



**Johnston
Pump**

A Sulzer Brand

JTS Vertical Turbine Pumps



Project Name: _____

Customer: _____

End User: _____

Size/Model: _____

Serial Number: _____

Customer Tag: _____

DS-V01-000 REV: 0 DATE 09/21

EN

Installation, Operation & Maintenance Manual

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INSTALLATION, OPERATIONS & MAINTENANCE MANUAL

SUBJECT: INTRODUCTION

1.0 ABOUT THIS MANUAL

This manual is prepared for operation and maintenance personnel. It provides INSTALLATION, OPERATION, AND MAINTENANCE instructions for the Sulzer Type JTS vertically suspended standard turbine pump. This manual contains important information on how to operate the pump safely, properly and most efficiently. Observing these instructions will help to avoid danger, to reduce repair costs and downtimes, and increase the reliability and life of the pump.

Read all of the instructions carefully before operating the pump.

Use this manual with the Cross Section drawing, Parts list, and General Arrangement drawing supplied with the order. See the auxiliary equipment section of the manual for instructions on auxiliary equipment manufactured by others and supplied by Sulzer.

2.0 HOW TO USE THIS MANUAL

The operating manual must always be available wherever the pump is in use. These instructions must be read and applied by any person in charge of carrying out work with and on the pump, such as transport, storage, installation, operation and maintenance.



This manual should be used in conjunction with the Cross Section drawing, Parts list, and General Arrangement drawing supplied with the order so that there is accurate information about your pump. Do not start or operate this pump unless you have complete understanding of the pump system and all auxiliary systems.

3.0 DESCRIPTION

The JTS vertically suspended standard turbine pump integrates the tradition of providing our highly engineered, reliable pump product with standard configurations. By standardization of configurations and materials, we are able to provide a more valuable product with shorter lead times to meet market demands. This pump is specifically designed for higher differential head water and waste water applications.

JTS pumps are single entry multistage pumps, available in sizes from 7" to 20" (180 to 510mm).

The JTS is designed to handle water from -15°C to 85°C , (5°F to 185°F).

4.0 FEATURES

4.1 **Bowl Assembly** The bowl assembly consists of multiple stages of the open line shaft configuration and consists of the following components:

4.1.1 **Bowls** The bowls are available in Cast Iron with coated hydraulic passageways for improved efficiency. The bowls are threaded for 7" and 8" sizes; flanged for 9" and larger. They are precisely machined with a register fit for staging requirements. A replaceable wear ring is standard in all bowls. Bowls are fitted with a single lead free Bronze sleeve bearing as standard. A Dual Rubber & Bronze Bearing option is also available.

4.1.2 **Impellers** The Stainless Steel impellers are a closed single suction design machined for replaceable wear rings as standard. The 18" and smaller impellers are driven and axially retained by a lock collet. The 20" impellers are key driven and axially retained by split ring.

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- 4.1.3 **Suction Bell** The suction bells are Cast Iron. They include anti-vortex ribs and a tail bearing bushing. Bells are supplied with a replaceable wear ring as standard. The bell lip can be machined to match the bowl OD for use in a barrel or well. The bells can be fitted with a clip on basket or cone strainer to keep solids from entering into the pump.
- 4.1.4 **Pump Shaft** The shafts in the JTS are made from 12% Chrome. Accurate machining provides precision fits and clearances for assembly and operation. The pump shaft design is modular or “size driven” by the number of stages.
- 4.1.5 **Wear Rings** Replaceable rings are fitted in the Suction Bell and Bowls as well as on the Impeller to provide close running clearances and reduce leakage from the impeller high pressure liquid side to the suction side.
- 4.2 **Column Assembly** The column assembly will consist of single or multiple sections to meet the NPSH requirements, and consist of the following components:
 - 4.2.1 **Column** Columns 12" and smaller are threaded, where the 14" and 16" columns are flanged. Column spacing is set to avoid a critical speed. Max Column Velocity to be 12.5 Ft/Sec
 - 4.2.2 **Bearing Spider Housing Assembly** The bearing spider housing is equipped with replaceable Rubber bushings as standard.
 - 4.2.4 **Lineshaft & Lineshaft Coupling** Lineshafts are sized to transmit the torque produced by the motor to the impellers. The Lineshaft couplings provide a secure threaded connection between each piece of shafting.
- 4.3 **Discharge Head Assembly** The discharge head assembly which serves to direct the flow as it exits the pump as well as to support the driver in proper alignment and support the pump components, consists of the following components:
 - 4.3.1 **Discharge Head** Cast heads are equipped with discharge nozzles conforming to ANSI B16 with ANSI 125# F.F. Flange (14" and Smaller) Fabricated heads (also available) are equipped with ANSI 150# R.F. or 300# R.F. Flanges. Max Discharge Nozzle Velocity to be 12.5 Ft/Sec.
 - 4.3.2 **Stuffing Box / Shaft Seal** The JTS has three different stuffing box options. 1. A standard gland packed stuffing box available as standard for pressures up to 175 PSI. 2. For higher pressures a by-pass gland packed stuffing box is available. 3. Optional seal box with cartridge type mechanical seal.
 - 4.3.3 **Mechanical Seal** Optional cartridge-type mechanical seals will fit into the stuffing box—specified equipment manufacturers only (John Crane Type 5610, and Chesterton Type 155 or Type 155).
 - 4.3.4 **Drive Coupling** The JTS will be supplied with 1 of 3 differed drive couplings depending upon the motor/thrust bearing selection.
 - 1. Hollow Shaft Driver with Thrust Bearing Located in the Motor: A threaded drive coupling will be provided. The Impeller lift setting will be achieved via the adjusting nut installed at the driver coupling.
 - 2. Solid Shaft Driver with Thrust Bearing Located in the Motor. A Flanged Adjustable non-spacer Rigid Drive Coupling will be provided. The Impeller lift setting will be achieved via. the adjusting nut within the drive coupling.

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SUBJECT: INTRODUCTION

3. Solid Shaft Driver with Thrust Bearing Located in the Pump. A flexible non spacer type coupling will be provided. The impeller lift setting will be achieved via the adjusting nut within the thrust bearing assembly.

4.3.5 **Integral Thrust Bearing Assembly** The pump unit may be equipped with an integral thrust bearing to carry all hydraulic axial and static loads. The integral thrust bearing is standard on 50Hz JTS units.

4.3.6 **Driver Stand** The driver stand is an optional feature required with the thrust bearing and some vertical solid shaft/drive coupling combinations. Located between the discharge head and the motor the driver stand is of sufficient length to access the coupling and removal of the mechanical seal without disturbing the driver.

4.3.7 **Auxiliary Piping** Factory installed piping and required external connections will be noted on the general arrangement drawing and any referenced piping drawing(s). Additional equipment such as isolating valves, strainers, heat exchanges and gages can be supplied.

5.0 PERFORMANCE FACTORS

Pump performance is affected by changes in fluid specific gravity, viscosity, pump operating speed, and NPSHA (net positive suction head available). Centrifugal pumps are designed for specific services and may not be suited for any other without loss of performance or damage.

CAUTION

Do not change operating conditions from the original design without contacting a Sulzer representative.

6.0 EXPLOSIVE ENVIRONMENT DESIGNATION



Pumps supplied in the European Union (EU), or the European Free Trade Association (EFTA) may be subject to the requirements of EU directive 94/9/EC (ATEX) and will be marked with an appropriate nameplate. The pump designation will allow their use in the following areas.

Group II			
Category 2		Category 3	
G (zone 1)	D (zone 21)	G (zone 2)	D (zone 22)

G – potentially explosive gas atmosphere

D – potentially explosive dust atmosphere

6.1 **Temperature classes** Ensure that the pumps are classified according to their group and provided with the appropriate certificates. Each group is determined by the ambient gas or ambient dust and temperature class, at a max. ambient temperature of 40 °C (104 °F).

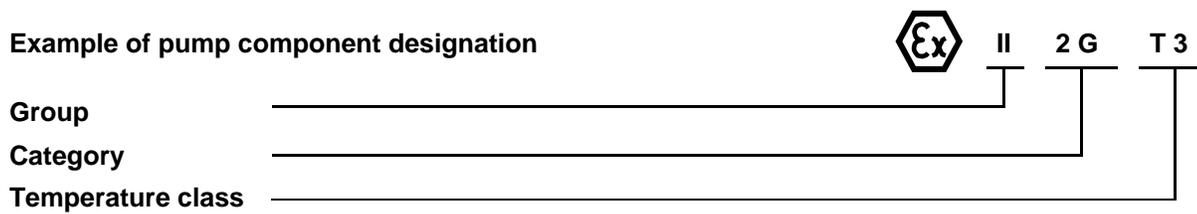
The maximum temperature permissible for the conveyed material must also be observed for the temperature class in question. The responsibility for observing the conveyed material temperature always lies with the operator.

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SUBJECT: INTRODUCTION

Temperature class	T1	T2	T3	T4	T5
Maximum temperature	450 °C (842 °F)	300 °C (572 °F)	200 °C (392 °F)	135 °C (275 °F)	100 °C (212 °F)
Max. medium temperature	430 °C (806 °F)	280 °C (536 °F)	180 °C (356 °F)	115 °C (239 °F)	80 °C (176 °F)

Example of pump component designation



7.0 GUARANTEE

Guarantee is assumed according to the contractual agreements. The normal Sulzer warranty covers manufacturing or material defect, it does not cover the damage caused by improper storage conditions, incorrect installation, operation and using against designated use.

During the guarantee period, modifications, disassembly or repairs can only be worked out by our service personnel or with our written approval.

INSTALLATION, OPERATIONS & MAINTENANCE MANUAL

SUBJECT:  SAFETY

1.0 Scope

This operating manual contains basic information that must be observed on the installation, commissioning, operation, and maintenance. Therefore, this manual **must be available at all times** on site for the use of service, or site personnel. It must also be read prior to commissioning and/or assembly or disassembly of the pump.

2.0 Marking of instructions in the operating manual

Bodily harm may result if the safety instructions contained in these operating sections are not observed.

Information on preventing injury to a person.



Denotes information on preventing damage to a system component.



Potential electrical hazard.



In terms of explosion protection with the special sign.



Indicators that are **directly attached to the equipment** itself such as

-Arrow for rotational direction

-Marking for fluid connections etc.

Must be kept in good, legible condition.

3.0 Qualification and training of personnel

The personnel who service, maintain, inspect, and assemble the equipment described in this manual must have the necessary qualifications for these jobs. Range of responsibility, competence, and monitoring of these personnel must be established by the user. The user must ensure that adequate training is provided. If requested and coordinated by the user, the equipment supplier may undertake training and instruction. Further, the user must ensure that the personnel have a complete understanding of the contents of the manufacturer's instruction manual.

4.0 Danger in non-observance of the safety regulations

4.1 Non-observance of the safety regulations may endanger persons as well as machinery and the environment. It may also invalidate claims for damages.

4.2 Non-observance may lead to the following dangers:

4.2.1 Failure of important functions of equipment /plant

4.2.2 Failure of required procedures of maintenance and repair

4.2.3 Endangerment to personnel by chemical, electrical, and/or mechanical means

4.2.4 Endangering of environment by leakage of dangerous materials

INSTALLATION, OPERATIONS & MAINTENANCE MANUAL

SUBJECT:  SAFETY

5.0 Safety guided working

The safety regulations given in this operation manual, national and state regulations on accident prevention, as well as company safety regulations issued by the user, must be observed.

6.0 Safety instructions for user / operator

- 6.1 Hot or cold parts must be secured against physical contact
- 6.2 Safety guards for rotating parts (e.g. coupling) may not be removed from equipment while in operation.
- 6.3 Leakages (e.g. from mechanical Seal) of dangerous fluids (e.g. explosive, toxic, hot etc.) have to be disposed of in such a way as to prevent endangerment of personnel and the environment. Legal regulations must be observed.
- 6.4 Electrical hazards have to be excluded (details see example in the regulations of national, state and/or local energy suppliers).
- 6.5 Special safety instructions in the following paragraphs of this operating manual must be observed.

7.0 Safety instructions for maintenance, inspection and assembly jobs

- 7.1 Work on the equipment must be carried out only during shutdown of the equipment. The procedure described in the operating manual for the shutdown of the equipment has to be strictly adhered to. The equipment has to be guarded against unauthorized or involuntary start-up.
- 7.2 Employees with long hair must tie it back. No loose clothing or jewelry, including rings should be worn. There is a risk of injury if such objects are caught or pulled into rotating equipment during operation.
- 7.3 Equipment operating with liquids hazardous to health must be decontaminated before being worked on.
- 7.4 Upon completion of work, all safety and protective devices must be reattached.
- 7.5 On a repeated start-up, all points given in the section on commissioning must be observed.

8.0 Prohibition of unauthorized rebuilding measures or alterations

Alterations or rebuilding measures on the equipment are only admissible in agreement with the manufacturer. Original spare parts and auxiliary equipment authorized by manufacturer are meant to guarantee safety. The use of other parts may lead to a loss of the manufacturer's liability for the consequences.

9.0 Inadmissible operating modes

- 9.1 The operational safety of the delivered equipment is only guaranteed by proper use according to the data sheet of this operating manual.
- 9.2 The limits given in the data sheet or nameplate must not be exceeded in any case.

INSTALLATION, OPERATIONS & MAINTENANCE MANUAL

SUBJECT:  SAFETY

10.0 Explosion Protection

- 10.1 Any designation of the pump refers to the pump component only. Shaft coupling, driver motor (e.g. electric motor) and auxiliary systems (shaft sealing, lubricating oil system, etc.) must be looked at separately.
- 10.2 Improper operating methods that result in the specified temperatures being exceeded (exceeding or falling short of the operating data, falling short of the minimum delivery flow, reduction or failure of cooling water or circulation delivery, etc.) should be avoided at all costs.
- 10.3 Before starting the pump, ensure that the pump system (suction pipe, pump casing and shaft seal) is completely full of fluid. This prevents the existence of any potentially explosive atmosphere in the system.
- 10.4 Monitor the pumps operation regularly. Instruments that can be used include, but are not limited to, manometers, thermometers, speed counters, ammeters, etc.
- 10.5 Maintain the pump properly. Only equipment that is in good technical condition can guarantee safe operation.

INSTALLATION, OPERATIONS & MAINTENANCE MANUAL

SUBJECT: TRANSPORT, RECEIVING, and STORAGE

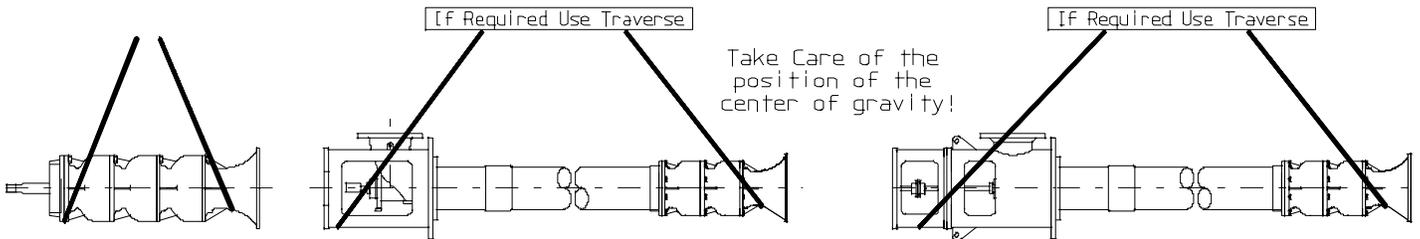
1.0 TRANSPORT

1.1 Transportation devices (including vehicles) must be checked for the admissible load weight. For total weight of the delivered goods see dispatch documents. The load must be secured against shifting while in transport.

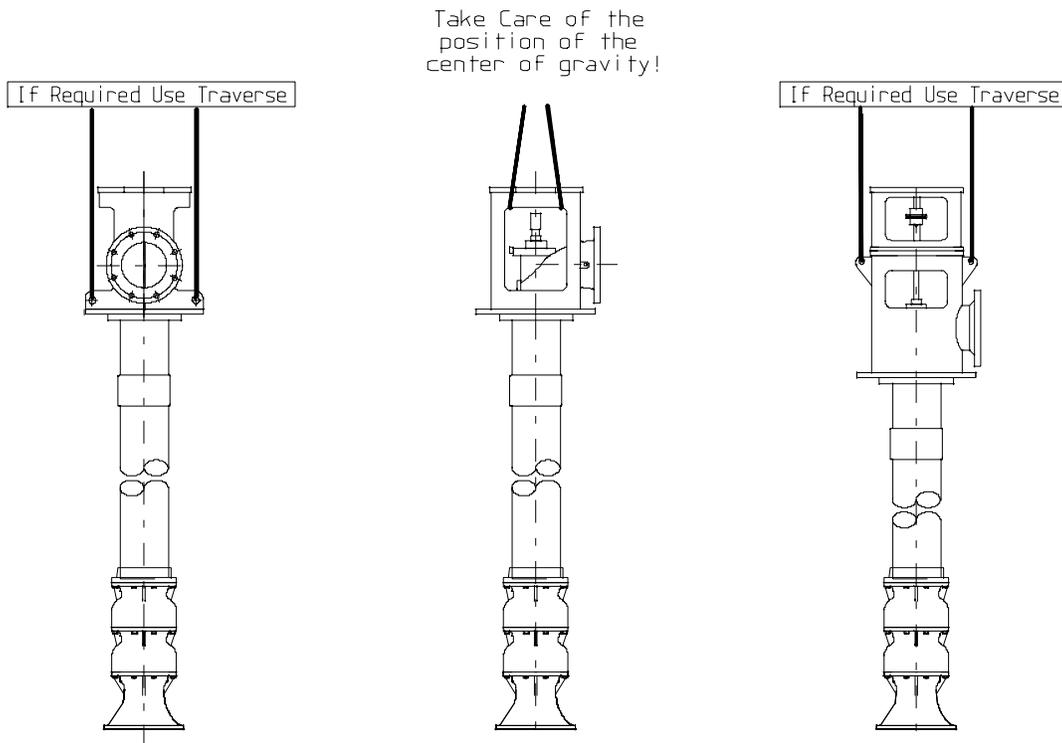
2.0 LIFTING

2.1 **Unloading** Undamaged slings and lifting devices must be used. Arrange slings or other hoisting devices to maintain a level lift, avoiding damage to piping or other components.

2.2 **Fastening spots for units** In case lifting lugs or bars are attached at the pump, the unpacked unit has to be fastened at these spots by shackling the sling. The pump can also be lifted by slings which are laid around certain parts of the pump. See sketches 2.2-1 and 2.2-3. Typical example: pump shape may vary due to pump type ordered.



Sketch 2.3-1 (Fastening spots for horizontal transport)



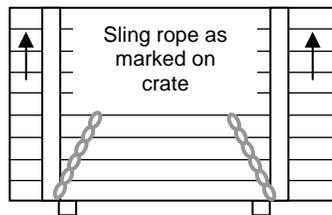
Sketch 2.3-2 (Fastening spots for vertical transport and installation)

INSTALLATION, OPERATIONS & MAINTENANCE MANUAL

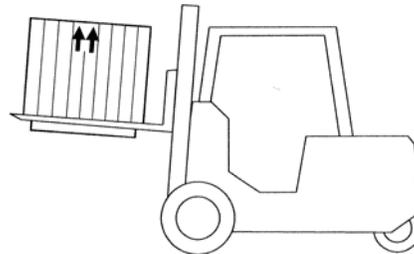
SUBJECT: TRANSPORT, RECEIVING, and STORAGE

- 2.3 **Fastening of ropes to sling crates** The points for fastening sling ropes to closed crates are marked on the side of the crate. Since the center of gravity cannot be seen on closed crates. Sling rope fastening must always be done at the marked locations. See sketch 2.3-1. Crates can be lifted and transported with a forklift, See sketch 2.3-2.

CAUTION



Sketch 2.3-1 (Sling Position on Crates)



Sketch 2.3-2 (Lifting and Transport with forklift)

- 2.4 **Support** the equipment on skids or timbers to ease later relocation to installation site or to storage. Prevent flex by providing a sufficient number of supports.

3.0 INSPECTION

- 3.1 **Inspection Upon Arrival** The products supplied by Sulzer received a final inspection in the factory. To ensure the product has not been damaged in transit, inspect upon arrival and note findings on carrier's ticket. Report damage or shortage immediately to the carrier and a representative of Sulzer.

4.0 STORAGE

- 4.1 **Storage Time** The following storage instructions are applicable to units stored 30 days to two years after shipment. Contact Sulzer for recommended long-term (greater than two years) storage procedure.

CAUTION

The following storage instructions apply only to the pump and may not be appropriate to furnished auxiliary equipment. Follow vendor instructions for all other components of the pump system. Contact Sulzer when a conflict in storage procedures occurs.

- 4.2 **Requirements** Prior to shipment, the pump and its components are prepared for outside storage. The following additional requirements should be followed by the customer.
- 1) Store off the ground on skids or cribbing so that no water will accumulate around the unit.
 - 2) Protect pump and attachments with a vinyl-coated nylon tarpaulin. Tie down flat so that water does not collect in pools on tarp surface. Maintain sufficient air circulation with a 3 in. (8 cm) minimum clearance between tarp and pump.
 - 3) Locate in an area that is free from blowing sand or dirt.
 - 4) Do not stack equipment.
 - 5) Prevent animal entry by keeping connections sealed.
 - 6) Maintain rust prevention coatings.
 - 7) Install or maintain drying agent (desiccant).

- 4.3 **Approved Storage Material** The following materials are recommended for maintenance use:

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SUBJECT: TRANSPORT, RECEIVING, and STORAGE

- 1) Drying Agent: Use "Cortec 110" vapor corrosion inhibitor emitter, or equivalent desiccant.
- 2) Nozzle Covers: Use metal nozzle covers equipped with rubber gaskets if prolonged storage is anticipated.
- 3) Weather Protection: Vinyl coated nylon tarpaulin.
- 4) Corrosion Protection Coatings: Use "Cortec 329, 368 or 377" vapor inhibitor coating, or equivalent, rust preventive.
- 5) Protective Wrap: Use "Cortec Cor-Pak VCI film", or equivalent wrap. {"Cortec" products are manufactured by the Cortec Corporation}

4.4 Inspection and Maintenance

4.4.1 Visually inspect the equipment and packaging every four weeks. Repair any damage to weather protection.

4.4.2 Perform the following maintenance every year:

- 6) Remove protective tarpaulin.
- 7) Remove nozzle cover(s). Drying agent will be attached to cover(s). Replace drying agent and reseal protective cover(s).
- 8) Inspect surfaces that require rust preventive protection. Recoat as required.
- 9) Examine loose parts and unpainted machined surfaces that are wrapped in Cortec VCI film. Re-wrap as required.
- 10) Replace and lash protective tarpaulin.

Records

Keep an inspection record with equipment.

- 1) Date of inspection.
- 2) Name of person performing inspection or maintenance.
- 3) Results of inspection.
- 4) Date of maintenance.
- 5) Description of maintenance performed.
- 6) Amount and type of drying agent replaced.

4.4.3 When the pump is removed from storage it is recommended that the seals and bearings are inspected. If rolling element bearings show any signs of contamination, replace prior to start-up. Refer to the appropriate section of this Maintenance Manual for specific instructions.

INSTALLATION, OPERATIONS & MAINTENANCE MANUAL

SUBJECT: INSTALLATION

Use the INSTALLATION SEQUENCE check list on PAGE 21 of this section to find the correct paragraph and ensure all events are completed in the correct order.



Machinery intended for use in potentially explosive areas must satisfy the “Ex” protection requirements. Check documentation and nameplates relating to the pump and any accessories or equipment.

1.0 GENERAL

- 1.1 Good planning and preparation result in fast, simple and correct installation. Safe running conditions with maximum accessibility are assured. When preparing for installation of the machine, it is necessary to take the following aspects into account:
- 1.2 The main dimensions, connections, position of fixing bolts etc., are shown on the Pump general arrangement drawing.
- 1.3 Suitable lifting devices must be available for installation and repair work. Good lighting is important and sockets for portable lights should be available.
- 1.4 The pump should be readily accessible from all sides.
- 1.5 The pump foundations and type of installation should be designed so that vibration is kept to a minimum both during operating and when the pump is at rest, otherwise the pump life will be reduced.
- 1.6 A drain must be provided so that gland leakage, cooling water (open system) and liquid drained from the pump during overhaul can be led away.



Drainage from the pump must not lead to the endangerment of personnel and or the environment.

- 1.7 Following manufacture, the pump flanges and external tappings are protected by plastic plugs which should not be removed before the pipework is ready to be attached to the pump. The pump should be protected if further site work is necessary nearby.
- 1.8 The foundation or any other necessary building work must be finished, set and dried. Roughen and clean the foundation. All preliminary work for erection must be completed. With large units, suitable door and wall openings are to be provided for transport to the installation site.

2.0 FOUNDATION



Machinery intended for use in potentially explosive areas must satisfy the “Ex” protection requirements. Check documentation and nameplates relating to the pump and any accessories or equipment.

- 2.1 **Site** Install near fluid source. Allow adequate space for operation, maintenance, and inspection.

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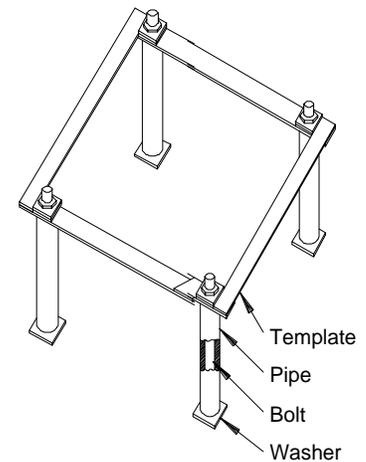
SUBJECT: INSTALLATION

2.2 **Design** The foundation must give adequate system support and meet external piping requirements. The foundation must also inhibit vibration. Soleplate surface must be level within 0.002 in/ft (0.17 mm/m). Reinforced concrete is the most satisfactory foundation.

2.2.1 Provide adequate support to prevent misalignment caused by yielding or springing of structure or base-plate. The general arrangement drawing provides pump hold-down dimensions necessary for foundation design.

2.3 **Soleplate Foundation** Construct a template to position the foundation bolts to match the soleplate hold-down holes shown on the general arrangement drawing. The template should be rigid enough to hold foundation bolt assemblies in place during the foundation pour.

2.4 **Foundation Bolts** Each foundation bolt should be surrounded by a pipe sleeve with an inside diameter approximately three times bolt diameter. By doing this, the pipe is held solidly in concrete while allowing later minor bolt adjustment.



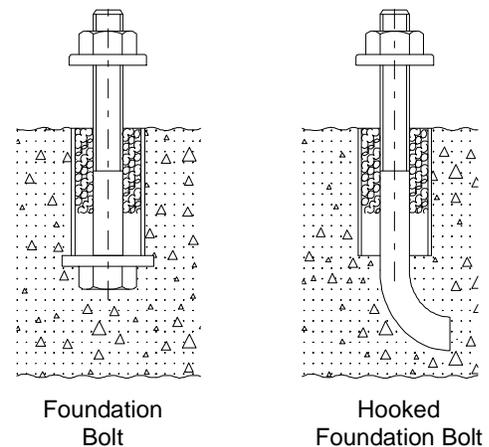
2.4.1 The bolts should extend above the top of the pipe sleeves far enough to allow 1 to 2 in. (25-50 mm) of grouting between the soleplate bottom and foundation.

2.4.2 Tack weld bolts, washers, and pipe together before installing on the template. Pack rags or stuffing around bolts to center within the sleeves.

NOTE: Hooked foundation bolts are useful for installation on existing construction, or where the pier height is limited. This type of bolt has greater mechanical hold capability and is less sensitive to vibration.

2.5 **Concrete Curing** It is essential that the concrete be fully cured—refer to the manufacturer's recommendations, before mounting the base-plate. After the foundation has cured, remove water and packing material from foundation bolt sleeves and dry entire foundation.

2.6 **Prepare the foundation** Surface preparation requires for grout to be scraped with a chipping hammer. **Note:** If grout must be applied to damp concrete, thoroughly coat the concrete with a penetrating sealer at least four hours in advance to pouring the grout. Remove any loose particles, dirt or oil soaked concrete.



2.7 **Prep for Grout** Remove ½ in. to 1 in. (13-25 mm) minimum * of foundation material to insure proper bonding of grout. This distance can vary depending on curing time, proper placement, and depth of sound aggregate. Doing so creates high porosity surfaces and eliminates low strength concrete foundations prior to grouting.

INSTALLATION, OPERATIONS & MAINTENANCE MANUAL

SUBJECT: INSTALLATION

3.0 SOLEPLATE INSTALLATION (If supplied)

- 3.1 Depending on size of pump and other factors, the pump may be shipped assembled or partially assembled.



Prior to and during the installation ensure that the atmosphere is not potentially explosive. Stop all work immediately if any danger arises.

CAUTION

Do not to let any foreign material enter the pump. This is essential, since the internal parts of the pump could be damaged by any debris passing through the unit.

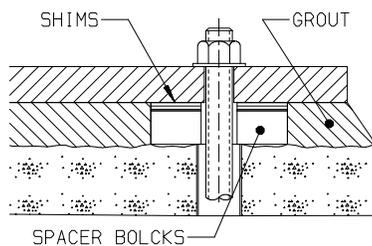
- 3.2 The soleplate should have been supplied separate from pump unit.
- 3.3 Lift the soleplate by slinging with eyebolts in tapped holes provided on soleplate face.
- 3.4 Clean underside of soleplate and surfaces that will be in contact with grout. Remove any extraneous material.
- 3.5 When epoxy grout has been specified, the underside of the soleplate will have been coated with a catalyzed epoxy primer.

CAUTION

Take care not to damage these painted surfaces when cleaning mechanically, or using solvents.

CAUTION

Do not use oil base solvents for cleaning. The residue can prevent grout adherence.



- 3.6 Position the soleplate over the foundation at the predetermined elevation, aligning with the foundation bolts set in the concrete block.
- 3.7 Place spacer blocks 4 to 6 in. (100-150 mm) long, 2 to 3 in. (50-80 mm) wide and thick enough to allow for proper grouting clearance adjacent to each hold-down bolt, but not in the way of the soleplate can leveling screw holes.

- 3.8 Lower soleplate over the bolts and set down on the spacer blocks as illustrated.
- 3.9 Place a precision level on the surface of the soleplate and check for leveling in two directions.

NOTE: Wax the spacer blocks, shims and leveling screws to prevent grout adhesion and to allow removal after grout has hardened.

- 3.10 Wrench tightened foundation bolts. Recheck soleplate leveling, and adjust the shim as necessary until the foundation bolts are fully tightened and the soleplate is secure and level.

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4.0 GROUT SELECTION AND APPLICATION

4.1 **Selection** Select a non-shrinking grout that is resistant to damage by any chemicals that may be spilled, and compatible with the highest temperature to which it may be exposed.

4.2 **References**

4.2.1 ASTM

C109 Test Method of Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or 50-mm Cube Specimens).

C531 Test Method for Linear Shrinkage & Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, and Monolithic Surfacing.

C579 Test Methods for Compressive Strength of Chemical-Resistant Mortars & Monolithic Surfacing.

C827 Test Method for Early Volume Change of Cementitious mixtures.

4.2.2 US ARMY CORPS OF ENGINEERS

CRD

C611 Test Methods for Flow Grout Mixtures (Flowcone Method).

C621 Corps of Engineers Specification for Non-Shrink Grout.

4.3 **Minimum Characteristics for Cementitious Grouts**

4.3.1 Shall not bleed (no water run off) while the grout is being transported or placed.

4.3.2 Shall not shrink nor expand more than 4.0 percent when tested according to ASTM C827 (before set) and no more than 1.0 percent when tested according to CRD C621 (after set).

4.3.3 Shall be of the minimum strengths specified by CRD C621 (minimum of 5000 PSI at 28 days).

4.4 **Minimum Characteristics for Epoxy Grout**

4.4.1 Shall not shrink nor expand more than 4.0 percent when tested according to ASTM C827 (before set) and no more than 1.0 percent when tested according to CRD C621 (after set).

4.4.2 The minimum allowable compressive strength of an epoxy grout at 7 days shall be 6000 PSI when measured according to ASTM C579.

4.4.3 The peak exotherm of a cylinder of epoxy grout 2 in (50 mm) in diameter and 4 in (100 mm) high, tested at a material and laboratory temperature of 75° F (24° C), shall not exceed 95° F (35° C).

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4.4.4 The coefficient of thermal expansion for an epoxy grout shall not exceed 30×10^{-6} in/in/°F (54×10^{-6} mm/mm/°C) when tested according to ASTM C531.

4.4.5 Epoxy grouts shall emit no odor or highly volatile inhalation irritants.

4.5 Types

4.5.1 High fluidity grouts as defined by CRD-C621 and CRD-C611, shall be within the range of 20-30 sec efflux from a standard flow cone.

4.5.2 Flowable grout, as defined per ASTM C-109 shall be within the range of 124-145% with five drops.

4.5.3 Standard dry packing using moist sand and cementitious materials is acceptable.

4.6 Placement

4.6.1 High fluidity grouts shall be placed by pouring down an inclined plane into forms around the soleplate. Pouring should be from one side only, and sufficient material should be poured to overflow the forms. In locations that are difficult to reach, placement with steel strapping is recommended. Where special placement requirements must be met, pumping of high-fluidity grouts can also provide acceptable placement.

CAUTION

The use of vibrators to aid placement can cause water and grout to separate and is therefore not recommended.

4.6.2 Flowable grouts normally require movement into position. The use of steel straps or a well and plunger is recommended. Placement with a chain is not recommended because of the possibility of air entrainment in the links.

4.6.3 Dry packing requires manual placement followed by compaction using a round-end rod. Care should be taken to avoid over packing.

NOTE: Consult a grout manufacturer for further information on selection preparation and placement.

5.0 SOLEPLATE GROUTING AND SECURING

5.1 Build wooden forms around the edges of the foundation. Forms must be strong enough to withstand the grout pressure and must be sealed and made watertight by caulking between forms and foundation. If forms are placed on rough concrete surface, seal bottom with a stiff sand and cement mortar, flush with the form inside face. This should be done immediately before placing grout because mortar shrinkage can result in leakage.

5.2 Apply two heavy coats of paste wax, or one coat of shellac and one heavy coat of paste wax to the forms. Plastic sheeting is acceptable, but it must be stretched tightly to prevent wrinkling.

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- 5.3 Cover the wedges with caulk or plastic tape if later removal is desired. Mark wedge positions on mounting flange, to locate after grout pour.
- 5.4 Force the grout under the edge of the base-plate. Fill the void under the soleplate completely, probing as necessary to ensure proper distribution of the grout.
- 5.5 After the grout has thoroughly hardened, remove forms, spacer blocks and shims. Back off leveling screws. Fill holes with grout.
- 5.6 Torque foundation bolts in accordance with **TORQUE VALUES ADDENDUM No. 2**

Note: Do not continue to the next phase of the installation until the grout under the soleplate is thoroughly cured according to the grout manufacturer's recommendations.

6.0 INSTALLATION OF THE BASKET AND CONE STRAINER (If provided)

NOTE: There are a number of methods for installing strainers, but the following steps are among the most practical and common.

6.1 Basket Strainer – Clip on Type

- 6.1.1 Place the strainer against the bottom of the suction bell.
- 6.1.2 Place the clips, slotted end down, over the outside diameter of the suction bell.
- 6.1.3 Insert the cap screws through the slots in the clips. Thread into the strainer and tighten.

6.2 Cone Strainer – Clip on Type (Double Bolted)

- 6.2.1 Install the clips to the cone strainer, angled to the inside.
- 6.2.2 Insert cap screws through the slots in the clips.
- 6.2.3 Thread into the strainer and tighten.
- 6.2.4 Place the strainer against the bottom of the suction bell.
- 6.2.5 Install the Strainer to the Suction Bell.
- 6.2.6 Insert cap screws through the remaining slot in the clips.
- 6.2.7 Thread into the suction bell and tighten.

7.0 INSTALLATION OF AN ASSEMBLED PUMP

- 7.1 Pumps 40 feet or less in length are usually shipped assembled.
 - 7.1.1 Refer to the OPERATION section for pre-start procedure before commencing the installation.
 - 7.1.2 Check all nuts and bolts for tightness.
 - 7.1.3 Check the mounting flange of the pump and the matching flange on the foundation for burrs and nicks. These must be smoothed with a mill file.
 - 7.1.4 Attach a lifting device to the upper end of the assembled pump and raise it to a vertical position over the foundation opening.

CAUTION

When a strainer is attached to the suction end of the pump, use care not to damage the strainer when raising the assembly to the vertical position. Do not allow the suction end to drag or support the total weight of the assembled pump.

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- 7.1.5 Carefully lower the unit hand guiding it so that it does not strike the sides of the soleplate or foundation and watch for any binding of the pump or obstructions which can be felt through the hands.
- 7.1.6 Stop lowering the unit when the head is still a few inches above the foundation. Rotate the pump to align the discharge flange with the discharge piping and the mounting holes with the anchor bolts or soleplate holes.
- 7.1.7 Slowly lower the pump onto the foundation or soleplate and install nuts to anchor bolts, or bolts to the soleplate but do not tighten.
- 7.1.8 Orient discharge flange to discharge piping and connect piping. All piping must be carefully aligned and supported to prevent exterior stresses from being transferred to the pump.
- 7.1.9 Tighten the discharge flange bolting, being sure the flanges mate without forcing, then tighten the anchor bolts to the soleplate.
- 7.1.10 Clean the mounting flange on top of the discharge head, checking for burrs or nicks. Use a flat file, if necessary. Thoroughly clean with solvent, then wipe a thin layer of light oil over the surface to help prevent rust and to facilitate driver alignment.

When the pump is fitted with external lines such as grease, by-pass, flush etc., extreme care must be used not to damage these lines while raising or lowering the assembly.

- 7.1.11 When the head-shaft is shipped separately with VHS Motors, clean the threads and install the head-shaft. Hand-tighten only.

NOTE: The threads are left hand.

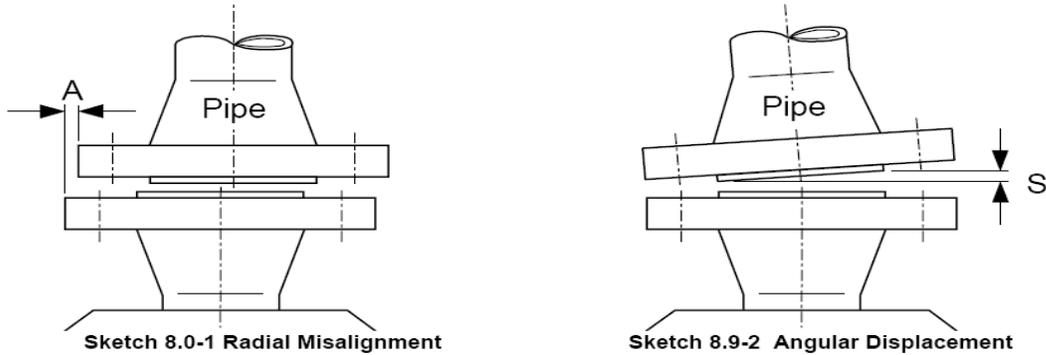
- 7.1.12 Install the shaft sealing assembly, when shipped separately, in accordance with section 8.4.2.1 and 8.4.3.
- 7.1.13 Mount the drive and align the pump in accordance with Align 0707 section.
- 7.1.14 Adjust the impellers in accordance with section 11.4

CAUTION

When connecting piping to the pump do not put a strain on the pump as this may cause misalignment.

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Stress free connection for flexible suction and discharge pipes (cold condition)		
Pipe Nominal Diameter	up to 8 in. (200mm)	Over 8 in. (200mm)
Radial Misalignment A	max. 0.02 in. (0.5mm)	
Angular Displacement S	max. 0.008 in. (0.2mm)	max. 0.016 in. (0.4mm)

8.0 INSTALLATION OF A PARTIALLY ASSEMBLED PUMP

8.1 Pumps 40 feet or more in length are usually shipped unassembled.

8.1.1 Uncrate and layout all parts on suitable timbers.

8.1.2 Arrange the components in a manner that is convenient for the site and for the equipment to be used during the installation.

NOTE: Upper Column section and lower column section should not exceed 60". Take precaution to ensure the shaft and column sections are matched.

8.1.3 Keep all parts away from the dirt. Be sure all the parts are clean and the threads are protected at all times.

8.1.4 The head-shaft and tube tension nipple should be left in the shipping crate until you are ready to install them.

NOTE: Never drop any crate or part to the ground. Always use skids. Great care should be taken in handling the shafting. Do not install a bent or sprung shaft.

8.1.5 Compare the parts against the quantities listed on the bill of material.

8.1.6 Prior to the installation of components received assembled, all nuts and bolts must be checked for tightness since they may have loosened during transportation.

8.1.7 Cleanse the line-shaft of all grease, oil, and foreign matter.

8.2 Bowl Assembly

8.2.1 The Bowl Assembly will be shipped fully assembled.

8.2.2 Before installing, verify the pump-shaft projection, i.e., the distance from the column seat to the top of the pump-shaft when the impellers are seated against the suction bell. Note this dimension for future reference because it must be verified after each section of column is added to the pump.

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- 8.2.3 When installing long bowl assemblies, leave bowl assembly attached to the shipping skid until raised to the vertical position. This will reinforce the bowl assembly and help prevent damage.
- 8.2.4 Lifting equipment should be positioned so that it will center over the foundation opening. Be sure that sufficient height is available to handle the longest piece of the pump.
- 8.2.5 Place the two setting beams on the foundation (or soleplate) opening. If a Sole plate is used, place a thin piece of plywood or cardboard beneath the beams to protect the machined surfaces.
- 8.2.6 Attach the proper clamp to the upper end of the bowl assembly beneath a convenient shoulder. Attach the sling to the clamp so that it may be removed when set on the beams making sure it will not touch the bowl shaft at any time.
- 8.2.7 Hoist bowl to the vertical position **being careful not to drag the suction strainer**. Center the bowl assembly over the foundation opening and carefully lower until the clamp ears are rested solidly on the beams. Hand guide the unit as it is lowered, watching for any obstructions or binding. The sling may now be removed.
- 8.2.8 Clean the threads and butt face of the discharge case and apply thread lubricant. Clean the threads of the bowl shaft and apply anti-seize compound. Screw the bowl shaft coupling ½ way onto the bowl shaft.
- 8.2.9 Place a rag over the shaft coupling and bowl assembly to prevent entry of any foreign material when the column assembly is raised above it during the next step.

8.3 OPEN LINE-SHAFT PUMP UNIT

- 8.3.1 Threaded or Flanged Column Assembly- Open Line-shaft
 - 8.3.1.1 Attach the elevators to the top of the bottom column, just beneath the column coupling or column flange.
 - 8.3.1.2 With a rope, throw a timber hitch around the column approximately one foot above the bottom threads or flange and a double half hitch around the shaft.
 - 8.3.1.3 Raise the entire column section and shaft to a vertical position directly over the bowl assembly while tailing in the section rope.

NOTE: Care should be taken to prevent the shaft from slipping or grinding as the assembly is rising.

- 8.3.1.4 Lower the column assembly and couple the shafts. Butt the shaft ends tightly together using pipe wrenches, but **do not distort**.
- 8.3.1.5 Clean the column threads. Check for burrs and nicks that should be smoothed with a mill file.

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- 8.3.1.6 Lower the **threaded column** and start the threads by hand. Use chain tongs and tighten until the columns butt. **Do not distort**. If **flanged column** is provided, lower the column to the registered fit and bolt the flange faces together. The bolts should be tightened uniformly, working to opposite sides of the flange. **Do not distort**.
- 8.3.1.7 Raise the entire assembly sufficiently to remove the lower elevators. Lower the entire unit, until the upper elevators are resting on the foundation. When **fabricated retainers** are supplied, lower the entire unit until the upper column flange is above the foundation to allow placing of the installing clamps.
- 8.3.1.8 Verify that the shaft is centered in the column. If the shaft is not centered, it may have been bent and must be removed.
- 8.3.1.9 Install a line-shaft bearing retainer with a bearing between the column sections, inside the column coupling or flange.
- 8.3.1.10 Measure the projection from the top of the shaft and compare this measurement with the pump-shaft projection. This measurement should be within 1/8 inch.
- 8.3.1.11 Thread the coupling on the shaft.
- 8.3.1.12 Repeat steps 8.3.1.4 through 8.3.1.11 until all intermediate column sections are installed.
- 8.3.2 Large Flanged Column with a Fabricated Retainer & Threaded Coupling
 - 8.3.2.1 When the pump is provided with a fabricated retainer and threaded coupling, proceed as follows:
 - 8.3.2.2 Temporarily place a coupling on the top end of the bottom shaft.
 - 8.3.2.3 With a rope, put a double half hitch on the shaft just below the coupling. Raise the shaft over the pump-shaft coupling.
 - 8.3.2.4 Butt the shaft ends tightly together using pipe wrenches, but **do not distort**. Remove the rope.
 - 8.3.2.5 Attach either installing elevators to the column or eye bolts to the top flange of the bottom column.
 - 8.3.2.6 Raise the column and carefully lower it over the shaft.

NOTE: The top end of the column is where the bearing retainer is fabricated.

- 8.3.3 Flanged Column with "O" Ring
 - 8.3.3.1 If the pump is supplied with "O" rings, use light grease and coat the "O" ring heavily. Place the "O" ring around the register of each flange connection.
 - 8.3.3.2 Repeat steps 2.1 through 3.3 until all intermediate column sections are installed

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8.3.4 Top Column – Threaded or Flanged

- 8.3.4.1 Thread the shaft coupling on the last section of line-shaft and hand-tighten.
- 8.3.4.2 Raise the top column while starting threads by hand and thread into the last coupling and tighten. If flanged column is provided, raise the top column and bolt in place.
- 8.3.4.3 Thread the top column flange onto the top column and tighten.

NOTE: Some pumps are furnished with the top column flange fabricated to the top column.

- 8.3.5 Clean the face of the top flange and apply a light coat of grease to hold the gasket/"O" ring in place. Place the gasket/"O" ring on the flange face.

8.4 Installing the Discharge Head Assembly (Open Line Shaft)

8.4.1 Discharge Heads

8.4.1.1 Cast Discharge Head

- 8.4.1.1.1 Raise the discharge head and clean the machined area that mates with the top column flange.
- 8.4.1.1.2 Lower and bolt the head securely to the top column flange.
- 8.4.1.1.3 Raise the assembly enough to remove the elevators.
- 8.4.1.1.4 Remove the elevators and lower the unit until the discharge head rests on the foundation.
- 8.4.1.1.5 Install the head-shaft through the packing box register and hand-tighten only.

8.4.1.2 Fabricated Barrel Discharge Head

- 8.4.1.2.1 Raise the head and check the flange faces for burrs and nicks that must be smoothed with a mill file.
- 8.4.1.2.2 Lay the barrel flange on the elevators. Lower the head and connect it to the column.
- 8.4.1.2.3 Raise the entire unit and remove the elevator. Place the gasket on the barrel flange.
- 8.4.1.2.4 Lower the entire unit and bolt the head to the barrel.
- 8.4.1.2.5 Install the head-shaft through the packing box register and hand-tighten only.

8.4.2 Standard Packing Box Assembly

8.4.2.1 Ring Packing Box Assembly

- 8.4.2.1.1 Lower the gasket and packing box over the head-shaft and bolt the packing box to the discharge head.
- 8.4.2.1.2 Tightly install four rings of packing into the packing box.

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- 8.4.2.1.3 Thread the studs into the top of the packing box and place the split gland and clips over the studs. Thread the nuts onto the studs and finger tighten.
- 8.4.2.1.4 Slip the deflector down over the head-shaft and position it just above the split gland.
- 8.4.2.2 By-Pass Packing Box Assembly
 - 8.4.2.2.1 Lower the gasket and packing box over the head-shaft and bolt the packing box to the head.
 - 8.4.2.2.2 Install with the threaded holes up, followed by four rings of packing.
 - 8.4.2.2.3 Screw the studs into the top of the packing box.
 - 8.4.2.2.4 Install the split gland, clips and nuts for the studs. Tighten the nuts finger tight.
 - 8.4.2.2.5 Connect the by-pass line to the hole leading to the head with the fittings and tubing supplied.
 - 8.4.2.2.6 Slip the deflector down over the head-shaft to a position just above the split gland.

CAUTION: USE CARE NOT TO DAMAGE OR DISTORT THE "O" RING/SHAFT PACKING.

NOTE: Coat all "O" rings with a light grease before installing.

8.4.3 Mechanical Seals

- 8.4.3.1 Place the "O" ring in the seal box.
- 8.4.3.2 Lower the seal box over the head-shaft and bolt to the discharge head.
- 8.4.3.3 Check to ensure the "O" ring is in the groove of the seal sleeve. Install the complete seal assembly over the head-shaft. Use care not to damage or distort the seal sleeve "O" ring. Bolt the seal gland to the seal box.
- 8.4.3.4 Flush/by-pass lines are to be connected to the upper holes in the seal gland. Vent-drain/quench lines are to be connected to the lower holes in the seal gland when utilized.
- 8.4.3.5 Install the drive and coupling in accordance with section 12.
- 8.4.3.6 Adjust the impeller in accordance with section 11, procedure

NOTE: When the impellers are re-adjusted, the seal must also be re-adjusted per the manufacturer's instructions.

- 8.4.4 Locate the mechanical seal collar in accordance with the seal instructions provided by the manufacturer on the mechanical seal drawing.
- 8.4.5 Secure the seal drive collar to the head-shaft with the setscrew provided.

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9.0 ENCLOSED LINE-SHAFT ASSEMBLY

9.1 Threaded or Flanged Column Assembly- Enclosed Line-shaft

9.1.1 The enclosing tube and line-shaft are ordinarily shipped assembled, if not the shaft should be slipped into the tube carefully so no damage will occur to the shaft bearing which will serve as a coupling for the five foot lengths of tube.

9.1.2 Slide each shaft and tube section or each shaft into a matching length of column pipe. If threaded column is provided, the top end is located where the coupling is. For flanged column, either end may serve as the top end.

9.1.3 Clean all threads, shaft ends, couplings, and mating surfaces with a solvent and wire brush just before making connections. Cleanse the line-shaft of all grease, oil, and foreign matter.

9.1.4 Pipe joint compound should be used on column threads. Non metallic anti-seize compound should be used on the tube-connector threads and shaft threads.

9.1.5 **Optional:** External Grease Line

CAUTION: ALL GREASE LINES MUST BE PURGED OF AIR.

9.1.6 Connect the external grease/flush line(s) to the bowl assembly

NOTE: The shaft threads are left hand.

9.1.7 Screw the enclosing tube on the tube adapter so it butts together tightly. Use pipe wrenches, but **do not distort**.

NOTE: The tube threads are left hand.

9.1.8 **Optional:** Fasten the grease line(s) to the enclosing tube during the tube installation.

9.1.9 **Optional:** Install the grease line guard during the tube installation.

9.1.10 Repeat procedure section 9.1.1 through 9.1.9.

9.1.11 Verify that the shaft and tube are centered in the column. If the shaft and/or tube are not centered, they may have been bent and must be removed.

9.1.12 Add approximately one pint of the proper oil to the enclosing tube.

9.1.13 Measure the projection from the column seat to the top of the shaft and from the tube seat to the top of the shaft. Compare these note measurements with those recorded previously. The measurements should be within 1/8.

9.1.14 Screw the enclosing tube on the tube adapter so it butts together tightly. Use pipe wrenches, but **do not distort**.

9.1.15 Install a line-shaft screw bearing and a line-shaft coupling. *Follow the same procedure for subsequent sections of column.*

A. *Pumps to be operated at 1800 RPM or below require tube stabilizers to be at 40-foot intervals, starting at 15 feet above the bowl assembly.*

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B. Pumps to be operated at 2900 RPM and above require tube stabilizers to be at 30 foot intervals, starting at 15 feet above the bowl assembly. In either case, the last stabilizer should be approximately 15 feet below the discharge head.

- 9.1.16 **Optional:** Connect the internal grease line(s) to the bearing(s) during the bearing(s) installation.
- 9.1.17 Wet the tube stabilizer with water (**DO NOT USE OIL**) and force it over the projecting end of the shaft enclosing tube. Locate the tube stabilizers two or three inches below the top of the column. It is not necessary to fasten the tube stabilizer in place.
- 9.1.18 **Optional:** Fasten the external grease/flush line(s) during the column installation.
- 9.1.19 **Optional:** Install the grease/flush line guard to the column during the column installation.

9.2 Top Column – Threaded or Flanged

NOTE: Start all threads by hand.

- 9.2.1 Thread a line-shaft screw bearing into the top section of the enclosing tube.
- 9.2.2 Thread a shaft coupling on the top section of the line-shaft and hand-tighten.
- 9.2.3 Connect the tube tension nipple to the top line-shaft screw bearing and tighten with a pipe wrench.
- 9.2.4 When threaded column is provided, raise the top column over the tube tension nipple, lower and thread into the last column coupling and tighten. Thread the top column flange onto the top column and tighten. Clean the face of the top column flange and apply a light coat of grease to hold the gasket in place.
- 9.2.5 Repeat steps 9.2.1 through 9.2.4 until all intermediate column sections are installed.

CAUTION: CARE MUST BE TAKEN NOT TO DAMAGE THE THREADS ON THE TUBE TENSION NIPPLE.

- 9.2.6 When flanged column is provided, raise the top column over the tube tension nipple then lower and bolt in place. Clean the face of the top flange and apply a light coat of grease to hold the gasket in place. Place the gasket on the flange face.

CAUTION: CARE MUST BE TAKEN NOT TO DAMAGE THE THREADS ON THE TUBE TENSION NIPPLE AND HEAD-SHAFT.

- 9.2.7 Clean the face of the top flange and apply a light coat of grease to hold the gasket on the flange face.

9.3 Sub-Base (Optional)

- 9.3.1 Confirm that the sub-base is grouted level and anchored before pump installation. For below base discharge-base plate assembly, see special instructions provided.

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10.0 INSTALLING the DISCHARGE HEAD ASSEMBLY (Enclosed Line-Shaft)

10.1 Discharge Heads

10.1.1 Cast Discharge Head

- 10.1.1.1 Raise the discharge head over the tube tension nipple. Lower and bolt the head securely to the top column flange.

CAUTION: Be careful not to damage the tube tension nipple threads.

- 10.1.1.2 Raise the assembly enough to remove the lower elevators.

- 10.1.1.3 Remove the elevators and lower the unit until the discharge head rests on the foundation.

10.1.2 Fabricated Discharge Head

- 10.1.2.1 Raise the discharge head over the tube tension nipple.

- 10.1.2.2 Check for burrs and nicks on the top flange of the column including the register fit on the discharge head. The column flange and register fit must be smoothed with a mill file.

- 10.1.2.3 Lower the discharge head to the register fit and then bolt to the top flange of the column. The bolts must be tightened uniformly, working to opposite sides of the flange. **Do not distort.**

- 10.1.2.4 Raise the entire unit while removing the installing clamps and lower until the discharge head rests on the foundation.

- 10.1.2.5 Install the head-shaft through the packing box register and hand-tighten only.

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10.2 Tube Tension Nuts

10.2.1 Enclosing Tube-Oil (FIGURE H)

10.2.1.1 Install the tube tension plate using a tube tension plate wrench to tighten the plate to the tube tension nipple.

10.2.1.2 Adjust the tube tension by stretching the tube about 1/8" for every 100 feet of tubing, or about 1-1/4 turns of the tube tension plate for every 100 feet of tubing after all slack is taken out of the tube.

10.2.1.3 Bolt the plate to the head. Install the head-shaft through the tube tension nipple and hand-tighten.

NOTE: The head-shaft threads are left-hand.

10.2.1.4 Install two rings of packing in the tube tension plate.

10.2.1.5 Check to make sure the oil passage in the tube nut is clear. Install the tube tension nut and tighten.

10.2.2 Enclosing Tube-Grease (FIGURE G)

10.2.2.1 Repeat procedure 10.2.1, steps 10.2.1.1 through 10.2.1.4.

10.2.2.2 Check to make sure the grease passage in the tube tension nut is clear.

10.2.2.3 Install the tube tension nut and tighten.

10.2.2.4 Install the lip seal in the tube tension nut with the lip down.

10.2.3 Enclosing Tube - Water Flush (FIGURE F)

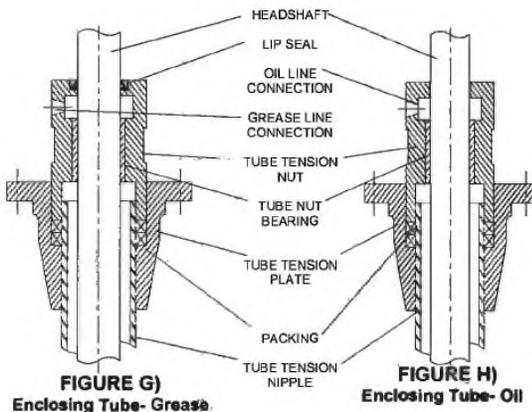
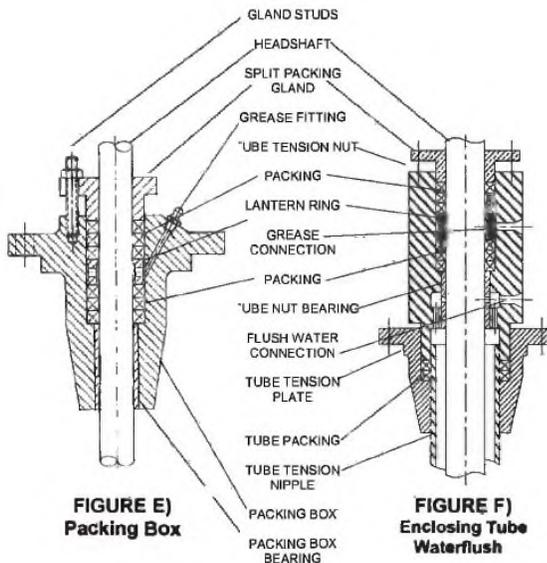
10.2.3.1 Repeat procedure 10.2.1, steps 10.2.1.1 through 10.2.1.4.

10.2.3.2 Check to be sure the grease and water passages in the tube tension nut are clear. Install the tube tension nut and tighten.

10.2.3.3 Install three rings of packing and place the lantern ring with the threaded holes up.

10.2.3.4 Add the remaining three rings of packing and screw the studs into the top of the tube tension nut.

10.2.3.5 Add the split gland, clips and nuts for the studs and tighten the nuts finger tight.



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10.2.3.6 Screw in the grease fitting and connect the water flush line to the fresh water supply.

10.2.4 Enclosing Tube with Shaft Sleeve – Water Flush

10.2.4.1 Repeat procedure 10.2.1, steps 10.2.1.1 through 10.2.1.4.

10.2.4.2 Check to be sure the grease and water passages in the tube tension nut are clear. Install the tube tension nut and tighten.

10.2.4.3 Coat the “O” ring lightly with grease and install inside the groove of the sleeve.

10.2.4.4 Slip the sleeve down over the head-shaft until the sleeve is well into the tube tension nut bearing. Hand-tighten the setscrew to hold the sleeve in place.

CAUTION: SHAFT THREADS MUST BE SMOOTH AND FREE FROM ALL BURRS AND NICKS SO THE “O” RING WILL NOT BE DAMAGED WHEN THE SLEEVE IS INSTALLED.

10.2.4.5 Repeat procedure 10.2.3, steps 10.2.3.1 through 10.2.3.6.

10.2.4.6 Loosen the setscrew in the sleeve and adjust the sleeve to a position approximately one inch above the packing gland. This step will have to be made after the impeller adjustment is completed. (See Section 11, procedure 11-5 for impeller adjustment).

11.0 INSTALLING THE DRIVER

11.1 Vertical Hollow Shaft Drivers (VHS)

WARNING: Pumps will be damaged by the wrong direction of rotation. Drive should first run UNCOUPLED from pump to check direction of rotation. Rotation of the drive should be in accordance with the rotation indicated on the nameplate.

11.2 Electric Motor, Gear or Belt Drive

11.2.1 Remove the drive cover and the top drive coupling. Try the drive coupling by slipping it over the head-shaft.

NOTE: This must be a sliding fit. If necessary, file, dress and polish, but do not force. Remove the coupling and try the gib key in the head-shaft keyway and in the coupling keyway. This must be a sliding fit, but not loose.

11.2.2 Raise the driver and check for burrs and nicks on the mounting register. This must be smoothed with a mill file.

11.2.3 Two piece Head-shaft instructions see section 11.6.

11.3 Pump Alignment – Refer to the Alignment section.

CAUTION: CARE MUST BE TAKEN NOT TO DAMAGE THE THREADS ON THE HEAD-SHAFT OR BEND THE HEAD-SHAFT.

11.4 Driver Electrical Connection

11.4.1 Connect the drive terminals to the leads from the starter panel. Bump the drive to make sure the rotation is as indicated on nameplate when viewed from above. **Drive should first run UNCOUPLED from pump to check direction of rotation.** If the rotation is wrong, interchange any two leads on three phase drives. On single-phase drives, follow the manufacturer’s instructions which accompany the driver. After changing the connections, recheck the rotation.

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SUBJECT: INSTALLATION

11.5 Impeller Adjustment (Lift Setting)

11.5.1 Slide the top drive coupling in place and insert the gib key. The top of the key should be slightly below the top of the drive coupling. Thread the adjusting nut on the head-shaft.

11.5.2 INITIAL ADJUSTMENT:

- A. Rotate the adjusting nut until the rotation assembly turns without dragging. Continue to rotate the adjusting nut until the vertical clearance obtained is slightly higher than the one listed in the pump nameplate. Install the capscrews through the adjusting nut into the coupling.
- B. Use an ammeter to check the preliminary setting.
IMPORTANT: Make sure that the impellers are not dragging and the motor is not overloaded.

11.5.3 FINAL ADJUSTMENT:

- A. After the system is operational, - the impellers can be reset to the recommended impeller lift as indicated on pump nameplate.

NOTE: The impellers must be adjusted so that they will turn without rubbing on the top or bottom while the pump is operating.

NOTE: REFER TO THE MANUFACTURER'S SPECIAL OPERATING INSTRUCTIONS PROVIDED FOR PUMP SETTINGS 50' OR DEEPER. MECHANICAL SEALS SHOULD BE ADJUSTED PER THE MANUFACTURER'S INSTRUCTIONS AFTER IMPELLER ADJUSTMENTS HAVE BEEN COMPLETED.

11.5.4 Check the lubricant in the driver in accordance with the drive lubrication instructions.

11.5.5 The unit is now ready for operation.

11.6 Vertical Hollow Shaft Driver with a two piece head-shaft and threaded coupling.

11.7 Electric Motor, Gear or Belt Drive

11.7.1 Complete section 11.2.

11.7.2 Thread a shaft coupling on the lower head-shaft and hand-tighten.

11.7.3 Lower the driver and bolt it securely to the discharge head.

11.8 Pump Alignment – Refer to the Alignment section.

NOTE: The shaft threads are left-hand.

11.9 SOLID SHAFT DRIVES WITH FLANGED COUPLINGS (VSS)

WARNING: Pumps will be damaged by the wrong direction of rotation. Drive should first run UNCOUPLED from pump to check direction of rotation. Rotation of the drive should be in accordance with the rotation indicated on the nameplate.

INSTALLATION, OPERATIONS & MAINTENANCE MANUAL

SUBJECT: INSTALLATION

- 11.10 Adjustable Flanged Coupling with No Spacer/ Electric Motor, Gear or Belt Drive
 - 11.10.1 The coupling halves are keyed to the driver shaft and the pump head-shaft with square keys. The split thrust ring locks the driver coupling half to the drive shaft, transmitting vertical thrust in either direction.
 - 11.10.2 Make certain all mating surfaces are clean and free of any burrs or chips.
 - 11.10.3 Fit the driver coupling half and key on the driver shaft before the driver is mounted. Push the coupling half well above the thrust ring groove. This should be a sliding fit.
 - 11.10.4 Fit the thrust ring into the groove and slide the driver coupling half down over the thrust ring into position. The bottom of the coupling should extend 1/8" past the thrust ring.
 - 11.10.5 Insert the pump head-shaft key and pin assembly into the pump coupling half keyway. Make sure the pin fits into the hole in the coupling and allows the key to seat properly in the keyway.

CAUTION: THE KEY SHOULD NOT EXTEND ABOVE THE COUNTER BORE IN THE TOP END OF THE PUMP COUPLING HALF.

- 11.10.6 Fit the pump coupling half and key assembly on the head-shaft. The key should be a slip fit in the head-shaft keyway.
- 11.10.7 Thread the adjusting nut on the head-shaft and screw down as far as possible.

NOTE: Adjusting nut threads are left-hand.

- 11.10.8 Clean the machined surfaces of the discharge head and the driver base. Hoist the driver into position and bolt down securely.
- 11.11 Driver Electrical Connection
 - 11.11.1 Connect the drive terminals to the leads from the starter panel. Bump the drive to make sure the rotation is correct. If the rotation is wrong, interchange any two leads on three phase drives. On single-phase drives, follow the manufacture's instructions which accompany the driver. After changing the connections, recheck the rotation.

IMPORTANT: Pumps will be damaged by the wrong direction of rotation. Drive should first run UNCOUPLED from pump to check direction of rotation. Rotation of the drive should be in accordance with the rotation indicated on the pump nameplate. Be sure that the endplay of the driver shaft clears the adjusting nut when checking rotation.

- 11.12 Impeller Adjustment
 - 11.12.1 Refer to the nameplate adjustment dimension for the impeller in the pump.

INSTALLATION, OPERATIONS & MAINTENANCE MANUAL

SUBJECT: INSTALLATION

- 11.12.2 Screw the adjusting nut upward on the shaft to within the impeller adjustment dimension of the driver coupling and back off to the nearest bolt hole on the pump coupling half.
- 11.12.3 Connect the coupling halves and tighten the coupling bolt securely.
- 11.13 Pump Alignment- Refer to Alignment section.

NOTE: Removing the coupling bolts and rotating the driver coupling half relative to the adjusting nut can result in lower run out.

- 11.14 Adjustable Flanged Coupling with Short Spacer/Electric Motor, Gear or Belt Drive
 - 11.14.1 Make certain all mating surfaces are clean and free of any burrs or chips.
 - 11.14.2 Fit the driver coupling half and key on the driver shaft before the driver is mounted. Push the coupling half well above the thrust ring groove. This should be a sliding fit.
 - 11.14.3 Fit the thrust ring into the groove and slide the driver coupling half down over the thrust ring into position. The bottom of the coupling should be flush with the bottom of the thrust ring.
 - 11.14.4 Insert the pump head-shaft key and pin assembly into the pump coupling half keyway. Make sure the pin fits into the hole in the coupling and allows the key to seat properly in the keyway.

CAUTION: THE KEY SHOULD NOT EXTEND ABOVE THE COUNTER BORE IN THE TOP END OF THE PUMP COUPLING HALF.

- 11.14.5 Fit the pump coupling half and key assembly on the head-shaft. The key should be a slip fit in the head-shaft keyway.
- 11.14.6 Thread the adjusting nut on the head-shaft and screw down as far as possible.

NOTE: Adjusting nut threads are left-hand.

- 11.14.7 Clean the machined surfaces of the discharge head and the driver base. Hoist the driver into position and bolt down securely.
- 11.14.8 Continue with the Driver Electrical Connection (11.10).
- 11.14.9 Place the spacer on the adjusting nut and proceed with the Impeller Adjustment (11.11 lines 11.11.2 and 11.11.3).
- 11.14.10 Pump Alignment – Refer to the Alignment section.
- 11.15 **Adjustable Flanged Coupling with /Long Spacer/Electric Motor, Gear or Belt Drive**
 - 11.15.1 Make certain all mating surfaces are clean and free of any burrs or chips.
 - 11.15.2 Fit the driver coupling half and key on the driver shaft before the driver is mounted. Push the coupling half well above the thrust ring groove. This should be a sliding fit.

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- 11.15.3 Fit the thrust ring into the groove and slide the driver coupling half down over the thrust ring into position. The bottom of the coupling should be flush with the bottom of the thrust ring.
- 11.15.4 Insert the pump head-shaft key and pin assembly into the pump coupling half keyway. Make sure the pin fits into the hole in the coupling and allows the key to seat properly in the keyway.

CAUTION: THE KEY SHOULD NOT EXTEND ABOVE THE COUNTER BORE IN THE TOP END OF THE PUMP COUPLING HALF.

- 11.15.5 Fit the pump coupling half and key assembly on the head-shaft. The key should be a slip fit in the head-shaft keyway.
- 11.15.6 Thread the adjusting nut on the head-shaft and screw down as far as possible.

NOTE: Adjusting nut threads are left-hand.

- 11.15.7 Clean the machined surfaces of the discharge head and the driver base. Hoist the driver into position and bolt down securely.
 - 11.15.8 Continue with the Driver Electrical Connection (11.10).
 - 11.15.9 Connect the spacer to the driver coupling half and tighten the bolts securely.
 - 11.15.10 Impeller Adjustment Refer to the nameplate adjustment dimension for the impeller in the pump.
 - 11.15.11 Screw the adjusting nut upward on the shaft to within the impeller adjustment dimension of the spacer flange and back off to the nearest bolt hole in the pump coupling half.
 - 11.15.12 Connect the pump coupling half to the long spacer and tighten the coupling bolts securely.
 - 11.15.13 Pump Alignment – Refer to the Alignment section.

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SUBJECT: INSTALLATION

INSTALLATION CHECK LIST

CUSTOMER _____ ORDER NO. _____ PRODUCT _____

TEMP (°F) _____ SPECIFIC GRAVITY _____ ROTATION CW CCW
RPM _____

RATED HEAD (FT) _____ FLOW (USGPM) _____ SUCTION PRESSURE
(PSIG) _____

DRIVER _____ COUPLING _____ MECH. SEAL _____

EVENT

- Foundation Construction
- Prepare Foundation
- Place Spacer Blocks
- Set Baseplate over Foundation Bolts
- Level Baseplate using Jack Screws and Shim Pack
- Snug-Up Foundation Bolt Nut
- Check Leveling of Baseplate
- Grout Baseplate
- Final Torque Foundation Bolts after Grout Cures
- Install Main Piping
- Mount Driver
- Align Driver to Pump
- Fill System

Note: Check off when satisfactorily completed

INSTALLATION, OPERATIONS & MAINTENANCE MANUAL

SUBJECT: ALIGNMENT

CAUTION

Before aligning the coupling and with the pump and driver uncoupled, check the direction of rotation of the driver corresponds with the direction of rotation arrow on the pump.

CAUTION

Bearings must be lubricated before attempting to turn rotors. Avoid any unnecessary turning of machine rotors.

CAUTION

Whenever practical, the pump must be filled with product before turning by hand.

CAUTION

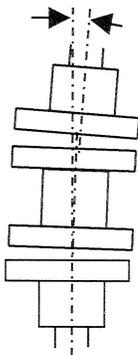
If initial alignment is done with cold water, when Hot Water is introduced, the alignment must be re-checked, re-done, and corrected if required.

1.0 SCOPE

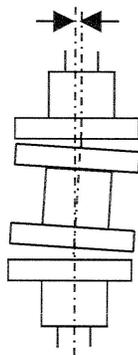
This section describes recommended procedures for aligning the motor (driving machine) to the pump (driven machine) for the pumpset supplied.

2.0 MISSALIGNMENT TYPES

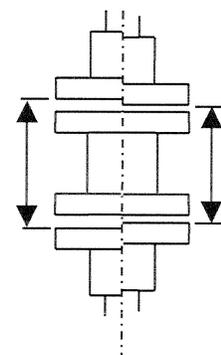
There are 3 Basic Misalignment types between the pump and driver shafts.



2.1 Angular Misalignment
Shafts with axes that intersect at a point.



2.2 Parallel Offset
Shaft with axes parallel but with offset.



2.3 Coupling Spacer Gap
Shaft with axes parallel but wrong spacer distance.

3.0 ALIGNMENT

Note: It is recommended that the coupling spacer gap and shaft alignment is checked even when the original pump and drive motor is being re-fitted after pump overhaul.

- 3.1 **Coupling Spacer gap distance** The axial distance between the coupling halves must be observed. Please see General Arrangement Drawing for the proper coupling spacer gap. Refer also to the coupling manufacturer's instructions.

- 3.1.1 Measure the gap between the pump and motor half coupling hubs. The gap is pre-set at the factory before shipment and should be correct. However, if the gap is incorrect, it is necessary to adjust the position on the shaft of one or both coupling hubs until the distance equals the dimension on the general arrangement drawing.

INSTALLATION, OPERATIONS & MAINTENANCE MANUAL

SUBJECT: ALIGNMENT

3.2 Radial and Axial Alignment Check

3.2.1 Misalignment Tolerances:

Operating Speed RPM	Maximum TIR	
	Parallel	Angular @ 12 in. (305mm) radius
1800 & slower	.006 in (.152mm)	.004 in (.102mm)
1800 to 4000	.003 in (.076mm)	.002 in (.051mm)
over 4000	.002 in (.051m)	.001 in (.025mm)

3.2.2 Clock Gauge Alignment (w/ Dial Indicators)

Alignment should be carried out with dial indicators in the radial and axial direction. Ensure that the supports for each indicator are sufficiently rigid to eliminate any sag that may cause spurious readings. All readings re radial and axial misalignment are determined every 90°, while both shafts are simultaneously turned.

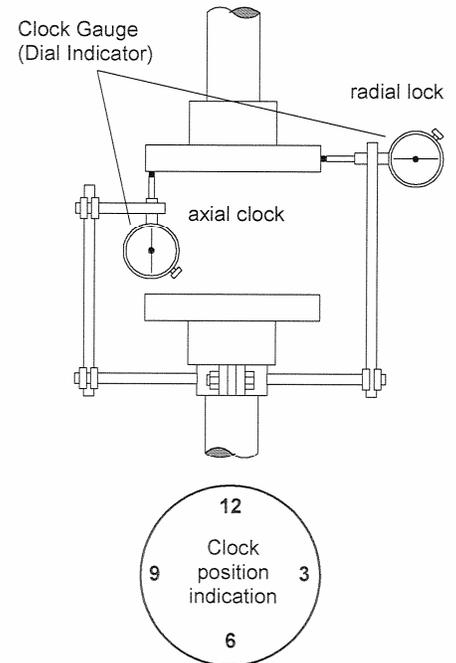
3.2.3.1 Position the dial indicator probe at 12 o'clock and set the gauge reading to zero.

3.2.3.2 Turn both shafts by 90° so that the dial indicator probe is at the 3 o'clock position. Record the reading on the dial indicator gauge.

3.2.3.3 Repeat step (2.) for the 6 o'clock and 9 o'clock positions of the dial indicator probe.

3.2.3.4 Finally turn both shafts to the 12 o'clock position. The dial indicator gauge should now read zero.

Note: If opposite readings are plus and minus, the readings are added together to determine the maximum reading.



INSTALLATION, OPERATIONS & MAINTENANCE MANUAL

SUBJECT: ALIGNMENT

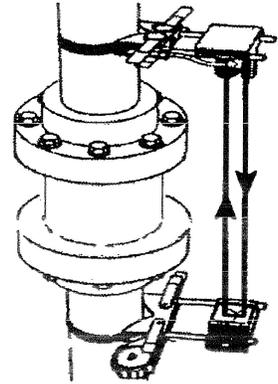
3.2.3 Optical Alignment

Instead of using a dial indicator, optical (laser) alignment equipment may be used. Laser optical alignment is the most exact shaft aligning method.

The transmitter is a laser diode mounted on one side of the coupling and the prism is mounted on the other side. The laser beam emitted by the laser diode is reflected by the prism to the localizer. The offset can be detected by rotating the shafts.

Because of the wider range of equipment available, these are not described in detail.

Refer to the equipment manufacturer's information.



CAUTION

Hot Fluid Start-up:

An alignment must be re-done or alignment should be checked and corrected when the pump becomes operational with hot water, or if there is a hot water start-up.

3.3 Coupling Safety Guard



The pump must only be operated with mounted coupling safety guard. After each alignment check the coupling guard must be refitted immediately. Check for correct assembly, fastening distance to rotating coupling.

INSTALLATION, OPERATIONS & MAINTENANCE MANUAL

SUBJECT: OPERATION

1.0 CHECKLIST

- 1.1 Use the PRE-START UP REQUIREMENTS CHECK LIST on page 7 of this section to ensure all procedures are being followed and preparations for start-up are controlled.

2.0 GENERAL

The following recommended start-up and operating procedures apply to the pump only. For information on any other equipment (i.e., driver, shaft coupling, shaft sealing system) refer to manufacturers' instructions.

- 2.1 **Safety Information:** Do not start or operate the pump:
 - 2.1.1 Unless the installation is verified to be correct and all safety and control functions have been checked.
 - 2.1.2 Unless you have a complete understanding of the location and function of all components of the pump aggregate including valves and any upstream and downstream equipment that may effect the flow of medium to or from the pump.
 - 2.1.3 Unless you have a complete understanding of all the auxiliary mechanical, electrical and hydraulic systems, as well as the functions of all monitoring gauges and warning devices.



When starting the pump, be prepared to execute an emergency shutdown in case of failure of the pump or auxiliary system.

3.0 COMMISSIONING

CAUTION

The items described individually have to be carried out, as far as applicable, step-by-step during commissioning.



With electric drives, qualified personnel must assure that the necessary protection measures are in working order. Earthing, re-set, residual current failure, operated device, etc. have to be ready for service according to approval by skilled personnel.

- 3.1 **Before Commissioning:** Check the following:
 - 3.1.1 **Connections:** Check bolted connections and plugs. Inspect ancillary pipework for correct installation.
 - 3.1.2 **Lube:** Rinse bearing housing with light oil and allow to drain. Fill with lubricating Grease or Oil, see also table for recommended lubricants.
 - 3.1.3 **Alignment:** Remove coupling guard. Check alignment of coupling.
 - 3.1.4 **Shaft Seal:** Check shaft seal.
 - 3.1.5 **Minimum Flow Line (if fitted):** Open and lock the valve in the minimum flow line.

4.0 PUMP STARTUP AND OPERATION

- 4.1 **Ancillary Equipment:** If available, put ancillary equipment into operation (i.e., cooling, heating, sealant pressure). Open the valves in the ancillary pipework (open quench after pump start-up). Vent pressure gauge.
- 4.2 **Start-up with Non-Pressurized System:**
 - 4.2.1 Close shut-off valve in the discharge pipe (minimum flow must be guaranteed).
 - 4.2.2 Start driver and bring the pump rotor immediately to operating speed.

INSTALLATION, OPERATIONS & MAINTENANCE MANUAL

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4.2.3 Open discharge valve **slowly**, until the differential pressure drops to the value given on the data sheet.

4.3 **Start-up with Pressurized System.** (precondition is non-return valve in discharge pipe)

4.3.1 Start driver with open discharge valve and bring the pump rotor immediately to operating speed.

CAUTION

Pump should produce pressure at discharge as soon as rated operating speed is reached. If not, shut down immediately and vent the pump system.

***Warning:** The differential pressure must not fall below the design point even with plants that have fluctuating system pressure.*

4.4 **Observe Ammeter Reading** The full load amps given on the rating plate of the motor must not be exceeded.

4.5 **Adjustments** The pump capacity can be adjusted by the discharge valve.

CAUTION

Do not operate against a closed discharge valve or below recommended minimum flow. Do not throttle the suction valve. To do so, may incur damage through cavitation.

5.0 STANDBY SERVICE (Starting of a Stand-by Pump or Starting a Parallel Working Pump)

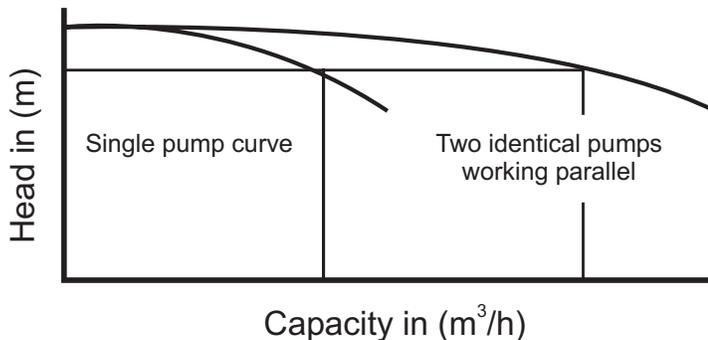
Note: If a stand-by pump should replace the function of another one (operating pump), both pumps have to run parallel for a short time.

5.1 Proceed with preliminary work for the stand-by or parallel working pump as given in Section 2.0 General and Section 3.0 Commissioning.

5.2 Start-up pump as given in Section 4.0 Pump Start-up and Operation; check discharge pressure. Operate both pumps parallel.

5.3 Standby pump. After running in full operation, the first operating pump can be shut-down. Refer to shut-down procedure.

5.4 **Parallel working pumps** Both pumps remain in operation. Each (identical) pump delivers only half of capacity delivered (see pump curves below). Non-identical pumps can also operate in parallel but selection must be done very carefully.



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SUBJECT: OPERATION

6.0 INADMISSIBLE OPERATING MODES

CAUTION

Overloads have to be avoided by all means as they may lead to a failure of parts due to too stringent mechanical requirements. Overloads occur if the pump is run beyond its original application range. The following are some examples:

- Exceeding the max. admissible speed.
- Remaining at the min. speed—low speed rotation, (e.g., by turbine drive, high-velocity flushing through the pump, damage or discharge non-return valve causing serious damage to the pump).
- Exceeding or remaining at the medium viscosity.
- Exceeding the max. admissible inlet pressure.
- Exceeding or remaining under the operating range of the pump.
- Running of the pump without proper venting of pump interior.
- Running of the pump without required safety devices (safety valves, electrical overload protection, etc.)
- Operating the pump with closed or strongly throttled shut-off device in the discharge line without having a minimum flow device (exception: during start-up).
- Operating the pump with closed or throttled shut-off device in the inlet line (dry running)
- Operating the pump for the delivery of fluids for which the pump is not suitable (chemical, solids, gas content).
- Operating the pump with wrong sense of rotation.
- Operating the pump with inadmissible bearing lubrication or with wrong lubricant.



Operating modes in any of the above mentioned ways may lead to heavy damage to the pump and other parts of the plant. Danger may arise due to the bursting of pressure-holding parts and people within are susceptible to injury if these and other operating modes are not followed. Hot, toxic or otherwise aggressive fluids can cause mortal harm.

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SUBJECT: OPERATION

7.0 SHUT-DOWN OBSERVANCE SEQUENCE

Note: If a non-return valve is fitted in the discharge pipe, the discharge valve can remain open if shut-down is for a short time only. For lengthy shut-downs, for repairs, and where there is no non-return valve, the discharge valve must be closed.

- 7.1 Close the discharge valve **slowly** and switch off the driver. When doing this pay attention to whether the rotor runs down smoothly.
- 7.2 **Standby Service— Ancillary** systems such as cooling, sealing, and quench systems are operational. Standby pumps should be started at regular intervals to ensure their readiness for immediate service. We recommend to start-up the pump unit once every two weeks and run for 20 minutes.
- 7.3 **Extended Shutdown**
 - 7.3.1 If the pump works on a suction lift and is not to be left ready for start-up, the suction valve should also be closed.
 - 7.3.2 If existing, close quench piping.
 - 7.3.3 If fitted, close the valves in the ancillary pipes with the exception of the cooling water, which should only be switched off when the pump has cooled down.
- 7.4 **Freeze Damage Preservation**
 - 7.4.1 If there is the danger of frost, prevent liquid from freezing within the pump. Drain all cooling jackets, including external heat exchangers and piping.
- 7.5 **Emergency Shutdown of the Pump**
 - 7.5.1 In case of failure of the pump or any auxiliary system, switch off the driver immediately.
 - 7.5.2 Before re-starting the unit once again, follow 8.0 Re-start Procedure.

8.0 RE-START PROCEDURE



If the pump is switched off by emergency shutdown or trip, do not re-start before the causes of the emergency have been found and removed.

- 8.1 Before restarting, check to make sure that the pump shaft is at a standstill. If the non-return valve in the discharge pipe is leaky, the pump shaft may rotate in reverse direction due to the backflow of the medium delivered.

CAUTION

The pump must not be switched on when the pump shaft is rotating in reverse direction as this may damage the pump.

- 8.2 Proceed with re-start as given in Section 4.0, Pump Startup and Operation.

INSTALLATION, OPERATIONS & MAINTENANCE MANUAL

SUBJECT: OPERATION

9.0 SERVICE CONTROL

- 9.1 **General:** A pump must be looked after and carefully supervised to ensure trouble free running. During the first period of operation (24 hours), supervision should be intensive. Read and check the operating parameters every hour. During the next period of operation (first week), supervision should be done every 24 hours. During normal use, checking should be done together with the regular inspections at least once every week.

CAUTION

If any vibrations, unusual noises or faults are observed, stop the pump unit immediately. Refer to Section on operating faults.

- 9.2 **Number of Starts:** The pumps are designed for continuous operation. Too many and too frequent starts can accelerate ageing and result in abnormally high wear and short life time. In case of many starts we recommend an intensive supervision and maintenance intervals should be shortened.

The recommended number of start-ups is as follows:

- Cumulative number of starts: max. number starts per hour allowed by motor manufacturer.
- Commissioning phase: up to 200 starts / stops (max. 6 starts per day)
- Commercial operation: up to 3 starts per day
- Cumulative number of starts: max. 600 starts per year

CAUTION

Electric Motor: Verify the rotation (see nameplate on discharge head with rotation arrow) as well as the number of starts per hour allowed by the motor manufacturer.

Note: In case of many start / stop cycles we recommend a general overhaul of the pump after 6 years running time.

9.3 Checking the Duty Point (design point) of the Pump:

Particularly important at initial start-up:

- 9.3.1 Check the speed.
- 9.3.2 Read the discharge pressure and subtract the suction pressure.
- 9.3.3 Convert this pressure (generated pressure) to a head and compare it with the generated head shown on the pump duty plate at the corresponding speed.

$$\text{Generated head (m)} = \frac{\text{generated pressure (bar)} \times 10,200}{\text{density of liquid (kg/m}^3\text{)}}$$

Metric Units

$$\text{Generated pressure (bar)} = \frac{\text{generated head (m)} \times \text{density of liquid (kg/m}^3\text{)}}{10,200}$$

$$\text{Generated head (ft)} = \frac{\text{generated pressure (psi)} \times 2.31}{\text{specific gravity}}$$

US Units

$$\text{Generated pressure (psi)} = \frac{\text{generated head (ft)} \times \text{specific gravity}}{2.31}$$

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CAUTION

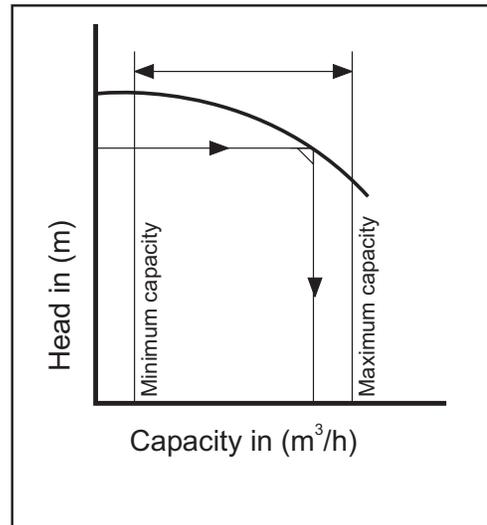
The generated pressure must not fall below the value given in the pump data sheet, otherwise the maximum allowable capacity could be exceeded, the driver could be overloaded, or the suction pressure could fall below the minimum required by the pump.

9.4 Checking the Capacity of the Pump:

The capacity is determined from the pump performance curve and the generated head (m or ft) as calculated in 9.3.

- 9.4.1 Find the calculated value of the generated head on the vertical axis of the performance curve*.
- 9.4.2 Draw a horizontal line through this point until it intersects the curve. The corresponding capacity is read on the horizontal axis vertically below the point of intersection.

** If the characteristic curve sheet only includes the pressure of one stage, divide head by number of stages of the pump supplied.*



Pump Characteristic Curve

9.5 Checking the Integral Thrust Bearing (If fitted)

- 9.5.1 **Cooling coil assembly for thrust bearing:** Check the cooling device for the thrust bearing to ensure it is properly installed and that the correct torque has been applied to all flanges and connective bolting.
- 9.5.2 Torque in accordance with **TORQUE VALUES ADDENDUM No 2.**

9.6 Checking the Vibration Levels:

- 9.6.1 Ensure vibration levels do not exceed recommended levels on the data sheet.

INSTALLATION, OPERATIONS & MAINTENANCE MANUAL

SUBJECT: OPERATION

PRE-START UP REQUIREMENTS CHECK LIST

CUSTOMER _____ ORDER NO. _____ PRODUCT _____

TEMP (°C or °F) _____ SPECIFIC GRAVITY _____ RPM _____

RATED HEAD (m or ft) _____ FLOW (m³/hr or GPM) _____ SUCTION PRESSURE (bar or PSIG) _____

DRIVER _____ COUPLING _____ MECH. SEAL _____

- Leveling and Grouting of Suction Can Mounting Plate or Soleplate
- Strainer in Suction
- Minimum Flow Orifice
- Warm Up Orifice
- Suction Gage
- Discharge Gage
- Pipe Strain
- Check Pump End Play _____
- Check Coupling Hub Runout (Pump & Motor)
- Oil Level Checked
- Rotation and No Load of Driver have been Checked
- Open Suction Valve
- Vent Pump or Warm Up Pump, if Required
- Purge Seals Flush
- Close Vent Valves
- Set Discharge Valve
- Suction Pressure at Start Up _____
- Discharge Pressure at Start Up _____
- Check the Integral Thrust Bearing, if equipped, to see that the temperature stabilizes.
- Check Vibration Horizontal Max. _____ Vertical Max. _____

Note: Check off when satisfactorily completed.

INSTALLATION, OPERATIONS & MAINTENANCE MANUAL

SUBJECT: MAINTENANCE

1.0 RECORD / ANALYZE BEFORE DISASSEMBLY

- 1.1. **Performance Record** An ongoing performance record will assist troubleshooting and pump service decisions. Long shutdowns and unnecessary expense can be avoided.
 - 1.1.1 Periodic vibration recordings are necessary to diagnose excessive vibration levels.
- 1.2 **Troubleshooting** Analyze performance before disassembly. A problem could be corrected externally without disassembling the pump. A performance record will help narrow the possible causes.
 - 1.2.1 Hydraulic problems typically originate in the suction system. Erroneous control adjustments should be eliminated, see the **OPERATION Module**, before further troubleshooting.
 - 1.2.2 Mechanical and hydraulic problems often are interrelated and the source can be difficult to trace. See **TROUBLESHOOTING, ADDENDUM No. 3**.

2.0 DISASSEMBLY



Prior to and during work verify that the atmosphere is not potentially explosive. Stop all work immediately if any danger arises.

- 2.1 **Reference** Refer to specific general arrangements, cross section drawings, and parts list. A typical cross section of the JTS pump and parts list is shown at the end of this module.
- 2.2 **Power** Lock power breakers in the off position. **Lock power breakers in the OFF position.**
- 2.3 **Drain** the suction barrel **151.271** and the bearing housing **350.301**.

All toxic fluids must be collected and disposed of in accordance with the current environmental regulations to prevent endangering people or the environment.

- 2.4 **Tools and Procedures** A variety of equipment is required for disassembly. Specific requirements differ according to location, physical surroundings, and size of each unit. Review entire removal procedure in advance.

Protect all parts. Place larger parts in a protected area and wrap in cloth or plastic. Place smaller parts in bags or boxes.
- 2.5 **Driver Removal**
 - 2.5.1 Disconnect power leads to driver.
 - 2.5.2 Remove any restraints from driver.
 - 2.5.3 Uncouple driver half coupling from pump coupling 852.241.
 - *See coupling manufacturer's instructions for correct procedure.*
 - 2.5.4 Loosen capscrews **901.523**. Remove capscrews **901.527** securing driver to driver stand. Lift driver to storage or maintenance location.

INSTALLATION, OPERATIONS & MAINTENANCE MANUAL

SUBJECT: MAINTENANCE

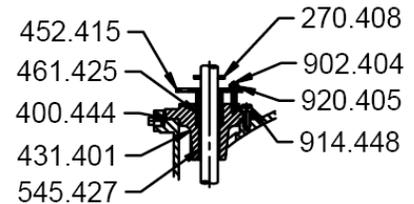
* See manufacturer's information for correct driver handling, storage and maintenance.

2.6 **Stuffing Box** Shaft sealing with a standard stuffing box.

2.6.1 Disconnect threaded plug **903.263** at discharge head (see discharge head details) prior to stuffing box removal. Cap ends of lines to prevent dirt entry.

2.6.2 Unbolt stuffing box capscrews **914.448** from discharge head **115.261**.

2.6.3 Remove the stuffing box assembly **431.401**.
*"O"-ring seal if required (not shown).



STANDARD STUFFING BOX

2.7 **Mechanical Seal Option** Shaft sealing with an Original Equipment Manufacturer's (OEM, or other than Sulzer) mechanical seal.

2.7.1 Disconnect seal circulation lines at seal plate prior to seal removal. Cap ends of lines to prevent dirt entry.

2.7.2 Unbolt seal gland plate nuts **920.405** and studs **902.404** from stuffing box **431.401**.

2.7.3 Remove the mechanical seal cartridge assembly **433.400***.

*Refer to manufacturer's mechanical seal drawing for additional instructions and parts list.

2.8 **Piping** Be certain pump system pressure has been isolated. Close suction, discharge, and auxiliary piping valves.

2.8.1 For complete pump unit disassembly it will be necessary to disconnect the suction, discharge, and auxiliary piping.

2.8.2 If pump unit is to be removed, disconnect all piping and instrumentation.

2.8.3 Disconnect discharge flange at the discharge head **115.261**.

CAUTION

Use care when lowering to horizontal position. Support full length to prevent excessive bowing and resultant damage. If there is insufficient headroom, pump will be partially disassembled in vertical position at suction barrel.

2.9 **Disassembly of the Pump** If the pump requires complete disassembly then follow the steps in this section. If only hydraulic parts are to be replaced then skip to the next section, **Bowl Assembly and Disassembly**.

2.9.1 **Note: Mark all parts in their disassembly sequence.**

CAUTION

During the disassembly process, use handling procedures adequate to avoid bumping, hitting or springing the shafts. Support shafts evenly over the entire length.

INSTALLATION, OPERATIONS & MAINTENANCE MANUAL

SUBJECT: MAINTENANCE

2.9.2 Remove the discharge head **115.261** from the column **711.204** by removing capscrews **901.252**. Take care of the gasket **400.253** at the joint.

2.9.3 If fitted, remove the bearing spider housing **383.211**. Take care not to damage the bearing bushing **545.212**.

2.9.4 Unbolt the column **711.204** from the top bowl **112.151** by removing the adapter **721.181** and capscrews **901.182**.

2.9.5 Carefully remove the column pipe **711.204**.

2.9.6 Remove the threaded coupling **852.171** to free the headshaft **213.225** from the pumpshaft **211.123**.

2.9.7 Set the headshaft **213.225** aside

2.10 Bowl Unit Disassembly

The bowl assembly should be disassembled in the maintenance shop where proper facilities are available.

Note: As the dismantling proceeds, the impellers, bowls, and wear parts should be marked as to their relative placement in the element (the order it was dismantled) so proper reassembly can occur.

2.10.1 Remove capscrews **901.182** and adapter **721.181**.

2.10.2 Remove capscrew **901.157** and bowl **112.151** which will reveal the impeller **230.161**.

CAUTION

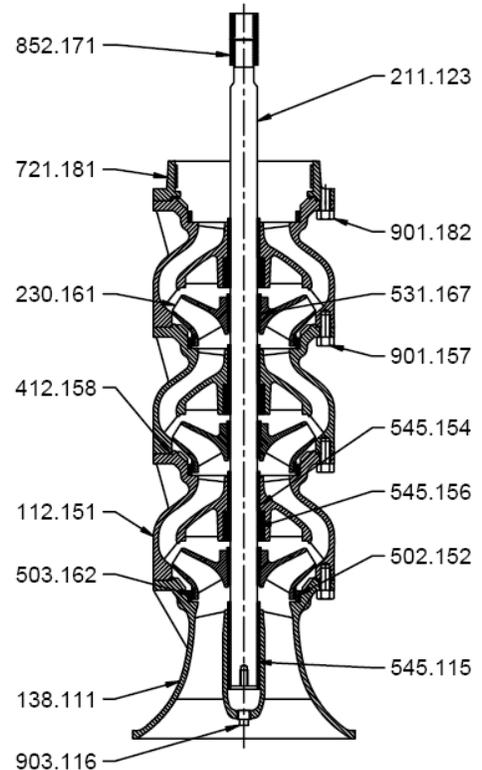
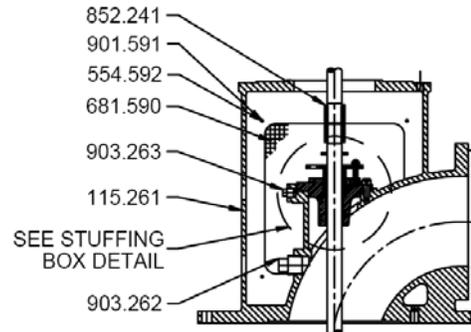
Care should be taken to avoid chipping or damaging the bushings in the bowls.

2.10.3 Pull the shaft out as much as possible. Using a lock collet hammer, strike the impeller to loosen the lock collet.

2.10.4 Remove the lock collet. Then slide the impeller **230.161** off the pumpshaft **211.123**.

2.10.5 Repeat above steps for the remaining bowls, lock collets, and impellers.

2.10.6 Once the last bowl has been removed just the pumpshaft **211.123** and suction bell **138.111** remain. Slide the pumpshaft out of the suction bell.



INSTALLATION, OPERATIONS & MAINTENANCE MANUAL

SUBJECT: MAINTENANCE

CAUTION Care should be taken to avoid chipping or damaging the bushing in the suction bell

3.0 INSPECTION

3.1 **Clean and Inspect** After disassembly, clean all parts except the mechanical seal in solvent and inspect for wear or damage. Inspect the bearings, wear rings, seal parts, bearing bushings and throttle bushing.

CAUTION Do not clean mechanical seal parts in solvent.

3.1.1 Check all running clearances (wear rings, bushings etc.) for excessive wear. Damaged or excessively worn parts should not be re-used.

3.1.2 If the unit is not immediately reassembled, protect machined surfaces against rust. A thin application of light machine oil is normally adequate for short-term storage.

3.2 **Mechanical Seal** Mechanical seal rotating and stationary faces are highly polished and optically flat. Keep these surfaces clean and free from substances that would mar seal faces. See seal vendor literature for refurbishing procedure.



Mechanical seals intended for use in potentially explosive areas must satisfy the “Ex” protection requirements.

3.3 **Impellers** Inspect the impellers **230.161** for wear or damage. Look for cavitation marks (pits) in the suction opening, erosion of vanes and cracks in the shroud. Smooth minor irregularities with a fine file and crocus cloth.

Verify impeller balance quality prior to re-assembly.

3.4 **Bowls** Check bowls **112.151** for burrs, chips, cracks or other damage.

Minor irregularities may be smoothed with a fine file and crocus cloth.

3.5 **Wear Rings (Stationary and Impeller Rings)** Inspect stationary rings **502.152**, and

3.6 Impeller rings **503.162** for grooves and uneven wear.

Dress minor irregularities with a fine file and crocus cloth. If proper equipment is available, rework surfaces by light machining.

Pump size	units	min	max
7APC	mm	.25	.35
	in.	.010	.014
7CC, 8AC	mm	.30	.40
	in.	.012	.016
8CC	mm	.33	.38
	in.	.013	.017
9LC, 9HC, 10AC	mm	.28	.41
	in.	.011	.016
11LC, 11HC, 12CC	mm	.30	.43
	in.	.012	.017
12GHC, 13CLC	mm	.46	.58
	in.	.018	.023
14CC, 14DC	mm	.305	.432
	in.	.012	.017
16CLC, 16HMC	mm	.381	.533
	in.	.015	.021
18CC, 18DC, 18EC	mm	.356	.559
	in.	.014	.022
20CC, 20DC, 20EC	mm	.356	.559
	in.	.014	.022

CAUTION Wear rings and wear surfaces must remain within allowable clearances after metal removal.

3.6.1 A minimum of 85 percent of the total wear surface must “Clean Up” to the acceptable wear diameter. The remaining wear surface must not vary more than 0.05 mm.

3.6.2 **Wear Surface Running Clearances** Running clearances of the JTS are listed in Table 3.5.2.1.

INSTALLATION, OPERATIONS & MAINTENANCE MANUAL

SUBJECT: MAINTENANCE

Note: The listed dimensions represent acceptable running clearances. During any pump maintenance, these clearances should be verified. Should dimensional verification indicate any existing deviation, please contact the factory or a Repair Center for acceptable running clearances.

3.6.3 **Wear Ring Clearance** Replace wear rings when pump performance drops below acceptable system standards, or the ring clearances increase to more than 140% of the maximum standard value shown in Table 3.5.2.1.

Measure the clearance between corresponding sets of impeller and stationary rings. Compare the impeller ring OD and stationary ring ID. Use several measurement locations, and then subtract the average impeller ring OD from the average stationary ring ID to determine diametrical clearance.

3.7 **Shafts** Remove burrs and smooth surface with crocus cloth. Protect shafts from damage.

3.7.1 Polish the shaft at the location of the impellers, seal, bushings, and couplings. Use crocus cloth or 400 grit emery paper.

3.7.2 Handle the shaft with care and support it evenly throughout its length to maintain straightness.

CAUTION Avoid bumping, hitting or springing the shaft.

3.7.3 Rest the shafts **211.123** and **213.225** on precision rollers at shaft bearing locations. Use a dial indicator to determine total indicator reading.

3.7.4 Straighten or replace shafts if runout exceed specification maximum shaft straightness must be within 0.0005 in/ft (0.0127 mm/0.305 m) with maximum of 0.005 in (0.076 mm) TIR.

3.8 **Bearings** Replace the bearings 545.XXX during a major overhaul.

3.9 **"O"-rings/Gaskets** Replace all "O"-rings and gaskets during a major overhaul. Spiral wound gaskets should never be re-used.

4.0 WEAR RING REPLACEMENT

Note: if new impeller rings are installed, stationary rings should also be replaced.

4.1 **Impeller Ring Removal** Remove the impeller wear rings **503.162** by applying even heat to the rings to ease removal.

4.2 **Stationary Ring Removal** Remove stationary wear rings **502.113** and **502.152** by inserting a pulling tool or pry bar between the ring and its seat and applying even pressure. Remove the ring.

4.3 **Impeller Ring Installation** Be sure impeller rings and seats are clean and free of burrs.

4.3.1 **RINGS** Heat the impeller wear rings **503.162** and install, chamfered inside edge to impeller. Check that installed rings contact the impeller shoulder circumference. Let cool.

CAUTION

Heat impeller wear rings in an electric oven or hot oil bath. Heating with a torch is not recommended due to uneven heating stresses.

INSTALLATION, OPERATIONS & MAINTENANCE MANUAL

SUBJECT: MAINTENANCE

4.4 **Stationary Ring Installation** Be sure rings and seats are clean and free of burrs.

4.4.1 Carefully tap the stationary rings **502.113** and **502.152** into place, chamfer to inside, with a soft face mallet. A press should be used to mount the rings.

5.0 BEARING BUSHING REPLACEMENT

JTS pumps are equipped with bronze and rubber bushings in these locations:

Bowls: 112.151..... Bushing: 545.154
 Bearing Spider Housing..... Bushing: 545.212

5.1 **Bearing Bushing Removal** Remove the applicable bushing by pressing bushing or breaking them out of their seat. Use care to avoid housing damage.

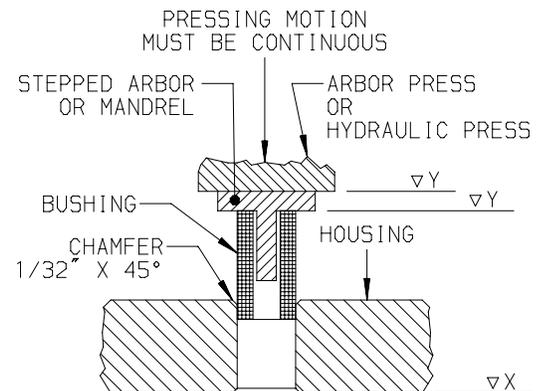
5.2 Bearing Bushing Installation

5.2.1 Use an arbor centering tool, a stepped arbor or mandrel and a hydraulic press to install the bearing bushings. The arbor or mandrel insures that the bearing bushing is correctly positioned.

5.2.2 The small diameter should be 2mm smaller than the inside diameter of the bearing bushing. The large outside diameter of the arbor should be larger than the outside diameter of the bearing bushing.

5.2.3 Surfaces X and Y must be parallel before and during pressing to insure final correct fit.

5.2.4 The bearing bushing can be pressed dry, but a dip coat of water will provide additional lubrication. During the press, pressure must be applied continuously



NORMAL METHOD OF PRESSING BEARING BUSHING INTO HOUSING BY ARBOR PRESS OR HYDRAULIC PRESS

CAUTION

While installing the bearing bushing do not stop and start the press, use continuous motion.

The inside diameter of a bearing bushing becomes smaller after installation due to reaction of press fitting. Wait 24 hours before measurement of inside diameter.

6.0 GENERAL ASSEMBLY

6.1 **Cleanliness** Assembled parts must be absolutely clean and free of oil or dust. Technical grade acetone is recommended for cleanings machined surfaces immediately before assembly. Air dry (use filtered, dry air) cleaned parts in a dust free area.

CAUTION

Acetone is extremely volatile and flammable. Work only in a well ventilated area, away from heat or flame. A "No Smoking" rule must be strictly enforced, and sparks must be prevented.

6.2 **Use New Parts** Use new "O"-rings, gaskets, and lockwashers. Replace gaskets with same material and thickness as original.

6.3 **Torque Values** Prior to assembly, refer to suggested torque values table as referenced within **TORQUE VALUES, ADDENDUM No. 2.**

INSTALLATION, OPERATIONS & MAINTENANCE MANUAL

SUBJECT: MAINTENANCE

7.0 ASSEMBLY

CAUTION

During the assembly process, use handling procedures adequate to avoid bumping, hitting, or springing the shafts. Support shafts evenly over the entire length.

7.1 Bowl Unit Assembly

The following procedure starts with assembly at the suction bell and works upwards. Refer to cross sectional drawing and parts list.

Note: In the disassembly process, the parts should have been marked in their disassembly sequence. Reassemble the bowl assembly in reverse order of the disassembly sequence.

7.1.1 Place the suction bell **138.111** in the chuck fixture.

7.1.2 Clean the pumpshaft **211.123** with solvent and slide the pumpshaft into the suction bell **138.111** and use adjusting bolt to achieve correct shaft projection.

Note: Shaft projection will be noted on Bill of Material.

7.1.3 Place the first impeller **230.161** on the pumpshaft **211.123** and position it into the suction bell **138.111**.

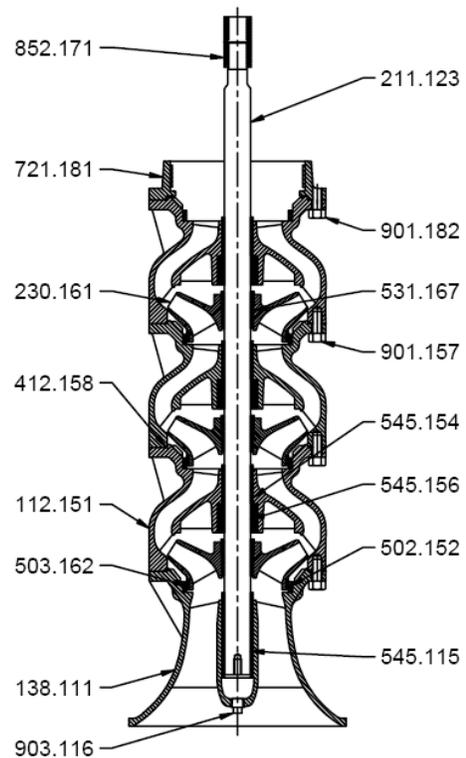
7.1.4 Place the first lock collet on the pumpshaft and, using the lock collet hammer, hammer the lock collet into the impeller.

Note: When the lock collet is in the proper position, it will project about 1/8 of an inch above the impeller hub.

7.1.5 Insert "O"-ring **412.158** on the suction bell register, lubricate pumpshaft **211.151**, and slide the next bowl **112.151** onto the pumpshaft **211.151** and against the suction bell **138.111**. Secure the bowl with hexagon head screws **901.157**. See **TORQUE VALUES**.

7.1.6 Continue to assemble all series stages in the same sequence until the final bowl is installed. Check as each stage is assembled for proper projection dimensions, freedom of rotation, and that axial end play is not lost.

7.2 **Column, Discharge Head Assembly** To assemble the column and discharge head assemblies onto the bowl assembly, perform the following procedure:



INSTALLATION, OPERATIONS & MAINTENANCE MANUAL

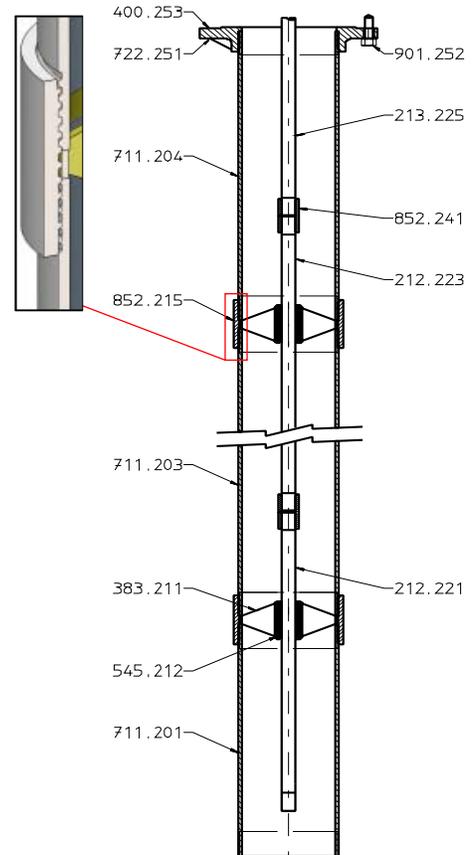
SUBJECT: MAINTENANCE

- 7.2.1 Couple the headshaft **213.225** to the pumpshaft **211.123** with the threaded coupling **852.171**.

CAUTION

Support the headshaft evenly over the entire length to prevent it from bending.

- 7.2.2 Place "O"-ring (if required) **412.158** on the register of the top bowl.
- 7.2.3 Slide the column **711.201** over the headshaft **213.225** and into position on the top bowl flange. Be careful not to damage the headshaft.
- 7.2.4 Secure the column to the top bowl with the adapter **721.181** and hexagon head screws **901.252**.
- 7.2.5 Torque in accordance with **TORQUE VALUES ADDENDUM No. 2**.
- 7.2.6 If equipped, install the bearing spider housing **383.211**. Take care not to damage the bearing bushing **545.212**.
- 7.2.7 Fasten discharge head **115.261** to the column **711.204** using capscrews **901.252**. See **TORQUE VALUES**. Remember to install the "O"-ring **400.253** at the joint.



THREADED COLUMN ASSEMBLY

- 7.2.8 Install stuffing box **431.401** and "O"-ring **412.445** (if required), gland packing **461.425** to the discharge head. Secure with socket head capscrews **914.448**. See **TORQUE VALUES, ADDENDUM No. 2**.

Note: The remainder of the assembly should be carried out once the pump has been installed vertically. See **INSTALLATION** within this IOM.

CAUTION

Release seal plate locking discs or spacers before tightening seal plate nuts 920.405.

7.3 Piping

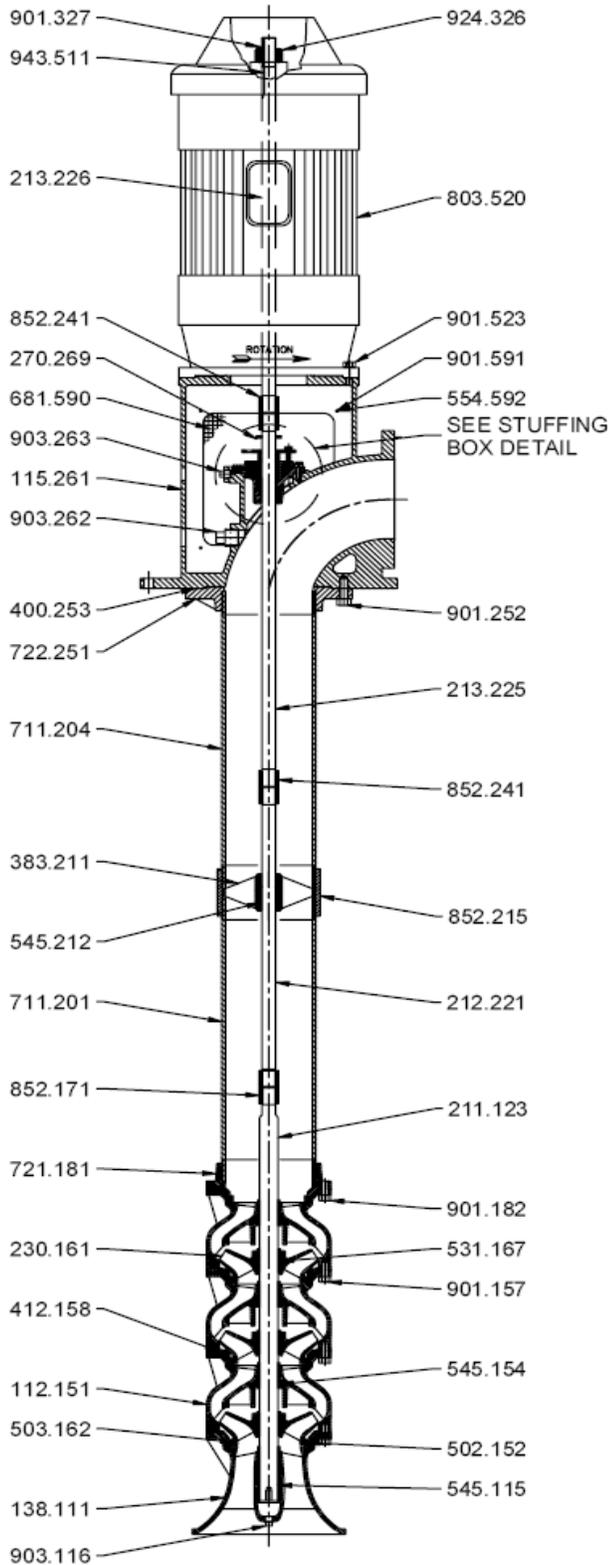
- 7.3.1 Reconnect seal circulation lines, taking care that the caps are removed and pipe ends are clean.
- 7.3.2 Reconnect the suction and discharge flanges.

7.4 Start-Up

- 7.4.1 Install the oil filler plug and breather **637.335**

INSTALLATION, OPERATIONS & MAINTENANCE MANUAL

SUBJECT: MAINTENANCE



Find No.	Description
138.111	Suction Bell
545.115	Bearing Bushing (Suction Bell)
903.116	Threaded Plug (Suction Bell)
211.123	Pump Shaft
112.151	Bowl
502.152	Stationary Ring
545.154	Bearing Bushing (Bowl)
901.157	Capscrew, Hex Head (Bowl)
412.158	O-ring
230.161	Impeller
503.162	Impeller Ring
531.167	Clamping Sleeve
852.171	Threaded Coupling
721.181	Adapter (Bowl/Column)
901.182	Capscrew, Hex Head (Adapter)
711.201	Column, Bottom
711.204	Column, Top
383.211	Bearing Spider Housing
545.212	Bearing Bushing (Lineshaft)
852.215	Threaded Coupling (Column)
212.221	Line Shaft, Bottom
213.225	Head Shaft
852.241	Threaded Coupling (Shaft)
722.251	Flanged Transition Piece
901.252	Capscrew, Hex Head (Flange)
400.253	Gasket (Flanged Transition Piece)
115.261	Discharge Head
903.262	Threaded Plug (Lineshaft pre-lube)
903.263	Threaded Plug (Gland spill drain)
341.501	Driver Stand
840.510	Coupling
800.520	Motor
901.523	Capscrew, Hex Head (Driver)
901.527	Capscrew, Hex Head (Driver Stand)
681.590	Coupling Guard
900.591	Screw (Coupling Guard)

INSTALLATION, OPERATIONS & MAINTENANCE MANUAL

SUBJECT: REPLACEMENT PARTS

1.0 SPARE PARTS

1.1 Spare parts should be kept to reduce downtime. The service of a pump usually dictates number of spare parts. The following parts should be stocked:

Anti-Friction Bearings (1 set)
Bearing Bushings
Stationary Rings, Impeller Rings
Gaskets and O-rings (1 set)
Gland Packing (1 set)
Mechanical Seal

1.2 For pumps used in important service or if several identical machines are operating in the same plant, it is recommended that a complete pump be stocked at the job site.

2.0 PARTS ORDERS

Order parts through the local Sulzer field office identified in the front of this manual. Please provide the following information:

- Type of pump
- Pump serial number
- Cross section drawing number
- The number of part as shown on cross section drawing and the parts list
- Quantity and description of part

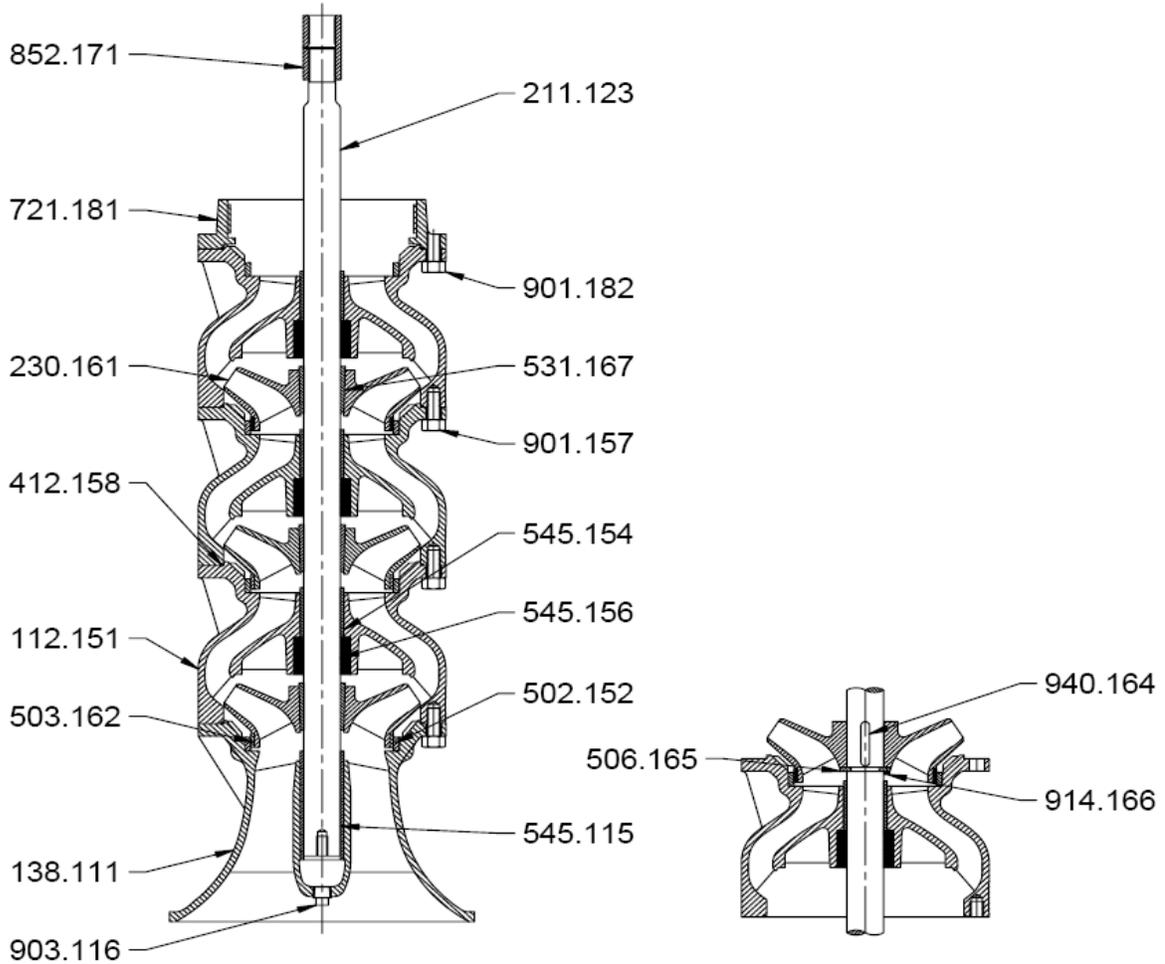
3.0 TYPICAL CROSS SECTION

Note: The illustration Figure (appearing before the Table of Contents, and also on last page of the ASSEMBLY Section) may differ from your specific application. Parts orders and other assured identification must be made by using the specific cross section and parts list.

INSTALLATION, OPERATIONS & MAINTENANCE MANUAL

SUBJECT: REPLACEMENT PARTS

(BOWL ASSEMBLY)



Find No.	Description
138.111	Suction Bell
545.115	Bearing Bushing (Suction Bell)
903.116	Threaded Plug (Suction Bell)
211.123	Pump Shaft
112.151	Bowl
502.152	Stationary Ring
545.154	Bearing Bushing (Bowl)

Find No.	Description
545.156	Bearing Bushing (Bowl)
901.157	Capscrew, Hex Head (Bowl)
412.158	O-ring
230.161	Impeller
503.162	Impeller Ring
940.164	Key (Impeller)
506.165	Retaining Ring

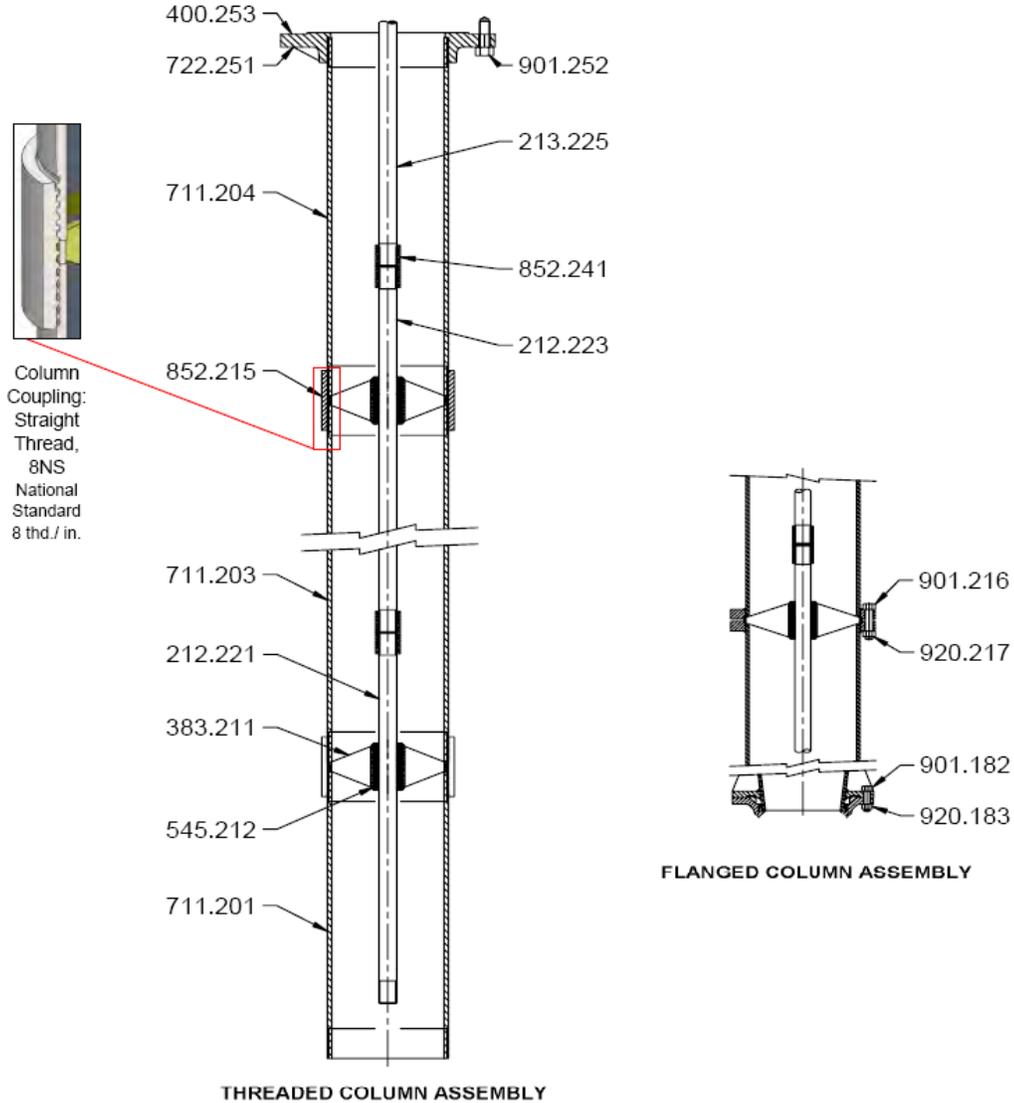
Find No.	Description
914.166	Capscrew, Socket Head (Retaining Ring)
531.167	Clamping Sleeve
852.171	Threaded Coupling
721.181	Adapter (Bowl/Column)
901.182	Capscrew, Hex Head (Adapter)

Note: Descriptions in parenthesis are for clarification or for items not illustrated, these descriptions shall not be incorporated in the actual part name.

INSTALLATION, OPERATIONS & MAINTENANCE MANUAL

SUBJECT: REPLACEMENT PARTS

(COLUMN ASSEMBLY)



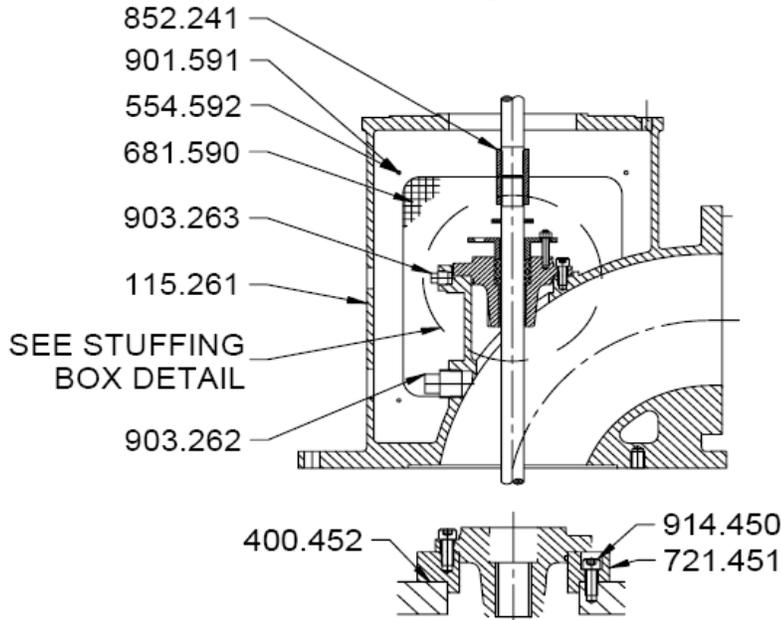
Find No.	Description	Find No.	Description	Find No.	Description
901.182	Capscrew, Hex Head (Column to Bowl)	545.212	Bearing Bushing (Lineshaft)	212.223	Line Shaft, Intermediate
920.183	Nut	852.215	Threaded Coupling (Column)	213.225	Head Shaft
711.201	Column, Bottom	901.216	Capscrew, Hex Head (Columns)	852.241	Threaded Coupling (Shaft)
711.203	Column, Intermediate	920.217	Nut (Column)	722.251	Flanged Transition Piece
711.204	Column, Top	212.221	Line Shaft, Bottom	901.252	Capscrew, Hex Head (Flange)
383.211	Bearing Spider Housing			400.253	Gasket (Flanged Transition Piece)

Note: Descriptions in parenthesis are for clarification or for items not illustrated, these descriptions shall not be incorporated in the actual part name.

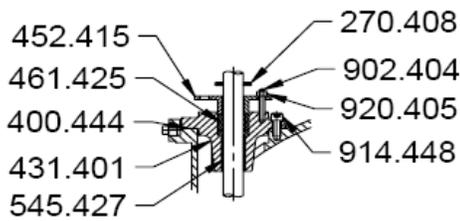
INSTALLATION, OPERATIONS & MAINTENANCE MANUAL

SUBJECT: REPLACEMENT PARTS

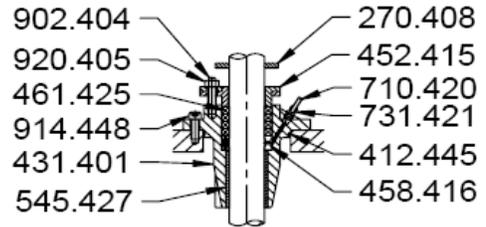
(DISCHARGE HEAD ASSEMBLY AND STUFFING BOX DETAIL)



Adapter (Stuffing Box) - When Required



Standard Stuffing Box



By-Pass Stuffing Box

Find No.	Description
852.241	Threaded Coupling (Shaft)
115.261	Discharge Head
903.262	Threaded Plug (Lineshaft pre-lube)
903.263	Threaded Plug (Gland spill drain)
431.401	Stuffing Box
902.404	Stud (Gland)
920.405	Nut (Gland)
270.408	Deflector
452.415	Gland

Find No.	Description
458.416	Lantern Ring
710.420	Tubing
731.421	Tube Fitting
461.425	Gland Packing
545.427	Bearing Bushing
400.444	Gasket (Stuffing Box)
412.445	O-ring (Stuffing Box)
914.448	Capscrew, Socket Head (Stuffing Box)
914.450	Nut (Adapter)

Find No.	Description
721.451	Adapter
400.452	Gasket (Adapter)
681.590	Coupling Guard
901.591	Capscrew, Hex Head (Coupling Guard)
554.592	Washer (Coupling Guard)

INSTALLATION, OPERATIONS & MAINTENANCE MANUAL

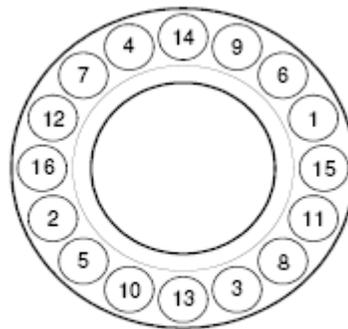
SUBJECT: TORQUE VALUES

1.0 PURPOSE

- 1.1 This process establishes the method and values for torquing fasteners to produce properly stressed joints with a minimum probability of fasteners breaking or loosening. Joint distortion will be avoided by using the correct tightening sequence during torque development.

2.0 METHOD

- 2.1 All fasteners are to be lubricated (if lubricants are permitted) with graphite and oil, molybdenum disulfide, or another anti-seize lubricant of comparable quality that is compatible with the fastener application. Cleaning specifications must be consulted to determine suitability or allowance of thread lubricant.
- 2.2 Consult the Parts List (if applicable) to determine the fastener and component material for determining torque value, or for special torque requirements.
- 2.3 Consult the following Fastener Application guideline to determine the table to be used based on the fastener application.
- 2.4 Tighten opposing fasteners in an alternating sequence as illustrated below when developing required torque.
- 2.5 Lubricate and install fasteners finger-tight. Develop the required fastener torque value in a minimum of three steps, with a maximum of 30 percent of the torque value being reached on the initial pass.



Circular Multi-Bolt,
Example Pattern

- 2.6 After the last torque-development pass, a final "check pass" tightening to the required torque value should be performed in a clockwise bolt to bolt sequence.
- 2.7 Refer to vendor instructions for proper torque values on vendor-supplied equipment.
- 2.8 Look for a grade identification marking on the fastener, then refer to the appropriate column in Torque Table 1, if the fastener is not covered by another specific table.
- 2.9 The material into which the fastener is threaded must also be considered. For fastener materials that have strengths greater than the material that is tapped, see the Parts List (if applicable) for special torque requirements.

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- 2.10 Where the material or fastener grade marking is unknown, and the application is for Table 1b, use the values in column 7 (AISI 304, 316 or monel material).
- 2.11 Torque values in Tables 4 through 6 will be unchanged regardless of the fastener material.
- 2.12 Typical applications that could have either flat or raised face flanges include, but are not limited to: Bowl & column assembly. Select either Table 1 or Table 3 as applicable.

FASTENER APPLICATION	TABLE NUMBER
Flat face flange joint with gasket	1 & 1M
Raised face flange* joint with gasket	3
Pump thrust end hold-down bolts for alignment keys	4

*** Note:** For the purpose of this standard the definition of a raised face flange is when the raised face diameter is less than the Pitch Circle Diameter minus the hole diameter

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TABLE 1a (TORQUE VALUES)

COLUMN NO.	1		2		3		4		5	
MATERIAL & GRADE	SAE Gr 8 A354 Gr BD		A & SA193 Gr B7 A & SA320 Gr L7		SAE Gr 5 A325 & A449 ASTM F468 - N05500 (Monel)		A193 Gr B6		A & SA193 Gr B7M A & SA320 Gr L7M	
BOLTING YIELD STRENGTH (Relative to Dia.)	<=2.5" 130 ksi 2.5"-4.0" 115 ksi		<=2.5" 105 ksi 2.5"-4.0" 95 ksi		0.25"-1.0" 92 ksi 1.12"-1.5" 81 ksi 1.6" - 3.0" 58 ksi		<=4.0" 85 ksi		<=2.5" 80 ksi	
FASTENER SIZE	lbf*ft	N*m	lbf*ft	N*m	lbf*ft	N*m	lbf*ft	N*m	lbf*ft	N*m
0.250 - 20 UNC	10	13	8	11	7	9	6	9	6	8
0.3125 - 18UNC	19	26	15	21	14	18	13	17	12	16
0.375 - 16 UNC	33	44	27	36	23	31	21	29	20	27
0.4375 - 14UNC	51	70	41	56	36	49	34	46	32	43
0.500 - 13 UNC	78	106	63	86	55	75	51	69	48	65
0.625 - 11 UNC	154	208	124	168	109	147	100	136	95	128
0.750 - 10 UNC	269	365	217	295	190	258	176	238	165	224
0.875 - 9 UNC	429	582	347	470	304	412	281	381	264	358
1.000 - 8 UNC	641	869	517	702	453	615	419	568	394	535
1.125 - 8 UN	929	1260	750	1017	579	785	607	824	572	775
1.250 - 8 UN	1292	1752	1044	1415	805	1092	845	1146	795	1078
1.375 - 8 UN	1739	2358	1405	1905	1084	1469	1137	1542	1070	1451
1.500 - 8 UN	2279	3090	1840	2496	1420	1925	1490	2020	1402	1901
1.625 - 8 UN	2941	3988	2375	3221	1312	1779	1923	2608	1810	2454
1.750 - 8 UN	3670	4976	2964	4019	1637	2220	2399	3254	2258	3062
2.000 - 8 UN	5534	7504	4470	6061	2469	3348	3618	4907	3406	4618
2.250 - 8 UN	7941	10768	6414	8698	3543	4804	5192	7041	4887	6627
2.500 - 8 UN	10960	14862	8853	12004	4890	6631	7166	9718	6745	9146
2.750 - 8 UN	12969	17586	10714	14528	6541	8870	9586	12999	-	-
3.000 - 8 UN	16906	22925	13966	18938	8527	11562	12496	16944	-	-
3.250 - 8 UN	21568	29247	17817	24160	-	-	15942	21617	-	-
3.500 - 8 UN	27016	36634	22318	30263	-	-	19969	27077	-	-
3.750 - 8 UN	33312	45171	27519	37315	-	-	24622	33387	-	-
4.000 - 8 UN	40516	54940	33470	45385	-	-	29947	40608	-	-

**NOTE: Socket Head Cap screws shall be fastened to column 2 values.
 All other material grades not listed or unidentifiable fasteners are to be fastened to column 9 values
 For cadmium plated applications use 70% of table value.**

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TABLE 1b (TORQUE VALUES)

COLUMN NO.	6		7		8		9	
MATERIAL & GRADE	A &SA193 Gr B8R		SAE Gr 2		SAE gr 1 ASTM A307 gr A or B		AISI 304, 316 ASTM A193 gr B8, B8M Monel	
BOLTING YIELD STRENGTH (Relative to Dia.)	<=4.0"	55 ksi	.25"-.75" .88"-1.5"	57 ksi 36 ksi	<=4.0"	36 ksi	<=4.0"	30 ksi
FASTENER SIZE	Lbf*ft	N*m	lbf*ft	N*m	lbf*ft	N*m	lbf*ft	N*m
0.250 - 20 UNC	4	6	4	6	3	4	2	3
0.3125 - 18UNC	8	11	8	11	5	7	4	6
0.375 - 16 UNC	14	19	14	20	9	12	8	10
0.4375 - 14UNC	22	29	23	31	14	19	12	16
0.500 - 13 UNC	33	45	34	47	22	29	18	24
0.625 - 11 UNC	65	88	67	91	43	58	35	48
0.750 - 10 UNC	114	154	118	160	74	101	62	84
0.875 - 9 UNC	182	246	119	161	119	161	99	134
1.000 - 8 UNC	271	367	177	241	177	241	148	200
1.125 - 8 UN	393	533	257	349	257	349	214	291
1.250 - 8 UN	547	741	358	485	358	485	298	404
1.375 - 8 UN	736	998	482	653	482	653	401	544
1.500 - 8 UN	964	1307	631	856	631	856	526	713
1.625 - 8 UN	1244	1687	-	-	814	1104	679	920
1.750 - 8 UN	1553	2105	-	-	1016	1378	847	1148
2.000 - 8 UN	2341	3175	-	-	1533	2078	1277	1732
2.250 - 8 UN	3360	4556	-	-	2199	2982	1833	2485
2.500 - 8 UN	4637	6288	-	-	3035	4116	2529	3430
2.750 - 8 UN	6203	8411	-	-	4060	5505	3383	4588
3.000 - 8 UN	8086	10964	-	-	5292	7176	4410	5980
3.250 - 8 UN	10315	13987	-	-	6752	9155	5626	7630
3.500 - 8 UN	12921	17521	-	-	8457	11468	7048	9557
3.750 - 8 UN	15932	21604	-	-	10428	14140	8690	11784
4.000 - 8 UN	19377	26276	-	-	12683	17199	10569	14332

**NOTE: Socket Head Cap screws shall be fastened to column 2 values.
 All other material grades not listed or unidentifiable fasteners are to be fastened to column 9 values.
 For cadmium plated applications use 70% of table value.**

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TABLE 1M (TORQUE VALUES)

COLUMN NO.	10		11		12		13		14		15	
MATERIAL & GRADE	Class 4.6		Class 8.8		Class 10.9		Class 12.9		A1, A2 & A4 Property class 50		A1, A2 & A4 Property class 70	
BOLTING YIELD STRENGTH (Relative to Dia.)	<= M36 240 MPa		M6 - M16 640 MPa M18 - M36 660 MPa		<= M36 940 MPa		<= M36 1100 MPa		<= M36 210 MPa		<= M20 450 MPa	
FASTENER SIZE	Lbf*ft	N*m	lbf*ft	N*m	lbf*ft	N*m	lbf*ft	N*m	lbf*ft	N*m	lbf*ft	N*m
M6	2	3	6	8	9	12	10	14	2	3	4	6
M8	5	7	14	19	21	28	24	33	5	6	10	13
M10	11	14	28	38	41	56	48	65	9	12	20	27
M12	18	24	48	65	71	96	83	112	16	21	34	46
M14	28	39	76	103	111	151	130	177	25	34	53	72
M16	43	59	115	156	169	229	198	268	38	51	81	110
M18	60	82	165	224	236	319	276	374	53	71	113	153
M20	84	114	232	314	330	448	386	524	74	100	158	214
M22	113	153	310	420	441	598	516	700	98	134	211	286
M24	145	197	399	542	569	771	666	903	127	172	272	369
M27	212	288	584	791	831	1127	973	1319	186	252	398	540
M30	290	393	796	1080	1134	1538	1327	1799	253	344	543	736
M33	364	493	1000	1357	1425	1932	1667	2261	318	432	682	925
M36	502	681	1380	1872	1966	2666	2300	3119	439	595	941	1276

NOTE: Socket Head Cap screws shall be fastened to column 2 values.

All other material grades not listed or unidentifiable fasteners are to be fastened to column 9 values.

For cadmium plated applications use 70% of table value.

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SUBJECT: TROUBLESHOOTING

	Symptoms	Possible Causes of faults	Remedies
1	Insufficient Pressure	A. Speed too Slow	Check if driver is across the line and receiving full voltage
		B. Improper impeller adjustment	Check the accuracy of the impeller adjustment. Follow manufacturers recommended clearances.
		C. Loose Impeller (rarely occurs)	Refit Impeller.
		D. Plugged impeller	Pull the pump. Inspect impeller and bowl pasageways.
		E. Wear rings worn	Inspect and replace.
		F. Entrained air in pump	Clean screen and trach racks. Check return line size and location in sump or tank. Increase suction bell diameter so the pumps required submergence is less than the actual submergence available.
		G. Leaking column joints of bowl castings	Pull pump and inspect.
		H. Wrong direction of rotation	Check - Refer to pump rotation arrow.
		I. Suction valve/line blocked	Inspect and correct.
		J. Foot valve blocked or damaged	Inspect foot valve
2	Insufficient Capacity	A. Speed too Slow	Check if driver is across the line and receiving full voltage
		B. Improper impeller adjustment	Check the accuracy of the impeller adjustment. Follow manufacturers recommended clearances.
		C. Loose Impeller (rarely occurs)	Refit Impeller.
		D. Impeller or bowl partially plugged	Pump pump and inspect for obstruction.
		E. Leaking joints	Pull pump and inspect.
		F. Strainer partially clogged	Backflush. Install finer mesh strainer or larger strainer. Pull pump and remove obstruction.
		G. Suction or discharge valve not fully open	Check valve position and correct as required.
		H. Minimum flow line open, minimum flow valve damaged or bypass orifice worn	Chcek minimum flow line, minumnm flow valve or bypass orifice.
		I. Wrong direction of rotation	Check - Refer to pump rotation arrow.
3	No Liquid Delivered	A. Pump suction broken (water level below bell inlet)	Check for adequate submergence.
		B. Suction valve closed	Open valve.
		C. Impeller plugged	Pump pump and inspect for obstruction.
		D. Strainer clogged	Backflush. Install finer mesh strainer or larger strainer. Pull pump and remove obstruction.
		E. Wrong direction of rotation	Check - Refer to pump rotation arrow.
		F. Shaft broken	Pull pump and replace shaft.
		G. Loose Impeller (rarely occurs)	Refit Impeller.
4	Using too Much Power	A. Speed too high	Check voltage on motor.
		B. Improper impeller adjustment	Check the accuracy of the impeller adjustment. Follow manufacturers recommended clearances.
		C. Improper impeller trim	Pull pump and inspect. Modify existing impeller to provide system requirements.
		D. Pump out of alignment or shaft bent	Check alignment of pump and driver, also foundations.
		E. Lubricating oil tool heavy	Check quantity and quality of lubricants. Refer to manufacturers recommendations.
		F. Pumping sand, silt, or foreign material	Test pumpage for suspended particals viscosity and specific gravity.

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SUBJECT: TROUBLESHOOTING

	Symptoms	Possible Causes of faults	Remedies
5	Vibration	A. Motor imbalance (electrical) B. Coupling alignment faults C. Worn shaft coupling D. Misalignment of pump castings, discharge head, column or bowls. E. Bent shaft F. Worn pump bearings G. Clogged impeller of foreign material in pump. H. Improper impeller adjustment I. Vortex problems in sump. J. Piping strain, excessive high nozzle forces and moments K. Foundation too weak, base not correctly grouted L. Resonance	Consult motor and pump manufacturer. Check coupling alignment. Check coupling condition and replace. Determine cause utilizing vibration frequency analyzer and/or pump disassembly. Check, straighten or replace. Check and replace. Backflush. Pull, check for damage and replace. Check the accuracy of the impeller adjustment. Follow manufacturers recommended clearances. Increase pump submergence. Apply sump modifications such as; install vertical splitter, install suction umbrella, relocate pump in sump or lower the inlet velocity in the sump. Piping should be properly supported to prevent strains from being imposed on the pump. Inspect foundation bolt tightening and baseplate grouting. System frequency at or near pump speed. Loosen anchor bolts. Change pipe strain.
6	Abnormal Noise	A. Motor Noise B. Broken bearing spiders C. Broken shaft or shaft enclosing tube D. Impeller dragging on bowl case E. Cavitation F. Foreign material in pump	Check for bearing failure. Monitor bearing oil temperature and oil level. Consult motor and pump manufacturer. Check and replace. Check and replace. Re-adjust impeller per manufactureres recommendations. Check submergence. Check for sufficient NPSH available. Elevate system head conditions and reduce pump capacity, if possible. Change pump impeller to lower NPSH design. Backflush or pull and inspect.
7	High shaft seal temperature. High leakage of mechanical seal. Short shaft seal life.	A. Seal flush insufficient (flow rate) or missing B. Wrong orifice size or worn orifice C. Solids block seal rings/springs D. Vaporisation in the seal ring area E. Seal fluid not suitable (abrasive) F. Seal rings, auxiliary gaskets (O-rings) or springs damaged G. Dry operation of seal. Seal system not correctly filled or vented. H. Seal face material inadequate I. Pump shaft bent J. Faces not flat	Check flow requirements. Enlarge flush line and/or orifices. Check size, flow requirements. Disassemble and remove solids, review application. Check circulation flow or cooling requirements. Review application, install filter or separator. Disassemble and replace damaged seal parts. Fill and vent shaft seal housing/system. Review application with seal manufacturer. Check shaft runout at seal area. Check for installation dimensions.

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Symptoms		Possible Causes of faults	Remedies
8	High Bearing Temperature. Short Bearing Life.	A. Pump not running at operating point	Review operating parameters
		B. Coupling alignment faults	Check coupling alignment
		C. Too much grease or oil in the bearing	Check and correct
		D. Oil level too low or high	Check and correct oil level
		E. Wrong lube oil quality	Verify that recommended lubricant is used. Change lube oil.
		F. Bearings loaded during assembly	Examine assembly and condition of bearing and associated parts
		G. Insufficient bearing cooling (air / water)	Check air intake (environmental temperatures under noise hoods). Check cooling water requirement.
		H. Bearings damaged	Disassemble and replace bearings
		I. Excessive pump thrust	Check hydraulic balance device, balance pipe. Disassemble and inspect pump internal clearances.
		J. Shaft bent	Disassemble pump and check shaft runout.
9	Lube Oil Leakage	A. Oil level too high	Check and correct oil level
		B. Labrynth seal or shaft seal ring improperly installed	Examine assembly (labrynth leakage bore downwards)
		C. Bearing cover gasket or seal damaged	Disassemble and replace gaskets/seals
		D. Vent blocked	Check and clean vent connection
10	Excessive Wear of Pump Internals -Corrosion -Erosion -Loss of Material	A. Pump not running at operating point	Review pump operating parameters with a Sulzer representative, make necessary correction to unit design. Refurbish pump with correct parts, clean system. Assemble filter or separator.
		B. Insufficient suction pressure	
		C. Operating fluid differs from specified value (temperature, specific gravity)	
		D. Materials of construction not compatible with medium delivered	
11	Pump Overheating/Seizure.	A. Operating below minimum flow (pump running dry)	Review hints for minimum flow. In case of seizure, disassemble and repair unit.