



CENTRIFUGAL PUMPS MODEL AW/AWF SERIES

IOM MANUAL

INSTALLATION, OPERATION AND MAINTENANCE (IOM) INFORMATION



PLEASE LEAVE THIS MANUAL FOR OWNER'S USE



SAFETY INSTRUCTIONS

Read this manual carefully to learn how to safely install and operate your pump. Throughout this manual there are a number of SAFETY HAZARDS that must be read and adhered to in order to prevent possible personal injury and/or damage to the equipment.

Three keywords, "DANGER", "WARNING", and "CAUTION", are used to indicate the potential severity of the hazard, and are preceded by a SAFETY ALERT SYMBOL. Failure to follow the safety-related instructions may result in a safety hazard.

DANGER Indicates an imminently hazardous situation which, if not avoided, *WILL* result in serious injury or death.

WARNING Indicates a potentially hazardous situation which, if not avoided, *COULD* result in serious injury or death.

CAUTION Indicates a potentially hazardous situation which, if not avoided, *MAY* result in minor or moderate injury.

THOROUGHLY REVIEW ALL INSTRUCTIONS AND WARNINGS PRIOR TO PERFORMING ANY WORK ON THIS PUMP.



CAUTION
Hazard

THE PUMP SHOULD NOT BE SUBJECTED TO MORE THAN A 50 PSIG SUCTION PRESSURE.

Introduction:

Because pump installations are seldom identical, this manual cannot possibly provide detailed instructions and precautions for each specific application. Therefore, it is the responsibility and the duty of all personnel involved in the installation, operation and maintenance of the equipment to ensure that applications not addressed in this manual are performed only after establishing that neither operator safety nor pump integrity is compromised by the installation.

Model AW is close-coupled. Model AWF is a flexible-coupled pump with an alignment casting that self-aligns the pump when servicing. The Model AWF is fitted with a mounting plate.

Pre-Installation Check:



WARNING
Hazard

Open all cartons and inspect for shipping damage. Report any damage to your supplier or shipping carrier immediately.

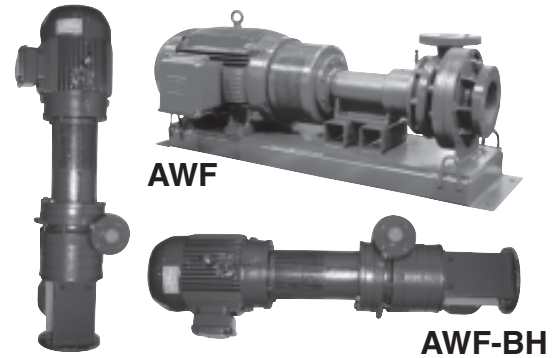
Always verify that the pump nameplate Voltage, Phase, and Horsepower ratings as well as Amps rating on motor match your control panel and power supply. Warranty does not cover damage caused by connecting pumps and controls to an incorrect power source (i.e., voltage and phase).

Installation:



WARNING
Hazard

Electrical connections are to be made by a qualified electrician in accordance with the National Electrical Code (NEC) or the Canadian Electrical Code, as well as all national, state and local codes. Code questions should be directed to your local electrical inspector. Failure to follow electrical codes and OSHA safety standards may result in



personal injury or equipment damage. Failure to follow manufacturer's installation instructions may result in unsatisfactory performance, electrical shock, fire hazard, personal injury or death, damaged equipment, and may void the manufacturer's warranty.

Motor must have a properly sized starter with a properly sized heater to provide overload and under voltage protection.

Pump should not be subjected to pressures beyond its design ratings. Failure to follow these instructions could result in serious injury or death.

Operating personnel should be trained in the operation of the pump and any associated system.

Handling:



WARNING
Hazard

Any lifting eyes supplied on pumps are intended for lifting pump only—NOT complete unit.

Site Inspection:



CAUTION
Hazard

The pump should be of the proper size and capacity for the proposed installation. Refer to nameplate for rated capacities. Check motor voltage against available power supply.

Compounds from a chemical feed tank should be injected into the discharge piping of the boiler feed pumps—NEVER ahead of pump into the pump suction piping. Failure to follow these instructions could result in minor or moderate injury as well as property damage.

Unit and/or Pump Location:

If pump and motor is operating at high or low temperatures, insulate and ventilate as required.

The pumps are typically furnished with motor classified as either Open Drip Proof (ODP) or Totally Enclosed, Fan Cooled (TEFC). Depending upon the application, other classifications (e.g., Explosion Proof) are available. Locate pumps only in areas of the proper classification. See motor data and NEMA classifications.

The pump should be located at a low point in the piping that keeps the impeller flooded. Consult factory for suction lift applications and use of foot valves. The ambient conditions should be checked with the motor data. A high ambient temperature *will cause* thermal overload protection to shut off the pump. To facilitate maintenance, place unit for easy access to all parts. Allow adequate space for servicing.

Seal Flush Line (or Bleed Line):



Pump seal flush line contains HOT condensate. Failure to close valve or drain line could result in serious injury (i.e., burns) or death.

Failure to connect seal flush line will cause mechanical seal and motor failures.

SHIPCO® pumps are manufactured with provisions for a seal flush line. This line helps prevent the pump from vapor binding and allows the pump to operate against a dead shut-off for periods of time without damaging the seals.

The flush line's copper tubing is 1/4" or 3/8" diameter depending on the GPM of the pump. If distance from pump to receiver is greater than 12" but shorter than or equal to 48", use 1" schedule 40 pipe after the first 12" run of copper tubing. If distance is greater than 48", use 1½" schedule 40 pipe after first 12" run of tubing. A valve for maintenance should be installed in the seal flush line. The valve *must remain open* at all times unless pump is removed for servicing. If you can meet above requirements, contact factory.

Bypass Lines:



Pump bypass line contains HOT condensate. Failure to close valve or drain line could result in serious injury (i.e., burns) or death.

Failure to connect bypass line will cause mechanical seal and motor failures.

If the following conditions are met—pump is used on a deaerator and runs continuously and motor horsepower is 7½ or larger and temperature of liquid in tank is 212°F or higher—then a bypass line is required. On complete units, the manufacturer will install the bypass line. When pump assemblies are purchased separately, the manufacturer will supply a bypass that must be installed from the discharge piping (immediately after the pump discharge flange) back into the receiver entering below the water line. If an automatic flow control valve is also installed in the discharge piping, the bypass line must be installed downstream after the flow control valve. Make sure an isolation valve is also installed in the discharge line for servicing. The isolation valve must remain open during operation of pump.

Suction Piping—Floor or Elevated Units:



Pump suction line contains HOT condensate. Failure to close valve or drain line could result in serious injury (i.e., burns) or death.

An isolation valve should be installed in the suction piping between the receiver and pump suction for servicing the pump. The valve should be sized to allow an adequate flow of water to meet the Net Positive Suction Head (NPSH) requirement of the pump.

Suction Piping — Elevated Units Only:

If pump is not bolted (i.e., flange mounted) onto the side of a floor-mounted unit (i.e., tank is elevated above pump), always install a section of straight, horizontal pipe (18" minimum length) between the suction of the pump and first elbow.

The recommended suction piping size is shown below:

Suction Pipe Diameter	Maximum GPM 210° F or less	Maximum GPM Greater than 210° F
2"	52	30
2½"	75	43
3"	114	66
4"	200	116
5"	312	181
6"	450	261
8"	750	450
10"	—	750

If size of tapping in tank for suction pipe is larger than pump suction connection, a reducing elbow is required.

Support the suction and discharge piping independently by using pipe hangers near the pump. Line up the vertical and horizontal piping so that the bolt holes in the pump flange match the bolt holes in the pipe flange. **Do not attempt to spring** the suction discharge lines into position.

The code for pressure piping (ASME Section 1) must be followed as well as any local and state codes.

If considerable condensate temperature changes are anticipated and/or unit is installed within a seismic zone, then fittings for absorbing expansion should be installed in the system in a way to avoid strain on the pump due to potential movement.

For new installation, pump suction strainers are **not to be installed** in the suction piping on the suction side of a *centrifugal* pump. Strainers can shut off or restrict flow of water resulting in failure of pump and/or mechanical seal. In addition, the Available NPSH cannot be calculated when a suction strainer is included. Instead, strainers should be installed in the return lines at the inlet tapping of the receiver and also in the make-up water lines.

For retrofit application with an existing suction strainer, be sure to remove any suction strainer when installing a SHIPCO® centrifugal pump.

Discharge Piping:

A spring-loaded check valve **must be installed** in the discharge piping near to the pump to prevent backflow into the unit. Next, a manual flow control valve (e.g., ball valve, globe valve, or steam cock) **must be installed** after the spring-loaded check valve and near to the pump discharge flange or union to "balance the pump" (i.e., adjusting discharge flow of the pump to keep it running at the design operating conditions for flow rate and discharge pressure). A gate valve **should not be used** as a manual flow control valve. Note that some people refer to the term "balancing the pump" as either "throttling the pump" or "choking the pump."

If pump discharge is rated for 75 PSIG or greater, the pump may be equipped with an automatic flow control valve (see Figure 2.1) that functions as the balancing valve. When an automatic flow control valve is included, it must be installed in the discharge piping *immediately after the pump's discharge flange or union and before any other valves*. The automatic flow control valve is used to set the pump at the design operating conditions to prevent motor overload and pump cavitations. Figure 2.2 shows piping for a continuous run application that requires a bypass line.

Notes on Piping:

1. The piping should include isolation valves on both the suction and discharge sides of the pump and have a drain valve in the suction line.

- When installing the suction and discharge connections to a threaded pump housing, a Teflon tape sealer or a high quality thread sealant is recommended.
- The discharge flange of the Model AW *can be rotated 90°* but would need to be realigned; the discharge of the Model AWF *cannot be rotated*.

Electrical Wiring:

Pumps are furnished for the most widely used voltages. Make sure the motor wiring, starters, transformers etc., match the power supply before installing. Controls, starter coils, etc., should match the control voltages. The secondary side of transformer is the control circuit.

Single-phase motors are usually furnished as dual 115/230/1/60. Motors should be connected according to manufacturer's instructions for correct voltage.

Maximum HP Maximum Volts					NEMA Size	Maximum Voltage	Class K5 or R Fuse (Ampere)	Class K1 or J Fuse (Ampere)	Inverse-Time Circuit Breaker (Ampere)
Single Phase		Three Phase							
115v	230v	208v	250v	600v					
$\frac{1}{3}$	1	$1\frac{1}{2}$	$1\frac{1}{2}$	2	00	600	10	15	15
						250	12	15	15
1	2	3	3	5	0	600	20	30	20
						250	25	30	35
2	3	$7\frac{1}{2}$	$7\frac{1}{2}$	10	1	600	30	60	40
						250	40	60	60
—	—	10	15	25	2	600	60	100	80
						250	60	100	90
—	—	25	30	50	3	600	100	200	125
						250	125	200	150

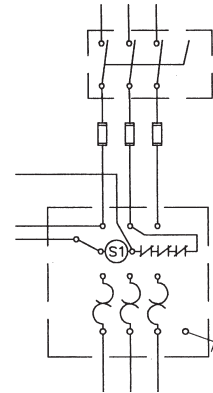


FIGURE 1

Lubrication Maintenance — Pump Bearing Assembly:

The pump is either a close-mounted or flexible-coupled unit. A flexible-coupled pump has a bearing assembly with two grease fittings located on top of bearing assembly—one fitting for thrust bearing and one for idler bearing. Each grease fitting has a corresponding outlet for excess grease to be expelled. The outlets are located on the bottom side and positioned at approximately 4 o'clock or 8 o'clock. The bearing assembly is initially greased at factory before pump is tested and shipped.

Lubrication Schedule:

Table A provides recommended lubrication intervals for bearing assembly based on motor horsepower for standard operating conditions. Depending on severity of service, refer to Table C for adjustment factors.

Table A—Standard Recommended Lubrication Intervals for Pump Bearing Assembly	
Motor Horsepower	Recommended Interval
15 HP or less	Every 2,500 hours
20 HP or greater	Every 1,100 hours

Type of Grease:

Due to the many maintenance departments using various types of greases, any type of grease used on the bearing housing other than factory recommended, should be checked for compatibility. The recommended grease is noted by a tag on the bearing housing. Please consult the factory prior to changing grease.

Lubrication Maintenance — Motor:

Maintenance should include:

- Checking general state of motor and motor bearings
- Cleaning and lubrication

Three-phase motors are usually furnished as tri-voltage 208/230/460/3/60. Motors should be connected according to manufacturer's instructions for correct voltage.

Confirm that the nameplate data on the control panel[s] of the furnished unit match the supply current. If the nameplate data does not match the power source, consult factory.

Wire in accordance with the National Electrical Code, state and local codes where applicable.

Short Circuit Protection:

According to the National Electrical Code, branch circuit over current protection must be provided for each contactor or starter. The following table is provided as a guide. DO NOT EXCEED MAXIMUM PROTECTIVE DEVICE RATINGS.

General Inspection:

Inspect the motor at regular intervals. Typical recommended intervals are approximately every 500 hours of operation or every 3 months, whichever occurs first. However, interval recommendations vary by manufacturer.

Keep the motor clean and the ventilation openings clear. If motor is not properly ventilated, overheating can occur and cause early motor failure.

Motor noise should be measured at regular intervals of one to four months depending on the local operating conditions. A well-tuned ear is perfectly capable of distinguishing unusual noises, even with rudimentary tools such as screwdriver, etc., without recourse to sophisticated listening aids. A uniform hum is a sign that a bearing is running perfectly.

Bearing temperature control is also part of routine maintenance. The temperature of bearings should not exceed 158°F. Constant temperature control is possible with external thermometers or by embedded thermal elements. Bearings should be lubricated to avoid metallic contact of the moving parts, and also for protection against corrosion and wear. Lubricant properties deteriorate in the course of time and mechanical operation. Also, all lubricants are subject to contamination under working conditions. Therefore, lubricants must be renewed and replaced from time to time.

Lubrication Schedule:

Larger horsepower motors typically have grease fittings that require routine maintenance. Proper lubrication helps extend bearing life. Smaller horsepower motors typically have sealed bearings and are not equipped with grease fittings. Since motor designs vary by manufacturer, it is difficult to define a specific motor HP where grease fittings are always present for all manufacturers. Check actual motor to determine it is equipped with grease fittings.

Motors with grease fittings are prelubricated at the factory and do not require initial lubrication. Once installed, the motor should be checked periodically, as dictated by the local operating conditions such as size of motor, speed, working conditions, and type of grease used.

Refer to Table B for recommended lubrication intervals. It is important to realize that the recommendations below are “typical” and based on average (i.e., “standard”) operating conditions. For harsher operating levels, check Table C for the appropriate “adjustment factor” to the “typical” intervals.

Table B—“Typical” Lubrication Intervals for Motors		
NEMA / (IEC) Frame Size	Rated Speed (RPM)	
	3600	1800
Up to 210 / (132)	5,500 hrs.	12,000 hrs.
Over 210 to 280/ (180)	3,600 hrs.	9,500 hrs.
Over 280 to 360/ (225)	*2,200 hrs.	7,400 hrs.
Over 360 to 5800/ (300)	*2,200 hrs.	3,500 hrs.

* Lubrication intervals are for ball bearings. For roller bearings, divide the listed lubrication interval by 2.

“Typical” Levels of Operating Conditions:

Lubrication intervals are a function of the motor operating conditions. The following table defines three levels of typical operating conditions—service levels. Since definitions for motor service levels vary by motor manufacturer, a user should check the Motor Operation and Maintenance Manual provided by the manufacturer for the specific maintenance information on their motor. Links to the motor maintenance manuals are provided on the SHIPCO® website (www.shipcopumps.com).

Table C also includes an “adjustment factor” (based on the severity of service) in column 4 for adjusting the recommended lubrication intervals in Table A based on the operating conditions. For example, for “severe” operating conditions, multiply the recommended hours for 3600 RPM by .5 – reducing the intervals by half.

Table C—Levels of Service and Corresponding Adjustment Factor				
Severity of Service	Ambient Temperature	Atmospheric Contamination	Vibration	Adjustment Factor
Standard	104°F	Clean, Little Corrosion	Minimal	1.0
Severe	105°F to 130°F	Moderate dirt, Corrosion	Some	.5
Extreme	130°F to 150°F or Class H Insulation	Severe dirt, Abrasive dust, Corrosion	Heavy	.1

Type of Grease:

Use grease specified on the motor nameplate. If no grease is specified, check Table D below for a brief overview of grease recommendations for various motor manufacturers. For a more in-depth discussion, refer to specific motor manufacturer’s *Motor Operation and Maintenance Manual*.

Both lithium-based and polyurea-based greases are commonly used for the lubrication of electric motor bearings because lithium-based grease has good mechanical stability, is insoluble in water, and has a drip point of approximately 392 °F. Polyurea-based grease is also moisture resistant.

Greases of different bases, such as lithium, polyurea, sodium, calcium, etc., may not be compatible when mixed. Mixing such greases can result in reduced or loss of lubricant life and premature bearing failure. For example, lithium-based grease, such as Chevron SRI #2, should never be mixed with sodium-based or calcium-based greases. If lubrication instructions specify synthetic oil—do not substitute. Also lithium-based greases are not compatible with polyurea-based grease.



For applications in the food and drug industry (including animal food), consult the petroleum supplier for lubricants that are acceptable to the Food & Drug Administration and other governing bodies.

“Generic” Lubrication Procedure:



Do not touch electrical connections before first ensuring that the power has been disconnected to motor. Electrical shock can cause serious injury or death.

Correct lubrication is important. ***Grease must be applied correctly and in sufficient quantity since both insufficient or excessive greasing are harmful.*** Excessive greasing causes overheating brought about by the greater resistance encountered by the rotating parts and, in particular, by the compacting of the lubricant and its gradual loss of lubricating qualities over time. This can cause seepage with the grease penetrating the motor and dripping on the coils. Use of non-compatible lubrications may also damage the motor.

Table D—Brief Overview of Grease Recommendations			
Motor Manufacturer	Motor Frame or Severity of Service	Temperature Operating Range	Recommended Lubrication
A. O. Smith	Standard	100°F or less	Check nameplate or use SRI #2 (Chevron) if no grease specified
	Severe	100°F to 150°F	Check nameplate or use SRI #2 (Chevron) if no grease specified
Baldor	Standard	Up to 104°F	Polyrex EM (Exxon Mobil) or equivalent
	Severe	105°F to 122°F	DC44 (Dow Corning) silicone-based or equivalent
General Electric	Easy, Standard, Severe	*	SRI #2 (Chevron) or equivalent
Lincoln	Standard	103°F or less	SRI #2 (Chevron) or equivalent
	Severe	104°F to 130°F	Beacon 325 lithium-based or equivalent
	Extreme	131°F to 530°F	DC44 (Dow Corning) silicone-based or equivalent
U.S. Motor	+	+	Polyrex EM (Exxon Mobil) or SRI #2 (Chevron)
WEG	143T – 215T	-4°F to 266°F	Alvania R3 or equivalent
	254T – 586/7	-22°F to 329°F	Unirex N2 or equivalent

- * GE defines levels of service by type of application, instead of by temperature.
- + U.S. Motors does not define levels of service; instead they define lubrication intervals and amount of grease by bearing frame sizes.
- The recommendations in Table D are based on typical information provided by the motor manufacturers. For a specific motor, check motor nameplate or consult with motor manufacturer for specific recommendations on type of grease and lubrication interval.

Relubrication should comply with instructions on the motor. If no motor-mounted instructions exist, use the following *generic* procedure:

- a) Wipe grease fittings clean. If present, remove grease outlet plug. Some motors have relief ports that allow excess grease to automatically discharge.
- b) Remove any hard grease and blockage with a mechanical probe, taking care not to damage bearings.



Under no circumstances should a mechanical probe be used while the motor is in operation.

- c) If motor is stopped, add the recommended type of grease until the lubricant begins to be expelled from the grease fitting or relief port. The **new grease must be compatible** with the existing grease in the motor.

If motor is to be greased while running, a slightly greater quantity of grease will have to be added.



Lubricant should be added slowly at a steady, moderate pressure. If added under heavy pressure, bearing shields may collapse.

Do not overgrease. Overgreasing can cause excessive bearing temperatures, premature lubricant breakdown and bearing failure.

- d) If power off, start motor; allow motor to run long enough to allow any excess grease to be expelled.
- e) Remove any excess grease extending beyond the edges of the bearings or from outlet plug or relief port.
- f) If present, replace filler and outlet plugs.
- g) Return motor to service.

When cleaning bearings, use diesel oil, kerosene or other solvent until thoroughly clean. Refill space around bearing cages with grease immediately after washing. **Never rotate bearings in their dry state washing.**

Rotation:

The pump must rotate CLOCKWISE when viewed from the motor end.

Startup: Putting the Pump into Service:

(See Steps 1-3 below)



Disconnect and lock-out/tag-out power before connecting or servicing. Failure to follow these directions could result in serious injury or death.

(See Steps 4-6 below)



Pump bypass line and suction housing may contain HOT condensate. Take proper precautions to avoid serious injury (i.e., severe burns) or death.

(See Step 7 below)



Reverse rotation can cause severe damage to pumps. Jog the motor to test for proper direction of rotation.

Failure to follow these directions could result in minor or moderate injury or property damage.

1. Make sure the unit is piped in accordance with system design.
2. Check power leads in accordance with wiring diagrams.
3. Check motor wiring in accordance with available voltage.
4. Avoid freezing conditions after receiver of unit has been filled.
5. Prime pump with water to prevent possible damage to pump seals. If present, open pipe plug in discharge flange of pump to allow air to escape and flood the seal chamber. A flooded suction chamber helps prevent pump from locking up. Tighten drain plug after. If no pipe plug in discharge flange, open drain plug in suction piping.

6. On all elevated units, the seal flush line at the pump must be temporarily disconnected to allow air to escape and remain open during initial operation to make sure all air is out of pump. Tighten bleed line once water starts flowing out.
7. Check for proper rotation of all three-phase motors. **Rotation must be clockwise** looking down on the motor as indicated by directional arrows on pump. If pump runs backwards (i.e., counter-clockwise), interchange two wires on three-phase motors.
8. If pump discharge pressure is rated for less than 75 PSIG, manually balance the pump while the pump is running and discharging water, by adjusting the flow control valve (e.g., ball valve, globe valve or steam cock) in the pump discharge line. Continue turning the flow control valve until the reading on the discharge pressure gauge at the pump approaches the rated pump discharge pressure on the nameplate. Tighten the plug nut or brake handle on the flow control valve to secure adjustment.

If pump discharge pressure is rated for 75 PSIG or greater, the pump may be fitted at the factory with an automatic flow control valve that automatically balances the pump.

Both the manual balancing and the automatic flow control valves are used to set pump discharge pressure at the design operating conditions (i.e., flow rate and discharge pressure) to prevent motor overload and cavitations.

Special Startup Considerations:

- a. **Filling "Cold" Boiler With Feed Pumps:** When centrifugal pumps are being used on either a boiler feed unit or deaerator, the pumps should not be used to fill a high pressure (i.e., operating pressure of 15 PSIG or higher) with water when the boiler is cold. When boiler is started up, there is no back-pressure on the pump. Without any back-pressure, the pump will "run out the curve" causing pump cavitations that will severely damage the pump.
However, if boiler feeds are used to fill a boiler, then the pump must be manually balanced to keep the pump at the design operating conditions and prevent pump cavitations. Manual balancing is required even if the pump is fitted with an automatic flow control valve. The automatic flow control valve is rated for a particular pressure range that allows the operating pressure in the boiler to fluctuate. However, the difference in operating pressure between boiler startup and the design operating pressure typically will exceed the pressure range of the automatic flow control valve rendering it ineffective at startup.
- b. **Chemical Injection:** Any chemicals injected into the steam system should be added after the pumps—preferably into the pump discharge piping. Otherwise, chemical residuals will contribute to the premature failure of a pump's mechanical seal. This scenario frequently occurs on boiler feed and deaerator applications.
- c. **Freezing Conditions:** Avoid freezing conditions after receiver of unit has been filled with condensate. Frozen water may cause the suction housing to crack.

Operation and Maintenance:



Failure to follow these directions could result in serious injury or death, including property damage.

Operators must be familiar with all sections of this manual to understand the operation of the unit.

Hot water or condensate, steam and electricity can be very dangerous and deadly.

While a properly installed unit should function unattended for long periods of time, periodic checks should be made to assure proper operation.

Problems such as overflow, noise, leaks, vibrations, etc., in a unit must be corrected immediately.

If pump is installed on a boiler feed unit, the pump must be operational and maintained to avoid jeopardizing the entire boiler and system operation.

Troubleshooting Checklist:

Pump Will Not Run:

1. Power supply has been interrupted. Disconnect switch is open or selector switch improperly positioned.
2. Improper voltage supplied to motor. Check voltage and wiring with motor characteristics.
3. Incorrect starter coil for power supply.
4. Overload relays in starter have tripped out and must be reset. Ambient temperature may be excessive.
5. Wiring to power source is incorrect or connections may be loose.
6. Control devices are in "open position."

GPM Capacity Is Reduced:

1. Pump is running backwards. **Rotation should be clockwise** looking down upon motor toward the pump. Rotation of three-phase motors can be corrected by interchanging any two of the three wires. (Note: a qualified electrician should perform any electrical service.)
2. Pump flow rate is not balanced to the pump design operating conditions.
3. Total pressure at pump discharge is greater than that for which the pump was designed. Check pressure requirements such as system back pressure, and friction and static head.
4. Excessive suction lift, incorrect piping or undersized discharge and/or suction piping.
5. A valve in the pump suction line or discharge line is closed too much. Check if valve in the pump discharge piping is installed backwards.
6. The eye of the impeller is blocked with trash or debris.
7. Pump is undersized for the system.
8. A strainer is dirty, causing a reduction in flow.
9. Pump has lost its prime. Release trapped air in the pump and reprime.
10. Steam traps are blowing through, causing the condensate to return at excessive temperatures. Depending on the unit and type of pump furnished, this could greatly reduce the capacity of the pump below its stated rating. Traps should be repaired or replaced.
11. Excessive temperatures. Capacity of pump may be reduced below its rating. Use SHIPCO® Model P type pumps for low Required NPSH conditions.

Excessive Pump Noise:

1. Pump is running backwards. Check rotation by bumping the motor. Rotation should be clockwise while looking down at the rear of the motor.
2. Pump is working against a lower pressure than it was designed for—the pump is not balanced. Install a balancing valve, plug

cock, or steam cock in the discharge line following the gate valve. Refer to piping diagrams in Figures 2.1–2.6. (Note: Do not use a gate valve as a balancing valve. The seats in the gate valve will wear over time, causing the pump to lose its capability to balance the flow rate at the design operating conditions.) Adjust the balancing valve until the operating pressure at the pump discharge approaches the rated pump pressure.

3. Magnetic hum or bearing noise in motor. Consult the motor manufacturer's authorized service technician.
4. Starter chatters. Trouble is caused by low line voltage, poor connections, defective start coil or burned contacts.
5. Excessive ambient temperature. Correct the system conditions.
6. Entrained air. Release the trapped air pocket.

Representative Servicing:

If trouble occurs that cannot be rectified, contact your local SHIPCO® representative who will need the following information in order to give you assistance:

1. Provide all information on pump and motor from SHIPCO® nameplate (see examples below).
2. Suction and discharge pipe pressure gauge readings.
3. Ampere draw of the motor.
4. A sketch of the pump hook-up and piping.

Nameplate Used on Assembled Unit Nameplate

UNIT MODEL			
MANUFACTURED BY		P.O. BOX 279, SHIPPENSBURG, PA 17257	
SHIPCO® PUMPS		PHONE: (717) 532-7321 • FAX: (717) 532-7704	
		WWW.SHIPCOPUMPS.COM	
RATED		GPM @	PSIG
MOTOR HP		VOLTAGE	
UNIT SERIAL NO.			
PUMP TYPE			

Used on Pumps (Not Installed When Pumps on Assembled Unit)

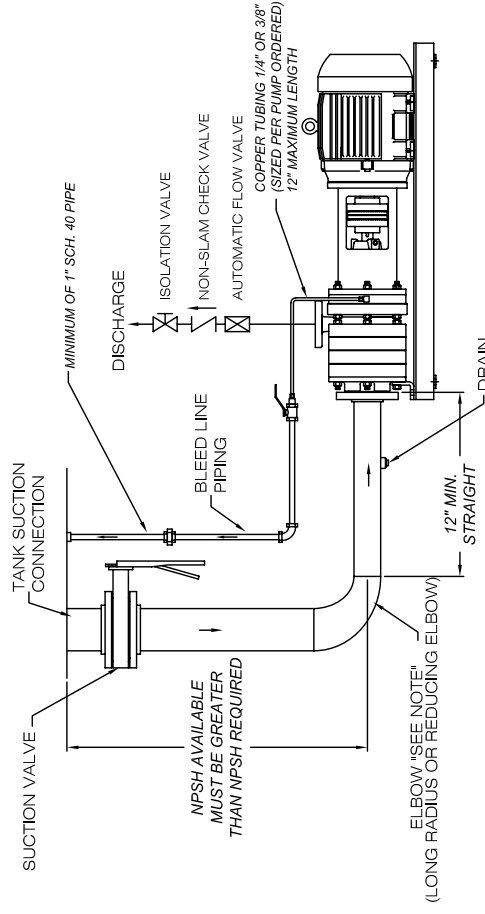
MANUFACTURED BY	MODEL NO.	
SHIPCO® PUMPS	SERIAL NO.	

PUMP MODEL AW & AWF TYPICAL PIPING DIAGRAM W/ AUTOMATIC FLOW VALVE

FIGURE 2.1

NOTE: The seal flushing (bleed) line must be field installed as detailed in Figure 2.1 when pumps are field piped. Factory packages include flushing line.

PIPING TO INDIVIDUAL PUMPS



NOTE: IF TANK SUCTION CONNECTION IS LARGER OR SMALLER THAN PUMP SUCTION CONNECTION A REDUCING ELBOW IS REQUIRED.
NOTE: BYPASS LINE CAN CONTAIN EITHER AN ORIFICE OR A FLOW VALVE

MANIFOLDED PIPING

MANIFOLDS AND MANIFOLD PIPING MUST BE LARGE ENOUGH TO ALLOW COMBINED FLOW RATES TO OR FROM EACH MANIFOLDED PUMP

VALVES CANNOT BE ELIMINATED BY MANIFOLDING PUMPS. EACH PUMP MUST HAVE A UNIQUE FLOW VALVE, CHECK VALVE, AND ISOLATION VALVES.

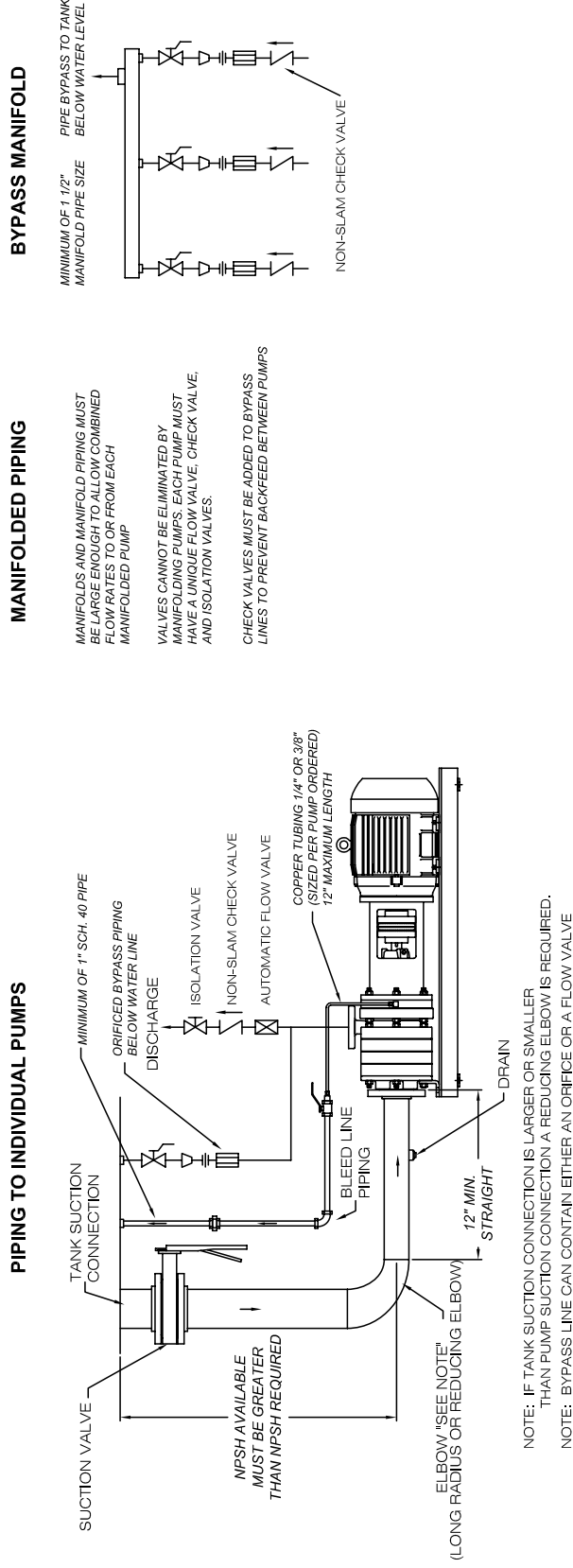
CAUTION: Pump should NOT be subjected to more than 50 psig suction pressure.

WARNING: The manufacturer will not be liable for any malfunction, damage, or destruction of the equipment if the equipment is not installed properly or is not installed by professionals, licensed and registered as required. Failure to follow and install the equipment according to job specific drawings, made by professionals who are licensed and registered as required and are familiar with the equipment, and failure to have the equipment installed by professionals, who are licensed and registered as required, in accordance with local, state, and federal codes will void all warranties and will void any liability upon the manufacturer. In addition, all warranties, including warranties of merchantability and fitness for a particular purpose are null and void for failure to follow job specific drawings made by professionals who are licensed and registered as required and are familiar with the equipment, and failure to have the equipment installed by professionals, who are licensed and registered as required, in accordance with local, state, and federal codes.

FOR DEAERATOR APPLICATIONS ONLY (WHEN MOTOR HORSEPOWER IS 7 1/2 HP & LARGER) PUMP MODEL AW & AWF TYPICAL PIPING DIAGRAM CONTINUOUS RUN W/ ORIFICE BYPASS & AUTOMATIC FLOW VALVE

FIGURE 2.2

NOTE: The seal flushing (bleed) line must be field installed as detailed in Figure 2.2 when pumps are field piped. Factory packages include flushing line.



CAUTION: Pump should NOT be subjected to more than 50 psig suction pressure.

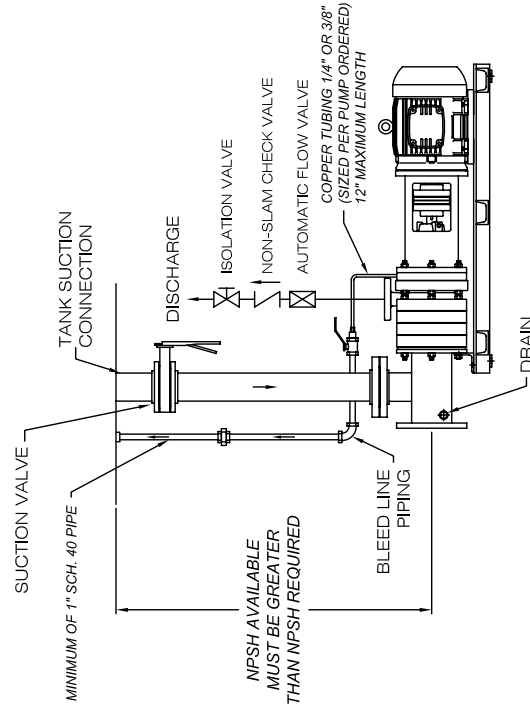
WARNING: The manufacturer will not be liable for any malfunction, damage, or destruction of the equipment if the equipment is not installed properly or is not installed by professionals, licensed and registered as required. Failure to follow and install the equipment according to job specific drawings, made by professionals who are licensed and registered as required and are familiar with the equipment, and failure to have the equipment installed by professionals, who are licensed and registered as required, in accordance with local, state, and federal codes will void all warranties and will void any liability upon the manufacturer. In addition, all warranties, including warranties of merchantability and fitness for a particular purpose are null and void for failure to follow job specific drawings made by professionals who are licensed and registered as required and are familiar with the equipment, and failure to have the equipment installed by professionals, who are licensed and registered as required, in accordance with local, state, and federal codes.

PUMP MODEL AW-BH & AWF-BH TYPICAL PIPING DIAGRAM W/ AUTOMATIC FLOW VALVE

FIGURE 2.3

NOTE: The seal flushing (bleed) line must be field installed as detailed in Figure 2.3 when pumps are field piped. Factory packages include flushing line.

PIPING TO INDIVIDUAL PUMPS



NOTE: IF TANK SUCTION CONNECTION IS LARGER OR SMALLER THAN PUMP SUCTION CONNECTION A REDUCING ELBOW IS REQUIRED.
NOTE: BYPASS LINE CAN CONTAIN EITHER AN ORIFICE OR A FLOW VALVE

MANIFOLDED PIPING

MANIFOLDS AND MANIFOLD PIPING MUST BE LARGE ENOUGH TO ALLOW COMBINED FLOW RATES TO OR FROM EACH MANIFOLDED PUMP
VALVES CANNOT BE ELIMINATED BY MANIFOLDING PUMPS. EACH PUMP MUST HAVE A UNIQUE FLOW VALVE, CHECK VALVE, AND ISOLATION VALVES.

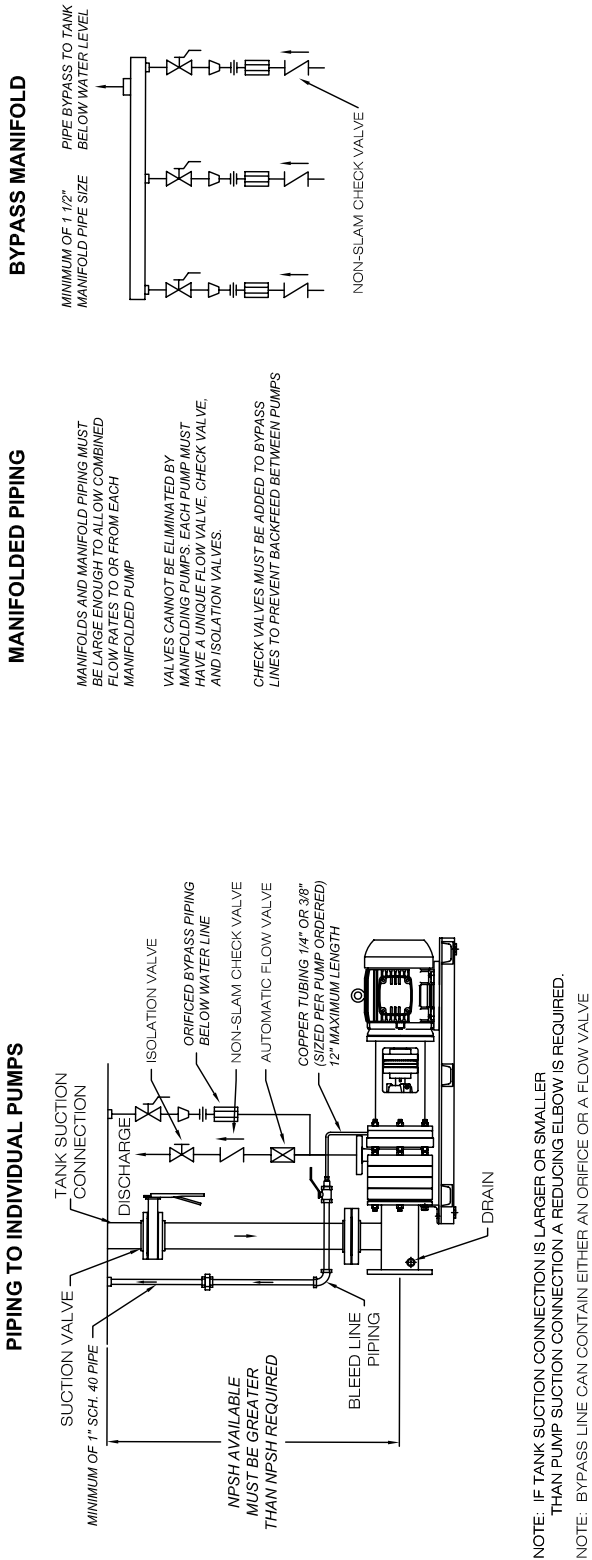
CAUTION: Pump should NOT be subjected to more than 50 psig suction pressure.

WARNING: The manufacturer will not be liable for any malfunction, damage, or destruction of the equipment if the equipment is not installed properly or is not installed by professionals, licensed and registered as required. Failure to follow and install the equipment according to job specific drawings, made by professionals who are licensed and registered as required and are familiar with the equipment, and failure to have the equipment installed by professionals, who are licensed and registered as required, in accordance with local, state, and federal codes will void all warranties and will void any liability upon the manufacturer. In addition, all warranties, including warranties of merchantability and fitness for a particular purpose are null and void for failure to follow job specific drawings made by professionals who are licensed and registered as required and are familiar with the equipment, and failure to have the equipment installed by professionals, who are licensed and registered as required, in accordance with local, state, and federal codes.

FOR DEAERATOR APPLICATIONS ONLY (WHEN MOTOR HORSEPOWER IS 7 1/2 HP & LARGER) PUMP MODEL AW-BH & AWF-BH TYPICAL PIPING DIAGRAM CONTINUOUS RUN W/ ORIFICE BYPASS & AUTOMATIC FLOW VALVE

FIGURE 2.4

NOTE: The seal flushing (bleed) line must be field installed as detailed in Figure 2.4 when pumps are field piped. Factory packages include flushing line.



CAUTION: Pump should NOT be subjected to more than 50 psig suction pressure.

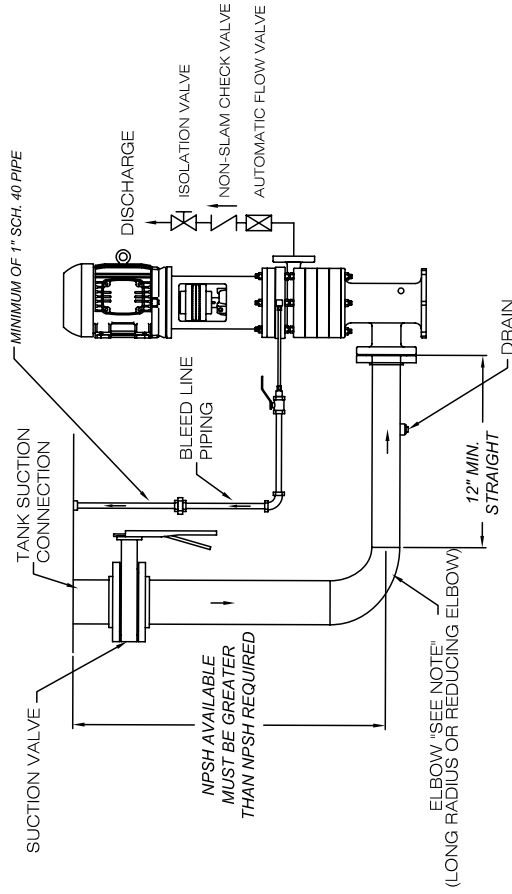
WARNING: The manufacturer will not be liable for any malfunction, damage, or destruction of the equipment if the equipment is not installed properly or is not installed by professionals, licensed and registered as required. Failure to follow and install the equipment according to job specific drawings, made by professionals who are licensed and registered as required and are familiar with the equipment, and failure to have the equipment installed by professionals, who are licensed and registered as required, in accordance with local, state, and federal codes will void all warranties and will void any liability upon the manufacturer. In addition, all warranties, including warranties of merchantability and fitness for a particular purpose are null and void for failure to follow job specific drawings made by professionals who are licensed and registered as required and are familiar with the equipment, and failure to have the equipment installed by professionals, who are licensed and registered as required, in accordance with local, state, and federal codes.

PUMP MODEL AW-BF & AWF-BF TYPICAL PIPING DIAGRAM W/ AUTOMATIC FLOW VALVE

FIGURE 2.5

NOTE: The seal flushing (bleed) line must be field installed as detailed in Figure 2.5 when pumps are field piped. Factory packages include flushing line.

PIPING TO INDIVIDUAL PUMPS



NOTE: IF TANK SUCTION CONNECTION IS LARGER OR SMALLER THAN PUMP SUCTION CONNECTION A REDUCING ELBOW IS REQUIRED.
NOTE: BYPASS LINE CAN CONTAIN EITHER AN ORIFICE OR A FLOW VALVE

MANIFOLDED PIPING

MANIFOLDS AND MANIFOLD PIPING MUST BE LARGE ENOUGH TO ALLOW COMBINED FLOW RATES TO OR FROM EACH MANIFOLDED PUMP

VALVES CANNOT BE ELIMINATED BY MANIFOLDING PUMPS. EACH PUMP MUST HAVE A UNIQUE FLOW VALVE, CHECK VALVE, AND ISOLATION VALVES.

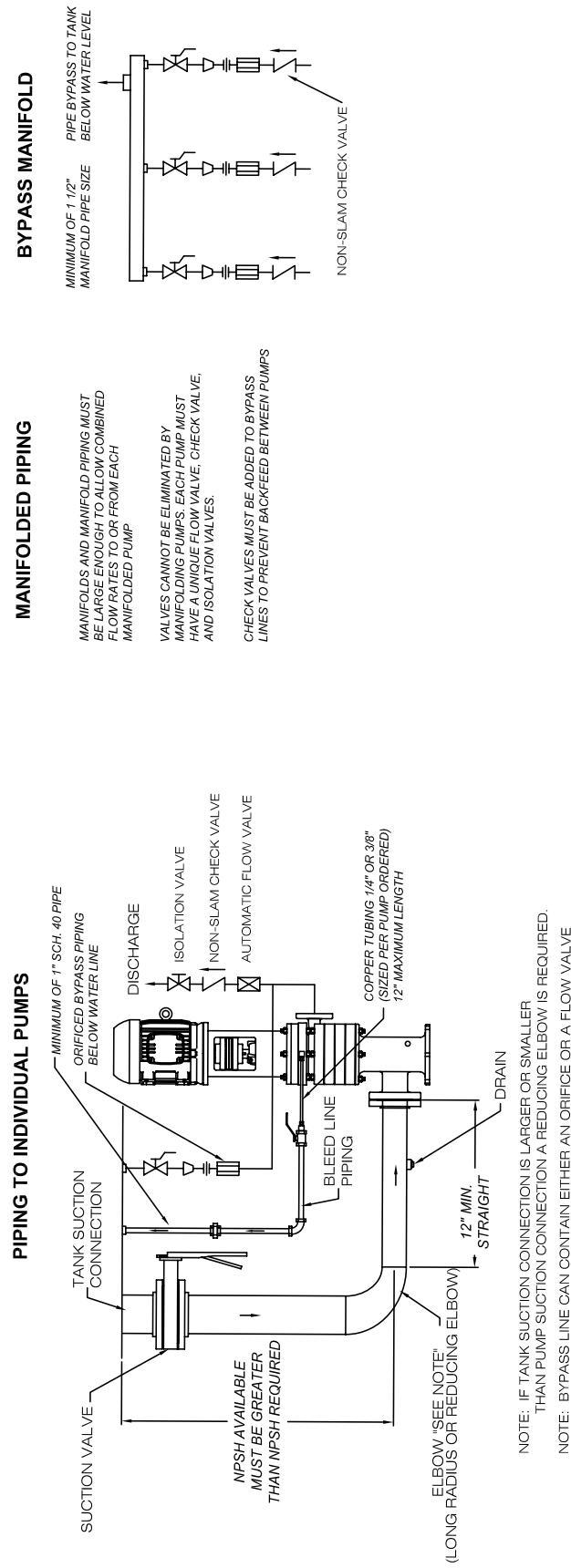
CAUTION: Pump should NOT be subjected to more than 50 psig suction pressure.

WARNING: The manufacturer will not be liable for any malfunction, damage, or destruction of the equipment if the equipment is not installed properly or is not installed by professionals, licensed and registered as required. Failure to follow and install the equipment according to job specific drawings, made by professionals who are licensed and registered as required and are familiar with the equipment, and failure to have the equipment installed by professionals, who are licensed and registered as required, in accordance with local, state, and federal codes will void all warranties and will void any liability upon the manufacturer. In addition, all warranties, including warranties of merchantability and fitness for a particular purpose are null and void for failure to follow job specific drawings made by professionals who are licensed and registered as required and are familiar with the equipment, and failure to have the equipment installed by professionals, who are licensed and registered as required, in accordance with local, state, and federal codes.

FOR DEAERATOR APPLICATIONS ONLY (WHEN MOTOR HORSEPOWER IS 7 1/2 HP & LARGER) PUMP MODEL AW-BF & AWF-BF TYPICAL PIPING DIAGRAM CONTINUOUS RUN W/ ORIFICE BYPASS & AUTOMATIC FLOW VALVE

FIGURE 2.6

NOTE: The seal flushing (bleed) line must be field installed as detailed in Figure 2.6 when pumps are field piped. Factory packages include flushing line.



CAUTION: Pump should NOT be subjected to more than 50 psig suction pressure.

WARNING: The manufacturer will not be liable for any malfunction, damage, or destruction of the equipment if the equipment is not installed properly or is not installed by professionals, licensed and registered as required. Failure to follow and install the equipment according to job specific drawings, made by professionals who are licensed and registered as required and are familiar with the equipment, and failure to have the equipment installed by professionals, who are licensed and registered as required, in accordance with local, state, and federal codes will void all warranties and will void any liability upon the manufacturer. In addition, all warranties, including warranties of merchantability and fitness for a particular purpose are null and void for failure to follow job specific drawings made by professionals who are licensed and registered as required and are familiar with the equipment, and failure to have the equipment installed by professionals, who are licensed and registered as required, in accordance with local, state, and federal codes.

Notes/Comments

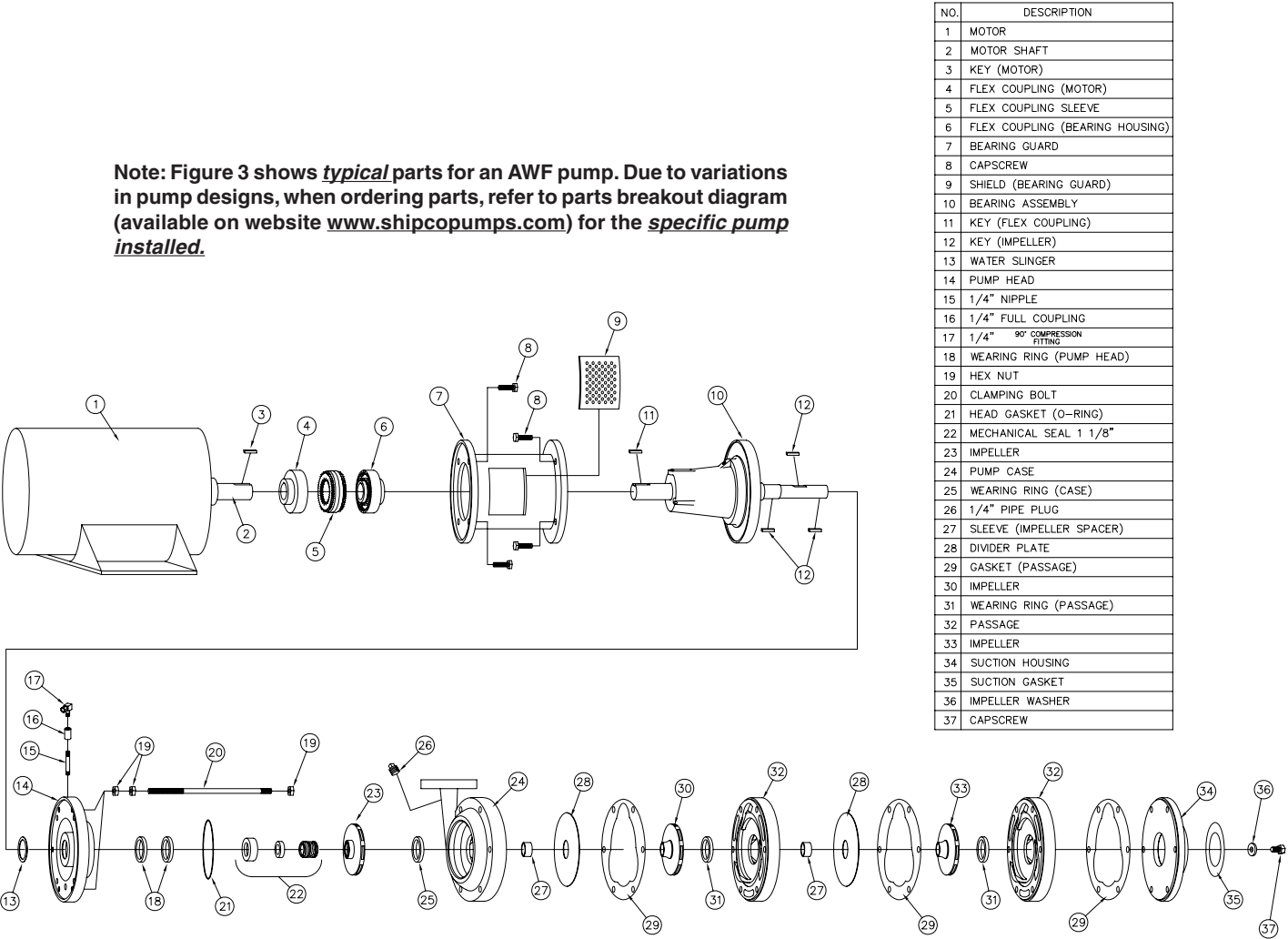
MECHANICAL SEAL REPLACEMENT INSTRUCTIONS FOR MODEL AWF PUMPS

Note: Seals will be damaged if operated dry or the pump is not balanced to its design operating conditions.

Pumps have mechanical seals. If system has not been properly cleaned prior to installation of pump, foreign matter such as dirt, pipe scale, etc., may clog the impeller and damage the seal. A strainer is recommended in the return line to the pump's receiver. Pumps cannot operate dry—the seals will be destroyed if operated without water present. Follow similar procedure for Model AW pumps.

FIGURE 3
MODEL AWF PARTS LIST

Note: Figure 3 shows *typical* parts for an AWF pump. Due to variations in pump designs, when ordering parts, refer to parts breakout diagram (available on website www.shipcopumps.com) for the *specific pump installed*.



(Steps A,B & Y below)

WARNING
Electrical Hazard

High Voltage. Failure to follow directions could result in serious injury or death.

(Step G-H below)

CAUTION
Heat/Hot Surface

Surfaces are HOT. Do not touch receiver while operating.
Failure to follow directions may result in minor or moderate injury (i.e., burns).

(Step J below)

CAUTION
Heat/Hot Surface

HOT water. Failure to follow directions may result in minor or moderate injury (i.e., burns).

- A. Disconnect and lock out power before connecting or servicing unit.
- B. Disconnect wiring to motor.
- C. *If present*, close both pump seal flush line (also referred to as bleed line) and pump bypass line.
- D. Close discharge gate valve.
- E. *If suction isolation valve present* (between pump and receiver), close valve.
- F. *Do not* close any vent on the receiver. Vents must remain open.
- G. Surfaces are hot when the system is in operation. Do not touch hot receiver. Let unit cool before servicing—check temperature gauge before servicing.
- H. Remove drain plug in suction piping of pump to empty any remaining liquid in pump and suction piping.
 - I. Remove the hex nut (#19) of clamping bolt (#20) that fastens all the “stages” including the suction housing (#34), pump case (#24) and pump head (#14) to the bearing assembly (#10). Make sure the pressure is relieved before loosening the pump assembly.
- J. Remove suction housing (#34) and first passage (#32); first wear ring is pressed into first passage.
- K. Remove impeller bolt (#37).
- L. Remove 1st stage impeller and divider plate (#28).
- M. The “key” (#11) on shaft bearing assembly (#10) for the 1st stage impeller must be removed before space sleeve (#27) can be removed.
- N. Repeat steps L & M for additional stages.
- O. Remove pump case (#24).
- P. Using two thin flat pry bars, pry the “last stage” impeller off the keyed shaft of the bearing assembly.
- Q. Remove key for “last stage” impeller.
- R. Remove the rotating portion (#22) of the mechanical seal (#22) from the end of the bearing assembly shaft. *Note: The non-rotating or stationary portion of the mechanical seal, the cup and the ceramic are pressed into the pump head (#14).*
- S. Remove the pump head (#14). *Note: The water slinger (#13) remains on the bearing assembly shaft unless it is also being replaced.*
- T. Remove the stationary parts of the mechanical seal (#22), the ceramic and cup rubber from the pump head (#14).
- U. Thoroughly clean the machined recess in the pump head (#14). Install new mechanical seal. Apply a thin coating of liquid detergent to the recess and outer edge of the stationary portion of the mechanical seal. The new seal can then be *pressed firmly into place by hand*. Make sure the seal bottoms evenly. Should you be unable to bottom the seal evenly, place a cardboard over the seal and force it into place with a flat tool.
- V. Clean the mating surfaces of the seal with a lint-free cloth. The carbon or rotating part should not be loose. Hold in place with a small amount of liquid detergent if necessary. Apply liquid detergent to the rubber lightly and install over the bearing assembly shaft with the carbon contacting the ceramic seal.
- W. Carefully start the “last stage” impeller and shaft key (#11) onto the bearing assembly shaft. Drive the impeller onto the bearing assembly shaft with a wood dowel or large fiber punch in the center of the impeller eye, making sure the impeller is going on straight and the key (#11) is going into place properly.
- X. Reassemble by reversing procedures. Install a new head gasket, suction housing gaskets and suction gasket.
- Y. Reconnect power supply, open isolation valves and seal flush line valve. Prime pump. Pump is now ready for operation.
- Z. Make sure all *installation procedures* listed in this manual are followed to ensure good pump operation.
- AA. Pump may be tested for operation by hand operating float switch (if condensate unit). Slight leakage may occur until seal surfaces adjust. **Check rotation on three-phase units—pumps should rotate clockwise. Seal flush line shut-off (if present) *MUST REMAIN OPEN* unless pump is being serviced.**
- BB. **DO NOT RUN PUMP DRY!** If pumps are run dry, seal damage may occur. Inspect pump seal regularly for leaks. Replace as required. Failure to follow these instructions could result in serious injury or property damage.
- CC. **DO NOT RUN MOTORS IN REVERSE!** Reverse operation can cause extensive damage to pumps. Jog the motor to test for direction of rotation. Failure to follow these instructions could result in serious injury or property damage.

Impeller Replacement for Keyed on Impellers

1. Pumps with keyed on impellers are pressed onto the shaft sleeve of the pump.
2. The impeller needs to be reamed, but not too much, so that the impeller is a tight or snug fit.
3. The impeller will now need to be placed onto the shaft.
4. Take the impeller washer and place washer into the impeller.
5. Next, take a capscrew and insert capscrew through impeller washer and impeller into the motor shaft.
6. Draw down onto the capscrew(s). Keep using capscrews of different thread lengths until impeller is tight against the pump head.

Wearing Ring Replacement

1. Make sure the wearing ring is pushed all the way down into the pump case or pump head so that it bottoms out.
2. Make sure the wearing ring is free of all dirt and debris.

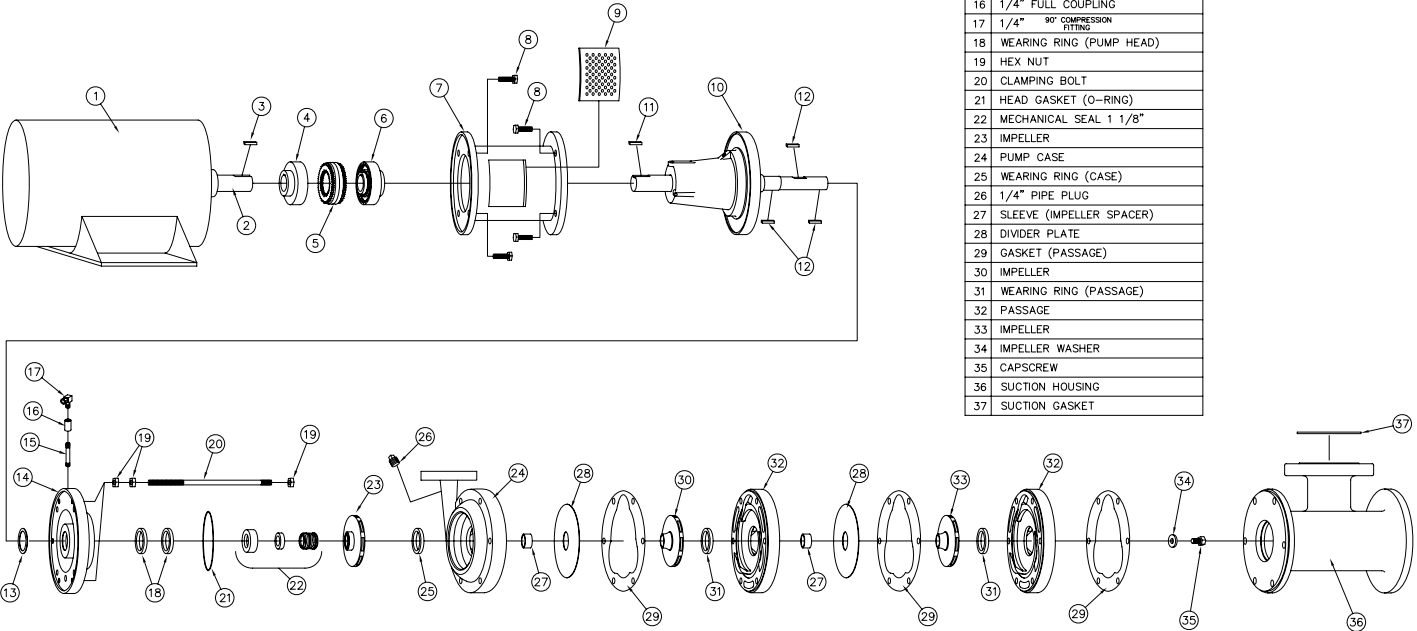
MECHANICAL SEAL REPLACEMENT INSTRUCTIONS FOR MODEL AWF-B PUMPS

Note: Seals will be damaged if operated dry or the pump is not balanced to its design operating conditions.

Pumps have mechanical seals. If system has not been properly cleaned prior to installation of pump, foreign matter such as dirt, pipe scale, etc., may clog the impeller and damage the seal. A strainer is recommended in the return line to the pump's receiver. Pumps cannot operate dry—the seals will be destroyed if operated without water present.

FIGURE 4
MODEL AWF-B PARTS LIST

Note: Figure 4 shows typical parts for an AWF-B pump. Due to variations in pump designs, when ordering parts, refer to parts breakout diagram (available on website www.shipcopumps.com) for the specific pump installed.



(Steps A,B & Y below)

WARNING
Electrical Hazard

High Voltage. Failure to follow directions could result in serious injury or death.

(Step G-H below)

CAUTION
Heat/Hot Surface

Surfaces are HOT. Do not touch receiver while operating.
Failure to follow directions may result in minor or moderate injury (i.e., burns).

(Step J below)

CAUTION
Heat/Hot Surface

HOT water. Failure to follow directions may result in minor or moderate injury (i.e., burns).

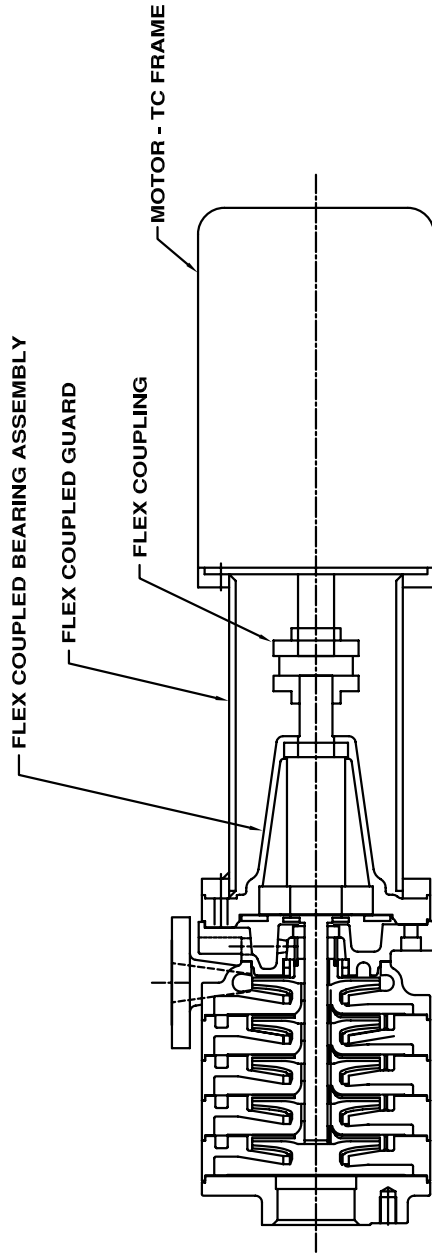
- A. Disconnect and lock out power before connecting or servicing unit.
- B. Disconnect wiring to motor.
- C. *If present*, close both pump seal flush line (also referred to as bleed line) and pump bypass line.
- D. Close discharge gate valve.
- E. *If suction isolation valve present* (between pump and receiver), close valve.
- F. *Do not* close any vent on the receiver. Vents must remain open.
- G. Surfaces are hot when the system is in operation. Do not touch hot receiver. Let unit cool before servicing—check temperature gauge before servicing.
- H. Remove drain plug in suction piping of pump to empty any remaining liquid in pump and suction piping.
 - I. Remove the hex nut (#19) of clamping bolt (#20) that fastens all the “stages” including the suction housing (#36), pump case (#24) and pump head (#14) to the bearing assembly (#10). Make sure the pressure is relieved before loosening the pump assembly.
- J. Remove suction housing (#36) and first passage (#32); first wear ring is pressed into first passage.
- K. Remove impeller bolt (#35).
- L. Remove 1st stage impeller and divider plate (#28).
- M. The “key” (#11) on shaft bearing assembly (#10) for the 1st stage impeller must be removed before space sleeve (#27) can be removed.
- N. Repeat steps L & M for additional stages.
- O. Remove pump case (#24).
- P. Using two thin flat pry bars, pry the “last stage” impeller off the keyed shaft of the bearing assembly.
- Q. Remove key for “last stage” impeller.
- R. Remove the rotating portion (#22) of the mechanical seal (#22) from the end of the bearing assembly shaft. *Note: The non-rotating or stationary portion of the mechanical seal, the cup and the ceramic are pressed into the pump head (#14).*
- S. Remove the pump head (#14). *Note: The water slinger (#13) remains on the bearing assembly shaft unless it is also being replaced.*
- T. Remove the stationary parts of the mechanical seal (#22), the ceramic and cup rubber from the pump head (#14).
- U. Thoroughly clean the machined recess in the pump head (#14). Install new mechanical seal. Apply a thin coating of liquid detergent to the recess and outer edge of the new cup rubber. The new ceramic seal can then be *pressed firmly into place by hand*. Make sure the seal bottoms evenly. Should you be unable to bottom the seal evenly, place a cardboard over the ceramic seal and force it into place with a flat tool.
- V. Clean the mating surfaces of the seal with a lint-free cloth. The carbon or rotating part should not be loose. Hold in place with a small amount of liquid detergent if necessary. Apply liquid detergent to the rubber lightly and install over the bearing assembly shaft with the carbon contacting the ceramic seal.
- W. Carefully start the “last stage” impeller and shaft key (#11) onto the bearing assembly shaft. Drive the impeller onto the bearing assembly shaft with a wood dowel or large fiber punch in the center of the impeller eye, making sure the impeller is going on straight and the key (#11) is going into place properly.
- X. Reassemble by reversing procedures. Install a new head gasket, suction housing gaskets and suction gasket.
- Y. Reconnect power supply, open isolation valves and seal flush line valve. Prime pump. Pump is now ready for operation.
- Z. Make sure all *installation procedures* listed in this manual are followed to ensure good pump operation.
- AA. Pump may be tested for operation by hand operating float switch (if condensate unit). Slight leakage may occur until seal surfaces adjust. **Check rotation on three-phase units—pumps should rotate clockwise. Seal flush line shut-off (if present) MUST REMAIN OPEN unless pump is being serviced.**
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5. Next, take a capscrew and insert capscrew through impeller washer and impeller into the motor shaft.
6. Draw down onto the capscrew(s). Keep using capscrews of different thread lengths until impeller is tight against the pump head.

Wearing Ring Replacement

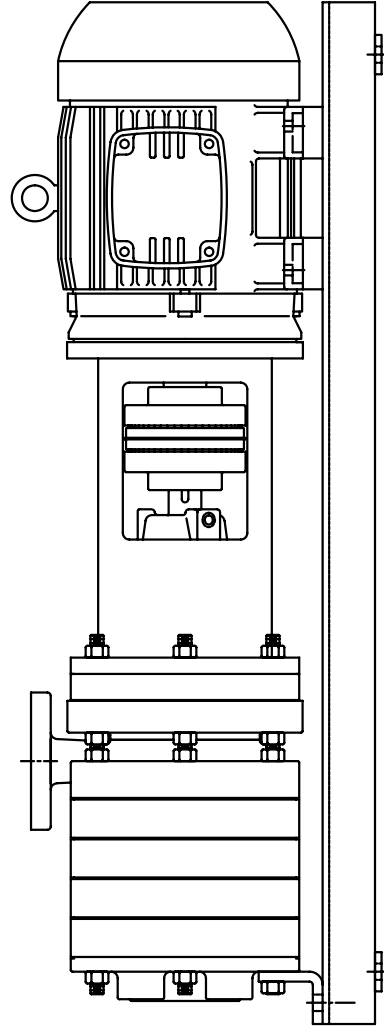
1. Make sure the wearing ring is pushed all the way down into the pump case or pump head so that it bottoms out.
2. Make sure the wearing ring is free of all dirt and debris.



SECTIONAL VIEW OF PUMP

Why Shipco AWF Flexible Coupled Pumps Are Self Aligning

1. TC frame motor (having a concentric shouldered diameter) will insert into a machined concentric counterbored surface in the Shipco Flex Coupled Guard.
2. Shipco Flex Coupling Guard (with machined concentric surfaces) will in turn insert into the Flex Coupled Bearing Assembly (through the same procedure).
3. Shipco pump parts are all machined with the same procedure to ensure assembly of parts will maintain concentricity.
4. With this procedure the need for laser alignment of the Shipco Flex Coupled Bearing shaft to the TC frame motor shaft is no longer needed.



PUMP SHOWN ON BASE

Notes/Comments

TERMS AND CONDITIONS OF SALE

AGREEMENT

By entering your order or requesting a quote, you confirm that the following terms and conditions of sale are the legal agreement governing your purchase, and that no changes or additional or different terms will apply unless you have previously established a different written contract for these purchases with Shippensburg Pump Company, Inc., hereafter referred to as the Seller.

ORDER ACCEPTANCE

All orders are subject to acceptance by Seller at its general office in Shippensburg, Pennsylvania. Acceptance will be evidenced by Seller issuing its Sales Acknowledgement Form. The Sales Acknowledgement Form, together with any documents incorporated therein, shall constitute the entire agreement and may not be changed except in writing signed by Seller and Buyer. Publication and circulation of current price lists, catalogues and related literature by Seller shall not be deemed an offer to sell, but rather an invitation for offers to buy. Acceptance by Seller of the Buyer's order is expressly limited to the Terms and Conditions stated herein; any additional, inconsistent or different terms and conditions contained in the Buyer's purchase order or other documents supplied by Buyer are expressly rejected.

PAYMENT TERMS—PRICES

Payment terms are as follows: If the Buyer is a Credit Card Customer, the Buyer agrees to pay at the time of purchase the price, shipping and handling charges, taxes and duties quoted by the Seller. If the Buyer is an Account Holder, the Buyer agrees to pay invoices with payment terms of net thirty (30) days after date of invoice unless otherwise specifically agreed to in writing. If the Seller believes that the Buyer's financial condition requires it, the Seller reserves the right to require full or partial payment prior to manufacture or shipment. If the Buyer fails to make any payment when due, (1) the seller reserves the right to suspend performance and the Buyer agrees that any charges incurred prior to the suspension will be assessed to the Buyer and payable to the Seller; (2) the Buyer further agrees to pay a charge on the amount past due at the rate of 1½% per month (18% per year) or the maximum lawful rate, whichever is less. In the event of non-payment, the Buyer agrees to pay the Seller reasonable attorney's fees and court costs, if any incurred by the Seller to collect payment and interest charges. These terms shall apply to partial, as well as complete shipments of Product. Published prices are subject to change without notice and the right is reserved to invoice at prevailing prices at time of shipment unless otherwise specifically agreed to in writing. All quotations are conditional on 30 days acceptance unless stipulated otherwise in writing and to approved credit rating or reference, otherwise payment terms are cash with order or C.O.D.

DELIVERY—DELAYS

Shipping dates represent estimates only and are based on projected production schedules and commitments by suppliers. Seller shall not be liable for failure or delay in manufacturing or shipping Products, nor shall such failure or delay constitute grounds for cancellation if such failure or delay is directly or indirectly due to shortages of fuel or energy; acts of omissions of the Buyer; acts of God; war, riot, civil disturbances; labor difficulties; accident; inability to reasonably obtain materials; acts of transportation companies; or other causes of any kind whatever beyond the control of Seller. In the event of such delays, Seller reserves the right to make adjustments in price and delivery schedules.

FREIGHT TERMS

Prices are f.o.b. factory unless otherwise stated. Seller's responsibility ceases upon delivery to the transportation company at shipping point. It is the Buyer's responsibility to examine shipment upon arrival to ascertain if in good order. Any shortage or damage claims must be pursued by the Buyer. All weights shown on price sheets and literature are approximate. All packaging is standard domestic boxing, slat and wire crating and/or skidding. An additional charge will be made for full wooden crating or special packaging when specified on the order.

Seller will make every effort to consolidate orders and backorders wherever possible. Seller will not be responsible for excess charges due to their inability to consolidate shipments.

When requested by Buyer, shipments may be routed using premium carriers such as express or airfreight or the Buyer may specify the method or route of shipment. In such cases the shipment will be made on a "collect" basis and where applicable the freight allowance will appear as a separate line item on the product invoice, Seller reserves the right to select the transportation company where freight is allowed.

TAXES

In addition to the price stated, the amount of any present or future sales, use, excise or other similar tax applicable to the production, sale, use or transportation of the Products shall be paid by Buyer. In lieu of paying such taxes to Seller, Buyer may furnish Seller a Tax Exemption Certificate or Certificates acceptable to appropriate taxing authorities at any time prior to Seller's shipment of the Products.

CANCELLATIONS

Any order placed with Seller may be cancelled by the Buyer only upon payment of reasonable cancellation charges that shall include but not be limited to expenses already incurred, as well as material and labor commitments made by Seller.

SHIPMENT—TITLE—RISK OF LOSS

Shipment terms are f.o.b. Seller's facility, unless otherwise specifically agreed to in writing. Notwithstanding the granting of any allowances for shipping, title to and risk of loss for Products will pass to the Buyer when delivered to the Common carrier at the Seller's facility.

BACK CHARGES

All invoices shall be due and payable when submitted for payment in accordance with the provision entitled "Payment Terms—Prices." No withholding of funds, back charges, or credits against amounts otherwise due Seller will be permitted unless specifically agreed to in writing by Seller. Settlement of any amounts due Buyer will be negotiated as separate items and not as offsets against amounts otherwise due Seller from Buyer for Products sold hereunder.

RETURNED GOODS

Unused material of current manufacture can only be returned for credit with the written consent of Seller, under return goods policies existing at the date of the return. Products that are obsolete or made to special order are not returnable.

PATENT INDEMNITY

a. Patent Indemnity by Seller to Buyer

Seller agrees to indemnify and hold harmless the Buyer from and against all legal expenses which may be incurred, as well as all damages and costs (except all consequential and special damages and costs) which may be finally assessed against Buyer in any action for infringement of any United States Letters Patent by the Products delivered to Buyer hereunder; provided that the Buyer shall give Seller prompt written notice of any action, claim or threat of patent infringement suit, either oral or written, or of the commencement of any patent infringement suit against Buyer relating to Products sold by Seller to Buyer hereunder; and provided Buyer shall give Seller opportunity to elect to take over, settle, or defend any such claim, action or suit through counsel of Seller's own choice and under

its sole direction, and at its sole expense, and provided that in the event Seller elects to take over, defend or settle same. Buyer will make available to Seller all defenses against any such claim, action, suit or proceeding known to or available to Buyer; and provided further that Seller shall have the right to substitute for any such Product or any part thereof claiming to infringe the patent right of others, non-infringing Products which will give equally good service. If the use of any such Product or any part thereof should be enjoined, Seller shall have the right at its own expense, to take any of the following courses of action:

- i. To procure for Buyer the right to continue using such Product;
- ii. To replace said Product with a non-infringing Product;
- iii. To modify the Product so that it becomes non-infringing; or
- iv. To remove said Product and refund the purchase price, transportation costs and installation costs thereof.

b. Limitation

The foregoing provisions as to patent protection by Seller to Buyer shall not apply to any of the following:

- i. To any Product manufactured to the design or specification furnished by the Buyer;
- ii. To orders for special non-commercial Products which Seller has not sold or offered for sale to the public on the open commercial market;
- iii. To any infringement occasioned by modification by Buyer of any Product without Seller's written consent, or any infringement arising from the use of a Product with any adjunct or device added by the Buyer without Seller's written permission.

c. Patent Indemnity by Buyer to Seller

To the extent that Products delivered hereunder are manufactured pursuant to detailed designs furnished by Buyer, Buyer agrees to indemnify Seller and hold Seller harmless from all legal expenses which may be incurred, as well as all damages and costs, which may finally be assessed against Seller in any action for infringement of any United States Letters Patent by such Products delivered hereunder. Seller agrees to promptly inform the Buyer of any claim for liability made against Seller with respect to such Products and Seller agrees to cooperate with the Buyer in every way reasonably available to facilitate the defense against any such claim.

GOVERNING LAW

The validity, interpretation and performance of any order shall be governed by the Uniform Commercial Code ("UCC") as adopted by the state in which the Products are manufactured by Seller.

WARRANTY AND LIMITATION OF LIABILITY

Seller warrants for a period of eighteen (18) months from date of shipment from its factory or one (1) year from date of installation, whichever occurs first, that all Products furnished by it are free from defects in materials and workmanship.

Seller's liability for any breach of this Warranty shall be limited solely to replacement or repair, at the sole option of Seller, of any part or parts found to be defective during the Warranty period providing the Product is properly installed and is being used as originally intended. Buyer must notify Seller of any breach of this Warranty within the aforementioned Warranty period; defective parts must be shipped by Buyer to Seller, transportation charges prepaid.

IT IS EXPRESSLY AGREED THAT THIS SHALL BE THE SOLE AND EXCLUSIVE REMEDY OF THE BUYER. UNDER NO CIRCUMSTANCES SHALL SELLER BE LIABLE FOR ANY COSTS, LOSS, EXPENSE, DAMAGES, SPECIAL DAMAGES, INCIDENTAL DAMAGES OR CONSEQUENTIAL DAMAGES ARISING DIRECTLY OR INDIRECTLY FROM THE DESIGN, MANUFACTURE, SALE, USE OR REPAIR OF THE PRODUCT WHETHER BASED UPON WARRANTY, CONTRACT, NEGLIGENCE OR STRICT LIABILITY. IN NO EVENT WILL LIABILITY EXCEED THE PURCHASE PRICE OF THE PRODUCT.

THE WARRANTY AND LIMITS OF LIABILITY CONTAINED HEREIN ARE IN LIEU OF ALL OTHER WARRANTIES AND LIABILITIES, EXPRESSED OR IMPLIED. ALL IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE HEREBY DISCLAIMED BY SELLER AND EXCLUDED FROM THIS WARRANTY.

Seller neither assumes, nor authorizes any person to assume for it, any other Warranty obligation in connection with the sale of the Product. This Warranty shall not apply to any Product or parts of Products which (a) have been repaired or altered outside of Seller's facilities; or (b) have been modified or damaged through misuse, abuse, accident, neglect or mishandling by Purchaser or Purchaser's customer, erroneous voltage, modification, acts of God, or any other act not specifically stated; or (c) have been used in a manner contrary to Seller's instructions.

Products covered by this warranty are for the intended uses as described in the corresponding seller's instructions. Before using for any other application, user shall determine the suitability of the product for its intended use and user assumes all risk and liability in connection therewith.

No oral statement made by the seller, its agents, employees, or other representatives, concerning the product, its value, description, condition, design, specifications, performance, capability, durability, adaptability, or accuracy, shall be relied upon by the purchaser and is specifically and expressly excluded and invalidated as the basis for any bargain or warranty.

In the case of Products not manufactured by Seller, there is no Warranty from Seller, but Seller will extend to the Buyer any Warranty of Seller's supplier of such Products.

FORCE MAJEURE

Seller shall have no liability in respect of failure to deliver or perform, or delay in delivering or performing any obligations due to causes such as acts of omissions of Buyer; acts of God, fire, flood, war and civil disturbances; riot, acts of governments, currency restrictions, labor shortages or disputes, unavailability of materials, fuel, power, energy or transportation facilities, failures of suppliers or subcontractors to deliver on time and every other circumstance outside the reasonable control of Seller.

MODIFICATIONS

Unless otherwise provided, Seller reserves the right to modify the specifications of Products ordered by the Buyer providing that the modification will not materially affect the performance.

STORAGE CHARGE

If Buyer is unable to accept products in accordance with the applicable shipping schedule then Seller may arrange to store ordered Products and the cost of storage will be charged to Buyer.

ENTIRE CONTRACT

These provisions constitute all the terms and conditions agreed upon by the parties and shall replace and supersede any provisions on the face and reverse side of Purchase Order and any attachment thereto, or any prior general agreement inconsistent with the provisions hereof except that orders by Representatives with whom Seller has an Agreement shall be subject to the provisions of the Agreement. No modification hereof shall be valid unless in writing and duly signed by a person authorized by Seller. The provisions hereof shall not be modified by any usage of trade, or any course of prior dealings or acquiescence in any course of performance.