CleaverBrooks®

Packaged Boiler Feed Systems

Installation, Operation, and Maintenance

750-180
09/07

⚠ WARNING

DO NOT OPERATE, SERVICE, OR REPAIR THIS EQUIPMENT UNLESS YOU FULLY UNDERSTAND ALL APPLICABLE SECTIONS OF THIS MANUAL.

DO NOT ALLOW OTHERS TO OPERATE, SERVICE, OR REPAIR THIS EQUIPMENT UNLESS THEY FULLY UNDERSTAND ALL APPLICABLE SECTIONS OF THIS MANUAL.

FAILURE TO FOLLOW ALL APPLICABLE WARNINGS AND INSTRUCTIONS MAY RESULT IN SEVERE PERSONAL INJURY OR DEATH.

TO: Owners, Operators and/or Maintenance Personnel

This operating manual presents information that will help to properly operate and care for the equipment. Study its contents carefully. The unit will provide good service and continued operation if proper operating and maintenance instructions are followed. No attempt should be made to operate the unit until the principles of operation and all of the components are thoroughly understood. Failure to follow all applicable instructions and warnings may result in severe personal injury or death.

It is the responsibility of the owner to train and advise not only his or her personnel, but the contractors' personnel who are servicing, repairing or operating the equipment, in all safety aspects.

Cleaver-Brooks equipment is designed and engineered to give long life and excellent service on the job. The electrical and mechanical devices supplied as part of the unit were chosen because of their known ability to perform; however, proper operating techniques and maintenance procedures must be followed at all times. Although these components afford a high degree of protection and safety, operation of equipment is not to be considered free from all dangers and hazards inherent in handling and firing of fuel.

Any "automatic" features included in the design do not relieve the attendant of any responsibility. Such features merely free him of certain repetitive chores and give him more time to devote to the proper upkeep of equipment.

It is solely the operator's responsibility to properly operate and maintain the equipment. No amount of written instructions can replace intelligent thinking and reasoning and this manual is not intended to relieve the operating personnel of the responsibility for proper operation. On the other hand, a thorough understanding of this manual is required before attempting to operate, maintain, service, or repair this equipment.

Because of state, local, or other applicable codes, there are a variety of electric controls and safety devices which vary considerably from one boiler to another. This manual contains information designed to show how a basic burner operates.

Operating controls will normally function for long periods of time and we have found that some operators become lax in their daily or monthly testing, assuming that normal operation will continue indefinitely. Malfunctions of controls lead to uneconomical operation and damage and, in most cases, these conditions can be traced directly to carelessness and deficiencies in testing and maintenance.

It is recommended that a boiler room log or record be maintained. Recording of daily, weekly, monthly and yearly maintenance activities and recording of any unusual operation will serve as a valuable guide to any necessary investigation. Most instances of major boiler damage are the result of operation with low water. We cannot emphasize too strongly the need for the operator to periodically check his low water controls and to follow good maintenance and testing practices. Cross-connecting piping to low water devices must be internally inspected periodically to guard against any stoppages which could obstruct the free flow of water to the low water devices. Float bowls of these controls must be inspected frequently to check for the presence of foreign substances that would impede float ball movement.

The waterside condition of the pressure vessel is of extreme importance. Waterside surfaces should be inspected frequently to check for the presence of any mud, sludge, scale or corrosion.

It is essential to obtain the services of a qualified water treating company or a water consultant to recommend the proper boiler water treating practices.

The operation of this equipment by the owner and his or her operating personnel must comply with all requirements or regulations of his insurance company and/or other authority having jurisdiction. In the event of any conflict or inconsistency between such requirements and the warnings or instructions contained herein, please contact Cleaver-Brooks before proceeding.

CONTENTS

Section 1 - Installation, General Operation and Maintenance

⚠ Caution

Waterside care is of prime importance. For specific information or assistance with your water treatment requirements, contact your Cleaver-Brooks service and parts representative. Failure to follow these instructions could result in equipment damage

⚠ Caution

Inspection and maintenance should be performed only by trained personnel who are familiar with this equipment. Failure to follow these instructions could result in equipment damage

⚠ Warning

When replacing a control, be sure to lock out the main power supply switch since the control is “hot”. Failure to follow these instructions could result in serious personal injury or death.

⚠ Warning

Disconnect and lock out electrical power to the equipment before performing any maintenance or service work. Failure to follow these instructions can result in electrical shock and serious personal injury or death.

A. INSTALLING THE UNIT

1. Location

Install the unit in a clean, dry, ventilated, location which is accessible for inspection and care. The receiver inlet should be low enough to permit all return lines to empty by gravity to the receiver. No special foundation is necessary for the unit, although the floor or other surface upon which it is to be installed should be structurally sound and relatively smooth and level.

2. Installing Unit In Place

The unit should be anchored to the floor or foundation by means of suitable bolts or lag screws through the holes provided in the feet of the stand.

3. Return Piping

Connect the return line to the receiver tank with a gate valve and union installed in the line as close as possible to the tank.The union should be nearest to the tank.

4. Discharge Piping

Connect the discharge piping from the boiler to the pump discharge connection. A union, pressure gauge, swing check valve, throttling device, gate valve and flexible connector - in that order - should be installed in the discharge piping, with the union nearest to the pump. If the discharge piping is longer than 50 feet, the pipe diameter should be one or two sizes larger than the pump discharge. All piping should be properly supported independent of the receiver or pump so as to prevent strain on the unit. Do not force pipes or fittings into place. Pipe strain on the pump causes misalignment in the coupling, which is harmful to the coupling and bearings and can eventually cause their failure.

5. Makeup Water Valve

Receivers are typically supplied with a float switch that activates a solenoid valve for make-up water. Prior to commissioning, the external shipping bar should be removed. The positioner then can be set for actual water level control. Follow the manufacturer's instructions on the switch for further details.

Receivers alternatively may be furnished with a float type makeup valve. On package type units, the valve is mounted on the tank ready to be connected to the makeup water supply line. Be sure to release the float from its shipping position by removing the wire found coming up through one of the openings in the top of the receiver. If the valve is not mounted on the receiver tank, it will be necessary to assemble the valve and mounting plate and then mount the valve to the tank. When mounting the valve, screw the valve tightly onto the mounting plate (this is a steel plate with a pipe coupling welded into it). Screw the valve on so that when the plate is in place on the tank, the valve discharge opening is facing straight down. Next, run a hex nut onto each end of the float rod; these will serve as lock nuts. Then assemble the float rod and float to the operating arm of the valve - screw the float on until it is tight and then tighten the lock nuts against the float and the valve arm. Next, mount this entire assembly to the end of the tank using the supplied rubber gasket and hex head cap screws. Tighten the cap screws evenly for a water tight installation.

6. Makeup Water Piping

Connect the fresh water supply to the makeup water valve. Use pipe at least as large as the valve connection. On long runs it might be necessary to use pipe one or two sizes larger. A union, check valve, and gate valve (in that order) should be installed ahead of the makeup valve, with the union nearest to the makeup valve. Be sure all piping conforms with local plumbing code and/or other governing regulations.

7. Water Level Gauge

Water level gauges which are mounted on the tank before shipping should be checked to be sure the glass is in good condition and to be sure the drain petcock in the bottom fitting is closed. Gauges shipped separately should be mounted on the tank after the makeup valve is connected to reduce the possibility of damaging the gauges while working on the valve. Screw the fittings into the end of the tank in the l/2" pipe connections provided, making sure the fitting with the drain petcock is in the lower position. Remove the compression nut, brass washer, and rubber sleeve from each fitting. Slide each piece onto both ends of the glass in the same order so that at least one inch of the glass sticks out. Then set one end of the glass in place in one of the fittings and carefully fit the other end into the other fitting. Center the glass vertically between the bottoms of the fittings and tighten compression nuts to a snug fit. After the tank is filled, it may be necessary to retighten the compression nuts if the tank leaks. Be sure the petcock is closed. Put the guard rods in place on each side of the glass.

8. Vent

Install the vent pipe in the openings on the top of the receiver and extend the pipe at least to a point above the boiler water level. Pipe the vent to a safe point of discharge.

9. Overflow

An overflow pipe should be installed in the top opening in the end of the receiver, or in one of the openings in the top of the receiver, and extended to a suitable drain.

10. Drain

A gate valve should be installed in the bottom of the receiver and should be piped to a suitable drain.

11. Submerged Heater Tube or High Temperature Return Assemblies

A heater tube is not standardly furnished. It is installed in the lower connection in the end opposite of the makeup valve before shipment on package type units. To assemble units shipped loose, screw the perforated tube tightly into the double tapped bushing in the opening opposite the hex end. If the end of the tube does not have a welded cap, screw the pipe cap furnished tightly onto the end of the pipe. Insert the tube into the lower fitting in the end of the receiver opposite the makeup valve and screw the bushing tightly into the fittings. Ensure the "T" stamped in the top of the pipe is on top. Refer to the dimension drawings furnished by your local authorized Cleaver-Brooks Representative for the proper location. Connect steam to this bushing according to the plans and specifications of the heating engineer.

B. WIRING

All wiring should be done in accordance with local code or power company regulations. All units should be wired with a safety switch installed so the entire circuit can be shut off from motor, starter, and/or any other electrical controls or devices which may be installed as part of the unit.

Refer to the appropriate wiring diagram furnished by your local authorized Cleaver-Brooks Representative to assist in connecting electric service to the unit.

C. OPERATING THE UNIT

1. Before Starting Unit

1. Be sure the pump rotates freely when turned by hand.
2. Check the motor nameplate data to be sure voltage and cycle correspond to electric current connected to unit.
3. Be sure the makeup valve float is released from shipping position.
4. Before placing the unit into regular service, it is advisable to start it without load to determine that the wiring is correct.
5. The check valve in the discharge line must be installed in the proper position to open when pump is in operation. All gate valves in return and discharge lines must be fully opened.
6. The gate valve in the makeup water line must be open.
7. Set the circuit breaker or disconnect switch to the “on” position.

2. Starting

1. Check the pump rotation. It must be running in the same direction as indicated by the arrow on the pump. Some pumps may have 2 arrows on the pump. One indicates rotation and the other flow through the pump. Ensure that the correct arrow is used to check rotation.
2. Check the pressure gauge to see if the pump is operating. Make sure the pressure is set to the appropriate discharge pressure. If the pressure is higher or lower than it should be, adjust the throttling valve in the discharge line.
3. Check the temperature of the water being pumped. If it is higher than the temperature for which the unit was sold, it might cause a reduction of capacity or it might even stop pumping. If in doubt, consult your dealer or the representative in your area.
4. For feed systems with intermittent pump operation, check to see that the pump controller is operating properly as the boiler water level lowers and rises. If adjustment of the controller is necessary, follow the manufacturer's instructions.
5. After the unit has run for some time, check to see that the motor bearings are not overheating. If in doubt as to safe operating temperature, take the temperature of the motor and surrounding air and consult with the local sales office or service station of the motor manufacturer.

D. MAINTENANCE

Cleaver-Brooks Boiler Feed Units are designed to give long, trouble free service, if installed and operated under suitable conditions and given proper care. However, in time, it may become necessary to service or replace certain parts of the unit to maintain its peak performance. In this event, the following procedures should be followed.

1. Pump

Refer to the pump instruction sheets for complete maintenance instructions.

If it becomes necessary to remove the pump:

1. Break the electrical circuit to the unit by setting the circuit breaker or disconnect switch in the “off” position.
2. Close the gate valve in the return and discharge piping to avoid flooding the receiver or floor while the pump is out of service.
3. Close the gate valve in the suction (and recirculation if applicable) piping between the receiver tank and pump, if there is one; otherwise, drain the receiver. Then disconnect the union in the discharge piping. Remove the drain plug in the bottom of the suction strainer to drain the suction pipe.

4. Loosen the flange bolts on the pump suction and discharge ports.
5. Remove the cap screws or nuts holding the pump to the base and then, by pulling the pump out and away. The pump can then be removed.

2. Motor

The only maintenance required by the motor is periodic lubrication, which should be done in accordance with the motor manufacturer's instructions. If repairs are needed, refer to the nearest authorized service station or the motor.

To remove the motor from the unit:

1. Disconnect and lock out the electrical circuit to the unit by setting the circuit breaker or disconnect switch in “off” position; then disconnect all wire connections from the motor manufacturer.
2. Remove the cap screws holding the motor to the base.
3. Disconnect the coupling from the motor shaft.

3. Suction Strainer

If the boiler water is maintained in proper condition, the strainer will require little if any maintenance. However, it should be inspected occasionally to be sure the screen is not plugged up with scale or other foreign material. Depending on the individual installation, it may be necessary to clean the strainer screen every month, or only once or twice per year. After a few times, experience will indicate how often it should be cleaned.

To remove the screen for inspection or cleaning:

1. Close the gate valve in the suction piping or else close the gate valves in the return piping and drain the receiver.
2. Remove the drain plug in the bottom cover of the strainer.
3. Remove the cap screws holding the cover on the strainer and take off the cover and gasket.
4. Carefully pull out the screen. Thoroughly clean the screen or replace with a new one if the old one cannot be used. Reassemble the parts and tighten the cap screws evenly for a leak-proof seal.

4. Makeup Valve

Normally, the only maintenance required on a makeup valve is to replace the rubber disc in the valve plunger. The valve must be removed for this purpose. Close the gate valve in the makeup water supply line and disconnect the union between the makeup valve and gate valve. Next, close the gate valve in the return piping and drain the tank until the water level is below the makeup valve mounting flange. Remove the cap screws from the valve mounting plate and lift the entire valve and plate assembly out of the tank. To replace the rubber disc, disconnect the valve linkage and remove the plunger. Unscrew the disc retainer from the end of the plunger and replace the disc. Reassemble the valve linkage and replace the valve assembly on the tank.

5. Ordering Repair Parts

Furnish complete information when ordering parts; include the unit number of the packaged feed system as found on the name plate. State the Cleaver-Brooks part number and the name and description of the part required. Also state the quantity desired and specify method of shipment. Indicate date the material is required. If parts are required, such as electric motors, etc., be sure to give the complete name plate data from the accessory for which the parts are required.

Repair or replacement parts should be ordered from your Cleaver-Brooks representative.

Section 2 - Water Pumps

A. General Pump Operation

1. Discharge piping

Pipe, valves and fittings should be at least the same diameter as the discharge pipe or sized in accordance with good piping practices to reduce excessive fluid velocities and pipe friction losses. Pipe, valves and fittings must have a pressure rating equal to or greater than the maximum system pressure. It is recommended that the discharge piping be pressure checked to at least the maximum pressure the pump is capable of generating or as required by codes or local regulations. Operating pressure of the vessel must also be taken into consideration.

Whenever possible, avoid high pressure loss fittings, such as elbows or branch tees directly on either side of the pump. The piping should be adequately supported to reduce thermal and mechanical stresses on the pump. Good installation practice recommends the system be thoroughly cleaned and flushed of all foreign materials and sediment prior to pump installation. Due to the natural accumulation of dirt and sediment, the pump should never be installed at the lowest point of the system. If excessive sediment or suspended particles are present, a strainer or filter should be used. Grundfos recommends that pressure gauges be installed on inlet and discharge flanges or in pipes to check pump and system performance.

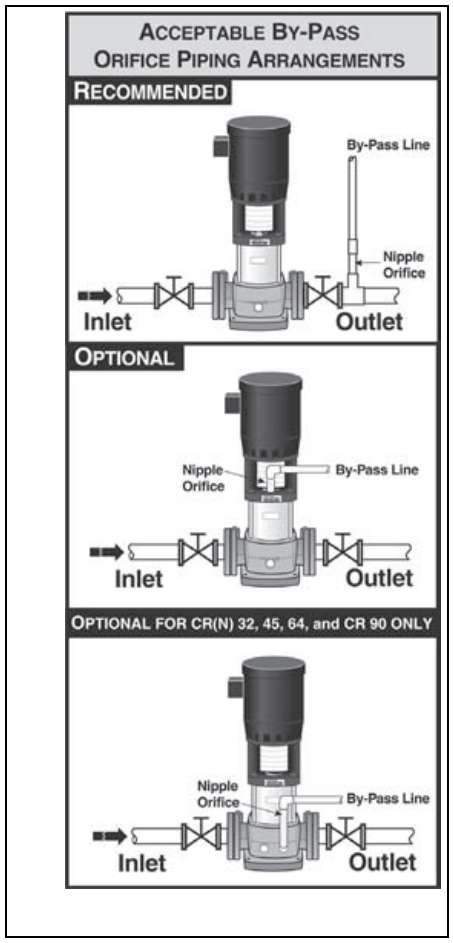


Figure 2-1

2. Check valves

A check valve may be required on the discharge side of the pump to prevent the pump's inlet pressure from being exceeded. For example, if a pump with no check valve is stopped because there is no demand on the system (all valves are closed), the high system pressure on the discharge side of the pump will "find" its way back to the inlet of the pump. If the system pressure is greater than the pump's maximum inlet pressure rating, the limits of the pump will be exceeded and a check valve needs to be fitted on the discharge side of the pump to prevent this condition.

3. Bypass

A bypass should be installed in the discharge pipe if there is any possibility the pump may operate against a closed valve in the discharge line. Flow through the pump is required to ensure adequate cooling and lubrication. To prevent erosion, elbows should be a minimum of 12" from the orifice discharge.

NOTE: If a "packaged" type system was provided, the height of the storage tank above the boiler feed pumps will have been predetermined to obtain proper Net Positive Suction Head (NPSH); this height must be adhered to and should never be lowered.

B. Electrical

All electrical work should be performed by a qualified electrician in accordance with the latest edition of the National Electrical Code, local codes and regulations.

> **⚠ Caution**
>
> The safe operation of this pump requires that it be grounded in accordance with the national electrical code and local governing codes or regulations.

1. Motors

Grundfos CR pumps are supplied with heavy-duty 2-pole (3600 RPM nominal), ODP or TEFC, NEMA C frame motors selected to rigid specifications.

C. Motor Protection

1. Single-Phase Motors

With the exception of 10 HP motors (which require external protection), single-phase CR pumps are equipped with multi-voltage, squirrel-cage induction motors with built-in thermal protection.

2. Three-Phase Motors

CR pumps with three-phase motors must be used with the proper size and type of motor-starter to ensure the motor is protected against damage from low voltage, phase failure, current imbalance and overloads. A properly sized starter with manual reset and ambient- compensated extra quick trip in all three legs should be used. The overload should be sized and adjusted to the full-load current rating of the motor. Under no circumstances should the overloads be set to a higher value than the full load current shown on the motor nameplate. This will void the warranty. Overloads for auto transformers and resistant starters should be sized in accordance with the recommendations of the manufacturer. Three phase MLE motors require only fuses as a circuit breaker. They do not require a motor starter. NOTE: Standard allowable phase imbalance difference is 5%.

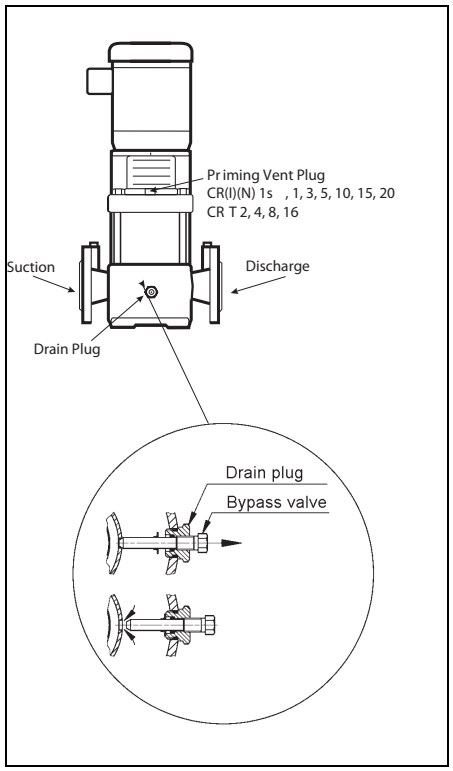


Figure 2-2 Drain Plugs

D. Starting the Pump the First Time

1. Priming

To prime the pump in a closed system or an open system where the water source is above the pump, close the pump isolation valve(s) and open the priming plug on the pump head. See **Figure 2-2**, **Figure 2-3**, and **Figure 2-4**. Gradually open the isolation valve in the suction line until a steady stream of airless water runs out the priming port. Close the plug and tighten securely. Completely open the isolation valves. For pumps with Cool-Top, see **Table 1-4**.

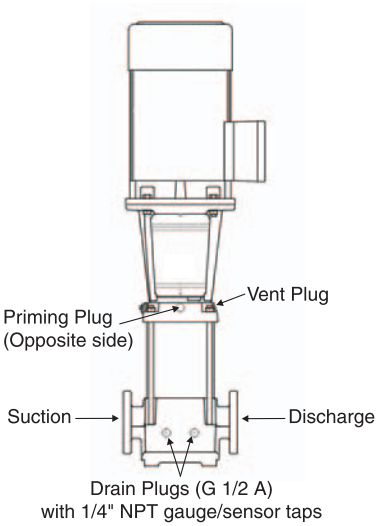


Figure 2-3 Drain Plugs

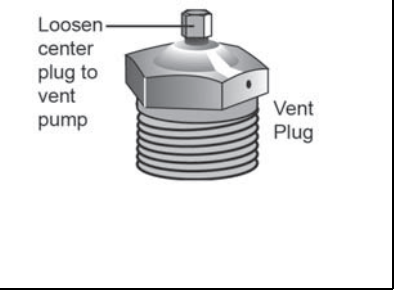


Figure 2-4 Vent Plug

⚠Caution

Motors should not be run unloaded or uncoupled from the pump at any time; damage to the motor bearings will occur.

In open systems where the water level is below the pump inlet, the suction pipe and pump must be filled and vented of air before starting the pump. Close the discharge isolation valve and remove the priming plug. Pour water through the priming hole until the suction pipe and pump are completely filled with water. If the suction pipe does not slope downward from the pump toward the water level, the air must be purged during filling. Replace the priming plug and securely tighten.

1. Switch power off.
2. Check to make sure the pump has been filled and vented.
3. Remove the coupling guard and rotate the pump shaft by hand to be certain it turns freely.
4. Verify that the electrical connections are in accordance with the wiring diagram on the motor.
5. Switch the power on and observe the direction of rotation. When viewed from the top, the pump should rotate counter-clockwise (clockwise for CRN-SF).
6. To reverse the direction of rotation, first switch OFF the supply power.
7. On three-phase motors, interchange any two power leads at the load side of the starter. On single-phase motors, see connection diagram on nameplate. Change wiring as required.8. Switch on the power and again check for proper motor rotation. Once rotation has been verified, switch off power again. Do not attempt to reinstall the coupling guards with the motor energized. Replace the coupling guard if the rotation is correct. After guards are in place the power can be reapplied.

Note: CR, CRI, CRN 1s to 5: For these pumps, it is advisable to open the bypass valve (**Figure 2-2**) during start-up. The bypass valve connects the suction and discharge sides of the pump, thus making the filling procedure easier. When the operation is stable, the bypass valve must be closed.

REMINDER: Do not start the pump before priming or venting the pump (**Figure 2-4**). Never operate the pump dry.

E. Operating Parameters

CR multi-stage centrifugal pumps installed in accordance with these instructions and sized for correct performance will operate efficiently and provide years of service. The pumps are water-lubricated and do not require any external lubrication or inspection. The motors may require periodic lubrication as noted in the following Maintenance Section.

Under no circumstances should the pump be operated for any prolonged periods of time without flow through the pump. This can result in motor and pump damage due to overheating. A properly sized relief valve should be installed to allow sufficient water to

circulate through the pump to provide adequate cooling and lubrication of the pump bearings and seals.

F. Pump Cycling

Pump cycling should be checked to ensure the pump is not starting more than: 20 times per hour on 1/3 to 5 HP models

15 times per hour on 7 1/2 to 15 HP models

10 times per hour on 20 to 60 HP models

Rapid cycling is a major cause of premature motor failure due to increased heat build-up in the motor. If necessary, adjust controls to reduce the frequency of starts and stops.

G. Boiler-Feed Installations

Make sure the pump is capable of supplying sufficient water throughout its entire evaporation and pressure ranges. Where modulating control valves are used, a bypass around the pump must be installed to ensure pump lubrication (see “Minimum Continuous Duty Flow Rates”).

H. Freeze Protection

If the pump is installed in an area where freezing could occur, the pump and system should be drained during freezing temperatures to avoid damage. To drain the pump, close the isolation valves, remove the priming plug and drain plug at the base of the pump. Do not replace the plugs until the pump is to be used again. Always replace the drain plug with the original or exact replacement. Do not replace with a standard plug. Internal recirculation will occur, reducing the output pressure and flow.

I. Motor Inspection

Inspect the motor at regular intervals, approximately every 500 hours of operation or every three months, whichever occurs first. Keep the motor clean and the ventilation openings clear. The following steps should be performed at each inspection:

1. Check that the motor is clean. Check that the interior and exterior of the motor is free of dirt, oil, grease, water, etc. Oily vapor, paper, pulp, textile lint, etc. can accumulate and block motor ventilation. If the motor is not properly ventilated, overheating can occur and cause early motor failure.

2. Use an Ohmmeter (“Megger”) periodically to ensure that the integrity of the winding insulation has been maintained. Record the Ohmmeter readings. Immediately investigate any significant drop in insulation resistance.

3. Check all electrical connectors to be sure that they are tight.

⚠ Warning

Do not touch electrical connections before you first ensure that power has been disconnected. Electrical shock can cause serious or fatal injury. Only qualified personnel should attempt installation, operation, and maintenance of this equipment.

J. Motor Lubrication

Electric motors are pre-lubricated at the factory and do not require additional lubrication at start-up. Motors without external grease fittings have sealed bearings that cannot be re-lubricated. Motors with grease fittings should only be lubricated with approved types of grease. Do not over-grease the bearings. Over greasing will cause increased bearing heat and can result in bearing/motor failure. Do not mix petroleum grease and silicon grease in motor bearings.

Bearing grease will lose its lubricating ability over time, not suddenly. The lubricating ability of a grease (over time) depends primarily on the type of grease, the size of the bearings, the speed at which the bearings operate and the severity of the operating conditions. Good results can be obtained if the following recommendations are used in your maintenance program. It should also be noted that pumps with more stages, pumps running to the left of the performance curve, certain pump ranges may have higher thrust loads. Pumps with high thrust loads should be greased according to the next service interval level.

If pump is fitted with a bearing flange that requires grease, see the stickers on either the bearing flange or coupling guards for proper grease type and greasing schedule.

1. Motor Lubrication Schedule (for Motors with Grease Nipples)

New motors that have been stored for a year or more should be regreased.

Table 2-1 Motor Lubrication Schedule

NEMA/(IEC) Frame Size	Standard Service Interval	Severe Service Interval	Extreme Service Interval	Weight of Grease to Add Oz./(Grams)	Volume of Grease to Add In^3/(Teaspoons)
Up through 210 (132)	5500 hrs.	2750 hrs.	550 hrs.	0.30 (8.4)	0.6 (2)
Over 210 through 280 (180)	3600 hrs.	1800 hrs.	360 hrs.	0.61 (17.4)*	1.2 (3.9)*
Over 280 up through 360 (225)	2200 hrs.	1100 hrs.	220 hrs.	0.81 (23.1)*	1.5 (5.2)*
Over 360 (225)	2200 hrs.	1100 hrs.	220 hrs.	2.12 (60.0)*	4.1 (13.4)*

2. Procedure

1. Clean all grease fittings. If the motor does not have grease fittings, the bearing is sealed and cannot be greased externally.
2. If the motor is equipped with a grease outlet plug, remove it. This will allow the old grease to be displaced by the new grease.
3. If the motor is stopped, add the recommended amount of grease. If the motor is to be greased while running, a slightly greater quantity of grease will have to be added.

Note: If new grease does not appear at the shaft hole or grease outlet plug, the outlet passage may be blocked. At the next service interval the bearings must be repacked. Add grease SLOWLY taking approximately one minute until new grease appears at the shaft hole

⚠ Caution

To avoid damage to motor bearings, grease must be kept free of dirt. For an extremely dirty environment, contact Grundfos, the motor manufacturer or an authorized service center for additional information. Mixing dissimilar grease is not recommended.

in the end plate or grease outlet plug. Never add more than 1-1/2 times the amount of grease shown in the lubrication schedule.

4. For motors equipped with a grease outlet plug, let the motor run for 20 minutes before replacing the plug.

K. Preventative Maintenance

At regular intervals depending on the conditions and time of operation, the following checks should be made:

1. Pump meets required performance and is operating smoothly and quietly.
2. There are no leaks, particularly at the shaft seal.
3. The motor is not overheating.
4. Remove and clean all strainers or filters in the system.
5. Verify the tripping of the motor overload protection.
6. Check the operation of all controls. Check unit control cycling twice and adjust, if necessary.
7. If the pump is not operated for unusually long periods, the unit should be maintained in accordance with these instructions. In addition, if the pump is not drained, the pump shaft should be manually rotated or run for short periods of time at monthly intervals.
8. To extend the pump life in severe duty applications, consider performing one of the following actions:
   - Drain the pump after each use.
   - Flush the pump, through system, with water or other fluid that is compatible with the pump materials and process liquid.
   - Disassemble the pump liquid components and thoroughly rinse or wash them with water or other fluid that is compatible with the pump materials and process liquid.

If the pump fails to operate or there is a loss of performance, refer to the Troubleshooting Section (**Table 2-3**).

L. Motor Replacement

If the motor is damaged due to bearing failure, burning or electrical failure, the following instructions detail how to remove the motor for replacement. It must be emphasized that motors used on CR pumps are specifically selected to our rigid specifications.

Replacement motors must be of the same frame size, should be equipped with the same or better bearings and have the same service factor. Failure to follow these recommendations may result in premature motor failure.

1. Disassembly

1. Turn off and lock out power supply. The power supply wiring can not be safely disconnected from the motor wires.
2. . Remove the coupling guards.

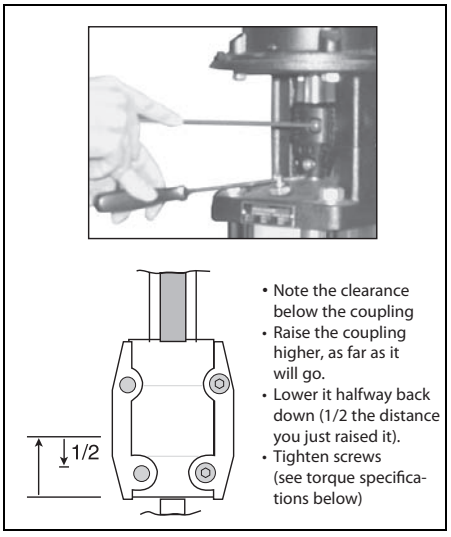


Figure 2-5

Torque Specifications CR(I)(N) 1s, 1, 3, 5, 10, 15, and 20CRT 2, 4, 8, and 16	
Coupling Bolt Size	Min. Torque Specifications
M6	10 ft-lbs.
M8	23 ft-lbs.
M10	46 ft-lbs.

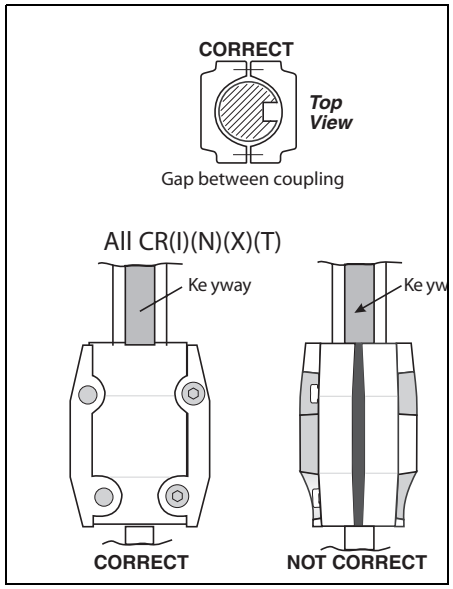


Figure 2-6

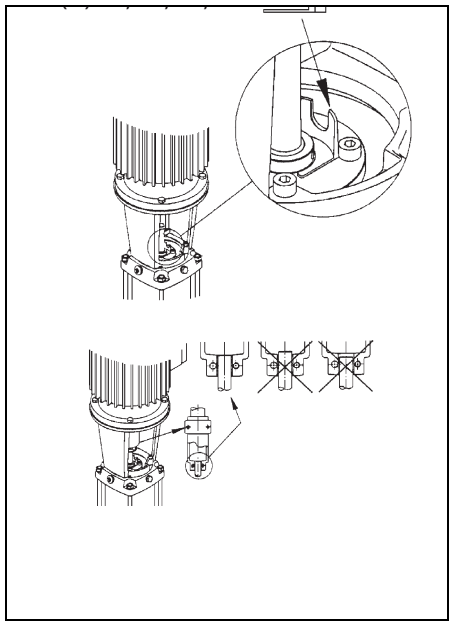


Figure 2-7

CR 1s, 1, 3, 5, 10, 15, and 20: do not loosen the three shaft seal securing allen screws.

3. Using the proper metric Allen wrench, loosen the four cap screws in the coupling. Completely remove coupling halves. On CR1s-CR20, the shaft pin can be left in the pump shaft. CR(N)32, 45, 64 and 90 do not have a shaft pin.
4. With the correct size wrench, loosen and remove the four bolts which hold the motor to the pump end.
5. Lift the motor straight up until the shaft has cleared the motor stool.

2. Assembly

1. Remove key from motor shaft, if present, and discard.
2. Thoroughly clean the surfaces of the motor and pump end mounting flange. The motor and shaft must be clean of all oil/grease and other contaminants where the coupling attaches. Set the motor on the pump end.
3. Place the terminal box in the desired position by rotating the motor.
4. Insert the mounting bolts, then diagonally and evenly tighten. For 3/8" bolts (1/2 to 2 HP), torque to 17 ft.-lbs., for 1/2" bolts (3 to 40 HP) torque to 30 ft.-lbs., and for 5/8" bolts (50 - 60 HP) torque to 59 ft.-lbs.
5. CR 1s, 1, 3, and 5:

Insert shaft pin into shaft hole. Reinstall the coupling halves onto shaft and shaft pin. Reinstall the coupling screws and leave loose. Check that the gaps on either side of the coupling are even, and that the motor shaft keyway is centered in the coupling half, as shown in **Figure 2-6**. Tighten the screws to the correct torque.

CR 10, 15 and 20:

Insert shaft pin into shaft hole. Insert plastic shaft seal spacer beneath shaft seal collar. Reinstall the coupling halves onto shaft and shaft pin. Reinstall the coupling screws and leave loose. Check that the gaps on either side of the coupling are even and that the motor shaft key way is centered in the coupling half, as shown in **Figure 2-6**. Tighten the screws to the correct torque. Remove plastic shaft seal spacer and hang it on inside of coupling guard.

CRT 2, 4, 8 and 16:

Reinstall coupling halves. Make sure the shaft pin is located in the pump shaft. Put the cap screws loosely back into the coupling halves. Using a large screwdriver, raise the pump shaft by placing the tip of the screwdriver under the coupling and carefully elevating the coupling to its highest point (**Figure 2-5**). Note: the shaft can only be raised approximately 0.20 inches (5mm). Now lower the shaft half way back down the distance you just raised it and tighten the coupling screws (finger tight) while keeping the coupling separation equal on both sides. When the screws are tight enough to keep the couplings in place, then torque the screws evenly in a criss-cross pattern.

CR(N) 32, 45, 64 & CR90:

Place the plastic adjustment fork under the cartridge seal collar (see **Figure 2-7**).

Fit the coupling on the shaft so that the top of the pump shaft is flush with the bottom of the clearance chamber in the coupling (see **Figure 2-7**).

Lubricate the coupling screws with an anti-seize and lubricating compound. Tighten the coupling screws (finger tight) while keeping the coupling separation equal on both sides and the motor shaft keyway centered in the coupling half as shown in **Figure 2-5**.

When the screws are tight enough to keep the couplings in place, then torque the screws evenly in a crisscross pattern.

Torque coupling screws to 62 ft.-lbs. Remove the adjustment fork from under the cartridge seal collar and replace it to the storage location (see **Figure 2-8**).

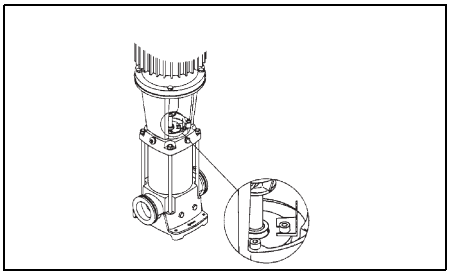


Figure 2-8

6. Check to see that the gaps between the coupling halves are equal. Loosen and readjust, if necessary.
7. Be certain the pump shaft can be rotated by hand. If the shaft cannot be rotated or it binds, disassemble and check for misalignment.
8. Prime the pump.
9. Follow the wiring diagram on the motor label for the correct motor wiring combination which matches your supply voltage. Once this has been confirmed, reconnect the power supply wiring to the motor.
10. Check the direction of rotation, by bump-starting the motor. Rotation must be left to right (counter-clockwise) when looking directly at the coupling.
11. Shut off the power, then re-install the coupling guards. After the coupling guards have been installed the power can be turned back on.

⚠ Warning

When working with electrical circuits, use caution to avoid electrical shock. It is recommended that rubber gloves and boots be worn, and metal terminal boxes and motors are grounded before any work is done. for your protection, always disconnect the pump from its power before handling.

Table 2-2 Preliminary tests

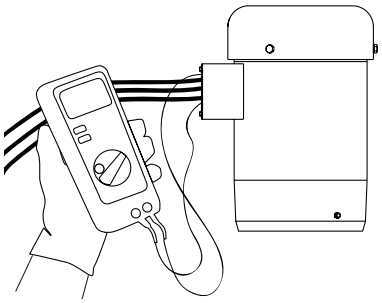
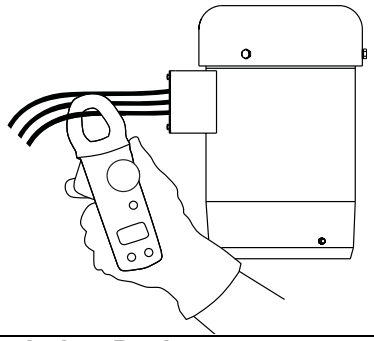
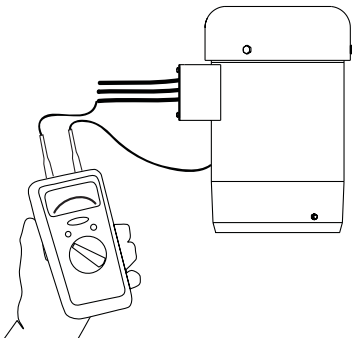
Supply voltage	How to measure	What it means
	Use a voltmeter, (set to the proper scale) measure the voltage at the pump terminal box or starter. On single-phase units, measure between power leads L1 and L2 (or L1 and N for 115 volt units). On three-phase units, measure between: • Power leads L1 and L2 • Power leads L2 and L3 • Power leads L3 and L1	When the motor is under load, the voltage should be within ±10% of the nameplate voltage. Larger voltage variation may cause winding damage. Large variations in the voltage indicate a poor electrical supply and the pump should not be operated until these variations have been corrected. If the voltage constantly remains high or low, the motor should be changed to the correct supply voltage.
Current measurement	**How to Measure**	**What it Means**
	Use an ammeter, (set on the proper scale) to measure the current on each power lead at the terminal box or starter. See the motor nameplate for amp draw information. Current should be measured when the pump is operating at constant discharge pressure.	If the amp draw exceeds the listed service factor amps (SFA) or if the current imbalance is greater than 5% between each leg on three-phase units, check the following: 1. Burned contacts on motor starter. 2. Loose terminals in starter or terminal box or possible wire defect. 3. Too high or too low supply voltage. 4. Motor windings are shorted or grounded. Check winding and insulation resistances. 5. Pump is damaged causing a motor overload.
Insulation Resistance	**How to Measure**	**What it Means**
	Turn off power and disconnect the supply power leads in the pump terminal box. Using an ohm or mega ohm meter, set the scale selector to Rx 100K and zero adjust the meter. Measure and record the resistance between each of the terminals and ground.	Motors of all HP, voltage, phase and cycle duties have the same value of insulation resistance. Resistance values for new motors must exceed 1,000,000 ohms. If they do not, motor should be repaired or replaced.

Table 2-3 Diagnosing specific problems

Problem	Possible cause	Remedy
The pump does not run	1. No power at motor.	Check for voltage at motor terminal box. If no voltage at motor, check feeder panel for tripped circuits and reset circuit.
	2. Fuses are blown or circuit breakers are tripped.	Turn off power and remove fuses. Check for continuity with ohmmeter. Replace blown fuses or reset circuit breaker. If new fuses blow or circuit breaker trips, the electrical installation, motor and wires must be checked.
	3. Motor starter overloads are burned or have tripped out.	Check for voltage on line and load side of starter. Replace burned heaters or reset. Inspect starter for other damage. If heater trips again, check the supply voltage and starter holding coil.
	4. Starter does not energize.	Energize control circuit and check for voltage at the holding coil. If no voltage, check control circuit fuses. If voltage, check holding coil for shorts. Replace bad coil.
	5. Defective controls.	Check all safety and pressure switches for operation. Inspect contacts in control devices. Replace worn or defective parts or controls.
	6. Motor is defective.	Turn off power and disconnect wiring. Measure the lead to lead resistances with ohmmeter (RX-1). Measure lead to ground values with ohmmeter (RX-100K). Record measured values. If an open or grounded winding is found, remove motor and repair or replace.
	7. Defective capacitor. (Single-phase motors)	Turn off power and discharge capacitor. Check with ohmmeter (RX-100K). When the meter is connected to the capacitor, the needle should jump towards 0 ohms and slowly drift back to infinity. Replace if defective.
	8. Pump is bound.	Turn off power and manually rotate pump shaft. If shaft does not rotate easily, check coupling setting and adjust as necessary. If shaft rotation is still tight, remove pump and inspect. Disassemble and repair.
The pump runs but at reduced capacity or does not deliver water	1. Wrong rotation	Check wiring for proper connections. Correct wiring.
	2. Pump is not primed or is airbound.	Turn pump off, close isolation valve(s), remove priming plug. Check fluid level. Refill the pump, replace plug and start the pump. Long suction lines must be filled before starting the pump.
	3. Strainers, check or foot valves are clogged.	Remove strainer, screen or valve and inspect. Clean and replace. Reprime pump.
	4. Suction lift too large.	Install compound pressure gauge at the suction side of the pump. Start pump and compare reading to performance data. Reduce suction lift by lowering pump, increase suction line size or removing high friction loss devices.
	5. Suction and/or discharge piping leaks.	Pump runs backwards when turned off. Air in suction pipe. Suction pipe, valves and fittings must be airtight. Repair any leaks and retighten all loose fittings.
	6. Pump worn.	Install pressure gauge, start pump, gradually close the discharge valve and read pressure at shutoff. Convert measured pressure (in PSI) to head (in feet): (Measured PSI x 2.31 ft./PSI = _____ ft.). Refer to the specific pump curve for shutoff head for that pump model. If head is close to curve, pump is probably OK. If not, remove pump and inspect. Disassemble and inspect pump passageways. Remove any foreign materials found.
	7. Pump impeller or guide vane is clogged.	
The pump runs but at reduced capacity or does not deliver water	8. Incorrect drain plug installed.	If the proper drain plug is replaced with a standard plug, water will recirculate internally. Replace with proper plug.
	9. Improper coupling setting.	Check/reset the coupling.

Pump cycles too much	1. Pressure switch is not properly adjusted or is defective. 2. Level control is not properly set or is defective. 3. Insufficient air charging or leaking tank or piping. 4. Tank is too small. 5. Pump is oversized.	Check pressure setting on switch and operation. Check voltage across closed contacts. Readjust switch or replace if defective. Check setting and operation. Readjust setting (refer to level control manufacturer's data). Replace if defective. Pump air into tank or diaphragm chamber. Check diaphragm for leak. Check tank and piping for leaks with soap and water solution. Check air to water volume. Repair as necessary. Check tank size and air volume in tank. Tank volume should be approximately 10 gallons for each gpm of pump capacity. The normal air volume is 2/3 of the total tank volume at the pump cut-in pressure. Replace tank with one of correct size. Install pressure gauges on or near pump suction and discharge ports. Start and run pump under normal conditions, record gauge readings. Convert PSI to feet (Measured PSI x 2.31 ft./ PSI = _____ ft.) Refer to the specific pump curve for that model, ensure that total head is sufficient to limit pump delivery within its design flow range. Throttle pump discharge flow if necessary.
Fuses blow or circuit breakers or overload relays trip	1. Low voltage. 2. Motor overloads are set too low. 3. Three-phase current is imbalanced. 4. Motor is shorted or grounded. 5. Wiring or connections are faulty. 6. Pump is bound. 7. Defective capacitor (single-phase motors). 8. Motor overloads at higher ambient temperature than motor.	Check voltage at starter panel and motor. If voltage varies more than ±10%, contact power company. Check wire sizing. Cycle pump and measure amperage. Increase heater size or adjust trip setting to a maximum of motor nameplate (full load) current. Check current draw on each lead to the motor. Must be within ±5%. If not, check motor and wiring. Rotating all leads may eliminate this problem. Turn off power and disconnect wiring. Measure the lead-to-lead resistance with an ohmmeter (RX-1). Measure lead-to-ground values with an ohmmeter (RX-100K) or a megaohm meter. Record values. If an open or grounded winding is found, remove the motor, repair and/or replace. Check proper wiring and loose terminals. Tighten loose terminals. Replace damaged wire. Turn off power and manually rotate pump shaft. If shaft does not rotate easily, check coupling setting and adjust as necessary. If shaft rotation is still tight, remove pump and inspect. Disassemble and repair. Turn off power and discharge capacitor. Check with ohmmeter (RX-100K). When the meter is connected to the capacitor, the needle should jump towards 0 ohms and slowly drift back to infinity. Replace if defective. Use a thermometer to check the ambient temperature near the overloads and motor. Record these values. If ambient temperature at motor is lower than at overloads, especially where temperature at overloads is above +104×F (+40×C), ambient-compensated heaters should replace standard heaters.

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