Carver Pump®

Operating Instructions
I-400 ATEX REV.0
Inch Units

API MAXUM
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: API MAXUM 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 T1

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 13, Recommended Spare Parts. Part numbers correspond to Figures 8 and 9.

1.6 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 safe operation the roller bearings must be replaced at 25000 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.

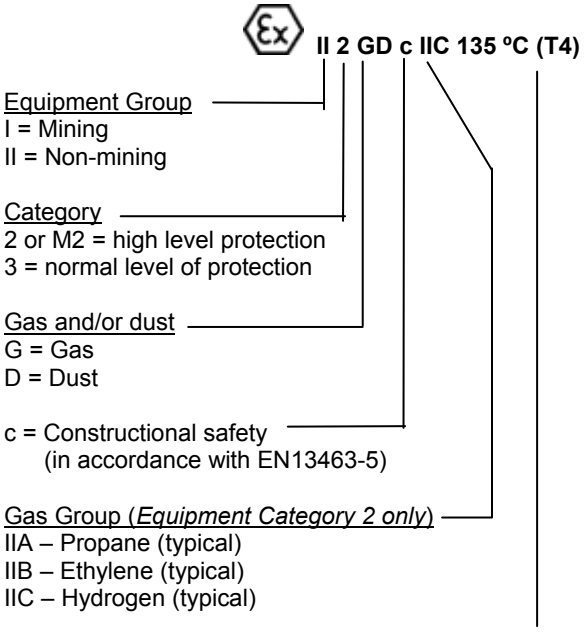
If the operator cannot warrant this condition, appropriate monitoring devices must be used.

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.

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 calculated in paragraph 5 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 and the fan inlet flow must be unimpeded.

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.

Table 1. Fluid Temperature Limits

Temperature class to EN 13463-1:	Temperature limit of fluid handled
T5	85 °C
T4	120 °C
T3	185 °C
T2	280 °C
T1	350 °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 without auxiliary cooling should NOT exceed 400 degrees Fahrenheit (F).

Pumps of high temperature construction are provided with cooled bearings for a unit operating temperature range between 400 and 650 degrees F. Cooling water is piped 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.

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 frame of 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. Do NOT exceed maximum 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.

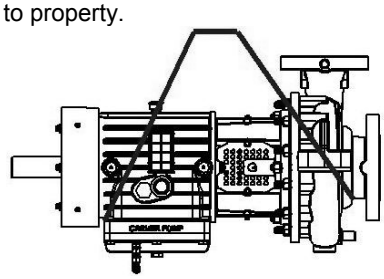


Fig. 1 Transport of the pump

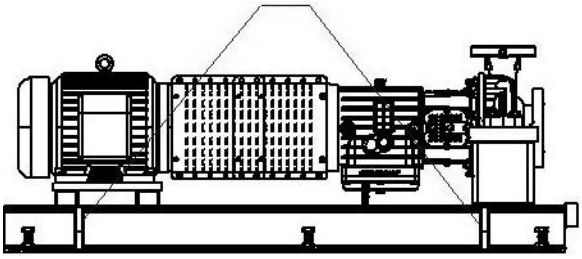


Fig. 2 Transport of the complete unit

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

The API Maxum is our process pump for handling hydrocarbons in refining and process industry applications. It is offered as a centerline mounted unit. Hydraulic performance extends to 9,000 GPM and 720 feet of head. The design is restricted as noted below.

The Maxum pump unit consists of a pump, base, coupling, coupling guard and a driver unit. The driver is usually an electric motor, but can be a steam turbine or any other power conversion device that can provide the

required horsepower at the proper RPM. Drivers other than electric motors must be reviewed for compliance with the applicable directives.

The Maxum pump is supplied with a volute that should always be mounted solidly on an adequate bedplate. No shims should be used under the feet of the casing.

The Maxum pump is designed as a back pullout unit. Therefore it should always be used with a spacer coupling. The spacer width should permit the entire rotating assembly to be removed from the casing. Normally the casing should be left in place on the base and remain connected to the suction and discharge piping.

The bare pump consists of following major parts and options. Please refer to figure 1.A, the sectional assembly drawing for the location of parts identified by item numbers.

Item 1 - Casing. The casing (1) houses the impeller (2) and wear ring (7) and consists of the suction inlet, discharge volute, and discharge nozzle. The backcover (11) is held in place between the casing (1) and the frame (19). The casing (1) is fastened to the backhead (11) with studs (631) and nuts (616) with lockwashers (655).

Item 2 - Impeller. Maxum pumps are equipped with enclosed impellers. The impeller (2) is keyed to the shaft (6) by the impeller key (32) and is locked in place by the impeller nut (24).

Item 6 - Shaft. The shaft of the Maxum pump is designed for maximum deflection of 0.002 inch at the face of the mechanical seal. The shaft is also designed to provide stabilization to the rotor system when pump operates away from the best efficiency point. A coupling connects the pump shaft (6) to the driver shaft. The coupling key (46) holds the coupling in place, causing it to rotate with the shaft (6).

Item 11 - Backcover. The backcover (11) is fastened to the casing (1) with studs (631), nuts (616), and lockwashers (655). The backcover (11) houses wear ring (7X). The backcover (11) is positioned in the volute bore by gasket (73C) or o-ring (89A). If gasket (73C) is on pump, o-ring (89A) is used only during pump testing.

The bearing frame (19) is attached to the backcover (11) with stud (632), Nut (617) and lockwashers (656). The backcover (11) contains forcing screws (610) to aid in loosening the backcover (11) from casing (1).

Item 16 and 18 - Bearings. A deep-groove Conrad-type, C3 internal fit radial bearing (16) and light preload, back-to-back mounted thrust bearings (18) are housed in the bearing frame (19). The thrust bearings (18) will be designated as 7000 or 8000 series. Thrust bearings (18) designated in the 7000 series will be duplex 40 degree angular contact bearings. Thrust bearings (18) designated in the 8000 series will have 40 and 15 degree angular contact. The thrust bearing (18) is held in place by the bearing locknut (22) and bearing lockwasher (69). The bearings are oil lubricated. Either oil bath lubrication or an oil mist system may be employed.

Item 19 - Bearing Frame. The principal function of the bearing frame (19) is to carry the loads from the liquid end of the pump to the base and to transport power from the power unit to the impeller. The bearing frame (19) has a radial bearing (16) located in the front end of the house (nearest to the volute) and a pair of back-to-back mounted angular contact thrust bearings (18) in the rear of the frame. This bearing frame (19) is designed to be oil lubricated, which can be accomplished in several ways.

The first method involves the use of a sight glass automatic oiler. The frame is designed so that it can be used with a sight glass automatic oiler. The sight glass maintains the oil level high enough on the higher of the two bearings so that the bearings themselves provide the motivation for the oil to be moved through the races of both bearings.

A second method is to provide an oil flinger which mounts on the shaft and literally flings the oil throughout the bearing frame. An oil view gauge indicator is usually used with this system to make sure that the oil level within the frame can be observed and maintained at the proper level.

A third method is the oil mist system. All Maxum pumps are equipped so that they can be used or can be converted to oil mist units without any field machining-.

Oil Mist system for ATEX applications require a user installed system of safety controls or alarms to insure that the pump is shut down in event of an oil mist failure.

In addition to the oil lube system, the power frame contains the shaft oil seals or oil containment system. The Maxum pump bearing frame can be equipped with a magnetic oil seal assembly which operates as a mechanical seal when running and becomes a static seal when shutdown or stopped. It is necessary to use an expansion chamber with the magnetic seal device. The Maxum pump can also be furnished with a number of labyrinth seal assemblies being offered on the market.

Baseplate. A groutable baseplate is designed to provide adequate support for the pump and motor so pump can be operated without baseplate deflection, excessive vibration, or resonance. The casing (1) is bolted to the baseplate with capscrews. Grouting of this type of baseplate is required by Carver Pump Company.

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.

Net positive suction head (NPSH).
Any liquid, hot or cold, must be pushed into the impeller of the pump by some absolute pressure, such as the atmosphere or the vessel pressure from which the pump takes its action.

The head in feet of liquid necessary to maintain the required flow into the pump is called the Net Positive Suction Head (NPSH). This value is measured above the vapor pressure of the liquid at the pumping temperature.

NPSH is commonly expressed in two ways: the NPSH required by the pump, and shown on the pump curve, is the head needed to cover the losses in the pump suction and the energy required to enable the liquid to climb onboard the leading edge of the impeller vane. The NPSH available is that inherent in the system, taking into account friction losses in suction piping, valves, fittings, etc. In all cases, the NPSH available, measured above vapor pressure, must exceed the NPSH required in order to push the liquid into the pump.

Changing Pump Speed.
Changing the speed of a centrifugal pump affects the capacity, total head, NPSH required and the brake horsepower. In general the capacity will vary in a direct ratio with the speed, whereas the total head and NPSH required will vary as the ratio of the speed squared. The brake horsepower will vary as the ratio of the speed cubed.

Effects of Viscosity.
The pump is designed to deliver rated capacity at rated head for a liquid with a particular viscosity. When pump is handling heavy viscous liquid, the viscosity of the liquid must allow it to be pumped easily. The liquid may have to be heated prior to starting the pump. When contemplating operation at some viscosity other than that for which the pump was originally designed, check with Carver Pump Company.

Effects of Specific Gravity.
The capacity and total head in feet of liquid 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 liquid pumped. However, since the discharge pressure in psi (pounds per square inch) and the brake horsepower required to drive the pump are functions of the specific gravity of the liquid, both will be affected in direct proportion by any change in specific gravity. Therefore, an in increase in specific gravity will raise the discharge pressure and is dangerous. as it might overload the pump's driver, or exceed the pump casing allowable pressure.

6. Mechanical Seal

Cartridge seals are to be used. Complete cartridge seal instructions should be obtained from the seal manufacturer.

The standard stuffing box dimensions are shown in Figure 3.

7. Bearing Lubrication and Cooling

CAUTION

Operation of the unit without proper lubrication can result in overheating of the bearings, bearing failures, pump seizures and actual breakup of the equipment, exposing operating personnel to injury. See Section V, Scheduled Maintenance for further instructions

Pumps are shipped with the bearing frames empty of oil. ISO Grade 68 mineral oils are recommended for proper lubrication of the pump. Refer to table 2 for specific recommended oil types.

Fill constant level oiler reservoir and allow it to fill bearing frame (19). To avoid adding too much oil, never finish filling oil in bearing frame (19) through plug at top of the bearing frame (19). It may take repeated fittings of constant level oiler reservoir to fill oil well. Use constant level oiler's glass sight to check oil level in bearing frame (19).

The API Maxum pump comes equipped with appropriate connections for the installation of an oil mist system by the customer if oil mist lubrication is desired. Oil mist lubrication provides the greatest protection against contamination by dirt and water.

The top port of the bearing frame (19) remains plugged for oil mist lubricated bearings. The plug in the bottom of the power frame should be removed so that condensed oil vapor can be drained and/or removed from the bearing frame (19).

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 (100 PSIG MAX.)

Temperature Range	*Flow Rate*
-20 degrees to 400 degrees F	Oil Lube – Air
400 degrees to 650 degrees F	Oil Lube - Water-3 GPM

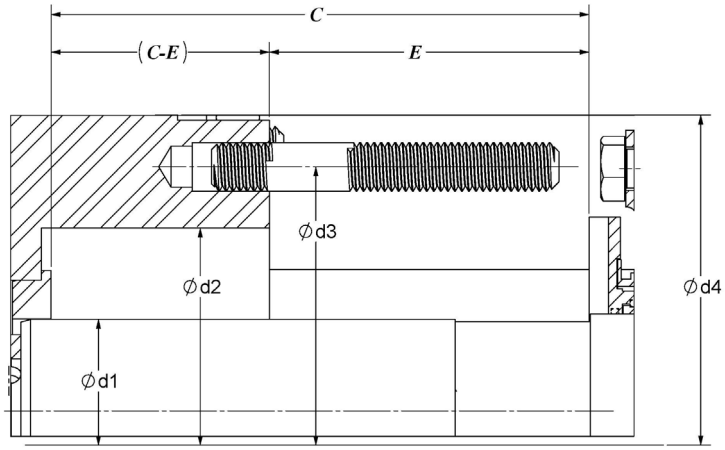
8. Technical Data

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. Estimated Noise Characteristecs

Rated power input P_N (kW)	Sound pressure level L pA (dB) 1)					
	Pump alone			Pump with motor		
	2900 1/min	1450 1/min	960/760 1/min	2900 1/min	1450 1/min	960/760 1/min
1.5	53.5	52.5	51.5	63.0	58.0	55.5
2.2	55.5	54.5	53.0	66.0	60.0	58.0
3.0	57.0	56.0	54.5	67.5	61.5	59.5
4.0	59.0	57.5	56.0	69.0	63.0	61.0
5.5	60.5	59.0	57.5	70.5	64.5	62.0
7.5	62.0	61.0	59.0	72.0	66.0	63.5
11.0	64.0	63.0	61.0	74.0	67.5	65.0
15.0	66.0	64.5	62.5	75.0	69.0	66.5
18.5	67.0	65.5	63.5	76.0	70.0	67.5
22.0	68.0	66.5	64.5	76.5	70.5	68.0
30.0	70.0	68.0	66.0	78.0	72.0	69.5
37.0	71.0	69.5	67.0	78.5	72.5	70.0
45.0	72.0	70.5	68.0	79.5	73.5	71.0
55.0	73.0	71.5	69.0	80.0	74.0	71.5
75.0	74.5	73.0	70.5	81.0	75.5	72.5
90.0	75.5	74.0	71.0	81.5	76.0	73.0
110.0	77.0	75.0	72.0	82.0	76.5	74.0
132.0	78.0	76.0	73.0	82.5	77.0	74.5
160.0	79.0	77.0	74.0	83.5	78.0	75.0
200.0	80.0	78.0	75.0	84.0	78.5	75.5
250.0	80.5	78.5	-	84.5	79.5	-

1) Measured at a distance of 1 m from the pump outline



Seal Chamber Dimensions								
Bearing Frame Number	**Shaft Diameter d1**	**Box Bore d2**	**Stud Circle d3**	**Max Gland Diameter d4**	**Total Length C**	**Clear Length E**	**Box Depth C-E**	**Stud Size (USC)**
3	1.575	3.543	4.921	6.625	6.500	4.000	2.500	1/2″-13
4	1.968	3.937	5.512	6.625	6.900	4.400	2.500	5/8″-11
5	2.362	4.725	6.219	7.750	6.900	4.400	2.500	5/8″-11
6	2.756	5.118	6.693	7.750	6.900	4.400	2.500	5/8″-11
8	3.543	6.219	8.070	10.875	7.290	4.790	2.500	3/4″-10

Figure 3. Stuffing Boxes Dimensions

Table 5. Basic Design Features

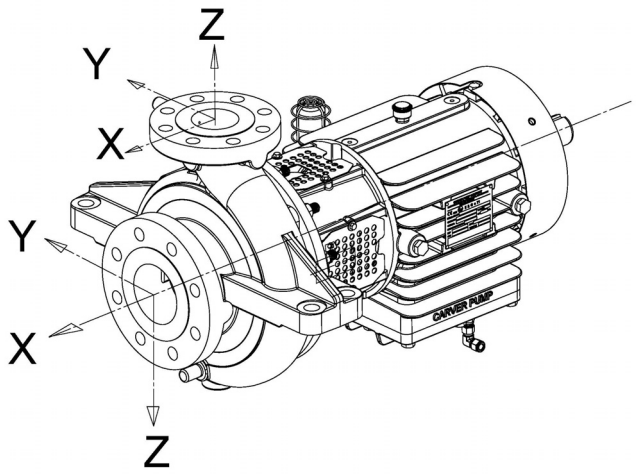
Pump Size	Bearing Frame	Max Speed (RPM)	1st Critical Speed (RPM)	Casing Design		Shaft Deflection @ 20% BEP		Shaft Stiffness L^3/D^4	WK^2 @ Max. Impeller Dia.
				Discharge	Volute(s)	@ Seal (in.)	@ Impeller (in.)		
AA- 1½ x 1 x 6	3	3500	13068	Centerline	Single	0.0002	0.0009	183.3	9.500
AB - 2 x 1½ x 6	3	3500	12098	Centerline	Single	0.0006	0.0019	183.3	10.45
AC- 3 x 1½ x 6	3	3500	11317	Centerline	Single	0.0006	0.0021	183.3	11.40
AD - 3 x 2 x 6	3	3500	12098	Centerline	Single	0.0011	0.0036	183.3	10.45
AE - 4 x 3 x 6	3	3500	10122	Centerline	Single	0.0021	0.0070	183.3	15.20
BA - 1½ x 1 x 8	4	3500	12262	Centerline	Single	0.0003	0.0011	83.6	34.31
BB - 2 x 1½ x 8	4	3500	10754	Centerline	Single	0.0005	0.0017	83.6	41.42
BC - 3 x 1½ x 8	4	3500	11193	Centerline	Single	0.0006	0.0022	83.6	39.05
BD - 3 x 2 x 8	4	3500	11193	Centerline	Single	0.0008	0.0029	83.6	39.05
BE – 4 x 3 x 8	4	3500	10363	Centerline	Dual	0.0004	0.0014	83.6	43.79
BF - 6 x 4 x 8	4	3500	10012	Centerline	Dual	0.0005	0.0017	83.6	46.16
CA – 2 x 1½ x 10	5	3500	13192	Centerline	Single	0.0002	0.0012	42.3	92.29
CB - 3 x 1½ x 10	5	3500	13192	Centerline	Single	0.0002	0.0011	42.3	92.29
CC - 3 x 2 x 10	5	3500	12773	Centerline	Single	0.0004	0.0022	42.3	92.29
CD - 4 x 3 x 10	5	3500	12042	Centerline	Single	0.0006	0.0032	42.3	108.6
CE - 6 x 4 x 10	5	3500	10429	Centerline	Dual	0.0002	0.0012	42.3	141.3
CF - 6 x 6 x 10	5	1750	8288	Centerline	Dual	0.0002	0.0010	42.3	141.3
CG - 8 x 6 x 10	5	1750	10020	Centerline	Dual	0.0002	0.0012	42.3	152.2
DA - 2 x 1½ x 13	6	3500	11224	Centerline	Dual	0.0003	0.0019	35.0	209.6
DB - 3 x 2 x 13	6	3500	8511	Centerline	Dual	0.0005	0.0026	35.0	201.8
DC - 4 x 3 x 13	6	3500	9515	Centerline	Dual	0.0009	0.0054	35.0	263.8
DD - 6 x 4 x 13	6	3500	9098	Centerline	Dual	0.0002	0.0013	35.0	287.1
DE - 6 x 6 x 13	6	1750	8306	Centerline	Dual	0.0002	0.0010	35.0	310.3
DF - 8 x 6 x 13	6	1750	7130	Centerline	Dual	0.0003	0.0016	35.0	310.3
DG - 10 x 8 x 13	6	1750	6728	Centerline	Dual	0.0004	0.0023	35.0	418.9
DH – 12 x 10 x 13	6	1750	6215	Centerline	Dual	0.0008	0.0043	35.0	418.9
ED- 6 x 4 x 16	8	1750	8223	Centerline	Dual	0.0001	0.0005	19.5	563.6
EA- 8 x 6 x 16	8	1750	7885	Centerline	Dual	0.0001	0.0011	19.5	647.3
EB - 10 x 8 x 16	8	1750	9053	Centerline	Dual	0.0001	0.0012	19.5	595.9
EE - 12 x 10 x 16	8	1750	7840	Centerline	Dual	0.0001	0.0006	19.5	722.6
EC - 14 x 12 x 16	8	1750	7752	Centerline	Dual	0.0004	0.0035	19.5	849.4
FA - 8 x 6 x 20	8	1750	7478	Centerline	Dual	0.0001	0.0012	19.5	1232.0
FB - 10 x 8 x 20	8	1750	7288	Centerline	Dual	0.0002	0.0018	19.5	1495.0
FC - 12 x 10 x 20	8	1750	6714	Centerline	Dual	0.0003	0.0026	19.5	1859.0
FD - 14 x 12 x 20	8	1750	6075	Centerline	Dual	0.0005	0.0039	19.5	2298.0

Table 6. Key Mechanical Data

Item		Bearing Frame				
		3	4	5	6	8
Max power (BHP)	@ 3500 RPM	150	240	550	550	-
	@ 1750 RPM	75	120	275	275	1500
	@ 1150 RPM	50	80	180	180	1000
Bearing type -	radial bearing	6211	6211	6213	6213	6219
	thrust bearing	7311	7311	7313	7313	7318
Lubrication method (standard)		Oil - ISO Grade 68				
L_{10} bearing life (hrs) -	radial	50,000				
	thrust	50,000				
Radial to thrust bearing centerline (in.)		5.192	5.192	8.939	8.939	13.198
Shaft diameter (in.)	@ coupling	1.375	1.375	2.000	2.000	3.000
	@ impeller hub (standard ext.)	1.000	1.375	1.375	1.875	2.375
	@ radial bearing	2.166	2.166	2.559	2.559	3.741
	@ thrust bearing	2.166	2.166	2.559	2.559	3.544
	@ seal box	1.575	1.968	2.362	2.500	3.543
Coupling Key –	width (in.)	0.313	0.313	0.500	0.500	0.750
	length (in.)	2.625	2.625	2.000	2.000	5.000

Table 7.

Permissible Nozzle Loads



Pump Size	Suction						Discharge					
	Fx	Fy	Fz	Mx	My	Mz	Fx	Fy	Fz	Mx	My	Mz
AA- 1½ x 1 x 6	200	160	130	340	170	260	160	130	200	340	170	200
AB - 2 x 1½ x 6	200	160	130	340	170	260	160	130	200	340	170	200
AC- 3 x 1½ x 6	300	240	200	700	350	530	160	130	200	340	170	200
AD - 3 x 2 x 6	300	240	200	700	350	530	160	130	200	340	170	200
AE - 4 x 3 x 6	400	320	260	980	500	740	240	200	300	700	350	530
BA - 1½ x 1 x 8	200	160	130	340	170	260	160	130	200	340	170	200
BB - 2 x 1½ x 8	200	160	130	340	170	260	160	130	200	340	170	200
BC - 3 x 1½ x 8	300	240	200	700	350	530	160	130	200	340	170	200
BD - 3 x 2 x 8	300	240	200	700	350	530	160	130	200	340	170	200
BE – 4 x 3 x 8	400	320	260	980	500	740	240	200	300	700	350	530
BF - 6 x 4 x 8	700	560	460	1700	870	1,300	320	260	400	980	500	740
CA – 2 x 1½ x 10	200	160	130	340	170	260	160	130	200	340	170	200
CB - 3 x 1½ x 10	300	240	200	700	350	530	160	130	200	340	170	200
CC - 3 x 2 x 10	300	240	200	700	350	530	160	130	200	340	170	200
CD - 4 x 3 x 10	400	320	260	980	500	740	240	200	300	700	350	530
CE - 6 x 4 x 10	700	560	460	1700	870	1,300	320	260	400	980	500	740
CF - 6 x 6 x 10	700	560	460	1700	870	1,300	560	460	700	1700	870	1300
CG - 8 x 6 x 10	1100	850	700	2600	1,300	1,900	560	460	700	1700	870	1300
DA - 2 x 1½ x 13	200	160	130	340	170	260	160	130	200	340	170	200
DB - 3 x 2 x 13	300	240	200	700	350	530	160	130	200	340	170	200
DC - 4 x 3 x 13	400	320	260	980	500	740	240	200	300	700	350	530
DD - 6 x 4 x 13	700	560	460	1700	870	1,300	320	260	400	980	500	740
DE - 6 x 6 x 13	700	560	460	1700	870	1,300	560	460	700	1700	870	1300
DF - 8 x 6 x 13	1100	850	700	2600	1,300	1,900	560	460	700	1700	870	1300
DG - 10 x 8 x 13	1500	1200	1000	3700	1800	2800	850	700	1100	2600	1,300	1,900
DH – 12 x 10 x 13	1800	1500	1200	4500	2200	3400	1200	1000	1500	3700	1800	2800
ED- 6 x 4 x 16	700	560	460	1700	870	1,300	320	260	400	980	500	740
EA- 8 x 6 x 16	1100	850	700	2600	1,300	1,900	560	460	700	1700	870	1300
EB - 10 x 8 x 16	1500	1200	1000	3700	1800	2800	850	700	1100	2600	1,300	1,900
EE - 12 x 10 x 16	1800	1500	1200	4500	2200	3400	1200	1000	1500	3700	1800	2800
EC - 14 x 12 x 16	2000	1600	1300	4700	2300	6300	1,500	1200	1800	4500	2200	3400
FA - 8 x 6 x 20	1100	850	700	2600	1,300	1,900	560	460	700	1700	870	1300
FB - 10 x 8 x 20	1500	1200	1000	3700	1800	2,870	850	700	1100	2600	1,300	1,900
FC - 12 x 10 x 20	1800	1500	1200	4500	2200	3400	1200	1000	1500	3700	1800	2800
FD - 14 x 12 x 20	2000	1600	1300	4700	2300	6300	1,500	1200	1800	4500	2200	3400

9. 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 damages or shortages to the carrier's agent or factory. Claims that are made at a later time cannot be accepted.

9.1 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.

9.2. Inspection upon Arrival

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.

9.3. 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.

A pump which is made of iron or steel 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.

9.4. 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 6 and Figure 7 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 4, 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 5, 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 4, 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.

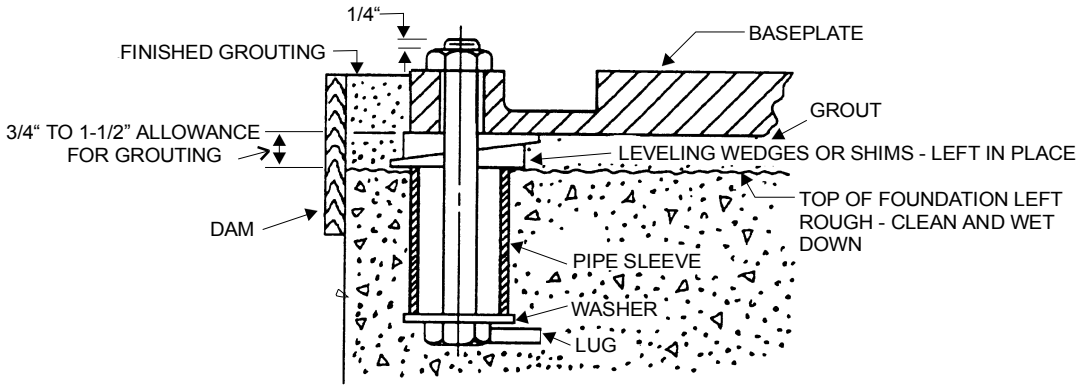


Figure 4. Grouting and Foundation Bolting

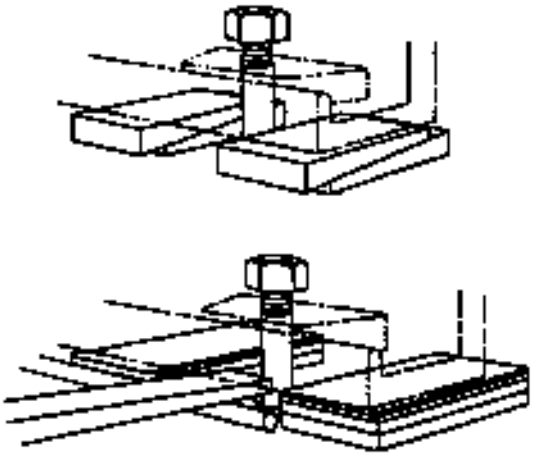


Figure 5. Unit Leveling

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 6, 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 7, 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.

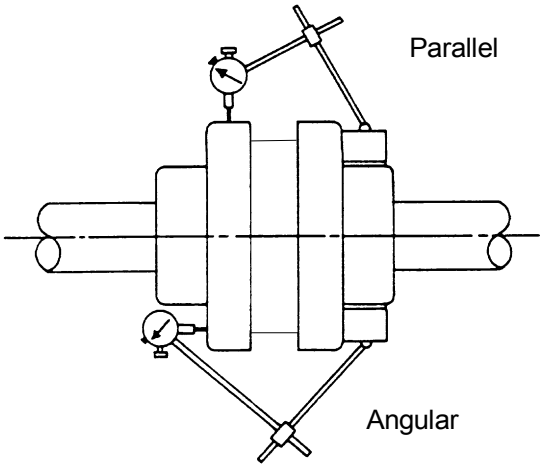


Figure 6. Coupling Alignment

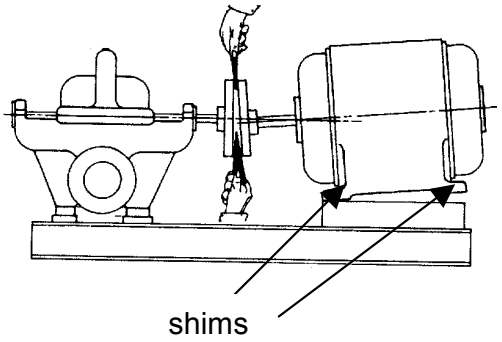


Figure 7. Adjusting Alignment

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.

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 7.

6. Auxiliary Piping Connections and Gauges

Any auxiliary piping connections and gauges should be installed now. Refer to vendor seal drawing for seal line connections to the seal cartridge.

III. Operation

1. Method of Operation

Pumped fluid enters suction and passes into the impeller, which propels the fluid into the discharge case and finally 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 the pump and driver 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.
6. Dry running may result in pump seizure or mechanical seal failure.

7. Pumps are shipped with no oil in the bearing frame. Adequate lubrication with ISO Grade 68 oil is essential at all times. Refer to Table 2, Oil Recommendations, for specific oil types. Turn on oil mist system*, wait for proper oil quantity and check monitoring system.
8. If necessary, turn on cooling lines to check for sufficient flow. Refer to Table 3 for minimum cooling flow rates.

3. Start-Up

Before starting the pumping unit, refer to the safety precautions in Section I. Refer to 5. below 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 5. below for 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. Partially 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.

5. Minimum/Maximum Flow Calculation.

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

Qmin = 0.1 x Qopt for short operation
Qmin = 0.3 x Qopt for continuous operation
Qmax = 1.1 x Qopt for 2-pole operation
Qmax = 1.25 x Qopt for 4-pole operation
Qopt = optimum efficiency

The data above refers 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.

$T_o = T_f + \Delta T$

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

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	[-]
Δ T Temperature difference	[°C]

6. Operating Checks

1. Check for undue vibration or noise. If any occurs and does not stop within a short period of time, turn off the pump. For determination of the cause and its remedy refer to "Troubleshooting" in section V or consult a Carver Pump Company representative.
2. Check mechanical seals for leakage.
3. If unit is equipped with seal cooling lines, check for adequate lubricating liquid flow to the seal.
4. Check that pump is operating within design criteria and perimeters.
5. Check and record bearing temperature. It should not exceed 185 degrees F. Both radial and thrust bearing temperatures should be measured and recorded at a minimum of 15 minute intervals until bearing temperatures stabilize. Stabilization of bearing temperature can be defined as the results of three consecutive readings at approximately 15 minute intervals with no temperature rise.
6. Check and record amp draw of the driver.
7. If unit is equipped with a constant level oiler, check oil level in the constant level oiler and refill as required.

7. Stopping the Pump

1. Begin to partially close discharge valve.
2. Tag out and lock power to driver according to OSHA Standard 1910.147 or applicable local laws and regulations.
3. Completely close discharge and suction valves.
4. If unit is equipped with seal cooling lines, turn off external cooling water line to seal. For information regarding seal circulation refer to "mechanical seal*" appendix.

When pump is handling hazardous fluid, extreme care must be taken to ensure safety of personnel when attempting to drain pump. Suitable protection devices should be used and/or protective clothing should be worn.
Remove casing plug to drain casing. Drain all piping if there is a possibility of liquid freezing. Provide pump and driver with a protective cover.

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 8, Pumping Unit Troubleshooting, to eliminate the most common causes of those problems, or contact a representative from Carver Pump Company.

Table 8. 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. Motor Running on two phases only	1.replace defective fuse 2. check electrical cable connections
		9. Excessive wear of internal parts.	1. Disassemble pump and replace worn parts.
Leakage at case joints.	1. Stop driver.	1. 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 8. Pumping Unit Troubleshooting (CONT.)

Symptom	*Immediate Action*	*Probably Cause*	*Corrective Action*
		3. Unsuitable oil.	1. Check for incorrect oil.
		4. Over oiled bearings.	1. Remove excess oil.
		5. Insufficient oil to bearings.	1. Add 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. Trim one or more impellers. c. Install more powerful driver. Consult Carver Pump Company specifying exact operating conditions.

Table 8. 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.

Parts marked with * are options or vary by pump or bearing frame size.

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. If equipped with a constant level oiler, check oil level in the constant level oiler and refill as required. Insure proper oil mist 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 1.5 overall displacement (unfiltered) peak to peak mils (0.001") at 3600 RPM and 3.0 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.

25000 Hours
- Replace roller bearings.
- Inspect casings for corrosion, erosion or other damage. 3mm limit of metal loss in casing and backhead (Items 1 and 11).

2. Bearings

The thrust bearings are installed back-to-back. Always replace the roller bearings when disassembling unit for seal service.

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 (420) at the bottom of the bearing frame (19). Add oil to bearing frame (19) through breather vent (45) until oil is at the center of the bullseye sight (143). Use bullseye sight (143) to check oil level in bearing frame (19). Refer to Section I, paragraph 7, Oil Lube Recommendations. Carver recommends changing the oil every 4,000 service hours under normal conditions.

3. Torque Values

Refer to Table 9, 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 tightened evenly and in stages. Refer to your torque wrench manual for the proper use of your wrench.

The Impeller Nut is to have 30 ft-lbs torque while holding the coupling end of the shaft.

Table 9. 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
5/8-11 UNC	65
3/4-10 UNC	110
7/8-9 UNC	150

4. Disassembly and Assembly Preparations

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 10, 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 clean, flat surface.

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

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


Factory Authorized parts must be used to safely maintain your CARVER Pump.

Table 10. Recommended Tools

Tools	*Materials*	*Testing Equipment*
Spanner wrench	Oil	Coupling alignment gauges
Rawhide or wood mallet	O-ring Lubricant	Volt-Amp Meter
Wooden wedge		
Allen wrench set		
Socket, open, & box wrench set		
Vice grips		
Torque Wrench		
Bearing Heater		

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.

Before attempting to disassemble the pump, the electrical power supply to 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.

Properly decontaminate pump and piping before disconnecting unit. Applicable hazardous material procedures must be followed.

3. Disconnect suction, discharge, and gauge lines. Disconnect auxiliary connections, as applicable.

4. Drain casing by removing pipe plug (422)*. If necessary, flush pump to remove corrosive or toxic pumpage. Reinstall pipe plug (422) in casing (1) when fluid has completely drained.

5. Drain oil from bearing frame (19). If a constant level oiler (143) provides lubrication for bearings, drain oil from the bearing frame by removing pipe plug (420) at bottom of bearing frame (19). If bearings are oil mist lubricated, drainage of bearing frame (19) is continuous.

6. Remove coupling guard. Uncouple the pump from the driver.

Use of a hoist with adequate capacity is recommended for removing the pump from the base. See Section I.3.

6. 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. 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 worn or damaged.

4. Inspect impeller for pitting, erosion, or clogged vanes. Replace an impeller that is damaged. If a new impeller is installed, check to make sure that it is balanced and of the correct trim.

5. Inspect casing and backhead for pitting, corrosion and erosion. The maximum allowable depth is 1/8" (3mm).

6. This pump is equipped with metal wear rings. These are available 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 11 for specified clearance of wear rings. Wear ring should be renewed when the measured clearance is twice that given in table 11.
   d. If wear ring replacement is required, replace wear rings as described in paragraph 6 of this section.

6. Wear Ring Replacement

NOTE

Refer to Section I, paragraph 2, Safety Precautions, before disassembling pump.

When pump is handling hazardous fluid, extreme care must be taken to ensure safety of personnel when attempting to drain pump. Suitable protection devices should be used and/or protective clothing should be worn.

The API Maxum pump has a replaceable wear ring (7) inserted in the casing (1) and a replaceable wear ring (7X) inserted in the backcover (11).

The wear ring clearances will increase with wear. Internal leakage will result and pump performance will decrease. The allowable clearance and method of measurement is described in paragraph 5.6 of the precceding section.

6.1 Casing Wear Ring (7).

The casing (1) must be removed from the base to replace the wear ring (7) in casing (1). To replace the wear ring (7) in the casing (1) follow these steps:

1. Disconnect suction and discharge piping. Unbolt casing (1) from base and take casing (1) and impeller (2) to a work area with access to machine shop equipment.
2. Remove setscrews (667) from wear ring (7). Remove the wear ring (7) from the casing (1). This can best be accomplished on a lathe. Take this work to a machine shop.
3. Press the new wear ring (7) into casing (1). The beveled edge of the wear ring (7) is installed away from the impeller.
4. Drill and tap two holes 180 degrees apart along edge of wear ring (7). Secure new wear ring (7) to casing (1) by inserting setscrews (667) into these holes.
5. Place impeller (2) on an arbor and mount between centers in a lathe or a grinder. Indicate impeller hub to within 0.002 TIR maximum to be sure the arbor and impeller are running square.
6. Turn the wear ring surface of impeller (2) until a 63 RMS or better finish is obtained.
7. Measure the outside diameter of the front impeller wearing and record this value. See measurement instructions in Section V, paragraph 5 above.
8. Mount the casing (1) with new wear ring (7) installed in a lathe. Indicate female rabbet to within 0.002 TIR maximum.

Note

When replacing wear ring with the standard wear ring, (part number beginning with "00") machining in step 9 is not required. When replacing wear ring with the undersize wear ring (part number beginning with "US") machining in step 9 is required.

9. If replacing with an undersize wear ring, bore wear ring (7) to within the specified tolerance listed in table 11 over the recorded size of the outside diameter of the front impeller wearing surface.
10. Reinstall casing (1) on base and secure with fastener. Reconnect suction and discharge piping.

6.2 Backcover Wear Ring (7X) .

To replace the wear ring (7X) in the backcover (11) follow these steps:

1. If pump is not disassembled, disassemble pump according to section V, paragraph 7, steps 1 through 4 to remove backcover (11).
2. Remove setscrews (667) from wear ring (7X). Remove the wear ring (7X) from the backcover (11). This can best be accomplished on a lathe. Take this work to a machine shop.
3. Press the new wear ring (7X) into backcover (11). The beveled edge of the wear ring (7X) is installed towards the impeller wearing surface.
4. Drill and tap two holes 180 degrees apart along edge of each wear ring (7X). Secure new wear ring (7X) to backcover (11) by inserting setscrews (667) into these holes.
5. Place impeller (2) on an arbor and mount between centers in a lathe or a grinder. Indicate back of impeller hub to within 0.002 TIR maximum to be sure the arbor and impeller are running square.
6. Turn the wear ring surface of impeller (2) until a 63 RMS or better finish is obtained.
7. Measure the outside diameter of the back impeller wearing surface and record this value. See measurement instructions in Section V paragraph 5.
8. Mount the backcover (11) with new wear ring (7X) installed in a lathe. Indicate male rabbet to within 0.002 TIR maximum.

NOTE

When replacing wear ring with the standard wear ring, part number beginning with "00" machining in step 9 is not required. When replacing wear ring with the undersize wear ring, part number beginning with "US" machining in step 9 is required.

9. If replacing with an undersize wear ring, bore wear ring (7X) to within the specified tolerance listed in table 11 over the recorded size of the outside diameter of the back impeller wearing surface.
10. Reassemble pump according to section V, section 7.2.

Table 11. Maximum Wear Ring Clearances

Pump Size	Factory Standard Diameteric Clearance	
	Minimum	*Maximum*
AA- 1½ x 1 x 6	0.012	0.017
AB - 2 x 1½ x 6	0.015	0.020
AC- 3 x 1½ x 6	0.014	0.019
AD - 3 x 2 x 6	0.016	0.021
AE - 4 x 3 x 6	0.016	0.021
BA - 1½ x 1 x 8	0.012	0.017
BB - 2 x 1½ x 8	0.012	0.017
BC - 3 x 1½ x 8	0.014	0.019
BD - 3 x 2 x 8	0.016	0.021
BE – 4 x 3 x 8	0.017	0.022
BF - 6 x 4 x 8	0.017	0.022
CA – 2 x 1½ x 10	0.012	0.017
CB - 3 x 1½ x 10	0.015	0.020
CC - 3 x 2 x 10	0.016	0.021
CD - 4 x 3 x 10	0.017	0.022
CE - 6 x 4 x 10	0.018	0.023
CF - 6 x 6 x 10	0.018	0.023
CG - 8 x 6 x 10	0.019	0.024
DA - 2 x 1½ x 13	0.016	0.021
DB - 3 x 2 x 13	0.016	0.021
DC - 4 x 3 x 13	0.017	0.022
DD - 6 x 4 x 13	0.018	0.023
DE - 6 x 6 x 13	0.018	0.023
DF - 8 x 6 x 13	0.020	0.025
DG - 10 x 8 x 13	0.021	0.026
DH – 12 x 10 x 13	0.023	0.028
ED- 6 x 4 x 16	0.018	0.023
EA- 8 x 6 x 16	0.020	0.025
EB - 10 x 8 x 16	0.021	0.026
ED - 12 x 10 x 16	0.023	0.028
EC - 14 x 12 x 16	0.024	0.029
FA - 8 x 6 x 20	0.020	0.025
FB - 10 x 8 x 20	0.021	0.026
FC - 12 x 10 x 20	0.023	0.028
FD - 14 x 12 x 20	0.025	0.030

7. Pump Disassembly and Assembly

The instructions that follow are an aid for properly trained personnel to service your Carver Pump. These instructions refer to Figures 8 and 9 as an example. If a specific sectional assembly drawing exists for a particular job then that drawing should be referred to for service work.

Parts marked with * are options or vary by pump or bearing frame size.

7.1 DISASSEMBLY

Read this entire section and study figures 8 and 9 before disassembling the pump.

NOTE

Refer to Section I, paragraph 2, Safety Precautions, before disassembling pump.

When pump is handling hazardous fluid, extreme care must be taken to ensure safety of personnel when attempting to drain pump. Suitable protection devices should be used and/or protective clothing should be worn.

NOTE

The individual components should be unscrewed or removed.

Use of a hoist with adequate capacity is recommended for lifting. See Section I.3 for instructions.

1. Remove coupling guard (131) and disconnect coupling halves. Remove coupling spacer between coupling halves.

2. Remove nuts (616) and lockwashers (655) from studs (631 & 631X) fastening casing (1) to backhead (11). Use forcing screws (610) to loosen rabbet fit of backhead (11) and casing (1). Pull rotating element back from casing (1) and take it to a suitable work area.

3. Remove impeller nut (24) and washer (28). Pull impeller (2) from shaft (6).

4. For Cartridge seals, reinstall seal clip and loosen setscrews hold the cartridge seal sleeve to shaft (6). Remove bolts (600) holding backcover (11) to bearing frame (19) and remove backcover. Remove nut (615) and remove seal (90) from backhead (11).

NOTE

Refer to Mechanical Seal vendor instructions for proper seal removal procedure.

5. Remove capscrews (601) fastening bearing cap (35) to bearing frame (19). Remove bearing cap (35) and inboard magnetic seal or labyrinth seal (47) from shaft (6). Remove gasket (73) from between bearing cap (35) and bearing frame (19).

Handle inboard magnetic seal or labyrinth seal (47) with care. Mishandling could damage faces of magnetic seal or labyrinth seal (47).

6. If necessary, remove inboard magnetic seal or labyrinth seal (47) from bearing cap (35). If necessary, remove inboard magnetic seal housing (311)* (if equipped) from bearing cap (35).

NOTE

It is not normally necessary to remove the inboard magnetic seal housing (311)*

7. Remove pump coupling halves and coupling key (46).

8. Remove nuts (603), lockwashers (651) and washers (640), fastening bearing cap (37) and fan guard (131) to bearing frame (19) and remove guard. Loosen setscrews (668) and remove fan (40) from shaft (6). Remove fan key (32F) from shaft (6). Remove bearing cap (37) and outboard magnetic seal or labyrinth seal (49) from shaft (6).

9. Remove o-ring (89-C) from bearing frame (19).

Handle outboard magnetic seal or labyrinth seal (49) with care. Mishandling could damage faces of magnetic seal or labyrinth seal (49).

10. Remove outboard magnetic seal or labyrinth seal (49) from bearing cap (37). If necessary, remove outboard magnetic seal

housing (310)* (if equipped) from bearing cap (43).

NOTE

It is not normally necessary to remove the outboard magnetic seal housing (310)*

11. Remove shaft (with radial and thrust bearing assemblies) from outboard end of bearing frame (19).

12. Un-crimp tang on bearing lockwasher (69). Remove bearing locknut (22) and bearing lockwasher (69).

NOTE

It is recommended that bearings removed from the shaft be replaced.

13. If desired, pull thrust bearing (18) from shaft (6).

14. If desired, pull radial bearing (16) from shaft (6).

7.2 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 clean, flat surface. Carver recommends all nuts and bolts be tightened according to Table 9, Recommended Torque Values. Check to make sure components are fitted in correct sequence. Perform the following procedures to assemble the pumping unit:

NOTE

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

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 2.

After 25000 Hours of service replace the roller bearings.

1. If removed, press thrust bearings (18) on shaft (6). A bearing heater is recommended for installation. Secure thrust bearing (18) with bearing lockwasher (69) and bearing locknut (22). Crimp tang of lockwasher (69) in groove provided in bearing locknut (22).

2. If removed, press radial bearing (16) on shaft (6). A bearing heater is recommended for installation.

3. Install shaft (6) in bearing frame (19).

4. Install new o-ring (89C) in groove provided around outboard end of bearing frame (19).

5. If removed, press outboard magnetic seal housing (310)* (if equipped) into bearing cap (43). Install outboard magnetic seal or labyrinth seal (49) in bearing cap (37).

Handle outboard magnetic seal or labyrinth seal (49) with care. Mishandling could damage faces of magnetic seal or labyrinth seal (49).

6. Reinstall bearing cap (37) on shaft (6).

7. Reinstall fan (40) over key (32F) on shaft (6), with setscrews (668). Install fan shroud with nuts (603), lockwashers (651) and washers (640)

8. Press inboard magnetic seal housing (311)* (if equipped) in bearing cap (35). Install inboard magnetic seal or labyrinth seal (47) in bearing cap (35).

Handle inboard magnetic seal or labyrinth seal (47) with care. Mishandling could damage faces of magnetic seal or labyrinth seal (47).

9. Install new gasket (73) on bearing cap (35). Reinstall bearing cap (35) on shaft (6). Secure bearing cap (35) to bearing frame (19) with capscrews (601).

10. Install seal (90) on backhead (11) with nut (615). Mount backcover (11) to frame (19) with nut (617) and lockwasher (656).

NOTE

Refer to Mechanical Seal vendor instructions for complete seal installation procedure.

11. Reinstall impeller key (32) in keyway on shaft (6).
12. Reinstall impeller (2) on shaft (6). Secure impeller (2) with impeller nut (24) and impeller washer (28).
13. Insure new gasket (73C)* or o-ring (89A)* is installed on casing (1).
14. Reinstall rotating element in casing (1). Secure backhead (11) to casing (1) with nuts (616) and lockwashers (655) on studs (631 & 631X).
15. Rotate shaft (6) by hand to insure shaft (6) rotates freely and no rubbing noises are present.
16. Reinstall coupling. Align coupling according to section II, paragraph 4. Reinstall coupling guard.
17. Remove all tags from valves and switches.
18. Start pumping unit in accordance with section III.

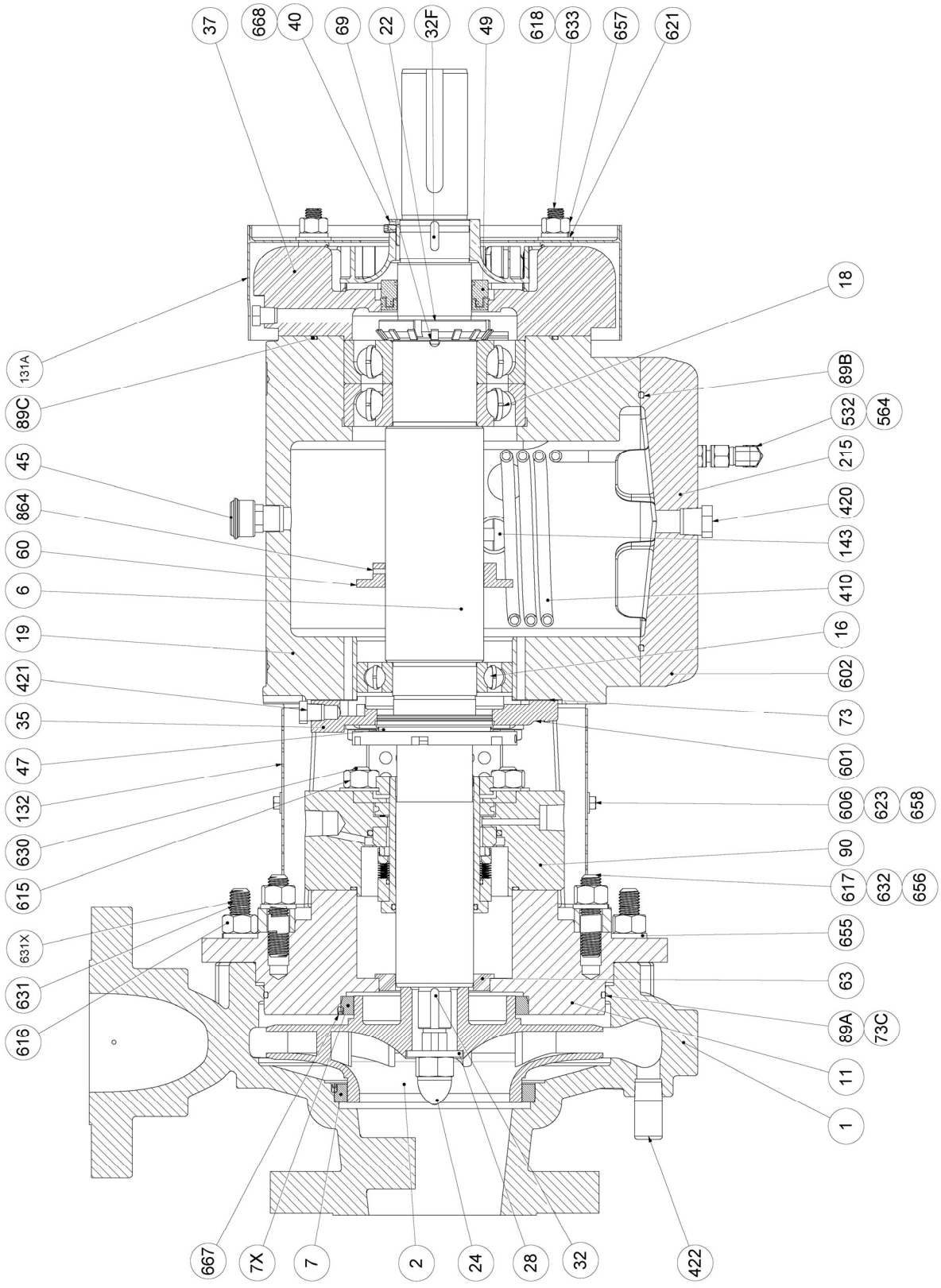


Figure 8 Sectional Assembly – Bare Pump

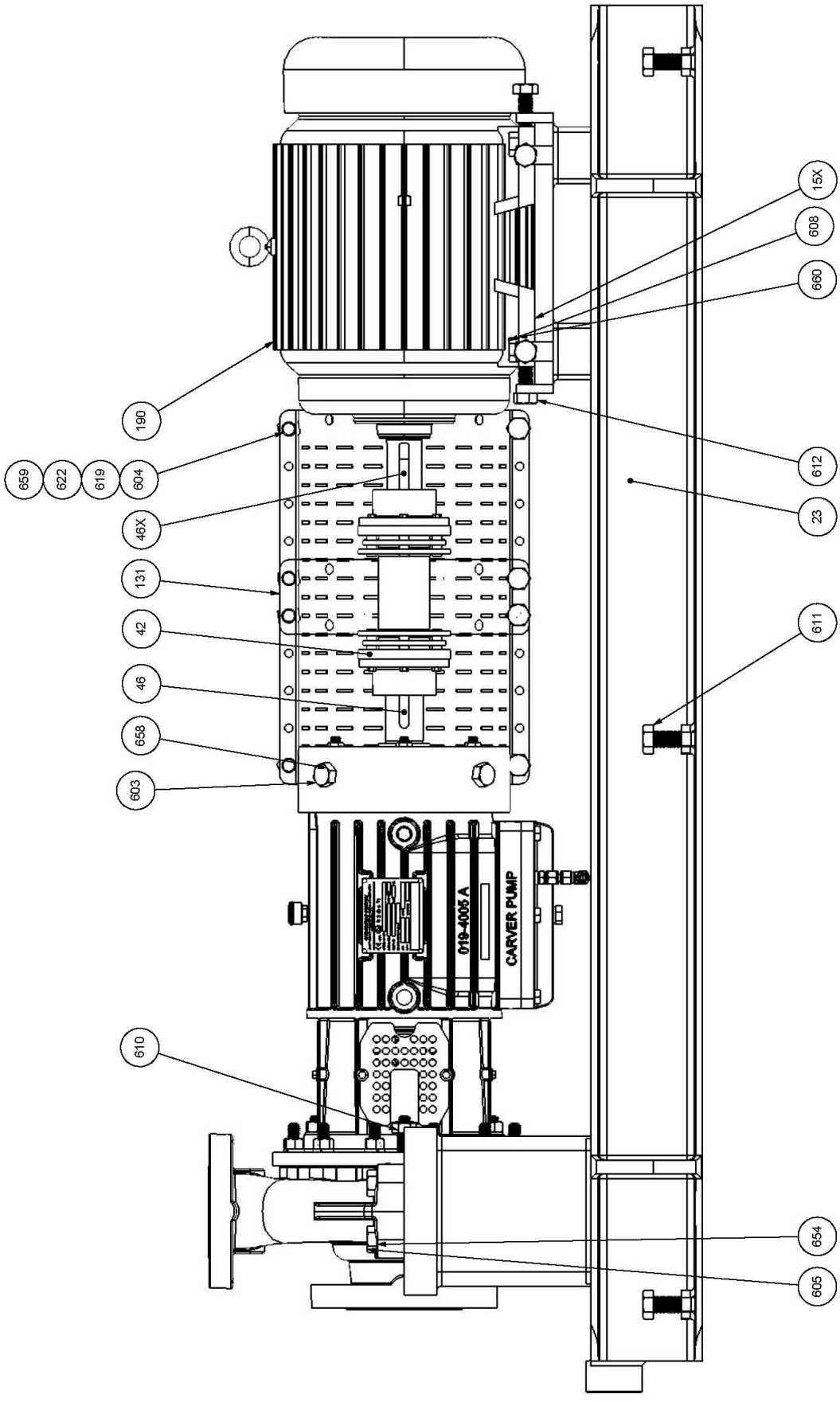


Figure 9 – Pump with Base

Table 12 - Parts List

Item No.	*Description*
1	Volute
2	Impeller
6	Shaft
7	Wear Ring – Case
7X	Wear Ring - Backhead
11	Backhead
15X	Shim – Motor / Base
16	Ball Bearing, Radial
18	Ball Bearing, Thrust
19	Bearing Frame
22	Bearing Locknut
23	Base
24	Impeller Nut
28	Impeller Washer
32	Key, Impeller
32F	Key, Fan
35	Bearing Cap, Inboard
37	Bearing Cap, Outboard
40	Fan, Frame Cooling
42	Coupling
45	Vent Breather
46	Coupling Key - Pump
46X	Coupling Key - Motor
47	Bearing Isolator – IB
49	Bearing Isolator – OB
60	Oil Flinger
69	Bearing Lockwasher
73	Gasket, Frame - Cap
*73C	Gasket, Casing
89A	O-Ring, Backcover-Case
89B	O-Ring, Oil Pan
89C	O-Ring, Bearing Cap
90	Mechanical Seal
131	Guard, Coupling
131A	Fan shroud
132	Guard, Seal
143	Oiler
190	Electric Motor
215	Oil Pan
310**	Housing – Magnetic Seal
311**	Housing – Magnetic Seal

Item No.	*Description*
410	Tubing - Cooler
420	Pipe Plug – Bearing Frame
421	Pipe Plug – Oil Mist Port
422	Drain Plug - Case
532	Male Connecter - BT
564	Male Connecter - 90 degrees
601	Capscrew – I.B Cap / Frame
602	Capscrew – Oil Pan
603	Capscrew – Fan Shroud / Guard
604	Bolt – Coupling Guard
605	Bolt – Coupling Guard
606	Capscrew – Seal Guard
608	Bolt – Motor / Base
610	Forcing Bolt
611	Foot Leveling Bolt
612	Adjusting Bolt - Motor
615	Hex Nut – Seal
616	Hex Nut – Volute
617	Hex Nut - Backhead
618	Hex Nut – Fan Shroud
619	Hex Nut – Coupling Guard
621	Flatwasher – Fan Shroud
622	Flatwasher – Coupling Guard
623	Flatwasher – Seal Guard
630	Stud – Seal
631	Stud – Volute / Adaptor
631X	Stud – Volute / Adaptor (Guide)
632	Stud – Backhead
633	Stud – Bearing Cap
654	Lockwasher – Volute / Base
655	Lockwasher – Volute / Backhead
656	Lockwasher – Adaptor / Frame
657	Lockwasher – Cap / Frame
658	Lockwasher – Seal Guard
659	Lockwasher – Coupling Guard
660	Lockwasher – Motor / Base
667	Setscrew – Wear Ring
668	Setscrew – Fan
864	Setscrew – Flinger
*890**	Vibration Transmitter, RTD, ETC

***** Options ****** Not Shown

Table 13. Recommended Spare Parts

Quantity	*Item No.*	*Description*
1	2	Impeller
1	7	Wear Ring
1	7X	Wear Ring
1	16	Ball Bearing, Suction End
2	18	Ball Bearing, Discharge End
1	22	Bearing Locknut
1	28	Washer
1	32	Key, Impeller
1	46	Key, Coupling
1	47	Bearing Isolator - IB
1	49	Bearing Isolator - OB
2	69	Bearing Lockwasher
2	73	Gasket, Frame – I.B. Bearing Cap
2	*73C	Gasket, Casing
2	89A	O-Ring, Backcover-Case
2	89C	O-Ring, Bearing Cap
2	89D	O-Ring, Oil Pan
1	90	Mechanical Seal

* Options

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