air is exhausted and the pump is developing a discharge pressure equal to or greater than the system pressure.

A pump is designed to run at specific head and flow conditions. Operating at conditions other than design can damage the pump.

Operating at low head and high flow conditions can cause the impellers on some pumps to “float”. This can occur if a pump which is designed to operate at system pressure is used to fill the system without throttling the discharge valve to create head (back pressure) on the pump.

Operating some pumps at high head and low flow conditions will cause the pump shaft to stretch sufficiently to allow the impellers to drag on the bowl.

Water hammer can be caused by starting a high pressure pump in a shallow setting, leading to damage. Special consideration must be given to the

rate of releasing the air from these pumps and to the operation of the discharge valve.

Pumps equipped with a pre-lube system supplied from a pressurized header, open the supply valve, and allow the pre-lube water to flow. The pre-lube system should be left running until after the pump has been started unless the discharge pressure of the pump will damage the pre-lube system.

Open line shaft units equipped with a tank type pre lube system, clean the tank, and fill it with clean water. Open the valve between the pre-lube tank and the pump and allow approximately half of the water in the tank to run into the well. The pump should be started immediately, and the pre-lube valve should remain open during the start up.

STARTING THE PUMP

Ensure that the system to which the pump is connected is ready to receive flow from the pump.

Partially open the flow isolation valve in the discharge line.

Partially open the Air Release Isolation Valve. It should not be closed or fully open. Not exhausting the air or exhausting it too quickly can damage the pump.

Ensure the system has/is properly pre-Lubed. If the start-up is delayed, the lubrication procedure must be repeated just prior to the actual on startup.

Energize the pump. If any abnormal noises, jerking, or vibration is noted, stop the pump immediately, determine the cause of the abnormalities and correct them.

After the pump is operating at full speed, slowly open discharge valve. If driver overheats or there is excessive vibration, stop the pump, determine the causes, and correct them.

If the air release valve is manually operated, close it.

For open lineshaft pumps, with the pump in operation, there should be some leakage at the packing box packing. The correct leakage rate is approximately one drop per second. Check the temperature of the leakage as well as the discharge head. If the pump runs hot and the leakage begins to choke off, stop the pump and allow it to cool down. A few light taps with a hammer on the split ring will upset the packing sufficiently to resume leakage. After pump has cooled, restart pump and follow the preceding procedure. Run pump 15 minutes, check leakage, if it exceeds two drops per second, adjust packing as described in “Packing Adjustment and Replacement”.

For enclosed line shaft pumps, adjust the lubricator valve for the proper flow rate of the lubrication oil.

5.2 NORMAL OPERATION & SHUTDOWN

Subsequent normal start-ups are the inverse of initial start-up described above, consisting of:

- Checking that the driver, the auxiliary equipment, and the system into which the pump is discharging are ready for operation.
- Pre-Lubing the pump as recommended.
- Energizing the pump.
- Managing air-release.
- Checking or adjusting system for desired flow.
- Check for proper oil drip rate or packing box leakage, whichever is applicable.
- Initiate post-lube when the pump is shut down.

On oil lubricated units, periodically check the oil level in the lubricator tank and ensure that it is dripping properly. Refill the tank if it is less than 1/4 full.

On water lubricated units, periodically check the packing for over- heating or excess flow. The amount of adjusting done on the split rings should be held to a minimum.

6.0 PREVENTATIVE MAINTENANCE

Preventive maintenance includes periodic inspection of oil level in the oil reservoir (for pump with oil lube column), re-lubrication of electric motors, gear drives and prime mover. Systematic inspection of the pump and its components shall be made at regular intervals.

Consult the applicable manufacturer’s instructions for detailed information on maintenance for the prime mover, driveshaft, electric motors, and gear drives.

Any deviation in performance or operations from what is expected can be traced to some specific cause. Variances from initial performance will indicate changing system conditions, wear, or impending breakdown of the unit.

DANGER

Before initiating maintenance procedures, disconnect all power sources to the equipment and accessories completely. Discharge all parts and accessories which retain electric charge. Failure to comply may result in severe personnel injury or death.

6.1 PACKING MAINTENANCE & ADJUSTMENT

Pumps with packing boxes shall be adjusted whenever the leakage rate exceeds or drops below two drops per second.

For no leakage, or if the packing box overheats, do not back off split ring nuts while the pump is running. This will allow the entire set of rings to move away from the bottom of the box, without relieving pressure of the packing on the shaft. Stop the pump, allow packing to cool, loosen the split ring, then restart the pump to ensure there is leakage before proceeding with any necessary packing adjustments.

It may be necessary to repeat this procedure several times before proper amount of liquid comes through to efficiently prevent overheating.

DANGER

Be sure to reinstall the coupling guard before restarting the pump.

Excessive packing box leakage. With the pump in operation, tighten the split ring nuts one-quarter turn for each adjustment. Allow packing to equalize against increased pressure and leakage to gradually decrease to a steady rate, before making another adjustment.

CAUTION

Do not overtighten the packing box. Excessive pressure can wear out packing prematurely and seriously damage the shaft.

With the pump shut down and when packing has been compressed to the point that the split ring is about to contact the upper face of packing box, remove the split rings, add one extra packing ring, and readjust. If this fails to reduce leakage to two drops per second, totally repack the packing box.

To Repack the packing box:

- Remove all the old packing and lantern ring. The packing can be removed using hooks. The lantern ring can be removed by forming a small hook at the end of a piece of small stiff wire and inserting this hook into the holes provided in the lantern ring and separator rings.
- Clean the packing box cavity, inspect the shaft for scoring and install the new packing using the instructions given in Section 4.9

6.2 MECHANICAL SEAL

Cartridge mechanical seals do not require any adjustment. This seal type is set to the shaft after the pump lateral is set and must be un-set prior to any adjustment. Refer to the Mechanical Seal Instruction Manual for further information.

Component 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 re-adjustment the seal does not correct the problem, refer to the Mechanical Seal Instruction Manual for further information.

The best way to ensure a long service life for your seal, is to lubricate them with cool, clean, and stable fluids. However, their dynamic nature makes them the first thing to fail if something else in the system fails. Vibration, dry-running, pump misuse and miss-installation can all cause the seal to fail.

Maintain your seal by not operating in a dry run. Install a Dry Run Monitor or flow sensor that will alert users when there is not sufficient fluid within the system. Continuous applications tend to be more stable with mechanical seal reliability than cyclic applications for this exact reason.

Mechanical seals on average are rated to last a minimum of a span of two years. Obviously as stated earlier this is largely dependent on the variables, conditions involved, and the limits to which you run at. Knowing your system and how it will function and what to look for when problems occur can go a long way in maintaining a mechanical seal.

Mechanical seal repairs can be replaced 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 seal bearing located at the bottom of the seal housing will usually require removal of the driver to obtain sufficient headroom.

6.3 SEASONAL SHUTDOWN

1. For oil lubricated pumps that are shut down for an extended period, it is suggested that the pump be operated for at least 15 minutes every two weeks with oil feed wide open 2 hours before and during startup to maintain a film of oil on the shafting and shaft bearings.
2. For product lubricated pump, if the pump is to be shut down for an extended period, operate it for at least 15 minutes with adequate pre-lubrication every two weeks.
3. Before resuming normal operations, oil should be changed on drivers, right angle gear and lubricating oil system.

⚠ WARNING

Manually rotate shaft several times prior to re-starting pump, which has been down.

6.4 MAINTENANCE SCHEDULE

TABLE 4

PROCEDURE	TIME INTERVAL (Operating Hours)
Clean dirt, oil and grease from driver and discharge head.	As required
Clean driver ventilation passage to prevent overheating.	As required
Change lubrication in gear drive	2,000 or once a year
Check oil level in the reservoir. It should never be less than ¼ full. Refill, check drip rate.	24 or monthly.
Tighten all loose bolts, and check for excessive vibration.	As required or annually.
If packing is grease lubricated, add as required	100 or monthly.
Check that there is some leakage through packing box while pump is in operation. Do not tighten split ring nuts unless necessary. See page 35 for tightening requirement.	As required or monthly.
Maintain a liquid film of lubrication between the seal rubbing faces.	As required.
Re-grease the motor bearings: 1800 RPM and above	Refer to Motor IOM
Below 1800 RPM	Refer to Motor IOM

6.5 RECOMMENDED LUBRICANTS

TABLE 5 –GREASE SPECIFICATIONS

Operating Temp Range	20° F to 120° F
Required Properties	
Pour Point :	20° F or lower (base oil)
Flash Point :	300° F or higher (base oil)
100° F Viscosity :	450 SUS or higher (base oil)
ASTM Dropping Point :	160° F or higher
Nitrile Rubber Swell :	Minimal (up to 3%)
Thickener Type:	Calcium or Lithium
Thickener Percent:	15% Minimum

TABLE 6 –TURBINE OIL SPECIFICATIONS

Operating Temp Range	20° F to 120° F
Required Properties	
Pour Point :	20° F or lower
Flash Point :	300° F or higher
100° F Viscosity :	150 SUS or higher
ASTM Dropping Point :	32
Nitrile Rubber Swell :	Minimal (up to 3%)

TABLE 7 –STANDARD INDUSTRIAL OILS

MANUFACTURER	RECOMMENDED
Chevron Texaco Corp.	+ Hydraulic Oil AW32
	+ Regal EP 32
CITGO Petroleum Corp.	+ Mystik Turbax Oil 32 (1812)
	Pacemaker Oil 32
	+ Duro Oil 32
Exxon Mobil Corp.	DTE Oil 24
	+ Nuto H Hydraulic Oil 32
Shell Oil	+ Tellus Plus Oil 32
Note: + subzero temperature service.	

TABLE 8 –FOOD MACHINERY OILS

MANUFACTURER	RECOMMENDED
Chevron Texaco Corp.	% + Lubricating Oil FM32
	% Cygnus Hydraulic Oil 32
CITGO Petroleum Corp.	% Mystik FG/AW 32 Oil (1931)
	% Clarion FG AW Oil 32
	% Ideal FG 32 Oil
Exxon Mobil Corp.	DTE FM 32 Oil
	+ Nuto FG Hydraulic Oil 32
Notes: Food machinery lubricants meet USDA H-1 requirements and FDA document 21 CFR 178.3570. + subzero temperature service % NSF 61 registered	

TABLE 9 –STANDARD INDUSTRIAL GREASES

MANUFACTURER	RECOMMENDED
Chevron Texaco Corp.	Ulti-Plex Grease EP2
	Novatex EP2
CITGO Petroleum Corp.	Mystik JT-6 Grease (5484)
	Premium Lithium EP2
	Litholine HEP Grease
Exxon Mobil Corp.	Mobilux Grease EP2
	Lodok EP 2
Shell Oil	Alvania EP Grease 2

TABLE 10 –FOOD MACHINERY GREASES

MANUFACTURER	RECOMMENDED
Chevron Texaco Corp.	% FM Grease EP2
	% Cygnus Grease 2
CITGO Petroleum Corp.	% Mystik FG2 Grease (5607)
	% Clarion FG HTEP Grease
	Ideal FG 2 Grease
Exxon Mobil Corp.	% Mobil Grease FM102
Notes: Food machinery lubricants meet USDA H-1 requirements and FDA document 21 CFR 178.3570. % NSF 61 registered	

TABLE 11 –THREAD COMPOUNDS

MANUFACTURER	RECOMMENDED
Jet-Lube®	Food Grade Silicone™ - Aerosol Lubricant Spray, NSF H1
	Magic Wrench® - Food Grade Penetrating Oil, NSF H1
	CC-Lube™ - Semi-Synthetic Multipurpose Lubricant (Clear) Rust & Corrosion Inhibitor, NSF H1
	White Night Food Grade Anti-Seize & Thread Lubricant, NSF H1
SAF-T-LOK Corp.	FD-GPS General Purpose Silicon Lubricant, Food/Drug Grade, NSF H1
	FD-TPS Thread Sealant Food/Drug Grade, NSF 61, NSF H1
	SAF-T-EZE® Anti-Seize Food Grade, NSF H1
Bostik / Never-Seez	Sprayon LU21 Anti-Seize Spray Food Grade, NSF H1
	NSWT-14 Anti-Seize & Lubricating Compound, White Food Grade with PTFE, NSF H1

7.0 DISASSEMBLY & REASSEMBLY

7.1 DISASSEMBLY

⚠ DANGER

POWER LOCKOUT - Disconnect and lockout electrical power before installing or servicing the pump.

1. Electric Motor driven pumps – after following Power Lockout procedures, remove the electrical connections at the conduit box and tag the electrical leads.
2. Loosen mechanical seal from shaft if present.
3. Hollow Shaft – Remove motor shaft nut lock screw, motor shaft nut, gib key. Lower shaft and unscrew motorshaft from topshaft.
4. Solid Shaft – Lower shaft and unbolt driver half coupling.
5. Remove driver bolts
6. Lift driver off pump and set on wooden supports.
7. Packing box — remove slinger and split ring.
8. Mechanical Seal – unbolt and remove.

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.

9. Tension assembly - remove lock screw and lubrication line and unscrew lock and tension nuts. Threads could be left or right hand.
10. Disconnect discharge piping from pump.
11. Remove anchor bolts or nuts.
12. Lift pump vertically until pump suction clears foundation plate.
13. Cover foundation opening.
14. Lower pump into a horizontal position on suitable supports.
15. Remove bolts attaching seal housing to discharge head and remove.

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.

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.

⚠ WARNING

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

16. Disconnect bowl assembly or top column from discharge head.
17. Remove discharge head, being careful not to damage or bend shaft.
18. Disconnect column pipe, if present, at first joint below top and remove from shaft.
19. Open Line Shaft construction – Each time a line shaft coupling is exposed by removing length of column pipe, the line-shaft and coupling should be removed by holding the lower line shaft and turning the coupling. Remove any nicks or burrs on the shaft before removing the bearing retainers.

⚠ 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.

20. Enclosed Line Shaft construction - each time a length of column pipe is removed, the enclosing tube and line shaft must also be disassembled. Locate the joint and unscrew the enclosing tube from the tube bearing. Remove the enclosing tube up to expose the line shaft coupling and uncouple as previously described.
21. Disconnect each section of column pipe one at a time and remove along with shaft and enclosing tube as applicable until all are removed.
22. Remove bowl assembly to a clear area and continue disassembly.

BOWL DISASSEMBLY

The Bowl Assembly is constructed using a Suction Bowl/Bell, Intermediate Bowl(s), Top Discharge Bowl, Impellers and Securing Hardware, Bearings, and Pump Shaft.

Turbine bowl impellers are secured to the shaft by either a taperlock or a key and split ring. Follow appropriate procedures that apply to the construction supplied.

It is helpful to match mark bowls and impellers in sequence of disassembly to aid in re-assembly.

TAPERLOCK CONSTRUCTION

1. Remove cap screws from the intermediate bowls
2. Slide discharge and top bowl off the bowlshaft.
3. Pull shaft out as far as possible and strike Impeller hub by sliding driver along the bowlshaft to unseat the taperlock.

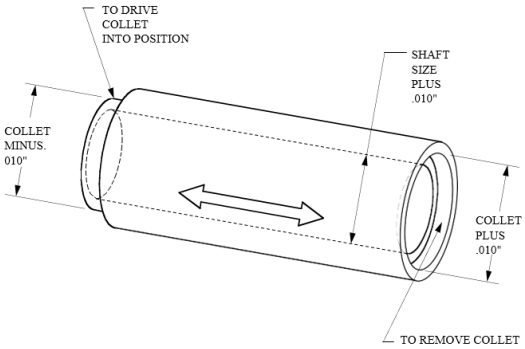


Figure 17

4. After the impeller is freed, insert a screwdriver into the taperlock slot and pull it off the shaft.
5. Repeat the above procedures until the bowl assembly is completely disassembled.

BOWL WEAR RING REMOVAL

1. Remove the set screws or grind off tack weld, when rings are furnished with those locking methods.
2. Using a diamond point chisel, cut two “V” shaped grooves on the bowl wear ring approximately 180 degrees apart. Be careful not to damage the wear ring seat.
3. With a chisel or drift, knock the end of one half of the ring in, and pry the ring out.
4. On special materials such as chrome steel, set the bowl up in a lathe and machine the wear ring off using extreme care not to machine or damage the ring seat.

BOWL AND LINE-SHAFT BEARING REMOVAL/INSTALL

Use an arbor press and a piece of pipe or sleeve with outside diameter slightly smaller than the outside diameter of the bearing to press the bearing out.

When pressing, ensure the bearing is pressed flush by using an oversized shaft to ensure bearing is not kinked. Pressing inside a bowl with the flange downward, until bearing if flush with the hub.

⚠ WARNING

NOTE: Bowl bearings are press fit. Do not remove unless replacement is necessary.

7.2 INSPECTION AND REASSEMBLY

When disassembled, inspect all components for wear, damage, or other deformities. All pump components that are worn or damaged components should be replaced with new parts.

⚠ 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 or replaced to avoid failure.

1. Clean all parts thoroughly with a suitable cleaner.
2. Check bearing retainers for deformation and wear.
3. Anytime the pump is disassembled caution should be taken to make sure the protruding shaft is supported to maintain straightness throughout the shaft. If a shaft becomes bent or deformed outside of the acceptable limit it requires straightening or replacement. Shaft

straightness shall be within 0.0005-inch total indicated runout (TIR) per foot of shaft length.

4. Visually check impellers and bowls for cracks and pitting
5. Check all bowl bearings for total clearance over the shaft diameter. Replace all bearings indicating wear. The maximum allowable diametrical clearance over existing shaft diameter:
   1.00" thru 1.69" shaft - .016" clearance
   1.94" thru 3.69" shaft - .018" clearance
6. Replace all worn or damaged parts with new parts. In addition, replace all gaskets and packing as required.

REASSEMBLY OF THE BOWL UNIT

NOTE: The shaft, taperlock and impeller must be clean and dry upon assembly. Check shaft for straightness

⚠ WARNING

Wear protective gloves and use appropriate eye protection to prevent injury when handling hot parts.

1. If the sand collar is not assembled to the shaft, install the sand collar. The larger diameter of the counterbore of the sand collar goes toward the suction bell bearing. Measurements should be taken to ensure proper shaft stick-up. Slide the plain end of the pump shaft into the suction bowl/bell bearing until the sand collar rests against the suction hub.
2. Hold the shaft in this position by inserting a long cap screw with an assembly jig into the bottom end of the suction hub and secure tight into the threaded hole at the end of the shaft.
3. Slide the first impeller over the shaft until it seats on the suction.
4. Insert a screwdriver into the taperlock slot, slide the taperlock over the bowlshaft and into the impeller hub.
5. Hold impeller firmly against the suction and drive the taperlock into place with the driver. After the impeller is secured in position, the top end of the taperlock should be flush with the impeller hub.
6. Slide intermediate bowl onto shaft and secure with the cap screws provided.
7. Repeat previous procedure for remaining number of stages.
8. Remove long cap screw and the assembly jig at the end of suction hub and check that the shaft rotates freely without dragging or binding. Also check for adequate lateral.

8.0 SPARE PARTS

8.1 RECOMMENDED SPARE PARTS

The decision on what spare parts to stock varies greatly depending on many factors such as the criticality of the application, the time required to buy and receive new spares, the erosive/corrosive nature of the application, and the cost of the spare part. Please contact your factory representative for more information.

Spare parts can be ordered from the local SIMFLO sales engineer, or from the distributor or representative. The pump size and type can be found on the pump name plate on the discharge head and suction. Please provide the item description, and alloy for the part(s) to be ordered.

TROUBLESHOOTING

PROBLEM		PROBABLE CAUSE		RECOMMENDED REMEDY
1.0	Pump not reaching design flow rate.	1.1	Insufficient NPSHA. (Noise may not be present)	Recalculate NPSH available. It must be greater than the NPSH required by pump at desired flow. If not, redesign suction piping, holding number of elbows and number of planes to a minimum to avoid adverse flow rotation as it approaches the impeller.
		1.2	System head greater than anticipated.	Reduce system head by increasing pipe size and/ than or reducing number of fittings. Increase impeller diameter. NOTE: Increasing impeller diameter may require use of a larger motor.
		1.3	Entrained air.	Air leak from atmosphere on suction side.
				1. Check suction line gaskets and threads for tightness.
				2. If vortex formation is observed in suction tank, install vortex breaker.
				3. Check for minimum submergence.
		1.4	Entrained gas from process.	Process generated gases may require larger pumps.
		1.5	Speed too low.	Check motor speed against design speed.
		1.6	Direction of rotation wrong.	After confirming wrong rotation, re-verse any two of three leads on a three-phase motor. Restart pump and check Flow/TDH.
		1.7	Impeller too small.	Replace with proper diameter impeller. NOTE: Increasing impeller diameter may require use of a larger motor.
		1.8	Impeller clearance too large.	Replace impeller and/or bowl wear rings.
		1.9	Plugged impeller, suction line or casing which may be due to large solids.	1. Reduce length of suction when possible.
				2. Reduce solids in the process fluid when possible.
				3. Consider larger pump.
		1.10	Wet end parts (bowl, impeller) worn, corroded, or missing.	Replace part or parts.
2.0	Pump not reaching design head (TDH).	2.1	Refer to possible causes under Problem #1.0	Refer to remedies listed under Problem #1.0 and #3.0.
3.0	No discharge or flow.	3.1	Not properly primed.	Repeat priming operation, recheck instructions. If pump has run dry, contact factory (or dealer) for further instructions.
		3.2	Direction of rotation wrong.	See #1.6 above.
3.0	No discharge or flow. (Cont'd)	3.3	Entrained air.	Air leak from atmosphere on suction side. Refer to recommended remedy under Problem #1.0, Item #1.3.
		3.4	Plugged impeller, suction line or casing which may be due to a fibrous product or large solids.	Refer to recommended remedy under Problem #1.0, Item #1.9.
		3.5	Damaged pump shaft, impeller.	Replace damaged parts.
4.0	Pump operates for short period, then loses prime.	4.1	Insufficient NPSHA.	Refer to recommended remedy under Problem #1.0, Item #1.1.
		4.2	Entrained air.	Air leak from atmosphere on suction side. Refer to recommended remedy under Problem #1.0, Item #1.1.
5.0	Excessive noise from wet end.	5.1	Cavitation - insufficient NPSH available.	Refer to recommended remedy under Problem #1.0, Item #1.1.
		5.2	Abnormal fluid rotation due to complex suction piping.	Redesign suction piping, reducing number of elbows and number of planes to a minimum to avoid adverse fluid rotation as it approaches the impeller.
		5.3	Bent shaft.	Straighten as required. Average total runout should be less than 0.0005" TIR per foot.
		5.4	Impeller rubbing.	1. Replace impeller and/or case wear rings.
				2. Check outboard bearing assembly for axial end play.
		5.5	Resonance	Check piping strain, consult factory.

TROUBLESHOOTING (Cont'd)

PROBLEM		PROBABLE CAUSE		RECOMMENDED REMEDY
6.0	Excessive noise from bearings.	6.1	Bearing contamination appearing on the raceways as scoring, pitting, scratching, or rusting caused by adverse environment and entrance of abrasive contaminants from atmosphere.	1. Work with clean tools in clean surroundings.
				2. Remove all outside dirt from housing before exposing bearings.
				3. Handle with clean dry hands.
				4. Treat a used bearing as carefully as a new one.
				5. Use clean solvent and flushing oil.
				6. Protect disassembled bearing from dirt and moisture.
				7. Keep bearings wrapped in paper or clean cloth while not in use.
				8. Clean inside of housing before replacing bearings.
				9. Check oil seals and replace as required.
				10. Check all plugs and tapped openings to make sure that they are tight.
		6.2	Brinelling of bearing identified by indentation on the ball races, usually caused by incorrectly applied forces in assembling the bearing or by shock loading such as hitting the bearing or drive shaft with a hammer.	When mounting the bearing on the out- board end use a proper size ring and apply the pressure against the inner ring only. Be sure when mounting a bearing to apply the mounting pressure slowly and evenly.
		6.3	False brinelling of bearing identified again by either axial or circumferential indentations usually caused by vibration of the balls between the races in a stationary bearing.	1. Correct the source of vibration.
				2. Where bearings are oil lubricated and employed in units that may be out of service for extended periods, the drive shaft should be turned over periodically to re-lubricate all bearing surfaces at intervals of one-to three months.
		6.4	Thrust overload on bearing identified by flaking ball path on one side of the outer race or in the case of maximum capacity bearings, may appear as a spalling of the races in the vicinity of the loading slot. These thrust failures are caused by improper mounting of the bearing or excessive thrust loads.	Follow correct mounting procedures for bearings.
		6.5	Misalignment identified by fracture of ball retainer or a wide ball path on the inner race and a narrower cocked ball path on the outer race. Misalignment is caused by poor mounting practices or defective drive shaft. For example, bearing not square with the centerline or possibly a bent shaft due to improper handling.	Handle parts carefully and follow recommended mounting procedures. Check all parts for proper fit and alignment.
		6.6	Bearing damaged by electric arcing identified as electro-etching of both inner and outer ring as a pitting or cratering. Electrical arcing is caused by a static electrical charge emanating from belt drives, electrical leakage, or short circuiting.	1. Where current shunting through the bearing cannot be corrected, a shunt in the form of a slip ring assembly should be incorporated.
				2. Check all wiring, insulation, and rotor windings to be sure that they are sound, and all connections are properly made.
				3. Where pumps are belt driven, consider the elimination of static charges by proper grounding or consider belt material that is less generative.
		6.7	Bearing damage due to improper lubrication, identified by one or more of the following: 1. Abnormal bearing temperature rise. 2. A stiff cracked grease appearance. 3. A brown or bluish discoloration of the bearing races.	1. Be sure the lubricant is clean.
				2. Be sure proper amount of lubricant is used. The constant level oiler supplied with some pumps will maintain the proper oil level if it is installed and operating properly. In the case of greased lubricated bearings, be sure that there is space adjacent to the bearing into which it can rid itself of excessive lubricant, otherwise the bearing may overheat and fail prematurely.
				3. Be sure the proper grade of lubricant is used.

TROUBLESHOOTING (Cont'd)

PROBLEM		PROBABLE CAUSE		RECOMMENDED REMEDY
7.0	Pump does not start.	7.1	Electrical circuit open or not completed	Check circuit and correct.
		7.2	Improper lateral adjustment. Impeller on bottom.	Reset impeller adjustment.
		7.3	Low voltage supplied to electric driver.	Check whether driver wiring is correct and receives full voltage.
		7.4	Defective motor.	Consult factory.
8.0	Pump works for a while and quits.	8.1	Excessive horsepower required.	Use larger driver. Consult factory.
		8.2	Pumping higher viscosity or specific gravity liquid than pump is designed for.	Test liquid for viscosity and specific gravity.
		8.3	Mechanical failure of critical parts	Check bearings and impellers for damage. Any irregularities in these parts will cause a drag on the shaft.
		8.4	Suction strainer clogged.	Pull pump and clean the strainer.
		8.5	Misalignment.	Realign pump and driver.
		8.6	Breaking suction.	Check dynamic water level in the well. Lower bowl assembly by adding column.
9.0	Pump takes too much power.	9.1	Damaged impeller.	Inspect, replace if damaged.
		9.2	Foreign object lodged between impeller and bowl.	Remove object as required.
		9.3	Specific gravity higher than pump designed for.	Test liquid for viscosity and specific gravity.
		9.4	Viscosity too high, partial freezing of pumpage.	Check for both viscosity and specific gravity. They can cause drag on impeller.
		9.5	Defective bearing,	Replace bearing, check shaft or shaft sleeve for scoring.
		9.6	Packing is too tight.	Release split ring pressure. Retighten. Keep leakage flowing. If no leakage, check packing, sleeve, or shaft.
10.0	Excessive vibrations.	10.1	A. Coupling misalignment, bent impeller unbalance, worn bearings, cavitation, piping strain and/or resonance.	1. Determine cause utilizing shaft vibration frequency analyzer and/or pump disassemble.
				2. Complex problem may require factory service assistance.
		10.2	Motor or gear driveshaft end play mis adjustment.	See Installation of Hollow Shaft Driver (VHS).
		10.3	Bent shaft.	Straighten as required. Average total runout should be less than 0.0005" TIR per foot.
		10.4	Crooked well.	Survey the well and consult factory.
11.0	Pump leaks excessively at packing box.	11.1	Defective packing.	Replace worn packing.
		11.2	Wrong type of packing.	Replace packing not properly installed or run-in. Replace improper packing with correct grade for liquid being pumped.
12.0	Packing box is overheating.	12.1	Packing is too tight	See #6.1.
		12.2	Packing is not lubricated.	Release split ring pressure and replace all packing if burnt or damaged. Re-grease packing as required.
		12.3	A. Wrong grade of packing.	Consult factory.
		12.4	Packing box improperly packed	Repack packing box.
13.0	Packing wears too fast.	13.1	Shaft or shaft sleeve worn.	Pull pump and re-machine or replace shaft and/or sleeve.
		13.2	Insufficient or no lubrication.	Repack and make sure packing is loose enough to allow some leakage.
		13.3	Improperly packed.	Repack properly, make sure all old packing is removed and packing box is clean.
		13.4	Wrong grade of packing.	Consult factory.