Carver Pump®

Operating Instructions
I-280 ATEX REV.0
Inch Units

RS Series multi-stage centrifugal pumps

ATEX Safety and Operation Manual

Part Number : _____

Serial Numbers: _____

These operating instructions contain fundamental information and precautionary notes. Please read the manual thoroughly prior to installation of unit, electrical connection and commissioning. It is imperative to comply with all other operating instructions referring to components of individual units.

This manual shall always be kept close to the unit's location of operation or directly on the pump set.

EC Declaration of Conformity

MANUFACTURER: CARVER PUMP COMPANY
2415 PARK AVE.
MUSCATINE, IOWA, USA 52761

PRODUCT DESCRIPTION: RS-6, RS-9 Multi-stage Pump

PART NUMBER:

SERIAL NUMBER:

DATE MANUFACTURED:

APPLICABLE EUROPEAN DIRECTIVES:

Machinery: 98/37/EC
ATEX: 94/9/EC

APPLICABLE INTERNATIONAL STANDARDS:

Machinery: EN 12100-1, EN 12100-2
ATEX: EN 1127-1, EN 13463-1, EN 13463-5

NOTIFIED BODY

Det Norske Veritas, ATEX NB 0575 retains a copy of the Technical File

ATEX product marking: II 2 G c T2

The product described in this Declaration of Conformity complies with the Applicable European Directives and relevant sections of the Applicable International Standards. The signature on this document authorizes the distinctive European mark to be applied to the equipment described. A Technical Construction File is available for inspection by designated bodies

Authorized Signature: Date:

Important safety information is contained in the installation, operation and service manuals; read and understand this information prior to installing or using this equipment

This Document applies only to the equipment described above and is invalid if not reproduced in its entirety

SERVICE RECORD PAGE

Service No. _____ Size and Type _____ Make _____

Cust. Order No. _____ Date Installed _____

Installation Date	Location	Application

PUMP RATING

Capacity (GPM) _____ Total Head (ft) _____

Suction Pressure _____ Speed (RPM) _____

Liquid _____ Temperature _____

Specific Gravity _____ Viscosity _____

Impeller Diameter (inches) _____

PUMP MATERIALS

Casings _____ Impeller _____ Diffuser _____

Shaft _____ Wear Ring _____

O-rings _____ Bearing Frame _____

Mechanical Seal, Suction End (Low Pressure) _____

Mechanical Seal, discharge End (High Pressure) _____

DRIVER DATA

Motor _____ Make _____ Serial No. _____

Type _____ Frame _____ AC or DC _____

HP _____ RPM _____ Volts _____

Phase _____ Cycles _____

NOTES ON INSPECTION AND REPAIRS

INSPECTION DATE	REPAIR TIME	REPAIRS	COST	REMARKS

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I. General Information

1. PREFACE

Carver Pump Company products are carefully engineered and manufactured and, if properly installed, maintained, and operated, should provide maintenance-free operation and a long service life.

These instructions must always be kept close to the product's operating location or directly with the product.

These instructions are intended to facilitate familiarization with the product and its permitted use to help satisfy ATEX safety requirements. These instructions may not have taken into account local regulations; ensure such regulations are observed by all, including those installing the product. Always coordinate repair activity with operations personnel, and follow all plant safety requirements and applicable safety and health laws/regulations.

These instructions should be read prior to installing, operating, using and maintaining the equipment in any region worldwide and in conjunction with the main user instructions provided. The equipment must not be put into service until all the conditions relating to safety instructions have been met.

1.1 ATEX Directive 94/9/EC

It is a legal requirement that machinery and equipment put into service within certain regions of the world shall conform with the applicable CE Marking Directives for Equipment for Potentially Explosive Atmospheres (ATEX).

Where applicable the Directive covers important safety aspects relating to the equipment, its use and the satisfactory provision of technical documents. Where applicable this document incorporates information relevant to these Directives. To establish if the product itself is CE marked for a Potentially Explosive Atmosphere check the nameplate and the Certification provided.

1.2 Disclaimer

Information in these User Instructions is believed to be reliable. In spite of all the efforts of Carver Pump Company to provide sound and all necessary information the content of this manual may appear insufficient and is not guaranteed by Carver Pump Company as to its completeness or accuracy.

1.3 Personnel qualification and training

All personnel involved in the operation, installation, inspection and maintenance of the unit must be qualified to carry out the work involved. If the personnel in question do not already possess the necessary knowledge and skill, appropriate training and instruction must be provided. If required the operator may commission the manufacturer/supplier to provide applicable training.

Follow instructions in this manual carefully. Factory warranty applies only when pump operates under conditions as specified on order acknowledgment, and if pump is properly installed and maintained as recommended herein. A copy of this manual should be available to operating personnel. Additional copies of this manual are available upon request from Carver Pump Company and your local distributor. For comments and/or questions about information provided, please contact Carver Pump Company or your local distributor.

1.4 Pump Identification

The type of pump, pump size, operating data, and serial number are all stamped on the nameplate attached to the pump. Pump specifications should be recorded upon receipt of the pumping unit. Record all necessary information on the pump service record page and inspection and repair record provided at the front of this manual. When ordering spare parts, check to make sure that the serial number and model number of the pump are correct. This information must be included in all correspondence regarding the unit. This will ensure that the correct pump and/or parts are ordered in a timely manner.

1.5. Parts Inventory Guide

To avoid unnecessary delays for maintenance, spare parts should be readily available for normal service. Most conditions will be covered if this manual is followed. For every one to three pumps, stock one spare set consisting of items listed in Table 15, Recommended Spare Parts. Part numbers correspond to Figures 9 and 10.

1.5 Parts Ordering

When ordering replacement parts, please specify:

- Serial number of pump (located on nameplate)
- Part name (located on parts list)
- Quantity of parts needed

Carver Pump Company may ship an interchangeable part that is not identical in appearance or symbol. This is done only if the part has been improved. Examine parts carefully upon delivery before questioning factory or company representative. Never return parts to the factory without authorization from Carver Pump Company.

If an impeller is ordered, specify diameter across blade tips. Be sure diameter was NOT trimmed further than diameter shown on Carver Pump Company records.

If a driver or driver parts are ordered, specify name of manufacturer and all other data found on the driver nameplate.

2. SAFETY

2.1 Summary of safety marking

These instructions contain the following specific ATEX safety marking where non-observance of the instruction will cause a hazard.

 This symbol indicates explosive atmosphere marking according to ATEX. It is used in safety instructions where non-compliance in the hazardous area would cause the risk of an explosion.

2.2 Products used in potentially explosive atmospheres

 Measures are required to:
- Avoid excess temperature
- Prevent build up of explosive mixtures
- Prevent the generation of sparks
- Prevent leakages
- Maintain the pump to avoid hazard

The following instructions for pumps and pump units when installed in potentially explosive atmospheres must be followed to help ensure explosion protection. Both electrical and non-electrical equipment must meet the requirements of European Directive 94/9/EC.

2.3 Scope of compliance

 Use equipment only in the zone for which it is appropriate. Always check that the driver, drive coupling assembly, seal and pump equipment are suitably rated and/or certified for the classification of the specific atmosphere in which they are to be installed.

Where Carver Pump has supplied only the bare shaft pump, the Ex rating applies only to the pump. The party responsible for assembling the pump set shall select the coupling, driver, seal and any additional equipment, with the necessary CE Certificate/ Declaration of Conformity establishing it is suitable for the area in which it is to be installed.

The output from a variable frequency drive (VFD) can cause additional heating affects in the motor and so, for pump sets with a VFD, the ATEX Certification for the motor must state that it covers the situation where electrical supply is from the VFD. This is particular requirement still applies even if the VFD is in a safe area.

2.4 Safety Awareness

It is imperative to comply with the safety instructions contained in this manual, the relevant national and international explosion protection regulations, health and safety regulations and the operator's own internal work, operation and safety regulations.

 Ex symbol relates to additional requirements which must be adhered to when the pump is operated in potentially explosive atmospheres.

2.5 Safety Instructions for the Operator / User

- Any hot or cold components that could pose a hazard must be equipped with a guard by the operator.
- Guards which are fitted to prevent accidental contact with moving parts (e.g. coupling) must not be removed whilst the unit is operating.
- Leakages (e.g. at the shaft seal) of hazardous fluids (e.g. explosive, toxic, hot) must be contained so as to avoid any danger to persons or the environment. Pertinent legal provisions must be adhered to.
- Electrical hazards must be eliminated. (In this respect refer to the relevant safety regulations applicable to different countries and/or the local energy supply companies.)

 If the pumps/units are located in potentially explosive atmospheres, it is imperative to make sure that unauthorized modes of operation are prevented. Non-compliance may result in the specified temperature limits being exceeded.

2.6 Safety Instructions for Maintenance, Inspection and Installation Work

The operator is responsible for ensuring that all maintenance, inspection and installation work be performed by authorized, qualified specialist personnel who are thoroughly familiar with the manual.

 To ensure dafe operation the roller bearings must be replaced at 20000 hours of service or when ever the mechanical seal is inspected or serviced.

The pump must have cooled down to ambient temperature, pump pressure must have been released and the pump must have been drained.

Work on the machine / unit must be carried out only during standstill. The shutdown procedure described in the manual for taking the unit out of service must be adhered to without fail.

Pumps or pump units handling fluids injurious to health must be decontaminated.

Immediately following completion of the work, all safety-relevant and protective devices must be re-installed and / or re-activated. Please observe all instructions set out in the chapters on Installation/Operation before returning the unit to service.

2.7 Unauthorized Modification and Manufacture of Spare Parts

Modifications or alterations of the equipment supplied are only permitted after consultation with the manufacturer and to the extent permitted by the manufacturer . Original spare parts and accessories authorized by the manufacturer ensure safety. The use of other parts can invalidate any liability of the manufacturer for consequential damage.

2.8 Unauthorized Modes of Operation

The warranty relating to the operating reliability and safety of the unit supplied is only valid if the equipment is used in accordance with its designated use as described in the following sections. The limits stated in the data sheet must not be exceeded under any circumstances.

2.9 Explosion Protection

If the pumps/units are installed in potentially explosive atmospheres, the measures and instructions given in the following sections 2.9.1 to 2.9.6 must be adhered to without fail, to ensure explosion protection.

2.9.1 Unit Fill

It is assumed that the system of suction and discharge lines and thus the wetted pump internals are completely filled with the fluid to be handled at all times during pump operation, so that an explosive atmosphere is prevented.

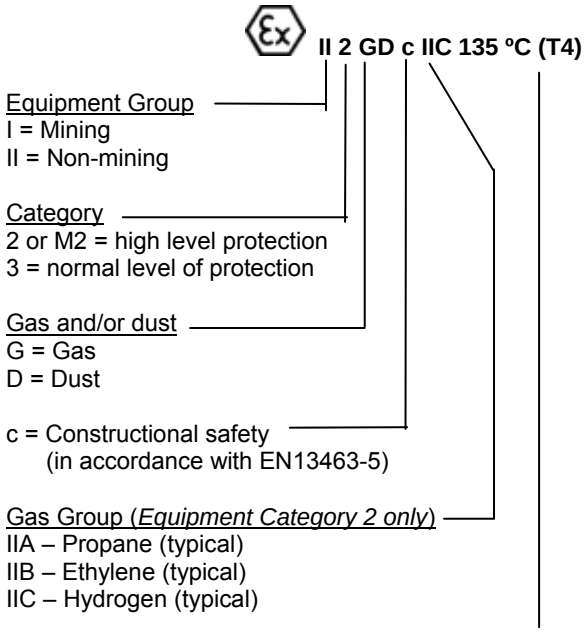
If the operator cannot warrant this condition, appropriate monitoring devices must be used.

In addition, it is imperative to make sure that the seal chambers, auxiliary systems of the shaft seal and the heating and cooling systems are properly filled.

2.9.2 Marking

The marking on the pump only refers to the pump part, i.e. the coupling and motor must be regarded separately. The coupling must have an EC manufacturer's declaration. The driver must be regarded separately.

An example of ATEX equipment marking is shown below. The actual classification of the pump will be engraved on the nameplate.



2.9.3 Checking the Direction of Rotation

If the explosion hazard also exists during the installation phase, the direction of rotation must never be checked by starting up the unfilled pump unit, even for a short period, to prevent temperature increases resulting from contact between rotating and stationary components.

2.9.4 Pump Operating Mode

Make sure that the pump is always started up with the suction-side shut-off valve fully open and the discharge-side shut-off valve slightly open. However, the pump can also be started up against a closed swing check valve. The discharge-side shut-off valve shall be adjusted to comply with the duty point immediately following the run-up process (see 6.1.7).

Pump operation with the shut-off valves in the suction and/or discharge pipes closed is not permitted.

In this condition, there is a risk of the pump casing taking on high surface temperatures after a very short time, due to a rapid temperature rise in the pumped fluid inside the pump. Additionally, the resulting rapid pressure build-up inside the pump may

cause excessive stresses on the pump materials or even bursting.

The minimum flows indicated in Table 8 of Section III refer to water and water-like liquids. Longer operating periods with these liquids and at the flow rates indicated will not cause an additional increase in the temperatures on the pump surface. However, if the physical properties of the fluids handled are different from water, it is essential to check if an additional heat build-up may occur and if the minimum flow rate must therefore be increased.

To check, proceed as described in Section III E.
In addition, the instructions given in section III of this operating manual must be observed.

Mechanical seals may exceed the specified temperature limits if run dry. Dry running may not only result from an inadequately filled seal chamber, but also from excessive gas content in the fluid handled.
Pump operation outside its specified operating range may also result in dry running.

2.9.5 Temperature Limits

In normal pump operation, the highest temperatures are to be expected on the surface of the pump casing, at the shaft seal and in the bearing areas. The surface temperature at the pump casing corresponds to the temperature of the fluid handled.
If the pump is heated, it must be ensured that the temperature classes stipulated for the plant are observed.
In the bearing bracket area, the unit surfaces must be freely exposed to the atmosphere.

In any case, responsibility for compliance with the specified fluid temperature (operating temperature) lies with the plant operator. The maximum permissible fluid temperature depends on the temperature class to be complied with.

The table below lists the temperature classes to EN 13463-1 and the resulting theoretical temperature limits of the fluid handled. In stipulating these temperatures, any temperature rise in the shaft seal area has already been taken into account.

Temperature class to EN 13463-1:	Temperature limit of fluid handled
T5	85 °C
T4	120 °C
T3	185 °C
T2	280 °C

Safety note:

The permissible operating temperature of the pump in question is indicated on the data sheet. If the pump is to be operated at a higher temperature, the data sheet is missing or if the pump is part of a pool of pumps, the maximum permissible operating temperature must be enquired from the pump manufacturer.

Based on an ambient temperature of 40°C and proper maintenance and operation, compliance with temperature class T4 is warranted in the area of the rolling element bearings. A special design is required for compliance with temperature class T6 in the bearing area. In such cases, and if ambient temperature exceeds 40°C, contact the manufacturer.

Pump operating temperature for bearings should NOT exceed 225 degrees Fahrenheit (F).

Pumps of high temperature construction are provided with cooled bearings for a unit operating temperature range between 225 and 300 degrees F. Cooling water flows through cavities of the bearing frame and keeps temperature of the bearings within acceptable limits. Refer to Table 3 for cooling flow rates of water temperature of 60 degrees F for bearings. Refer to Figure 1 illustrating the water cooling (30 PSIG MAX.) system.

2.9.6 Maintenance

Only a pump unit which is properly serviced and maintained in perfect technical condition will give safe and reliable operation.

This also applies to the reliable function of the rolling element bearings whose actual lifetime largely depends on the operating mode and operating conditions. Regular checks of the lubricant and the running noises will prevent the risk of excessive temperatures as a result of bearings running hot or defective bearing seals.

The correct function of the shaft seal must be checked regularly.
Any auxiliary systems installed must be monitored, if necessary, to make sure they function correctly.

2.9.7 General Safety Instructions

1. Various federal, state, and local laws affect installation, use, and operation of pumping equipment. Compliance with such laws relating to proper installation and safe operation of pumping equipment is the responsibility of the equipment owner.
2. Prior to working on pump or driver, ensure all switches and circuit breakers have been locked in the open (off) position and tagged, “Out of Service.”
3. All circuits NOT known to be dead must be considered live at all times.

4. Do NOT wear loose or torn clothing around rotating machines.
5. While working near electricity, do NOT use metal rules, flashlights, metallic pencils, or any other objects having exposed conducting material.
6. Make sure you are NOT grounded while adjusting electrical equipment or using measuring equipment.
7. In general, use only one hand when servicing live electrical equipment.
8. Make sure to de-energize all electrical equipment before connecting or disconnecting meters or test leads.
9. For connecting a meter to terminals for measurement, use a range higher than the expected voltage.
10. Check to make sure that the frameof the driver and starter panel are securely grounded before operating pumping unit or performing any tests or measurements.
11. If a test meter must be held or adjusted while voltage is applied, ground case of meter before starting measurement. Do NOT touch live equipment while holding the meter. Some moving vane-type meters should not be grounded nor held during measurements.
12. Do NOT use test equipment known to be damaged or in poor condition.

The following specific safety precautions apply to the pumping unit:

1. Hydro suction case separately on RS-9 units.
2. Isolate pump for system hydro.
3. Do NOT exceed maximum suction pressure of 415 PSIG on suction case.
4. Do NOT exceed maximum rated discharge pressure on discharge case.

3 Transport and Interim Storage

3.1 Transport

Transport of the unit requires proper preparation and handling. Always make sure that the pump or the unit remains in horizontal position during transport and cannot slip out of the transport suspension arrangement. Do not use lifting slings on the free shaft end of the pump or on the motor eyebolt.

If the pump / unit slips out of the suspension arrangement, it may cause personal injury and damage to property.

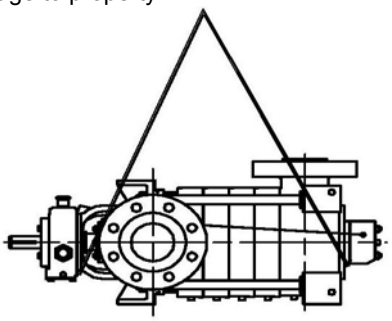


Fig. 3.1-1 Transport of the pump

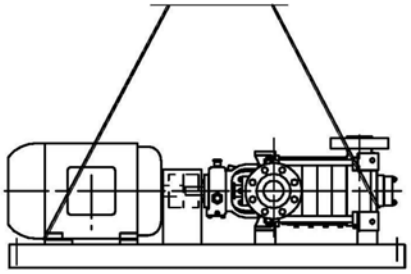


Fig. 3.1-2 Transport of the complete unit

3.2 Interim Storage (Indoors) / Preservation

When the unit is temporarily put into storage, only the wetted low alloy must be preserved. Commercially available preservatives can be used for this purpose. Please observe the manufacturer's instructions for application / removal.

The unit / pump should be stored in a dry room where the
atmospheric humidity is as constant as possible.
If stored outdoors, the unit and crates must be covered by
waterproof material to avoid any contact with humidity.
Protect all stored goods against humidity, dirt, vermin and unauthorized access!
All openings of the assembled unit components are closed and
must only be opened when required during installation.
All blank parts and surfaces of the pump are oiled or greased
(silicone-free oil and grease) to protect them against corrosion.

4. Equipment Description

RS high-pressure pumps are multi-stage, centrifugal pumps with radially split casings. The pump consists of a suction case, a discharge case, plus a number of intermediate (stage) casings, all secured with tie bolts. Diffusers are inserted in individual stage casings. O-rings seal the individual stage casings. Suction casing, stage casings and diffusers are provided with wear rings. Diffusers are provided with bushings. Due to prolonged operation, wear rings and bushings may become worn and/or damaged. Replace all worn and/or damaged parts with new. The bearing frame is attached to the suction case and discharge case by bolts.

The pump shaft is protected against wear by interstage sleeves, spacer sleeves, and shaft sleeves. Impellers are secured on the pump shaft by keys and located by sleeves and shims. All impellers face the same direction on the shaft.

RS high-pressure pumps incorporate special design refinements, which help to absorb the appreciable axial thrust generated by their high head operation. Residual axial thrust is absorbed by the thrust bearings.

5. Effects of Fluids

Solids in Fluid Pumped.
Solids in the fluid pumped may cause internal damage to pump casing and damage to the seal faces with resulting Hazardous conditions. Care is to be taken to ensure that the process fluid is clear of solids and debris.

Effects of Viscosity
The pump is designed to deliver rated capacity at rated head for a fluid with a particular viscosity. If the pump is handling heavy viscous fluid, the fluid may have to be heated prior to starting the pump in order to travel through the pump easier. If contemplating operating the pump at a high viscosity, check with Carver Pump Company.

Effects of Specific Gravity
The capacity and total head in feet of fluid developed by a centrifugal pump are fixed for every point on the curve and are always the same for the same speed. Neither capacity nor total head will be affected by a change in the specific gravity of the fluid pumped. However, since the discharge pressure in pounds per square inch (psi) and the brake horsepower required to drive the pump are functions of the specific gravity of the fluid, both will be affected in direct proportion to any change in specific gravity. Therefore, an increase in specific gravity will raise the discharge pressure and may overload the driver, or exceed the pump case allowable pressure.

6. Noise

The RS pump is incorporated into a high energy machine. Noise levels may exceed 85dBa at 1 meter during operation. Ear protection must be worn whenever working in high noise locations.

7. Mechanical Seal

Component or cartridge seals may be used. Complete cartridge seal instructions should be obtained from the manufacture.

8. Bearing Lubrication and Cooling
Refer to Figure 9, Cooling Options, for bearing lubrication and cooling options.

8.1. Grease Recommendations

Standard pump bearings are grease lubricated. Refer to Section V; paragraph 2, for grease-lubricated bearings.

Non-soap, polyurea thickened grease with a drop point of 450 degrees Fahrenheit is recommended for bearing grease. This grease is selected due to its suitability to extreme pressures and its high temperature stability. Never mix greases with differing properties. Polyurea base greases are NOT compatible with lithium or soda soap base greases. Therefore, the type of grease added should NOT vary. Refer to Table 1 for specific recommended grease types.

8.2 Oil Lube Recommendations

Pumps with oil lubrication are shipped with no oil in the bearing frame. Adequate lubrication with ISO Grade 68 oil is essential at all times. Refer to Table 1, Oil Recommendations, for specific oil types. Refer to Section V; paragraph 2 for oil-lubricated bearings.

Table 1. Grease Recommendations

Manufacturer	*Number*
Amoco	2EP
Aero Shell	22
Mobil	28

Table 2. Oil Recommendations

Manufacturer	*ISO Grade 68*
Royal Purple	Synfilm 68
Texaco	Regal R&O 68
Phillips	Magnus 68
Exxon	Teresstic 68
Mobil	DTE 16 M

Table 3. Bearing Cooling Flow Rates (30 PSIG MAX.)

Temperature Range	*Flow Rate*
-20 degrees to 180 degrees F	Grease Lube – Air
-20 degrees to 225 degrees F	Oil Lube – Air
225 degrees to 285 degrees F	Oil Lube - Water-1 Gallons Per Minute (GPM)
285 degrees to 300 degrees F	Oil Lube - Water-2 GPM

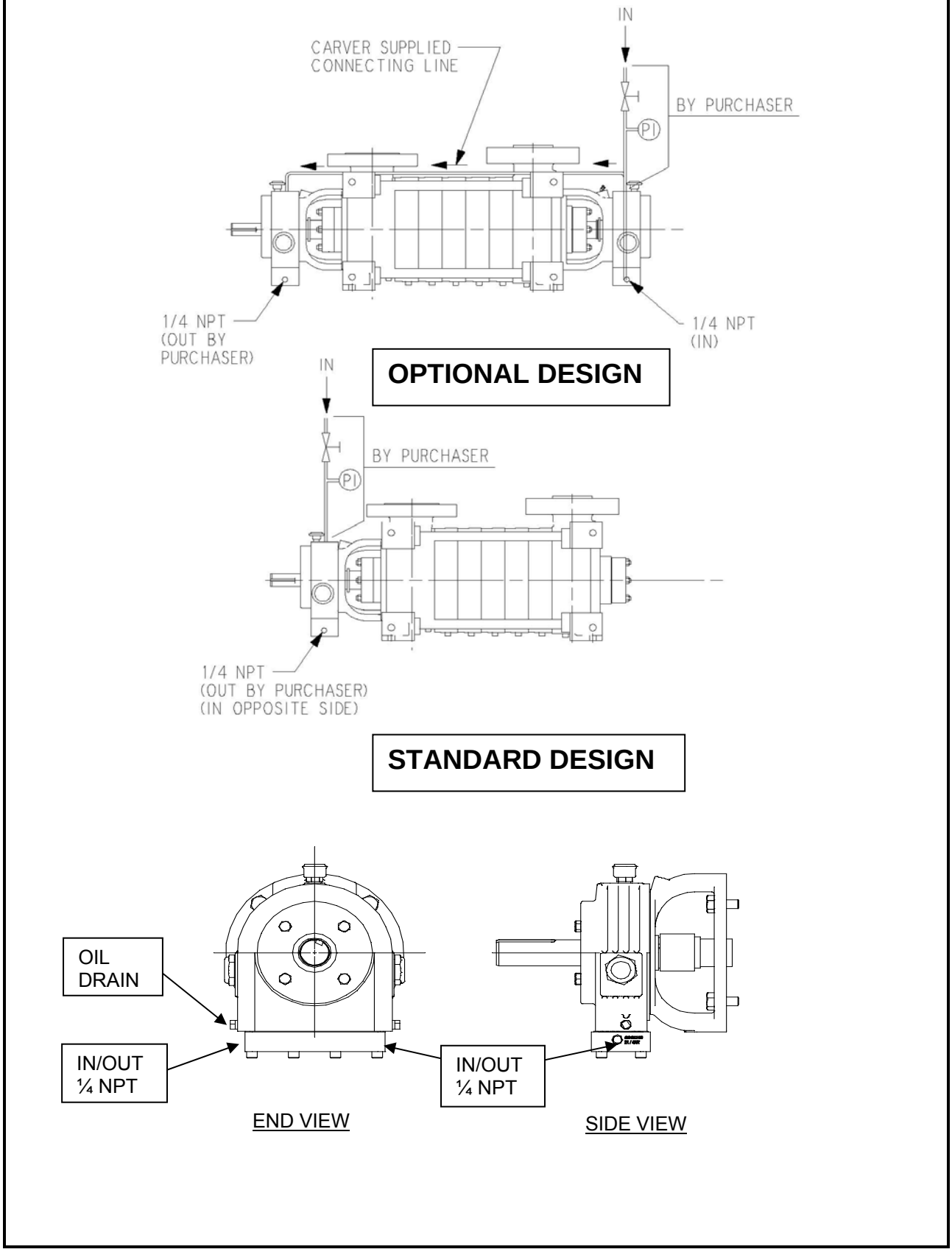


Figure 1. Water Cooling

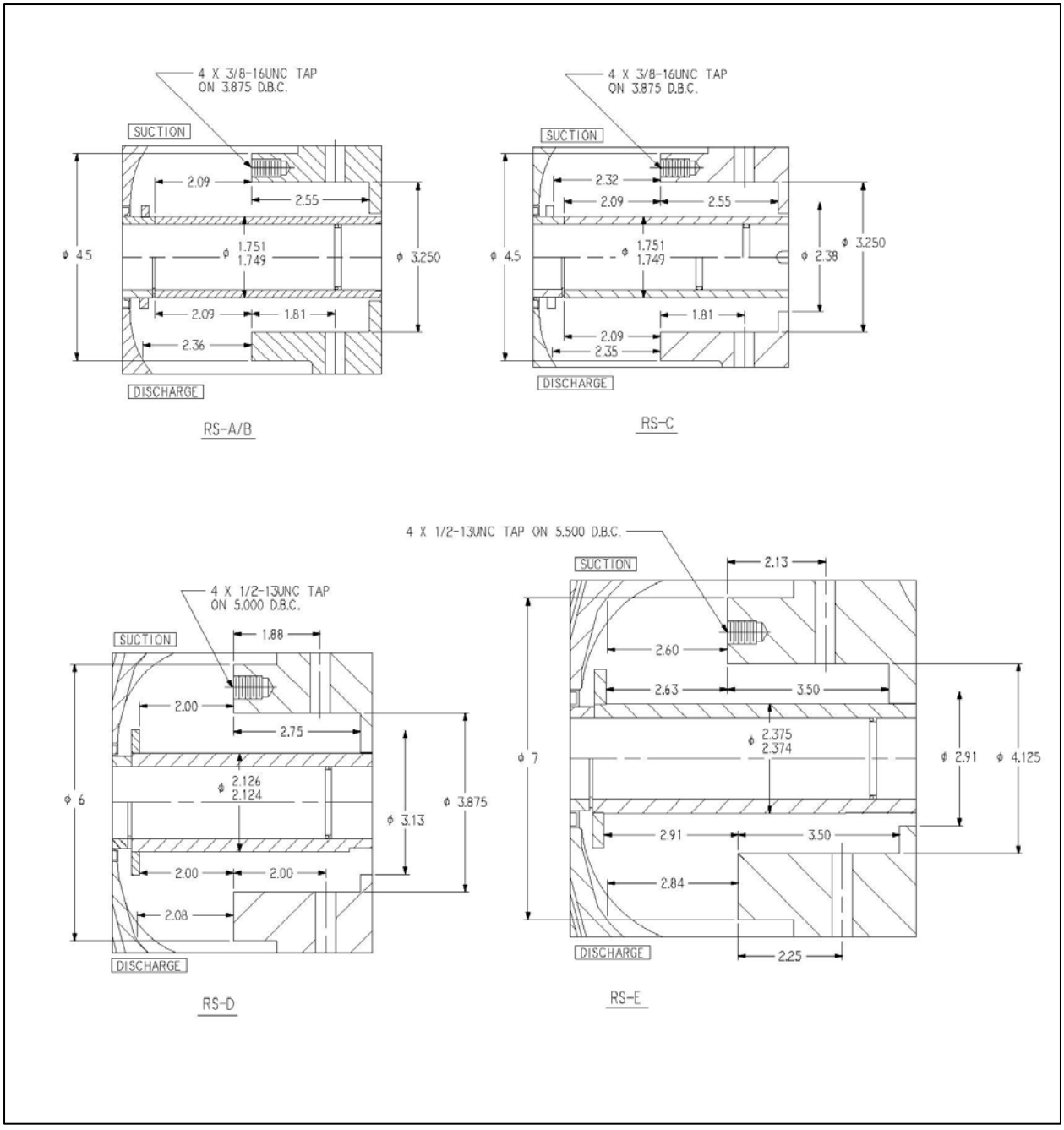


Figure 2. Stuffing Box

9. Technical Data

Specifications and operating limits should be recorded on the Service Record Page located in the front matter of this manual. Record the necessary information upon receipt of the pumping unit.

Table 4. Shaft Dimensions

Pump Model	*At Impeller*	*At Coupling*
RS A	1.437 inches	1.250 inches
RS B	1.437 inches	1.250 inches
RS C	1.437 inches	1.250 inches
RS D	1.574 inches	1.500 inches
RS E	1.771 inches	1.625 inches

Table 5. Sleeve Bearing Dimensions

Pump Model	*Sleeve Bearing*		*Sleeve*	
	New	Replace	New	Replace
RS A	1.755/1.756 inches	>1.758 inches	1.751/1.749 inches	>1.746 inches
RS B	1.755/1.756 inches	>1.758 inches	1.751/1.749 inches	>1.746 inches
RS C	1.755/1.756 inches	>1.758 inches	1.751/1.749 inches	>1.746 inches
RS D	1.969/1.970 inches	>1.972 inches	1.965/1.963 inches	>1.961 inches
RS E	2.380/2.381 inches	>2.383 inches	2.375/2.373 inches	>2.371 inches

Table 6. Standard Design Pump Mechanical Seal Settings *(from end of sleeve to face of collar)*

Pump Model	*Suction End*
RS A	3.100 inches
RS B	3.100 inches
RS C	3.100 inches
RS D	3.590 inches
RS E	4.500 inches

Table 7. Optional Design Pump Mechanical Seal Settings *(from face of box to face of collar)*

Pump Model	*Discharge End (Seal Type 8B1) (for reference only)*	*Suction End (Seal Type 1 or 21)*
RS A	1.375 inches	1.000 inch
RS B	1.375 inches	1.000 inch
RS C	1.375 inches	1.000 inch
RS D	1.750 inches	1.312 inch
RS E	1.812 inches	1.594 inch

10. Unpackaging

After receiving the pumping unit, inspect for missing hardware, flange covers or possible damage. In general, check to make sure the shipment complies with the purchase order. Inspect any parts containers that may be shipped with unit (i.e. coupling, seals, etc.). Immediately report any damage or shortage to the carrier's agent or factory. Claims that are made at a later time cannot be accepted.

10.1 Packaging

If the pumping unit is sent back to Carver Pump Company for repair, drain the unit, and re-seal all flanges and connections that were covered or plugged. Ship the pump(s) in an assembled condition to prevent damage to sealing faces of individual components. A Material Safety Data Sheet (MSDS) is required on all returned pumps. Copies of MSDS records should be kept and maintained by the customer. The customer is responsible for cleaning and flushing the pump before it is returned to the factory. Make sure to specify the fluid used in the service.

10.2. Inspection upon Arrival

NOTE

The pump and equipment, as shipped from Carver Pump Company, have adequate protection for short-term storage. If the equipment is NOT immediately installed and operated, store the equipment in a covered, clean, dry, well-ventilated location, free from vibrations, moisture, and rapid or wide variations in temperature.

10.3. Storage of Pump

If the equipment is NOT immediately installed and operated, Carver Pump Company recommends rotating each shaft several revolutions at least once every two weeks to prevent flat spots on ball bearings.

Consider a unit to be in storage when any of the following situations occur:

- The pump has been delivered to the job site and is waiting to be installed.
- The pump has been installed but operation is delayed pending completion of construction.
- There are long (30 days or more) periods between operating cycles.
- The plant (or department) is shut down for periods of longer than 30 days.

caution

A pump which is made of ductile iron that sits in extreme heat, high humidity, or full or partially full water over 30 days will rust and will most likely seize. If the pump rusts and/or seizes, a complete overhaul and repair may be necessary to refurbish the pump.

Storage requirements vary depending on the length of storage, the climatic environment, and the equipment. For storage periods of three months or longer, contact a representative from Carver Pump Company for specific instructions. Improper storage will damage the equipment and will require non-warranty restoration and/or non-warranty product failures. Refer to Section V, Maintenance and Repair, for pump disassembly and assembly procedures. When disassembling the pump, replace and repair rusted parts, as necessary.

10.4. Pump Protection during Prolonged Shutdown

NOTE

If the customer anticipates that the pump/equipment will be subject to an extended period of storage after installation, (for example, a unit used for seasonal operation), contact a representative from Carver Pump Company. If this is the case, Carver will provide specific instructions and special protection for the equipment during the extended period of storage. In general, if a pump is to be shut down for an extended period, the following steps are recommended:

1. Shut down the pumping unit in accordance with the Operating Procedures outlined in this manual.
2. Shut off system suction and discharge valves.
3. Drain the unit.
4. Fill unit with mineral oil or suitable non-corrosive protectant that is compatible with the system.
5. Provide pump and motor with a protective cover.

II. Installation

1. Foundation and Mounting

A hoist or suitable lifting device should be used to lift the pumping unit. Do NOT lift the complete unit by the driver, the pump shafts or the driver lifting eyes. See Section I.3

Hydraulic Institute (HI) recommends a foundation capable of absorbing vibration at least five times the weight of the pumping unit and to form a permanent, rigid support for the base plate. Consequently, maintaining the alignment is important for a flexible coupled unit. Refer to Figure 5 and Figure 6 illustrating alignment. A concrete foundation on a solid base is recommended. Use foundation bolts of the proper size embedded into the concrete. A pipe sleeve larger in diameter than the bolt should be used. This allows movement for final positioning of the bolts. Refer to Figure 3, Grouting and Foundation Bolting.

As soon as the pump and driver, mounted on a base plate, is placed on the foundation, remove the coupling guard and disconnect coupling halves. Reconnect the coupling after alignment operations have been completed. The base plate should be supported on either rectangular metal blocks with shims or on metal wedges having a small taper. The support pieces should be placed close to the foundation bolts. Refer to Figure 4, Unit Leveling. Place supports directly under the part of the base plate, which carries the greatest weight. Space the supports closely enough to provide uniform support of the base plate. Adjust the metal supports or wedges until the pump and driver shafts are level. Check coupling faces, as well as, suction and discharge flanges of the pump for horizontal or vertical positioning by means of a level. Make corrections, as necessary, by adjusting the supports or wedges under the base plate.

2. Grouting

After the pumping unit has been leveled and the alignment is correct, grout the unit to the foundation using a high-grade, non-shrinking grout. Proceed grouting using the following procedure:

1. Lightly tighten foundation bolts evenly but not fully. Refer to Figure 3, Grouting and Foundation Bolting.
2. Build a wooden dam around the base plate to retain the grout.
3. Pour grout through grouting holes provided in base plate. This should be done until the entire space under base plate is filled. While filling the holes, make sure there are no voids or air pockets.
4. Insert a stiff wire through the grouting holes to work the grout and release any voids or air pockets.
5. After grout has hardened (usually 48 hours), remove the dam and shims or wedges under the base plate, if desired. Fill remaining holes by the shims with grout.
6. Tighten foundation bolts loosely. Allow the grout to fully cure before firmly tightening the foundation bolts.

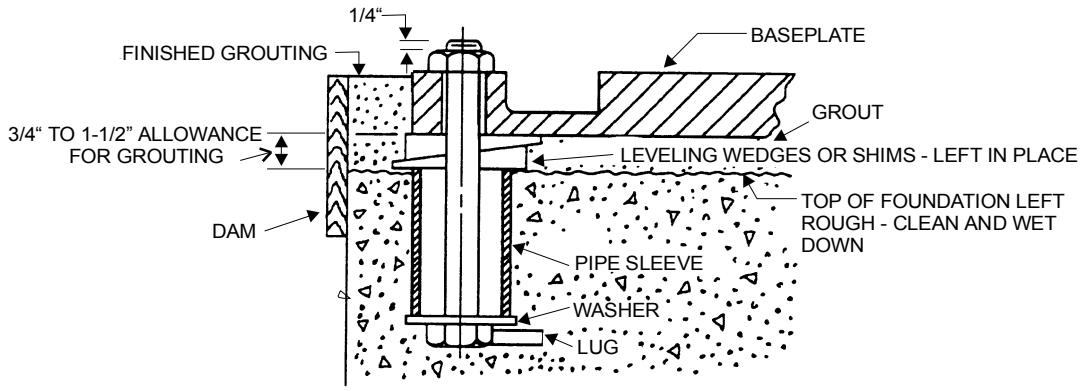


Figure 3. Grouting and Foundation Bolting

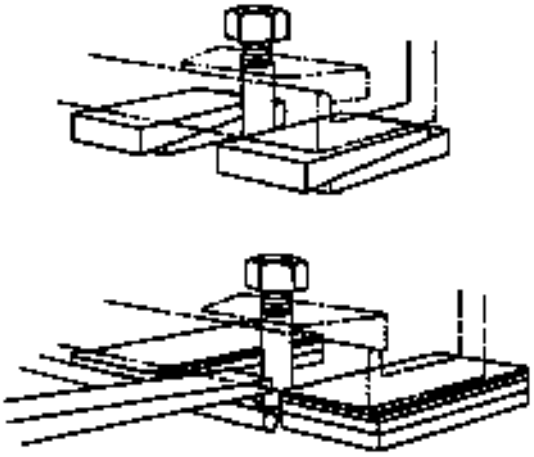


Figure 4. Unit Leveling

3. Handling

A hoist or suitable lifting device should be used to lift pumping unit. Do NOT lift the complete unit by the driver, the pump shafts or the driver lifting eyes. See section I-3

The complete pumping unit must be handled with care. Do NOT pass the lifting slings through the lifting eyes on driver.

4. Coupling

The coupling should NOT be reconnected until the alignment has been completed. Align coupling using a dial indicator to attain more accurate coupling alignment. Refer to Figure 5, Coupling Alignment.

Proceed as follows with parallel alignment:

NOTE

The corrections, which are made to the alignment in one direction, may affect the alignment in the other direction. Angular and parallel misalignment are corrected by means of shims. The shims are placed under the driver mounting feet to align the coupling. Refer to Figure 6, Adjusting Alignment.

1. Check the parallel misalignment by fastening the dial indicator to the pump half of the coupling.

2. Set the dial on the indicator to zero and rotate both hubs 360 degrees. With the dial indicator needle against the face of the other hub, take indicator readings at four points, 90 degrees apart.

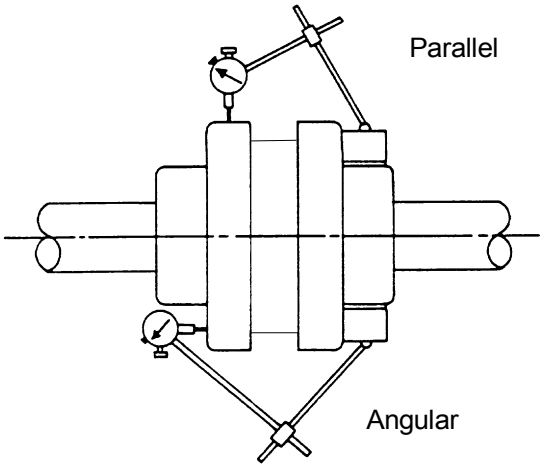


Figure 5. Coupling Alignment

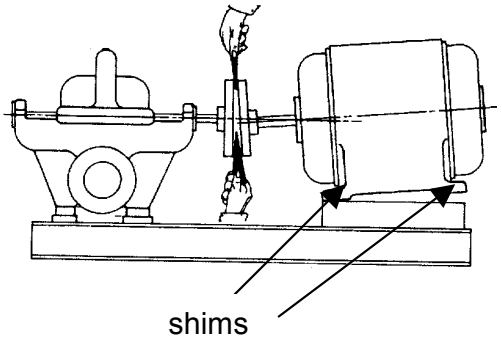


Figure 6. Adjusting Alignment

3. Shim all mounting feet on the driver until all four readings are identical (0.005) maximum Total Indicator Runout (TIR).

Proceed as follows with angular alignment:

1. Check the angular misalignment by fastening dial indicator to one coupling hub.
2. Set the dial on the indicator to zero and rotate both hubs 360 degrees. With the dial indicator needle in contact with the surface of the outside diameter of the opposite coupling hub, take indicator readings at four points, 90 degrees apart.
3. Adjust driver until all four readings are identical (0.008 maximum TIR).
4. Reconnect coupling halves.
5. Reinstall coupling guard.

5. Piping

The pump is shipped with flange covers to protect flange faces and to prevent foreign matter from entering pump. Flange covers should remain intact until suction and discharge piping are connected to pump flanges.

All piping should be supported so that no undue piping strain or weight is placed upon the pump. Do NOT force piping. Never use pump as an anchorage point for the piping.

caution

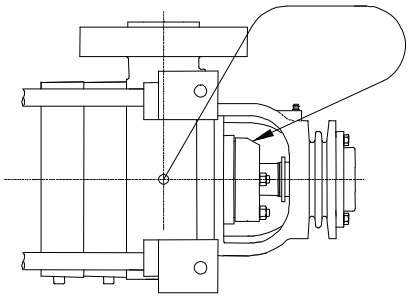
Extreme care should be taken when connecting new piping to make sure that no foreign matter such as dirt, slag, chips, tools, etc., are in the piping. Otherwise, the debris will be drawn into the pump and will cause excessive damage. During initial installation and testing, a strainer should be installed in suction piping to keep debris from entering pump.

Suction lift lines should be laid with a rising slope toward the pump and positive suction-head lines should be laid with a downward slope. This is done to avoid air pocket formation. Suction piping must be at least the same size as pump suction nozzle. Compensation for heat elongation must be provided where required.

If necessary, the coupling should be realigned after installing piping. Realign, if necessary, by adjusting the driver end. Refer to Figure 6.

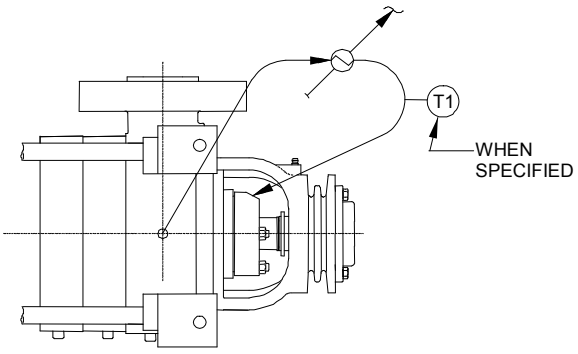
6. Auxiliary Connections

Connect auxiliary connections. For an illustration of bearing cooling, refer to Figure 1, Water Cooling. Figure 7, Fluid Line Schematic, illustrates the heat exchanger and cooling water for the seal.



RECIRCULATION FROM PUMP CASE TO SEAL

PLAN 11



RECIRCULATION FROM PUMP CASE THROUGH HEAT EXCHANGER TO SEAL

PLAN 21

Figure 7. Fluid Line Schematic

III. Operation

1. Method of Operation

Pumped fluid enters suction case and passes into first stage impeller, which propels fluid into first stage diffuser. The fluid then flows into the next impeller. This process is repeated from one stage to the next. Through each stage, fluid pressure increases (this is termed "stage head"). After leaving final stage diffuser, fluid enters discharge case and passes into discharge piping.

2. Pre-Start Cautions

Before starting the pumping unit, make the following checks:

Before activating the pumping unit, check to make sure there are no personnel working on the unit. Serious injury or death to personnel could result if unit is activated while being worked on.

1. Rotate both shafts by hand to assure all moving parts are free.
2. Check motor for correct rotation before connecting the coupling.
3. If necessary, recheck coupling alignment.
4. Install closed guards around all exposed rotating parts.
5. Check to make sure that fluid in the pump is clean, clear, and free of debris. Never run pump dry because the close running fits that are within the pump are lubricated by the fluid being pumped. Dry running may result in pump seizure or mechanical seal failure.
6. Standard grease lubricated pumps are shipped with factory lubrication packed bearings. Lubrication is adequate for a minimum of 1,000 operating hours or six months of continuous operation under normal conditions. After extended storage or exposure to unusually humid or hot environmental conditions, the bearings and their lubricant should be checked before operating the pumping unit.
7. If necessary, turn on cooling lines to check for sufficient flow. Refer to Table 8 for minimum cooling flow rates.

3. Start-Up

Before starting the pumping unit, refer to the safety precautions in Section I. Refer to Table 8 for minimum flow rates.

Do NOT operate pumping unit against a closed discharge system. If pump has any chance of operation against a closed system, a bypass system allowing a minimum design flow should be installed. This bypass will be satisfactory for short periods of operation. For extended periods of operation the bypass should be sized for the minimum continuous flow required by the pump. Refer to Table 8, Minimum and Minimum Continuous Flow Rates.

Proceed as follows to start the pumping unit:

1. Completely open system valve in suction line to pump and fill with fluid.
2. Open system valve in discharge line to pump to allow a minimum design flow.
3. Open valves to pressure gauges in the system.
4. Start electrical power supply to driver.
5. Slowly open system valve in discharge line until pumping unit reaches specified pumping conditions. (Refer to the pump nameplate for design point condition.)

4. Turbine Applications

For turbine applications, consult your local distributor or a representative from Carver Pump Company.

Table 8. Minimum Flow Rates RS-6 & RS-9

Pump Model	*Speed*	*Minimum Flow*	*Min. Continuous Flow*
RS A	1450 RPM	15 GPM	30 GPM
	1750 RPM	20 GPM	20 GPM
	2900 RPM	25 GPM	40 GPM
	3500 RPM	35 GPM	50 GPM
RS B	1450 RPM	15 GPM	40 GPM
	1750 RPM	20 GPM	50 GPM
	2900 RPM	25 GPM	80 GPM
	3500 RPM	35 GPM	100 GPM
RS C	1450 RPM	30 GPM	75 GPM
	1750 RPM	40 GPM	90 GPM
	2900 RPM	50 GPM	150 GPM
	3500 RPM	100 GPM	180 GPM
RS D	1450 RPM	30 GPM	125 GPM
	1750 RPM	50 GPM	150 GPM
	2900 RPM	120 GPM	250 GPM
	3500 RPM	200 GPM	300 GPM
RS E	1450 RPM	30 GPM	200 GPM
	1750 RPM	50 GPM	250 GPM
	2900 RPM	150 GPM	400 GPM
	3500 RPM	200 GPM	500 GPM

5. Minimum/Maximum Flow Calculation for Fluids other than water.

Unless specified otherwise in the characteristic curves or on the data sheets, the following applies:

Q_{min} = 0.1 x Q_{opt} for short operation
Q_{min} = 0.3 x Q_{opt} for continuous operation
Q_{max} = 1.1 x Q_{opt} for 2-pole operation
Q_{max} = 1.25 x Q_{opt} for 4-pole operation
Q_{opt} = optimum efficiency

The data refer to water and water-like liquids. However, if the physical properties of the fluids handled are different from water, the calculation formula below must be used to check if an additional heat build-up may lead to a dangerous temperature increase at the pump surface. If necessary, the minimum flow must be increased.

$T_o = T_f + \Delta\nabla$

$$\Delta\nabla = \frac{g * H}{c * \eta} * (1 - \eta)$$

c Specific heat [J / kg K]
g Acceleration due to gravity [m/s_]
H Pump head [m]
T_f Temperature of fluid handled [°C]
T_o Temperature of casing surface [°C]
η Pump efficiency at duty point [-]
$\Delta\nabla$ Temperature difference [°C]

IV. Troubleshooting

If the installation and starting procedures outlined in this manual have been followed, the pump should provide reliable service and long life. However, if operating problems occur, use Table 9, Pumping Unit Troubleshooting, to eliminate the most common causes of those problems, or contact a representative from Carver Pump Company.

Table 9. Pumping Unit Troubleshooting

Symptom	Immediate Action	Probably Cause	Corrective Action
Pump does not deliver rated capacity	1. Stop driver.	1. Excessive system pressure.	1. Check GPM and head against design conditions; pump impeller may be too small. Consult local distributor or Carver Pump Company.
		2. Incomplete priming or venting of pump or piping	1. Prime pump and piping again and carefully vent.
		3. Suction line or strainer clogged.	1. Clean out suction line or strainer.
		4. Positive suction head is too low.	1. Reduce the distance from centerline of pump to source of liquid being pumped.
		5. Valves are not fully open.	1. Open valves and if necessary, lock valves open to prevent accidental closure.
		6. Clogged impeller.	1. Dismantle pump and clean impeller, if necessary.
		7. Reverse rotation.	1. Correct rotation is clockwise when viewed from driver end.
		8. Improperly installed impeller.	1. Disassembly pump and correctly axial align impeller.
		9. Excessive wear of internal parts.	1. Disassemble pump and replace worn parts.
Leakage at case joints.	1. Stop driver.	1. Tie Bolts not sufficiently tightened.	1. Release the pressure and tighten tie bolts evenly.
		2. O-rings damaged.	1. Replace o-rings.
Bearings run hot.	1. Stop driver.	1. Pump and driver shafts are misaligned.	1. Check coupling alignment.
			2. Check pipe strain.
		2. Piping causes pump to "warp".	1. Ensure piping transmits no stress to pump. Alter piping layout, if necessary. Realign pump and driver shafts.

Table 9. Pumping Unit Troubleshooting (CONT.)

Symptom	*Immediate Action*	*Probably Cause*	*Corrective Action*
		3. Unsuitable grease.	1. Check for incorrect grease.
		4. Over greased or oiled bearings.	1. Remove excess grease or oil.
		5. Insufficient grease (or oil) to bearings.	1. Add grease (or oil), as necessary.
		6. Insufficient cooling of bearing frame.	1. Check cooling flow rate to bearing frame.
		7. Worn bearings.	1. Replace bearings.
		8. Worn/damaged wear rings or bushings	1. Replace wear ring or bushings
Pump discharge pressure excessive.	1. Stop driver.	1. Excessive speed.	1. Check speed precisely. Decrease speed, if possible.
		2. Wrong impeller trim.	1. Trim outlet tips of impeller vanes. Consult Carver Pump Company specifying exact operating conditions.
		3. Pump is pumping fluid with specific gravity in excess of that specified. (If temperature of fluid is lower, then specified specific gravity will be higher.)	1. If prescribed fluid temperature or specific gravity can not be attained, one or more of the following measures can be taken: a. Partially close discharge valve, reducing pump capacity to a point where driver is not overloaded. b. Remove one or more impellers and their diffusers and install special blind stage parts. c. Trim one or more impellers. d. Install more powerful driver. Consult Carver Pump Company specifying exact operating conditions.

Table 9. Pumping Unit Troubleshooting (CONT.)

Symptom	*Immediate Action*	*Probably Cause*	*Corrective Action*
Driver overloaded.	1. Stop driver.	1. Pump discharge pressure is lower than design point (check pump nameplate)	1. Partially close discharge valve until pressure at discharge flange is as specified. Decrease speed or trim impellers if driver remains overloaded (consult Carver Pump Company before taking this step).
		2. Same as 3 under "Pump Discharge Pressure Excessive."	1. Same as 3 under pump discharge pressure excessive.
		3. Wrong impeller trim.	1. Trim outlet tips of impeller vanes. Consult Carver Pump Company specifying exact operating conditions.

V. Maintenance and Repair

1. Scheduled Maintenance

The pump should always run quietly and smoothly, without vibration. To ensure such operation, the following maintenance schedule should be applied at regular intervals during operation of the pump. A pump service record and an inspection and repair record are provided for this purpose in the front matter of this manual.

Regular inspection and service are essential for safe operation of the pump in ATEX applications.

Daily Inspection:
- Visually inspect unit.
- Check bearing temperatures.
- Refer to Table 3, to check bearing cooling flow rates, if applicable.
- Check for leakage at mechanical seals.
- Check that oil level is at center of bullseye, if applicable.

Weekly Inspection:
- Check power (amps) readings.
- Check pump discharge pressure. Prescribed operating discharge pressure should never drop below 90 percent of design point pressure.
- Check vibration on pump and driver bearings. Vibration should NOT exceed 1.8 overall displacement (unfiltered) peak to peak mils (0.001") at 3600 RPM and 3.5 overall displacement (unfiltered) peak to peak mils (0.001") at 1750 RPM.

Monthly Inspection:
- Check coupling alignment.
- If necessary, grease coupling. Do NOT over grease.
- Check foundation bolts.

Semi-annual Inspection:
- Grease bearings or change oil. Do NOT over grease or add excess oil.
- Check coupling alignment due to settling of foundation.
- If stand-by pumps are installed, it is advisable to operate pumps on a rotation system to give each pump a certain duty. This ensures that stand-by pumps will always be in good condition for instant start-up.

20000 Hours
- Replace roller bearings.
- Inspect casings for corrosion, erosion or other damage. 3mm limit of metal loss in casings (items 1, 9 and 111).

2. Bearings

The thrust bearings are installed back-to-back. The standard package has a matched set of bearings located on the suction end. The optional package has a matched set of bearings located on the discharge end with a single bearing on the suction. Always replace the roller bearings when disassembling unit for seal service.

Grease Lubricated

The pump has grease-lubricated bearings, which are packed at the factory for six months or 1,000 hours continuous operation under normal conditions without re-lubrication. Carver Pump Company lubricates bearings with Rykon premium grease; a non-soap polyurea thickened grease with a drop point of 450 degrees F. This grease was selected due to the suitability to extreme pressures and high temperature stability. Never mix greases with differing properties. Polyurea base greases are NOT compatible with lithium or sodium soap base greases. Therefore, the type of grease added should NOT vary. If it is necessary to change grease type, the following items should be removed, cleaned and flushed with a suitable solvent: bearings, bearing frame, and bearing caps. Refer to Section I, paragraph K, Grease Recommendations. If changing grease type, use the following procedure:

1. Place bearings, bearing frame end of bearing frame, and bearing caps in a wire or mesh basket and suspend basket in a light mineral solvent and allow to soak, preferably overnight.
2. After soaking and cleaning, bearings, bearing frame end of bearing frame, and bearing caps, rinse in a clean, light mineral solvent and agitate vigorously to remove all loosened hard grease and dirt.
3. Dip bearings in clean, light oil and spin by hand, ensuring that all foreign matter has been removed. Failure to remove all foreign matter could cause poor bearing performance later.
4. After cleaning, repack bearings on both sides with recommended grease. The bearings themselves should be packed to nearly 100% full. Do NOT fill the entire bearing cap so that excess grease will have room to move on start-up. Excess grease will be purged through the vent hole in the bearing cap.

If bearing temperatures increase by 10 to 15 degrees F during a period of one week and there is not a variance in ambient or liquid temperature, add grease to bearings through grease fittings on top of bearing frame with a hand-operated grease gun. Over greasing will cause bearings to overheat.

Pump should run a minimum of one hour to permit expulsion of excess grease through overflow opening in bearing cap.

 After greasing, bearing temperatures may exceed 200 degrees F at 80 degrees ambient due to excess grease in bearing frame. After the run-in period, bearing temperatures should stabilize and NOT exceed 185 degrees F at 80 degrees ambient. If bearing temperatures remain high, the pump should be shut down and the cause determined. Refer to Table 9, Pumping Unit Troubleshooting, for common causes of high bearing temperatures.

Before the pumping unit is started after prolonged shutdown, grease level must be checked. Add grease, as necessary. Check temperature of bearings and listen for quiet running at regular intervals.

Oil Lubricated

NOTE

Pumps are shipped without oil and should be filled with oil before starting. Failure to operate without oil could result in damaged pump or parts.

To drain old oil from bearing frames, remove pipe plug (425) at the bottom of the outboard oil cap (37) on units with outboard mechanical seal and plug (425) from the side of the inboard oil cap (35). Add oil to bearing frame (99) through breather vent (405) until oil is at the center of the bullseye sight (143). Use bullseye sight(s) (143) to check oil level in bearing frame(s) (99). Refer to Section I, paragraph L, Oil Lube Recommendations. Carver recommends changing the oil every 1,000 service hours under normal conditions.

3. Torque Values

Refer to Table 10, Recommended Torque Values. Clean and properly lubricate threads and bearing face of the fastener to obtain the proper fastener loading from these torque values. Fasteners should be torqued evenly and in stages. Refer to your torque wrench manual for the proper use of your wrench.

Refer to the pump nameplate to determine your pump model for tie rod torques.

The first Shaft Jam Nut is to have 15 ft-lbs torque while holding the coupling end of the shaft. The second Shaft Jam Nut is to be tightened to 30 ft-lbs while holding on the first nut.

Table 10. Recommended Torque Values

Fastener Size	*Torque (foot pounds)*
1/4-20 UNC	5
5/16-18 UNC	10
3/8-16 UNC	15
1/2-13 UNC	30
SHAFT JAM NUTS	15/30 (see Section V Paragraph C.)
RS6-A,B,C,D TIE ROD	160
RS9-A,B,C,D TIE ROD	315
RS9-E TIE ROD	446

4. Disassembly and Assembly Preparations

NOTE

Refer to Section V, paragraph 2 for oil lubrication and water cooling disassembly and assembly procedures.

During disassembly, match mark parts so they can be replaced in their original position. All parts should be thoroughly cleaned or replaced with new, if necessary. Sealing faces should be perfectly clean. Carver Pump Company recommends that all o-rings and shims are only used once.

NOTE

To avoid damage to o-rings, check to make sure all parts are free of sharp edges or burrs.

Close suction and/or discharge valves. The pump cases should be cooled down to ambient temperature. Cases must be empty and not under pressure.
After prolonged operation, components may not be easily removed from shaft

In such instances, rust solvent may be used and suitable extracting tools applied wherever possible. Do NOT use force under any circumstances. Refer to Table 11, Recommended Tools, for proper tooling during disassembly and assembly. Refer to appropriate sectional drawing, for location of parts followed by an item number. Assemble the pump in accordance with accepted rules of engineering practice. Coat individual components with a suitable lubricant before assembling. Assembly of unit should be performed on a flat surface.

While assembling the pumping unit, Carver Pump Company recommends that the following parts be replaced with new:

- O-rings
- Shims
- Bearings
- Grease seals
- Mechanical seals

If new impellers or new shaft protecting sleeves are fitted, impellers must be axially aligned with respect to diffusers. Refer to paragraph F of this section for procedures regarding axial impeller alignment.

Table 11. Recommended Tools

Tools	*Materials*	*Testing Equipment*
Spanner wrench Rawhide or wood mallet Wooden wedge Allen wrench set Socket, open, & box wrench set Vice grips “C” clamp	Grease (Rykon) or oil	Coupling alignment gauges

Prepare the pumping unit for disassembly using the following list:

1. Read this entire section and review the applicable sectional assembly drawing and parts list before disassembling the pump. For cooling options, refer to Figure 9.

Before attempting to disassemble the pump, the electrical power supply from the driver must be locked and tagged in the "OFF" position to prevent injury or death to personnel servicing the pump.

2. Stop the pumping unit.
3. Disconnect suction, discharge, and gauge lines. Disconnect auxiliary connections, as applicable.
4. Remove coupling guard. Uncouple the pump from the driver.

caution

Use of a hoist with adequate capacity is recommended for removing the pump from the base.

5. Remove the bolts that hold the pump to the base. Remove the pump from the base and take to a suitable work area.

5. Parts Cleaning and Inspection

NOTE

Mark or number each component while dismantling according to sequence. IMPORTANT: Check for shims between impellers and spacer sleeves, and mark the sequence accordingly. The individual components should be unscrewed or removed.

During disassembly of the pump, individual parts should be cleaned and inspected as follows:

1. Discard used oil seals and o-rings. Thoroughly wash and clean all parts with a suitable solvent.
2. Check shaft for runout, scratches, grooves, or any possible damage. Touch up scratches and grooves with a polishing cloth and inspect for remaining grooves or deep scratches. A bent or excessively damaged shaft should be replaced.
3. Inspect mechanical seals. Repair or replace mechanical seals that are extremely dirty or damaged.
4. Check all shaft sleeves and spacer sleeves visually for score marks, scratches, pits, grooves or burrs. Touch up sleeves with polishing cloth and inspect for remaining grooves or deep scratches. Remove burrs with a file. Shaft sleeves and spacer sleeves should be replaced if any marks, pits or grooves are still visible after touching up.
5. Inspect impellers for pitting, erosion, or clogged vanes. Replace impellers that are damaged. If new impellers are installed, check to make sure all impellers are balanced and axially aligned with respect to the diffusers. Refer to paragraph F of this section for axial alignment procedures.
6. This pump is equipped with Rulon wear rings and bushings for greater life and higher efficiency. These are available as "to-size" spare parts and not as "under-size" parts. Inspect wear ring clearance for each stage as follows:
   a. Measure outside diameters of impeller hubs in three places.
   b. Measure the inside diameters of corresponding wear rings in three places.
   c. Corresponding differences between high readings of inside diameters of wear rings and low readings of outside diameters of impellers. Refer to Table 13 and Table 14 for specified clearance of wear rings.
   d. If wear ring replacement is required, replace wear rings as described in paragraph G of this section.

6. Axial Impeller Alignment

If new parts are fitted during assembly, such as impellers and/or sleeves, the impellers must be axially aligned with respect to the diffuser. Refer to Figure 8 and Table 12.

Standard Sleeve Bearing

Measure distance from the outboard face of the suction or interstage case to the back shroud of the impeller. Compare the measured distance to the dimensions given in Table 12, Axial Impeller Alignment Control Dimensions. If shimming is necessary, install shims between the impeller and the shaft sleeve, as shown in Figure 8. Repeat measuring and shimming until the correct control dimension is achieved.

Optional Mechanical Seal

Measure distance from the inboard face of the interstage case to the inboard face of the impeller hub. Compare the measured distance to the dimensions given in Table 12, Axial Impeller Alignment Control Dimensions. If shimming is necessary, install shims between the impeller and the shaft sleeve, as shown in Figure 8. Repeat measuring and shimming until the correct control dimension is achieved.

Table 12. Axial Impeller Alignment Control Dimensions

Pump Model	*Distance "A" ± 0.020 inch*	*Distance "B" ± .0.020 inch*
	Standard Sleeve Bearing	
RS A	0.772	0.772
RS B	0.770	0.766
RS C	0.905	0.904
RS D	1.088	1.147
RS E	1.512	1.470
	Optional Mechanical Seals	
RS A	- 0.110	-0.110
RS B	+ 0.210	-0.110
RS C	+0.538	-0.125
RS D	+0.792	+0.137
RS E	+0.250	+0.185

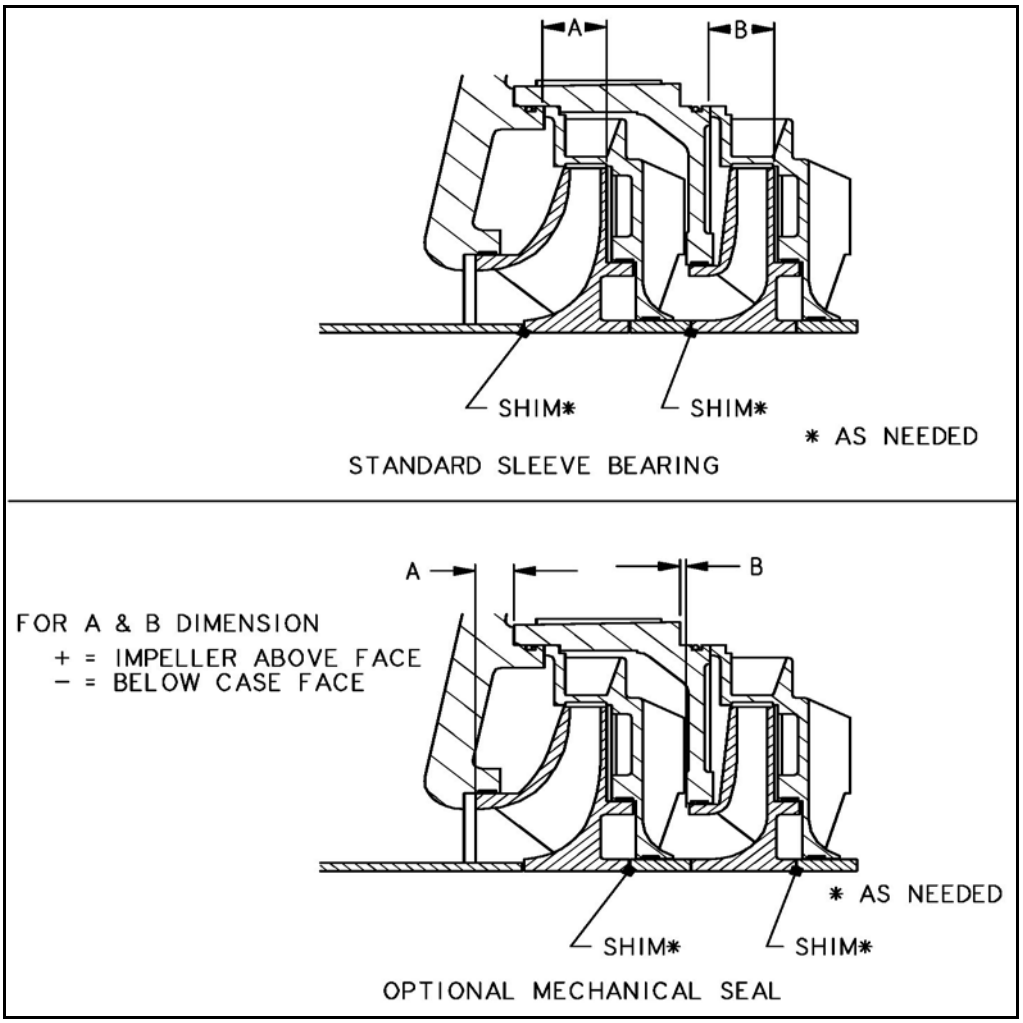


Figure 8. Axial Impeller Alignment

7. Wear Ring Replacement

To replace wear rings and bushings, proceed as follows:

1. Remove old wear ring or bushing from suction case, interstage case and/or diffuser. This can best be accomplished by peeling out the old ring.
2. Insert the new wear ring in suction case, interstage case and/or diffuser. Be sure that there are no deposits or debris in the locating groove before inserting the part.

Table 13. Maximum Wear Ring Clearances

Pump Model	*Maximum Diametrical Clearance*
RS A	0.022 inch (casing & diffuser)
RS B	0.022 inch (casing & diffuser)
RS C	0.022 inch (casing & diffuser)
RS D	0.022 inch (casing & diffuser)
RS E	0.022 inch (casing & diffuser)

Table 14. New Wear Ring Clearance Limits

Pump Model	*Casing Diametrical Clearance Limit*	*Diffuser Diametrical Clearance Limit*
RS A	0.009 to 0.011 inches	0.009 to 0.011 inches
RS B	0.009 to 0.011 inches	0.009 to 0.011 inches
RS C	0.009 to 0.011 inches	0.009 to 0.011 inches
RS D	0.009 to 0.011 inches	0.009 to 0.011 inches
RS E	0.009 to 0.011 inches	0.009 to 0.011 inches

8. Oil Lubrication and Water Cooling Service (Refer to Figure 9.)

NOTE

Mark or number each component during disassembly and assembly according to sequence.

NOTE

Do not remove oil cooler (215A) from cap (35)

DISASSEMBLY

1. Remove plugs (425) from bearing cap (37) on the outboard ends, if applicable. This allows cooling cover to drain.
2. Remove plug (425) from bottom of oil caps (35) and drain oil from inboard end.
3. To remove cooling connecting line, disconnect male connector retaining nuts from tube connector body (412). Remove tube (409). Retaining nuts will remain with tube if applicable (Not Shown).
4. Remove bearing caps (35 or 37) by removing bolts (601). Remove o-ring (89F) from bearing frame (99).

ASSEMBLY

1. Install new o-rings (89F) on bearing frame (99). Install new oil seal (168) on oil cap (35).
2. Install bearing caps (35) and (37) and secure to bearing frame (99) with bolts (601).
3. Install tube (409). Secure tube by tightening retaining nuts on tube connector (412). (Not Shown)
4. Install plug (425) in bottom of oil cap (37).
5. Install plugs (425) in bearing caps (35). Fill through breather vent (405) to center of bullseye with oil according to Table 2.
6. If removed, apply liquid gasket to mating surfaces of gasket (73) and install oil pan (215) and oil cooler (215A) with bolt (605).

9. Cartridge Seal Replacement (Refer to sectional assembly Figure 10 or Figure 11+ vendor seal drawings.)

DISASSEMBLY

NOTE

1. Refer to Section I, paragraph , Safety Precautions, before disassembling pump.

2. For seal/seal design pumps; Do not remove both bearing frames at the same time. Complete replacement of one seal before proceeding to the second seal. Care is to be taken to avoid axial movement of the shaft during seal replacement. Installing the seal locating tabs before starting installation will help prevent movement.

1. Remove coupling half from pump shaft (6). Remove coupling key (46).
2. Install seal locating tabs in seal(s).
3. Drain pump by removing the following plugs: plug (424) from the bottom of each interstage case (111), plug (421) from suction case (9) and plug (422) from discharge case (1).
4. Clamp down suction case foot to steady pump during disassembly.
5. Disconnect male connector retaining nuts from male connector (410), (411), and (413) bodies, as applicable.
6. Remove tubing (400) or (408), as applicable. Retaining nuts will remain with tubing.
7. Remove bolts (601) and remove bearing cap (35).
8. Un-crimp locking tab of bearing lockwasher (69). Remove bearing locknut (22) and bearing lockwasher (69). Remove male connector (410) body from seal gland (17A).
9. Remove bolts (600). Remove bearing frame (99). Radial bearing (16) and oil seal (169) will come off with bearing frame (99).
10. Inspect bearing (16 and/or 18) and oil seal (169) for wear, corrosion or contamination. Carver recommends replacing bearings (16 & 18) and oil seals (168 & 169) after they have been removed from shaft (6). Refer to paragraph B of this section for bearing maintenance.
11. Remove slinger (40).
12. Loosen setscrews retaining seal sleeve to the pump sleeve.
13. Remove nuts (615) from studs (630) on seal gland (17A) and remove gland.

ASSEMBLY

Refer to the applicable sectional drawing for location of parts followed by an item number. Carver recommends all nuts and bolts be torqued according to Table 10, Recommended Torque Values.

NOTE

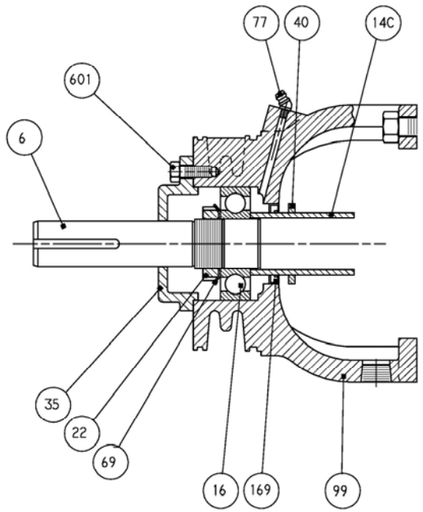
Carefully deburr and polish the shaft sleeve where center-drilled to prevent damage to the seal o-ring during installation.

1. Before starting the installation, read the following instructions carefully.
2. Remove the seal from its packaging, inspect for any damage, and wipe clean.
3. Lubricate sleeve O-ring with appropriate lubricant. Lubricate shaft sleeve sparingly. Lubricate gland plate bolts/nuts as required.

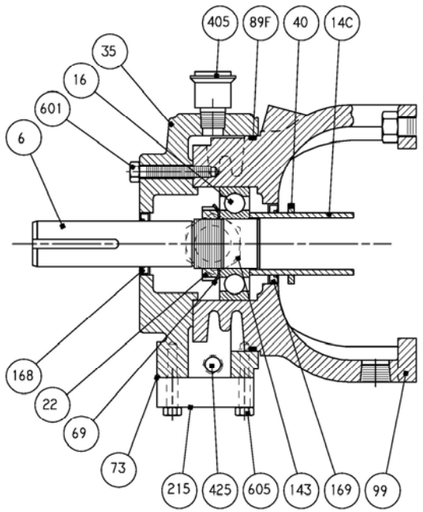
Make sure that gland plate gasket or o-ring is properly positioned, and that collar set screws do not extend past sleeve ID. Slide complete cartridge seal assembly onto shaft sleeve. Slide cartridge onto studs until gasket or o-ring is flush against the face of seal chamber. Hand tighten gland plate bolts/nuts.

NOTE: Always use a lubricant that is compatible with your machinery and product. Use lubricant sparingly, only enough to install seal with ease.

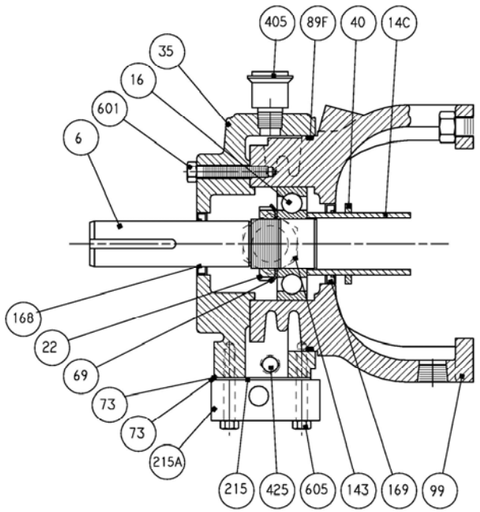
4. Reassemble pump in reverse order as disassembly above.
5. Continue tightening gland plate bolts/nuts in an alternating pattern until secure (1/4 turns, 180˚ apart), with gland plate and face of pump seal chamber metal-to-metal. Do not over-stress or distort gland plate.
6. Remove seal locking setscrews and counter-drill to prevent seal slippage during operation.
7. Tighten collar set screws evenly (1/4 turns, 180˚ apart), securing cartridge seal to shaft.
8. Remove spacers and save. Make appropriate piping connections to the sea l assembly.



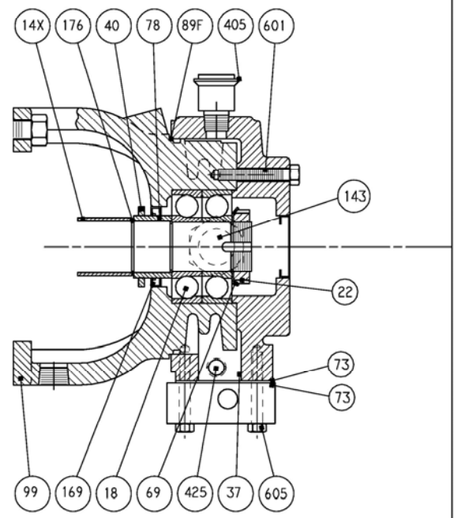
GREASE LUBE – AIR COOLED



OIL LUBE – AIR COOLED

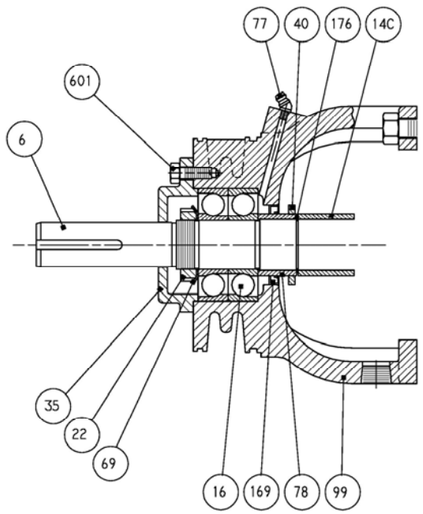


OIL LUBE – WATER COOLED



OIL LUBE OUTBOARD DETAIL

PUMP W/ OPTIONAL MECHANICAL SEAL



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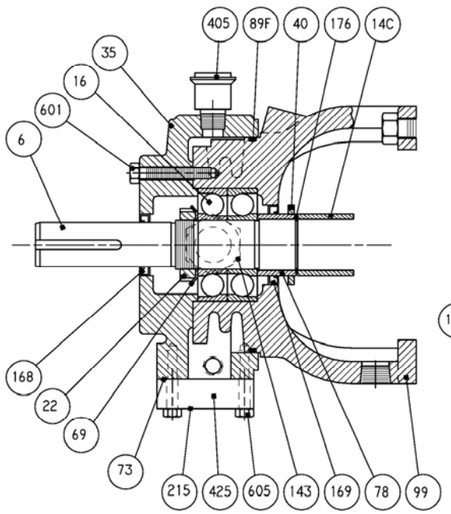
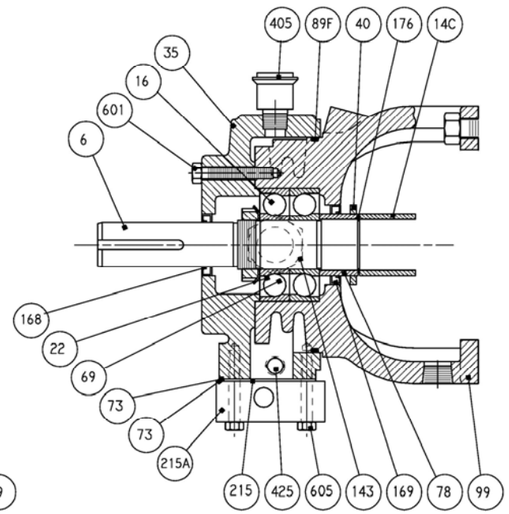


OIL LUBE – AIR COOLED



OIL LUBE – WATER COOLED

PUMP W/ OUTBOARD SLEEVE BEARING – STANDARD

ITEM	DESCRIPTION
6	SHAFT
14G	SPACER SLEEVE
14X	SEAL SLEEVE
16	BEARING – IB
18	BEARING – OB
22	BEARING LOCKNUT
35	OIL CAP – IB
37	OIL CAP – OB
40	SLINGER
69	BEARING LOCKWASHER
73	GASKET
77	GREASE FITTING
78	BEARING SPACER
89F	O-RING – OIL CAP
99	BEARING FRAME
143	OIL SIGHT
168	OIL SEAL – IB. OIL CAP
169	OIL SEAL – BRG. FRAME
176	SNAP RING
215	OIL PAN
215A	OIL COOLER
405	BREATHER VENT
425	PLUG – OIL CAP DRAIN
601	BOLT – BRG. CAP
605	BOLT – OIL CAP

Figure 9. Cooling Options
RS A, B, C, D and E

30

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10. Pump Disassembly and Assembly RS-A Thru RS-E (with standard sleeve bearing) (Refer to Figure 10.)

DISASSEMBLY

NOTE

Refer to Section I, paragraph E, Safety Precautions, before disassembling pump.

NOTE

Pump should be dismantled from discharge end. Mark or number each component while dismantling according to sequence. IMPORTANT: Check for shims between impellers and spacer sleeves, and mark the sequence accordingly. The individual components should be unscrewed or removed.

1. Remove coupling half from pump shaft (6). Remove coupling key (46).
2. Drain pump by removing the following plugs: plug (424) from the bottom of each interstage case (111), plug (422) from suction case (9) and plug (421) from discharge case (1).
3. Clamp down suction case foot to steady pump during disassembly.
4. Disconnect all male connector retaining nuts from male connector (410), (411), and (413) bodies, as applicable. Remove tubing (400) and (401), as applicable. Retaining nuts will remain with tubing.
5. Support interstage cases (111) before dismantling to prevent from being dropped while discharge case (1) is removed.
6. Remove hex nuts (616) and washers (645). Remove tie bolts (173) connecting discharge case (1) and suction casing (9).

caution

Use of a hoist with adequate capacity is recommended for lifting the discharge case (1).

7. Remove nut (615) from stud (631). Remove end cap (37A) from discharge case (1). Remove o-ring (89H) from end cap (37A).

NOTE

8. Remove jam nuts (614) and washer (28) from shaft (6). Remove shaft sleeve (14X) from shaft (6).
9. Remove discharge case (1).

Refer to Table 5, Sleeve Bearing Dimensions to determine if replacement of sleeve bearing is required.

10. If replacing sleeve bearing, remove sleeve bearing (63Y) from discharge case (1).
11. Remove wear ring (7X) with last stage diffuser (5X).
12. Remove sleeve key (32X), if applicable.
13. Remove last stage impeller (2X). Remove impeller key (32A), as applicable.
14. Remove interstage casing (111) with casing o-ring (89D), diffuser (5A), bushings (63) and wear ring (7X) intact. Remove o-ring (89D) from interstage casing (111).
15. If necessary, remove diffuser (5A) with wear ring (7X). Remove impeller (2X).
16. Remove impeller key (32A). Remove interstage sleeve (58). Remove interstage shims (73G), as necessary, from both sides of interstage sleeve (58). Record the location of all removed shims for ease of assembly.
17. Repeat steps 14 through 16 for each stage.
18. Remove the first stage impeller (2A). Remove spacer sleeve (14D).
19. Remove hex nuts (615) from studs (630) on seal gland (17A).
20. Remove bolts (600). Remove bearing frame (99). Shaft (6), mechanical seal (90), seal gland (17A) and oil seal (169) will come off with bearing frame (99).
21. Remove bolts (601) and remove bearing cap (35).
22. Uncrimp locking tab of bearing lockwasher (69). Remove bearing locknut (22) and bearing lockwasher (69). Remove male connector (413) body from seal gland (17A).
23. Remove back-to-back bearings (16) with bearing frame (99).
24. Inspect back-to-back bearings (16) and oil seal (169) for wear, corrosion or contamination. Carver recommends replacing back-to-back bearings (16) and oil seal (169) after they have been removed from shaft (6). Refer to

paragraph B of this section for bearing maintenance.
25. Remove bearing spacer (78) with slinger (40) intact, from shaft (6).
26. Remove snap ring (176).
27. Remove spacer sleeve (14A).

NOTE

Do NOT remove rotating element of mechanical seal (90) from shaft sleeve (14A) at this point, especially if mechanical seal (90) is relatively clean and in good working condition.

28. Remove o-ring (89X).
29. If necessary to replace mechanical seal, remove stationary element of mechanical seal (90) in seal gland (17A). Remove gland o-ring (89H) from seal gland (17A).
30. Remove sleeve (14A) and rotating element of mechanical seal (90). Inspect rotating element of mechanical seal (90). If replacement is required, remove element from sleeve (14A).
31. Remove key (32X) from shaft (6).

NOTE

Do NOT remove seal collar (68), unless sleeve (14A) needs replaced.

32. Remove setscrews (665) from shaft collar (68). Remove shaft collar (68) from sleeve (14A).

ASSEMBLY

Refer to the applicable sectional drawing for location of parts followed by an item number. Assemble the pump in accordance with accepted rules of engineering practice. Assembly of the pumping unit should be performed on a flat surface. Carver recommends all nuts and bolts be torqued according to Table 10, Recommended Torque Values. Check to make sure components are fitted in correct sequence. Assembly begins at the suction (inboard end) of the pump. Perform the following procedures to assemble the pumping unit:

NOTE

To ensure proper seating of bearing parts, rotate the bearing while clamping the parts.

1. Install sleeve key (32X) into keyway in shaft (6). Install o-ring (89X). Slide shaft sleeve (14A) onto end of shaft (6), lining up keyway of shaft sleeve (14A) with sleeve key (32X).
2. To determine placement of seal collar (68) on shaft sleeve (14A), refer to Table 6. For installation of mechanical seal (90) rotating element, refer to the following procedure:
   a. Scribe a mark on shaft sleeve (14A) at the distance from coupling end. Refer to Table 6, Standard Mechanical Seal Settings, for specified distance.
   b. Install seal collar (68) immediately to the impeller side of the scribe mark. Secure seal collar (68) to shaft sleeve (14A) with setscrews (665).
3. Lubricate both gland (17A) and stationary element of mechanical seal (90) with petroleum jelly or suitable lubricant. Insert stationary element of mechanical seal (90) into gland (17A). Install o-ring (89H).
4. Slide gland (17A) onto end of shaft (6). As applicable, ensure tap flush lines in gland (17A) is positioned so flush lines can be connected.
5. Install snap ring (176) on shaft (6).
6. Install slinger (40) on bearing spacer (78). Slide bearing spacer (78) onto end of shaft (6).
7. Install oil seal (169) in frame.
8. Install end of shaft (6) through inboard side of bearing frame (99).

caution

While installing back-to-back bearings, do NOT unnecessarily hit bearings. If damage to bearings occurs, replace damaged bearings with new bearings. Refer to Section V, paragraph B.

9. Install new bearing (16) back-to-back on shaft (6).
10. Install bearing lockwasher (69) so that tab of lockwasher (69) fits into keyway on shaft (6).
11. Install bearing locknut (22) and tighten against lockwasher (69). Crimp lockwasher tab into slot provided on outside of bearing locknut (22).
12. Secure bearing cap (35) to bearing frame (99) with bolts (601).
13. Install shaft assembly through inboard side of suction casing (9).
14. Secure bearing frame (99) to suction casing (9) by tightening bolts (600).

Secure gland (17A) loosely in place with hex nuts (615) on studs (630). Do NOT tighten hex nuts (615) at this point.

15. Slide spacer sleeve (14D) onto outboard end of shaft (6), next to shaft sleeve (14A).
16. Install impeller key (32A) into keyway on shaft (6).

NOTE

Replace the same number of new interstage shims (73G) during assembly that were removed during disassembly.

NOTE

IMPORTANT: Assemble any shims found during disassembly in correct sequence only if no sleeves or impellers were replaced.

NOTE

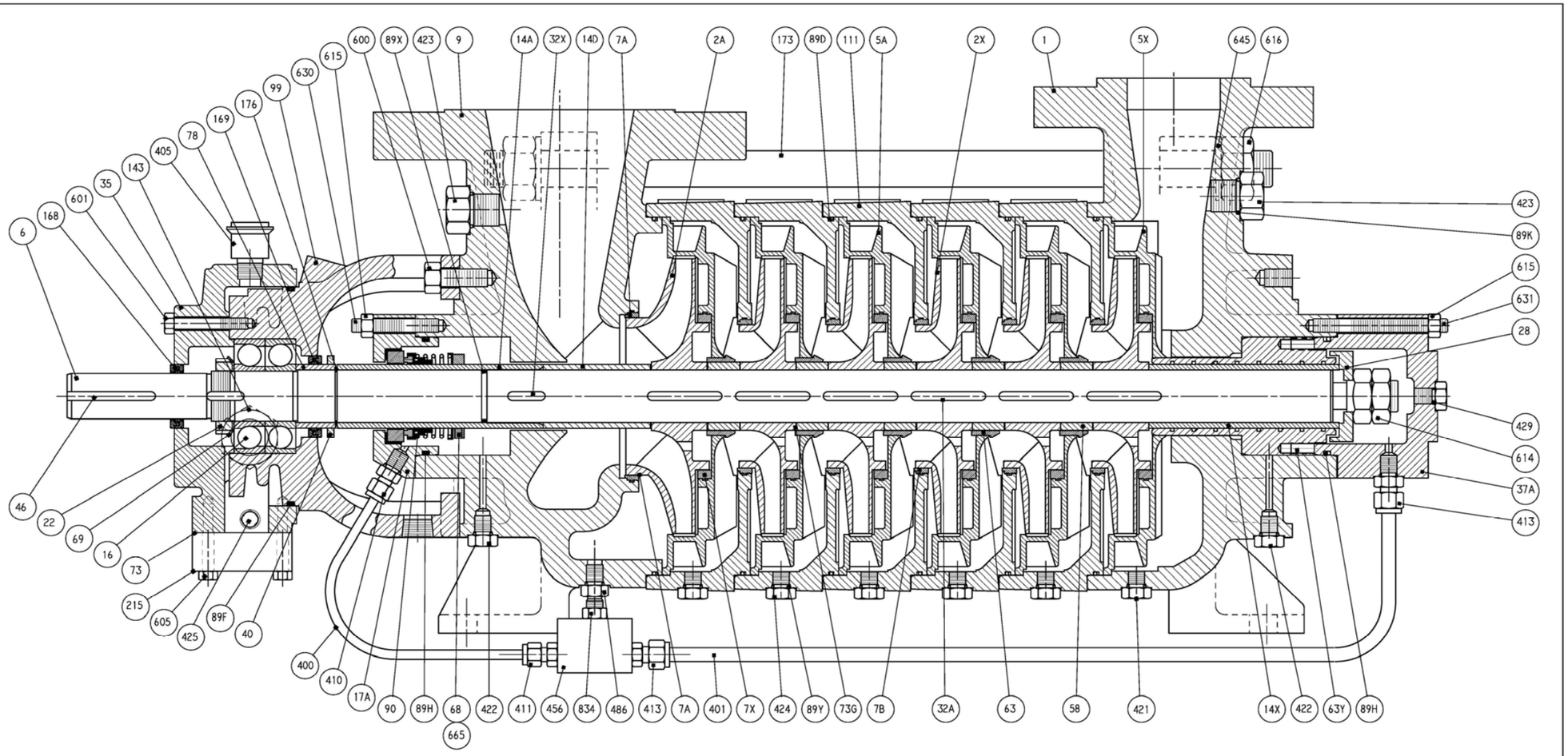
Check alignment in accordance with Figure 8, Axial Impeller Alignment.

17. Check to make sure wear ring (7A) is in casing (9). Slide first stage impeller (2A) onto shaft (6) from outboard end, fitting keyway of impeller to impeller key (32A) on shaft (6).
18. Install interstage sleeve (58).
19. Check impeller setting in accordance with Table 12, Axial Impeller Alignment Control Dimensions.
20. Check to make sure wear ring (7X) is in interstage casing (111). Lubricate and install o-ring (89D) onto suction casing (9). Check to make sure wear ring (7X) and bushing (63) are in diffuser (5A). Install new lubricated o-ring (89D) in groove provided on interstage casing (111). Lightly tap diffuser (5A) into interstage casing (111). Align diffuser vanes on either side of boss located in interstage casing (111).
21. Install impeller (2X).
22. Clamp interstage casing (111) to suction casing (9) and check impeller setting in accordance with Table 12.
23. Install interstage assembly onto previous interstage casing (111).
24. Install interstage casing assembly over shaft (6) and fit onto suction casing (9).
25. Repeat steps 17 through 25 for each stage.
26. Install impeller key (32A) into keyway in shaft (6) before installing last impeller (2X).
27. Install the last stage impeller (2X). Install key (32X), if required (Not Shown).
28. Slide outboard shaft sleeve (14X) onto outboard end of shaft (6), aligning keyway in sleeve (14X) with impeller key (32A) or sleeve key (32X).

NOTE

Refer to Table 5, Sleeve Bearing Dimensions.

29. Install sleeve bearing (63Y) in discharge casing (1).
30. Install discharge casing (1) with diffuser (5X),and wear ring (7X) on interstage casing (111).
31. Install tie bolts (173), washers (645) and hex nuts (616).
32. Install washer (28). Install and tighten jam nut (614).
33. Install new lubricated o-ring (89H) on bearing cap (37A).
34. Secure bearing cap (37A) to discharge casing (1) with nuts (615) on studs (631).
35. Rotate shaft (6) by hand to ensure smooth rotation. Tighten nut (615) on gland (17A).
36. Install tubing (400) and (401), as applicable. Secure tubing by tightening nuts on male tube connector (410), (411) and (413) bodies, as applicable.
37. Install plugs (421), (422), (423), (424) and (429).
38. Install pump on base and secure with capscrews.
39. Install coupling key (46). Install coupling half on pump shaft (6).
40. Align coupling as outlined in Section II, paragraph D, Coupling, and reference Figure 5, Coupling Alignment.
41. Install coupling guard.
42. Connect suction, discharge and gauge lines. After connection of piping, check for smooth rotation of shaft.
43. Open system valves.
44. Unlock and connect electrical power supply to motor. Remove tags. Start pumping unit according to Section III, paragraph C, Start-Up.



ITEM	DESCRIPTION
1	DISCHARGE CASE
2A	IMPELLER – 1ST STAGE
2X	IMPELLER
5A	DIFFUSER
5X	DIFFUSER – LAST STAGE
6	SHAFT
7A	WEAR RING – FIRST STAGE
7B	WEAR RING – FRONT
7X	WEAR RING – BACK
9	SUCTION CASE
14A	SLEEVE
14D	SPACER SLEEVE
14X	SLEEVE

ITEM	DESCRIPTION
16	BLL BEARING
17A	GLAND
22	BEARING LOCKNUT
28	BEARING WASHER
32A	KEY – IMPELLER
35	BEARING CAP – IB.
37A	BEARING CAP – OB.
40	SLINGER
46	KEY – COUPLING
58	SLEEVE – INTERSTAGE
63	BUSHING – DIFFUSER
63Y	SLEEVE BEARING

ITEM	DESCRIPTION
68	SLEEVE COLLAR
69	BEARING LOCKWASHER
73	GASKET – BEARING CAP
*73G	GASKET – INTERSTAGE SLEEVE
78	BEARING SPACER
89D	O-RING – CASING
89F	O-RING – IB. BRG. CAP
89H	O-RING – GLAND
89K	O-RING – GA. PLUG
89X	O-RING – SLEEVE
89Y	O-RING – PLUG
90	MECHANICAL SEAL
99	BEARING FRAME
111	INTERSTAGE CASE
168	BEARING ISOLATOR – IB. BRG. CAP
169	BEARING ISOLATOR – BRG. FRAME

ITEM	DESCRIPTION
173	TIE BOLT
176	SNAP RING
215	IB. OIL CAP
400	TUBE
401	TUBE
410	TUBE CONNECTOR
411	TUBE CONNECTOR
413	TUBE CONNECTOR
421	PLUG – DISCHARGE CASE
422	PLUG – STUFFING BOX
423	PLUG – GAUGE CONN.
424	PLUG – CASE DRAIN
425	PLUG – IB. BRG. CAP DRAIN
429	PLUG – OB. BEARING CAP
456	TEE

ITEM	DESCRIPTION
486	UNION
600	BOLT – BRG. FRAME
601	BOLT – BRG. CAP
614	JAM NUT
615	NUT – GLAND
616	NUT – TIE BOLT
630	STUD – GLAND
631	STUD – OB. BRG. CAP
645	WASHER – TIE BOLT
665	SETSCREW – SLEEVE COLLAR

* USE AS REQUIRED

Figure 10. Sectional Assembly RS-A Thru RS-E with standard Bearing

35

Blank

11. Pump Disassembly and Assembly RS-A Thru RS-E, (with optional mechanical seals) (Refer to Figure 11.)

DISASSEMBLY

NOTE

Refer to Section I, paragraph E, Safety Precautions, before disassembling pump.

NOTE

Pump should be dismantled from suction end. Mark or number each component while dismantling according to sequence. IMPORTANT: Check for shims between impellers and spacer sleeves, and mark the sequence accordingly. The individual components should be unscrewed or removed.

1. Remove coupling half from pump shaft (6). Remove coupling key (46).
2. Drain pump by removing the following plugs: plug (424) from the bottom of each interstage case (111), plug (422) from suction case (9) and plug (422) from discharge case (1).
3. Clamp down discharge case foot to steady pump during disassembly.
4. Disconnect male connector retaining nuts from tube connector bodies (410), (411) and (413). Remove tube (400) and (408). Retaining nuts will remain with tube.
5. Support interstage cases (111) before dismantling to prevent them from dropping when suction case (9) is removed.
6. Remove bolts (601) and remove bearing cap (35).
7. Uncrimp locking tab of bearing lockwasher (69). Remove bearing locknut (22) and bearing lockwasher (69). Remove male connector (410) body from seal gland (17A).
8. Remove bolts (600). Remove bearing frame (99). Radial bearing (16) and oil seal (169) will come off with bearing frame (99).
9. Inspect radial bearing (16) and oil seal (169) for wear, corrosion or contamination. Carver recommends replacing radial bearing (16) and oil seal (169) after they have been removed from shaft (6). Refer to paragraph B of this section for bearing maintenance.
10. Remove spacer sleeve (14G) with slinger (40) intact.
11. Remove nuts (615) from studs (630) on seal gland (17A) and remove gland.

NOTE

Do NOT remove rotating element of mechanical seal (90) from sleeve (14A) at this point, especially if mechanical seal (90) is relatively clean, in good working condition.

12. Remove sleeve (14A) and rotating element of mechanical seal (90). Inspect rotating element of mechanical seal (90). If replacement is required, remove element from sleeve (14A).
13. If necessary to replace mechanical seal, remove stationary element of mechanical seal (90) in seal gland (17A). Remove gland o-ring (89H) from seal gland (17A).
14. Remove hex nuts (616) and washers (645). Remove tie bolts (173) connecting suction case (9) and discharge case (1).

caution

Use of a hoist with adequate capacity is recommended for lifting suction case (9).

NOTE

Refer to Table 13, Maximum Wear Ring Clearances, before removing wear ring from casing.

15. Remove wear ring (7A) and suction case (9).
16. Remove case o-ring (89D) from suction casing (9).
17. Remove sleeve o-ring (89X) and key (32X). Remove spacer sleeve (14D) or (14E). Remove first impeller (2A).
18. Remove interstage case (111) with wear ring (7X), diffuser (5A) and case o-ring (89D) intact. Remove o-ring (89D) from interstage case (111).
19. Remove impeller key (32A). Remove interstage sleeve (58). Remove interstage shims (73G), as necessary, from both sides of interstage sleeve (58).
20. Remove interstage impeller (2X).
21. Repeat steps 18 through 20 for each remaining stage. Number and match mark impellers during removal.

22. If required for wear ring replacement, remove wear ring (7X) and last stage diffuser (5X), which holds bushing (63X). Do NOT remove bushing (63X/63XR) from last stage diffuser (5X).
23. Remove spacer sleeve (14E), if applicable.
24. Remove nut (615) from stud (630).
25. Remove bolts (600).
26. Remove bearing frame assembly with seal (91) and shaft (6).
27. Remove bolts (601) from bearing cap (37). Remove bearing cap (37).
28. Uncrimp locking tab of bearing lockwasher (69). Remove bearing locknut (22) and bearing lockwasher (69). Remove male connector (410) body from seal gland (17X).
29. Remove bearing frame (99). Bearings (18) and oil seal (169) will come off with bearing frame (99).
30. Inspect back-to-back bearings (18) and oil seal (169) for wear, corrosion or contamination. Carver recommends that the back-to-back bearings (18) and oil seal (169) be replaced after removed from shaft (6). Refer to paragraph B of this section for bearing maintenance.
31. Remove bearing spacer (78) and slinger (40) from shaft (6).
32. Remove snap ring (176).

NOTE

Do NOT remove rotating element of mechanical seal (91) from sleeve (14X) at this point, especially if mechanical seal (91) is relatively clean, in good working condition.

33. If necessary to replace mechanical seal, remove stationary element from mechanical seal (91) in seal gland (17X). Remove gland o-ring (89H) from seal gland (17X).
34. Remove sleeve o-ring (89X). Remove seal sleeve (14X) and sleeve key (32X), as applicable.
35. Remove rotating element of mechanical seal (91). If replacement is required, remove from shaft sleeve (14X).
36. Remove remaining impeller key (32A), as necessary.

ASSEMBLY

Refer to the applicable sectional drawing for location of parts followed by an item number. Assemble the pump in accordance with accepted rules of engineering. Assembly of the pumping unit should be performed on a flat surface. Carver recommends all nuts and bolts be torqued according to Table 10, Recommended Torque Values. Check to make sure components are fitted in correct sequence. Assembly begins at the discharge (outboard) end of the pump. Perform the following procedures to assemble the pumping unit:

NOTE

To ensure proper seating of bearing parts, rotate the bearing while clamping the parts.

1. Secure discharge casing to work area.
2. Lubricate and install sleeve o-ring (89X) into groove on discharge end of shaft.
3. Install sleeve key (32X) into keyway in shaft (6). Lubricate inside of shaft sleeve (14X) and slide onto shaft (6), lining up keyway of shaft sleeve (14X) with sleeve key (32X).
4. Install rotating element of mechanical seal (91) onto shaft sleeve (14X). Tighten setscrews in mechanical seal (91).
5. Install sleeve (14X) on shaft (6) with rotating element through discharge casing (1).
6. If stationary element of mechanical seal is replaced, clean, dry, and lubricate seal gland (17X).
7. Lubricate and install stationary element of mechanical seal (91) in seal gland (17X).
8. Lubricate and install o-ring (89H) on seal gland (17X).
9. Install seal gland (17X) over shaft (6), onto discharge casing (1). Check to make sure seal gland is correctly positioned to orient piping. Secure seal gland (17X) with nuts (615) on studs (630) to discharge case (1), finger tight.
10. Install snap ring (176).
11. Install slinger (40) on onto shaft sleeve (14X)
12. Install bearing spacer (78) onto shaft (6).
13. Install oil seal (169) into bearing frame (99).

caution

While installing back-to-back bearings, do NOT hit ball bearings. If damage to the bearings occurs, replace damaged bearings with new bearings. Refer to Section V, paragraph B.

15. Install end of shaft (6) through outboard side of bearing frame (99).
16. Install new bearings (18) back-to-back on shaft (6).
17. Install bearing lockwasher (69) so that tab of lockwasher (69) fits into keyway on shaft (6).
18. Install bearing locknut (22) and tighten against lockwasher (69). Crimp lockwasher tab into slot provided on outside of bearing locknut (22).
19. Install bearing cap (37) with bolts (601) on bearing frame (99).
20. Install bearing frame (99) with bolts (600).
21. Install impeller key (32A). Install wear ring (7X) in diffuser (5X).
22. Install last stage diffuser (5X) with bushings (63X/63XR) into discharge casing (1).
23. Install the last stage impeller (2X). Check depth reading in accordance with Figure 8 and Table 12.

NOTE

Replace the same number of new interstage shims (73G) during assembly that were removed during disassembly.

NOTE

IMPORTANT: Assemble any shims found during disassembly in correct sequence only if no sleeves or impellers were replaced.

24. Install shims (73G), as necessary.
25. Install impeller key (32A) and interstage sleeve (58).
26. Lubricate and install o-ring (89D) into interstage casing (111).
27. Install wear ring (7X) and bushing (63) in diffuser (5A) into interstage casing (111). Check to make sure locking tab engages the diffuser to keep from rotating.

NOTE

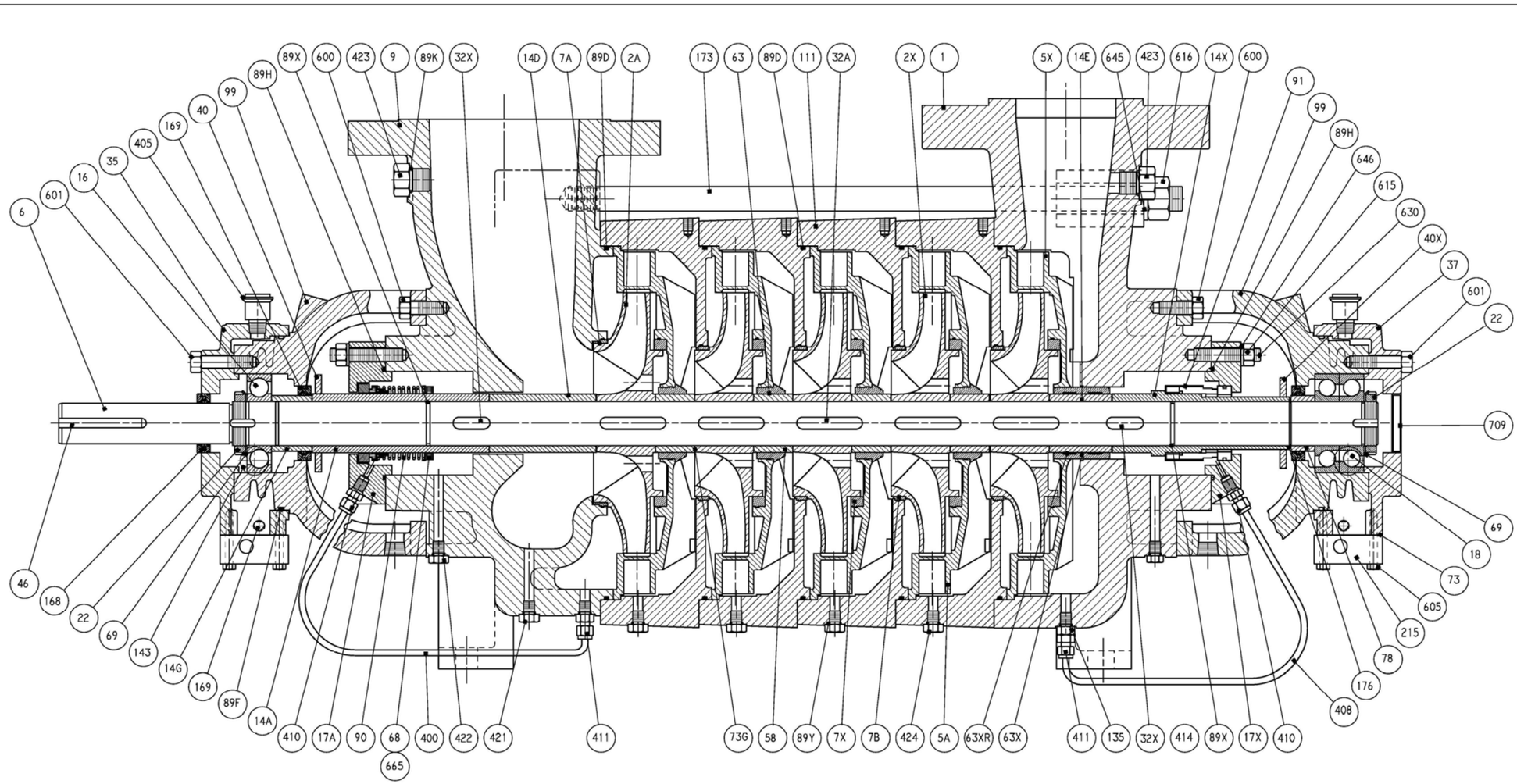
Check alignment in accordance with Figure 8, Axial Impeller Alignment.

28. Install interstage casing (111) into discharge casing (1).
29. Install the next stage impeller (2X) and impeller key (32A).
30. Repeat steps 23 through 25 for each stage.
31. Install spacer sleeve (14D) or (14E) onto shaft (6).
32. Install key (32X).
33. Install sleeve (14A).
34. Mark sleeve and end of shaft to determine location of key aligning key to keyway.
35. Lubricate and install o-ring (89D) onto suction casing (9).
36. Install suction casing (9) and tap into place against interstage casing (111).
37. Install tie bolts (173) and secure with flat washers (645) and hex nuts (616). Tighten hex nuts (616) firmly and evenly. Refer to Table 10 for recommended torque requirements.
38. Scribe a mark on sleeve (14A) flush with stuffing box face.
39. Remove sleeve (14A). Make second scribe mark according to Table 7.
40. Install locking collar (68) with setscrews (665) to the impeller side of the second scribed mark for seal setting on sleeve (14A).
41. Lubricate and install o-ring (89X) and slide into groove on shaft (6).
42. Lubricate inside of sleeve (14A).
43. Align keyway to mark scribed in step 34.
44. Slide sleeve (14A) over o-ring (89X).
45. If stationary element of mechanical seal is replaced, clean, dry and lubricate seal gland (17A).
46. Install stationary element of mechanical seal into seal gland.
47. Lubricate and install o-ring (89H) on seal gland (17A).
48. Install rotating elements of mechanical seal onto sleeve (14A).
49. Install seal gland with elements of mechanical seal gland (17A) onto suction casing with studs (630) and nuts (615) finger tight.
50. Install bearing spacer sleeve (14C) with slinger (40) onto shaft (6).
51. Install bearing frame oil seal (169).
52. Install bearing frame (99) to suction casing (9) with bolts (600).

caution

While installing bearings, do NOT unnecessarily hit bearings. If damage to the bearings occurs, replace damaged bearings with new bearings. Refer to Section V, paragraph B.

53. Install new radial bearing (16) on shaft (6).
54. Install bearing lockwasher (69) so that tab of lockwasher (69) fits into keyway on shaft (6).
55. Install bearing locknut (22) and tighten against lockwasher (69). Crimp lockwasher tab into slot provided on outside of bearing locknut (22).
56. Secure bearing cap (35) onto bearing frame (99) with bolts (601).
57. Rotate shaft (6) by hand to ensure smooth rotation. Tighten nut (615) on gland (17A).
58. Add grease to bearings through grease zerks in bearing frame (99). Refer to this section, paragraph B, Bearings, for bearing maintenance.
59. Install tubing (408) to orifice assembly with male tube connector (410) and (411) bodies.
60. Install tubing (400) with male tube connector (410) and (411) bodies. After connecting tubing, inspect shaft for concentricity.
61. Install plugs (422) for stuffing box, (423) for gauge connector and (424) for the casing drain.
62. Return pump to installation site. Install pump on base and secure with bolts.
63. Install coupling key (46). Install coupling half on pump shaft (6). Align coupling as outlined in Section II, paragraph D, Coupling, and reference Figure 5, Coupling Alignment.
64. Install coupling guard.
65. Connect suction, discharge and gauge lines. After connecting piping, check once more for smooth rotation of shaft.
66. Open system valves.
    1.69. Unlock and reconnect the electrical power supply to the driver. Remove all tags. Start the pumping unit in accordance with paragraph C, Start-Up, of Section III, Operation.



ITEM	DESCRIPTION
1	DISCHARGE CASE
2A	IMPELLER – 1ST STAGE
2X	IMPELLER
5A	DIFFUSER
5X	DIFFUSER – LAST STAGE
6	SHAFT
7A	WEAR RING – FIRST
7B	WEAR RING – FRONT
7X	WEAR RING – BACK
9	SUCTION CASE
14A	SLEEVE
14D	SPACER SLEEVE
14E	SPACER SLEEVE
14G	SPACER SLEEVE
14X	SLEEVE
16	BALL BEARING – IB.
17A	GLAND – IB.
17X	GLAND – OB.

ITEM	DESCRIPTION
18	BALL BEARING – OB.
22	BEARING LOCKNUT
32A	KEY – IMPELLER
32X	KEY – SLEEVE
35	BEARING CAP – IB.
37	BEARING CAP – OB.
40	SLINGER – IB
40X	SLINGER – OB
46	KEY – COUPLING
58	SLEEVE – INTERSTAGE
63	TEFLON BUSHING – DIFFUSER
63X	BUSHING – LAST STG. DIFF.
63XR	RULON BUSHING – LAST STG. DIFF.
68	SLEEVE COLLAR
69	BEARING LOCKWASHER
73	GASKET – COOLER
*73G	GASKET – INTERSTAGE SLEEVE

ITEM	DESCRIPTION
78	BEARING SPACER
89D	O-RING – CASING
89F	O-RING – BRG. CAP
89H	O-RING – GLAND
89K	O-RING – GA. PLUG
89X	O-RING – SLEEVE
89Y	O-RING – PLUG
90	MECHANICAL SEAL – IB.
91	MECHANICAL SEAL – OB.
99	BEARING FRAME
111	INTERSTAGE CASE
135	ORIFICE
143	OIL VIEW SIGHT
168	BEARING ISOLATOR – BRG. CAP
169	BEARING ISOLATOR – BRG. FRAME
173	TIE BOLT

ITEM	DESCRIPTION
176	SNAP RING
215	COOLER
400	TUBE
405	BREATHER VENT
408	TUBE
410	TUBE CONNECTOR – GLAND
411	TUBE CONNECTOR
421	PLUG – SUCT. & DISCH. CASE
422	PLUG – STUFFING BOX
423	PLUG – GAUGE CONN.
425	PLUG – OIL CAP
423	PLUG – CASE DRAIN

ITEM	DESCRIPTION
600	BOLT – BRG. FRAME
605	BOLT – COOLER
601	BOLT – BRG. CAP
615	NUT – GLAND
616	NUT – TIE BOLT
630	STUD – GLAND
645	WASHER – TIE BOLT
646	WASHER – GLAND
665	SETSCREW – SLEEVE COLLAR
709	BORE PLUG

* USE AS REQUIRED

Figure 11. Sectional Assembly RS-A Thru RS-E with optional mechanical seals

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Table 15. Recommended Spare Parts

Quantity	*Item No.*	*Description*
1	2A	Impeller, First Stage
AR	2X	Impeller, Per Stage
1	6	Shaft
1	7A	Wear Ring
AR	7B	Wear Ring
AR	7X	Wear Ring
1	14A	Shaft Sleeve
1	14X	Shaft Sleeve, Bushing
AR	14D	Spacer Sleeve, Suction End and/or Discharge End
AR	14E	Spacer Sleeve, Suction End and/or Discharge End
1	14G	Spacer Sleeve, Suction End
1	16	Ball Bearing, Suction End
1	17A	Gland
2	18	Ball Bearing, Discharge End
1	22	Bearing Locknut
1	28	Washer
1	32A	Key, Impeller
1	32X	Key, Sleeve
1	46	Key, Coupling
AR	58	Interstage Sleeve
AR	63	Diffuser Bushing, Rulon
1	63Y	Sleeve Bearing
2	69	Bearing Lockwasher
AR	73G	Shims, Interstage Sleeve
2	89X	O-Ring, Sleeve
AR	89D	O-Ring, Case
2	*89F	O-Ring, Bearing Cap
2	*89H	O-Ring, Bearing Gland
2	*89J	O-Ring, Bearing Cap O.B.
AR	89Y	O-Ring, Plugs & Fittings
1	90	Mechanical Seal, Suction End
1	*91	Mechanical Seal, Discharge End
1	176	Snap Ring

AR = As Required
* Options

Notes:

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