CRSS
Condensate Return System
Installation, Operation, and Maintenance
TO: Owners, Operators and 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.

It is the responsibility of the owner to train and advise all service, repair, and operating personnel 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.

“Automatic” features, where present, should not be understood as substituting for the normal responsibilities of the attendant. Such features merely alleviate certain repetitive chores, allowing more time for proper upkeep of the equipment.

This manual is intended for a general scope of application. Because of state, local, or other applicable codes, controls and safety devices may vary considerably from those described herein.

It is recommended that a boiler room log be maintained, recording daily, weekly, monthly and yearly maintenance activities and noting unusual observations.

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 must comply with all requirements or regulations of the owner’s insurance provider 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.
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CRSS Condensate Return System

Installation, Operation and Maintenance

⚠️ Warning

- Do not pressurize tank
- Isolate tank during leak test
- Do not restrict vent
- Do not plug overflow
- Open inlet valves slowly
- Do not use as a flash tank

⚠️ 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.

⚠️ 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.
The CRSS condensate return system comprises an atmospheric stainless steel receiver tank and vertical flange-mounted stainless steel centrifugal pumps. Pumps are float operated to return accumulated condensate to a boiler feed tank.

Refer also to the C4/C5/C6 centrifugal pump manual, provided in appendix, for pump information.

1. Preparing to Install

Inspect the unit upon arrival and ensure no damage has occurred during shipping. Handle the unit with care during installation.

Position the unit to allow easy access to all components. Allow adequate space for service and code requirements.

Verify proper ambient conditions. Motors are designed to operate in 104°F (40°C) maximum ambient temperature.

2. Piping

Pipe the unit according to the diagram below. Pump discharge piping should not place a load on the pump; use pipe supports where necessary.

Gravity condensate return lines from the system should be properly pitched down to the unit inlet. Returns must also be trapped to prevent steam entry into the unit. An inlet basket strainer is recommended.

Bypass piping to a drain is recommended per the piping diagram.

![Diagram of CRSS Piping](image-url)
Install a vent pipe to atmosphere. Pipe to be the size of the vent opening on unit. Do not restrict or reduce vent opening or exceed 20 inch vertical height unless an overflow connection is provided.

Pipe overflow port to drain using an overflow loop when condensate temp will exceed 200°F (93°C).

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**Caution**

NOT FOR USE AS A CHEMICAL PUMP

Inject boiler feed compounds from chemical feed tank into boiler feed piping - never into the condensate tank.

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**Figure 2  CRSS COMPONENTS/CONNECTIONS**

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### 3. Float Switches/Mechanical Alternators

Floats are locked in place to prevent damage during shipment.

Remove shipping locks. Check factory settings. Floats and mechanical alternators are adjustable for various levels of operation.

The lead pump should start with tank 3/4 full and shut off at 2” or more above pump inlet. Lag pump should start before the tank overflows. Float and alternator settings should avoid short cycling of the pump.

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**Warning**

HIGH VOLTAGE ELECTRICITY

Disconnect and lock out power before installing or servicing unit.
4. Electrical Wiring and Controls

Connect power wiring per NEC and local code requirements. Recheck nameplate vs. specifications and conditions. All single phase motors have internal thermal protection.

Three phase motors must use starters with properly sized overload relays. Overload relays furnished are designed for manual reset.

5. Putting the Unit into Service

1. Assure that the unit is piped in accordance with instructions in this manual.

![Warning]

**EXPLOSIBLE**

Do not pressurize receiver.
Isolate receiver during leak test.
Do not plug overflow.
Do not restrict vent opening to atmosphere.
Open valves slowly.
2. Isolate the tank before performing a system leak test. Do not pressurize the tank as part of the leak test.
3. Check floats/alternators for free operation.
4. Wire unit in accordance with NEC and local code requirements. See wiring diagrams in this manual.
5. Install drain plugs if necessary.
6. Fill receiver half full of water to prime pumps and to prevent possible damage to pump seals. Avoid freezing conditions after receiver has been filled.
7. Check for proper rotation of all three phase motors. Rotation must be clockwise looking down on the motor, as indicated by arrow on pump casting. If pump runs backwards, interchange two pump wires (3 phase only).
8. Assure all shipping locks have been removed from all float switches.
9. If possible, observe operation through several cycles.

6. Operation and Maintenance

Operators must be familiar with all sections of this manual before operating the unit.

A properly installed unit should function unattended for long periods of time. Periodic checks to assure proper operation are highly recommended. Refer to troubleshooting section when necessary.

Check motor nameplates for motor lubrication requirements.

Pumps require no lubrication.

**NOTE:** Single phase motors will restart automatically after thermal overload protection trips. For three phase motors, overload thermal relays in starters must be reset manually.
The inlet strainer (when furnished) is intended to protect the pump and system. Periodic cleaning should be included in the maintenance schedule. Check frequently in new systems.

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**Caution**
A unit showing symptoms of possible problems (overflow, noise, leaks, vibrations, continual operation, etc.) must be diagnosed and the problem corrected immediately.

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**Float Switch**
The float switch (simplex units) controls liquid level in the tank by means of float movement.

**Mounting** - Screw-in tank float switches are mounted directly to the tank by means of the threaded fitting (D). Before screwing the fitting into the tank, loosen nut (C) so that the fitting (D) is free to rotate in the switch bracket. Tighten the fitting (D) to ensure no leakage past the threads. Then revolve the switch case until horizontal and tighten nut (C).

![Figure 4 FLOAT SWITCH](image)

**Adjustment** - Switches are shipped from the factory set for a specified float travel. Reasonable adjustment of float travel can be made in the field by moving adjusting strips (1), which are held in place by screws (A) and (B). Loosening screw (B) and moving upper adjusting strip (1) will affect the upper limit of float travel only. Loosening screw (A) and moving lower adjusting strip (1) will affect the lower limit of float travel.

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**Caution**
Switches are shipped with a bracket attached to the mounting plate. This bracket prevents the float and the rod from moving in the tank during shipment. When installing the system, this clearly marked shipping bracket must be removed and discarded.

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**Mechanical Alternator**
Mechanical alternators serve to open and close an electric circuit by an upward and downward float movement. Two switch units are alternated on successive cycles. If the liquid level continues to rise or fall with one pump in operation, the lever will continue to travel until the second switch is operated.
Mounting - Mechanical alternators are mounted directly to the tank by means of the threaded fitting (D). Before screwing this fitting into the tank, loosen nut (C) so that fitting (D) is free to rotate in the switch bracket. Tighten the fitting (D) to ensure no leakage past the threads. Then revolve the switch case until horizontal and tighten nut (C).

Standard Operation - Contacts are arranged for sump action. In this configuration the contacts will close on increase in liquid level.

Reverse Action - To reverse the switch action, relocate the operating link to the opposite slot in the base plate and corresponding hole in the adjusting plate.

Adjustment - Switches are shipped from the factory set for a specified float travel. Reasonable adjustment of the float travel can be made in the field by moving adjusting strips (1), which are held in place by screws (A) and (B). Loosening screw (B) and moving upper adjusting strip (1) will affect the upper limit of float travel only. Loosening screw (A) and moving lower adjusting strip (1) will affect the lower limit of float travel.

Caution
Switches are shipped with a bracket attached to the mounting plate. This bracket prevents the float and the rod from moving in the tank during shipment. When installing the system, this clearly marked shipping bracket must be removed and discarded.
7. Troubleshooting

All units are thoroughly tested at the factory before shipment. The unit should operate satisfactorily without further adjustment if undamaged and properly installed. If system or unit performance is not satisfactory, refer to the following check list.

• Pump will not start

1. The power supply has been interrupted, disconnect switch is open, or selector switch is improperly positioned.
2. Incorrect supply voltage for motor. Check voltage and wiring with motor characteristics.
3. Incorrect starter coil for power supply.
4. The overload relays and the starter have tripped and must be reset. Ambient temperature may be too high.
5. Check pump controls or other controls for proper operation.
6. Wiring to control cabinet is incorrect or connections are loose.
7. The strainer is dirty and is retarding the flow. Clean strainer. (Strainer should be cleaned periodically as part of normal maintenance.)

• Pump runs continuously

1. Pump is running backward. Rotation of 3 phase motors may be corrected by interchanging any two of the three wires. Rotation should be clockwise looking down on the motor.
2. Steam traps are blowing through, causing condensate to return at excessive temperatures. This may reduce the capacity of the pump below its rating, depending on the unit and type of pump furnished. Traps should be repaired or replaced.
3. The total required pressure at the pump discharge is greater than the pressure for which the pump was designed. Check the total pressure, which includes atmospheric pressure, friction head, and static head.
4. A valve in the discharge line is closed or throttled too tightly, or a check valve is installed backwards.
5. The impeller eye is clogged.
6. Pump is too small for system.

• Condensate pump is noisy

1. Excessive condensate temperature. Correct system conditions.
2. Magnetic hum or bearing noise in motor. Consult motor manufacturer’s authorized service representative.
3. Starter chatters. Trouble is caused by low line voltage, poor connections, defective starter coil, or burned contacts.
4. Pump is running backward.

• System is noisy

1. Banging sound in steam mains is usually caused by steam ‘imploding’ at low points in condensate lines. Problem can be eliminated by installing drip legs, properly supporting the pipe, or by increasing the pitch of the lines.
2. Improper dripping of the steam mains and risers; where there is a rise in the steam main, or where it branches off into a riser, drip trap must be installed in the drain line.
3. The piping is too small to drain properly.
4. A defective trap is holding condensate in the steam supply line.
APPENDIX

Pump Operation and Maintenance

A1 - General Instructions

When properly installed and given reasonable care and maintenance, centrifugal pumps should operate satisfactorily for many years. The C Series pumps use tight running clearances to build pressure. Abrasive particles in high enough concentrations, can eventually open up the close clearances between the impeller and the casing, thus reducing pressure output. To avoid this, careful selection and use of a low resistance suction strainer should be considered. For critical services it is recommended that you keep an identical pump for stand-by use.

A1.1 - Inspection of Equipment

Immediately upon receipt of the shipment, inspect the equipment for damage or missing components. Check the shipping manifest and report any damage or shortage to the transportation company’s local agent. Put the instructions that came with the shipment in a safe place where they will be available to those who will be using them for installation and service.

A1.2 - Storage

If the pump is to be stored before use, it should be inspected as described above, crated and stored in a dry location. Standard shipping containers are not suitable for outdoor storage. In some areas, it may be necessary to cover the pump’s exterior surface with oil or other rust inhibiting coating.

A1.3 - Application Considerations

Electrical Wiring

All electrical equipment and wiring should conform to Local and National Electrical Codes. Use the motor manufacturer’s instructions for connecting the motor. Note the correct rotation and wiring diagrams on the assembly. Make sure the motor rotation and speed matches that required for the pump.

Construction Materials

While it is reasonable to assume that good judgement has been used in selecting all the materials in the pump for compatibility with process fluids, actual conditions sometimes vary from original expectations. Also, typical material selection charts do not consider all the temperature, pressure, and fluid variables. The customer’s engineer should be consulted for final judgement on the best materials for critical process applications.

Valves

If a shutoff valve is necessary in the suction line, use a gate, ball, butterfly, or other full port valve. Globe or other flow restricting valves can in some cases reduce pump flow or increase chances of cavitation.

A swing check valve in the suction line is recommended even when the pump inlet is only slightly higher than the fluid source to aid in priming. It should be the same size as the pump inlet or sized based on reasonable fluid friction losses.

A foot valve is recommended when lifting fluid from a sump. This will save wear and tear on any pump, even those equipped with self priming equipment.

A low resistance suction strainer is recommended immediately ahead of the pump on any newly constructed system. Foreign material large enough to damage pump clearances may remain in the piping even though the system has been flushed.
Valves in the outlet piping of a centrifugal pump should be closed, or nearly closed, when the pump is started. This will reduce the start-up load on the pump and motor. **Never start the pump with the discharge valve fully open**, unless system friction losses are substantial enough to prevent the pump from operating at “run out” - otherwise cavitation or motor overload may occur.

Inlet valving should be fully open when starting any pumping system. Without some fluid in the pump at startup, the unit can gall and lock up the impeller. Always fill the pump and vent it of air for best pump life. Violent pump failure will result from continued operation with the inlet valve closed.

**NPSH (Net Positive Suction Head)**

The NPSH required varies with every size and capacity of pump. The NPSH required by your unit can be obtained from the performance curves or from your C-B representative.

If the NPSH available is not equal to or greater than that required by the pump, it must be increased or a different pump selected. The usual method for increasing NPSH is to raise the static head on the pump inlet.

By definition, NPSH means: Net positive suction head **above** the vapor pressure of the pumped liquid, available at the centerline of the pump. It should always be given in feet of pumped liquid. The NPSH indicates the amount of energy available in the pumped liquid to produce the required absolute entrance velocity in the pump. If a pump requires more energy (or NPSH) than is available at a given capacity, the pressure at the inlet will fall below the vapor pressure of the pumped liquid and fluid vaporization and loss of performance will result.

\[
\text{NPSH} = (2.31) \left( \frac{P_s - P_{vp}}{\text{sp. gr.}} \right) + H_s - H_f
\]

where

- \(P_s\) = Pressure in the suction vessel in PSIA
- \(P_{vp}\) = Vapor pressure of the pumped fluid in PSIA
- \(H_s\) = Static height of the pumped fluid above (+) or below (-) the centerline of the pump
- \(H_f\) = All friction losses from the vessel to the pump
- sp. gr. = specific gravity

For boiling liquids, \(P_s\) and \(P_{vp}\) are equal. This item then becomes zero and can be omitted from the equation.

**Noise**

Motors, bearings, and other rotating components add to noise, which sometimes create objectionable harmonics. Careful pump installation can contribute to noise reduction. Proper alignment of the pump and driver is essential. Adequate supports for the inlet and discharge piping is equally important. A degree of noise reduction may be obtained when the pumping unit is supported free of building structures by the use of vibration isolators, flexible piping and conduit connections. To separate motor noise and vibration from the fluid and piping structure, using a flexible elastomer-coupled (long coupled) configuration is very desirable.

**Freezing**

When ambient temperatures drop below the freezing point of the fluid, consideration should be given to heating, insulating, or draining the pump. If you choose to drain the pump, first remove the drain plugs and drain the suction and discharge lines. Carefully blow out the pump with compressed air to clear all internal cavities of fluid.
A1.4 - Recommended Spare Parts

FOR ROUTINE MAINTENANCE: Only a complete set of “O” ring gaskets and a mechanical seal are recommended.

FOR SERVICING A PUMP THAT DOES NOT PRODUCE RATED CAPACITY OR HEAD: “O” ring gaskets, impeller, mechanical seal, and pump casing.

FOR CRITICAL SERVICES: A duplex installation, with two identical pumping units in parallel, is the safest, and many times the most cost effective choice where downtime cannot be tolerated.

A2 - Service

A2.1 - Preliminary

Before attempting any service on the pump or motor, disconnect the electrical power to the pump motor. If the pump and motor are to be removed as a unit, note the wiring configuration.

1. Disconnect the inlet and outlet piping before unbolting the pump and motor.
2. Unbolt the motor from the base and remove the unit. All work on the unit should be performed on an elevated workbench whenever possible.

A2.2 - Disassembly

The following tools and equipment are needed for disassembly.

- Soft plastic or wooden mallet.
- 5/8” wrench or socket.
- 10 mm socket wrench.
- 13 mm wrench or socket.
- 5 mm Allen wrench.
- Penetrating oil.
- 3/4” wood dowel (Approx. 6” long).
- Small O.D. Snap Ring Pliers.
- Cealube G or similar glycol base lubricant. (DO NOT use petroleum products.)

To disassemble the pump (item numbers refer to the illustration below):

1. Remove all liquid from the pump.
2. Remove the casing (#108) by removing the jam nuts (#20) from the casing studs (#5). Slide the casing off and rest it on the studs.
3. Remove the impeller (#11) by removing the 10mm Bolt (#19) and washer (#41), then sliding forward (may require a gear puller).
4. Remove the snap ring (#4) from the shaft using snap ring pliers.
5. Remove the impeller key (#23) from the shaft.
6. Remove the rotating element from the shaft. The element normally adheres tightly to the shaft and some force may be necessary to remove it. This is common and, if care is taken, the element can be reassembled and reused. **It is recommended that a new rotating element be used for reassembly.** DO NOT attempt to remove the seal using a screwdriver or other sharp object. Extensive damage to the shaft or element could occur.
7. Remove the motor bracket. Loosen and remove the four socket head screws (#33A) with a 5 mm Allen wrench. **Note:** The rotating element must be removed before the motor bracket can be removed. It is not necessary to remove the adjusting screws # 33.
8. Remove the seat portion of the seal from the motor bracket.
   a. Place the motor bracket face down on a flat surface
   b. Look into the opening in the center of the motor bracket, you will see a portion of the seat.
c. Insert the 3/4” dowel and, very gently, tap the seat until it drops out.
d. Care must be taken with the seats. They are often a brittle material and are prone to breakage. It is recom-mended that a new replacement seat be installed during reassembly.

Figure 6  PUMP DISASSEMBLY

A2.3 - Inspection of Components
Thorougly clean all parts. All components should be examined for wear and corrosion. Replace any parts that show visible wear.

The “O” rings and other elastomeric components should be replaced if they have been deformed or cut.

If seal components must be reused, carefully inspect for microscopic cracks and nicks. Scratches that might be ignored elsewhere can produce leakage if they are on seal carbons and seat wearing surfaces.

Cleanliness is imperative when working with mechanical seals. Microscopic grit and particles between seal faces can be, and often are, the cause of early seal failures.

If the impeller can be rocked or wobbled on the shaft, it is too loose and must be replaced.

Check the shaft for galling, pitting, and corrosion. If the shaft is corroded where the seal elastomer comes in contact with it, the motor must be replaced. Surface corrosion must be removed so that seals can slide freely during assembly. The shaft diameter should be no smaller than .002” below the nominal fractional seal sizes. Remove any nicks or burrs which may have occurred during disassembly. Re-clean parts as necessary.
A2.4 - Reassembly

All parts should be visually inspected and cleaned or replaced as outlined above.

1. The seal seat (#125) must be installed in the motor bracket before the bracket is installed on the motor. 
   To install the seat:
   a. Place the motor bracket face up on a flat surface
   b. Carefully press the seat, smooth side up, into the seat cavity of the motor bracket. To make the installation of the seat easier, apply a very thin coating of compatible seal lubricant to the elastomer portion of the seat prior to installation. Care must be taken not to damage the seal face. Thumb pressure is usually sufficient to install the seat. Make sure the seat is installed firmly and squarely and that it is then carefully cleaned.

2. Install the motor bracket (#84).
   a. This is best done with the motor standing on end.
   b. From the motor side: If removed during disassembly, thread the four (4) adjusting screws (#33) into the mounting flanges of the motor bracket until they are flush with the front faces of the flanges
   c. Slide the four (4) small “O”-rings (#8) fully onto the socket head screws (#33A).
   d. Place the motor bracket (#84) on the motor. Slide the bracket back until the feet are resting against the motor face. The orientation of the motor bracket is not critical unless a flush line is used. In that case, align the flush line to meet system requirements.
   e. Insert the four (4) socket head screws (#33A) into the motor bracket holes and thread into the motor face. Tighten securely using a 5 mm allen wrench. Do not exceed 7 ft-lbs of torque or damage to the motor “C”-face may occur.

3. Install rotating element (#12).
   a. Tip the pump assembly over into a horizontal position on the work area.
   b. Lightly lubricate the motor shaft. Push the rotating element, spring, and then spring holder over the shaft.
   c. Prepare the snap ring in the snap ring pliers and then compress and hold the seal spring slightly below the snap ring groove. Install the snap ring (#4). Make sure the snap ring is locked in the groove.

4. Install the impeller (#11).
   a. Place the key (#23) in the shaft sleeve.
   b. The impeller should slide on firmly, but easily, until it stops. Force should not be required to install the impeller in the correct position.
   c. The impeller hub should be facing toward the motor.
   d. Fasten the impeller using the washer (#41) and screw (#19). Tighten the screw securely (do not exceed 7 ft-lbs of torque), while holding the impeller stationary. The impeller should not have any play or wobble.

5. Install the casing (#108).
   a. Hand tighten four (4) studs (#5) into the casing until they are seated.
   b. Lubricate and install the casing “O”-ring (#7) onto the first step in the motor bracket.
   c. Place the casing over the motor bracket being careful not to pinch the “O”-ring. The casing discharge should be oriented to meet system requirements.
   d. Loosely thread four (4) jam nuts (#20) onto the casing studs.

6. Adjusting Impeller/Casing Clearance
   a. Seat the casing down against the impeller with light hand pressure.
   b. Turn the adjusting screws until they just touch the back face of the casing. The casing should not move during this adjustment. This will determine the zero clearance position. Set the minimum free running clearance as follows:
      i. Viewing from the back of the motor bracket, (rear of motor) turn each adjusting screw clockwise exactly 30° (1/12 of a full revolution).
      ii. Securely tighten the four (4) jam nuts against the adjusting nuts using a 9/16” wrench and a 5/8” wrench, being careful to prevent the adjusting nuts from turning.
   c. Turn the impeller clockwise and listen for any scraping noises or interference. This may be done by turning the impeller screw with a 10 mm socket through the inlet port (Be careful not to loosen the screw), and listening
through the discharge. If any contact is detected between the impeller and casing, perform the following steps:
   i. Loosen the jam nuts, being careful not to turn the adjusting nuts.
   ii. Repeat steps 6.b.i and 6.b.ii.
   iii. Repeat step 6.c.

A2.5 - Testing and Final Adjustment

The pump is now ready for installation.

1. Reconnect the electrical connections referring to the colored or numbered tape used to mark the wires during disassembly.
2. Connect all piping and fill the pump with fluid
3. Make sure all suction valves are opened and fluid will flow through the system. Discharge valve should be partially opened.
4. Start the pump and check for leaks on the pump and piping. Special attention should be given to the seal area at the rear opening in the motor bracket.
5. Using an amprobe or similar device, check for motor overload. If motor is overloading it is possible that the impeller clearance was not properly set as outlined in Reassembly Step 6 above.