Volume III:

OPERATIONS, MAINTENANCE, AND MONITORING PLAN

Former Carborundum Facility
2040 Cory Drive
Village of Sanborn, Town of Wheatfield, Niagara County, New York

Submitted to:

New York State Department of Environmental Conservation
Division of Hazardous Waste Remediation
270 Michigan Avenue
Buffalo, New York 14203

Submitted by:

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A BP affiliated company

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September 2006
Revised March 2007 / August 2013

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GROUNDWATER EXTRACTION AND TREATMENT SYSTEM MANUFACTURER'S CATALOG-CUTS/MANUALS FORMER CARBORUNDUM FACILITY

Village of Sanborn, Town of Wheatfield, Niagara County, New York

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Groundwater Well Pumps

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Installation and Operating Instructions

Stainless Steel Submersible Pumps

GRUNDFOS

Please leave these instructions with the pump

Installation and Operating Instructions

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Installation and Operation Instructions

GRUNDFOS STAINLESS STEEL SUBMERSIBLE PUMPS

Your Grundfos Submersible Pump is of the utmost quality. Combined with proper installation, your Grundfos pump will give you many years of reliable service.

To ensure the proper installation of the pump, carefully read the complete manual before attempting to install the pump.

SECTION 1.

Shipment Inspection

Examine the components carefully to make sure no damage has occurred to the pump-end, motor, cable or control box during shipment.

This Grundfos Submersible Pump should remain in its shipping carton until it is ready to be installed. The carton is specially designed to protect it from damage. During unpacking and prior to installation, **make sure that the pump is not dropped or mishandled.**

The motor is equipped with an electrical cable. **Under no circumstance should the cable be used to support the weight of the pump.**

You will find a loose data plate wired to the pump. It should be securely mounted at the well or attached to the control box.

SECTION 2.

Pre-Installation Checklist

Before beginning installation, the following checks should be made. They are all critical for the proper installation of this submersible pump.

☑ **A. CONDITION OF THE WELL**

If the pump is to be installed in a new well, the well should be fully developed and bailed or blown free of cuttings and sand. The stainless steel construction of the Grundfos submersible make it resistant to abrasion; however, no pump, made of any material, can forever withstand the destructive wear that occurs when constantly pumping sandy water.

If this pump is used to replace an oil-filled submersible or oil-lubricated line-shaft turbine in an existing well, **the well must be blown or bailed clear of oil.**

Determine the maximum depth of the well, and the draw-down level at the pump's maximum capacity. Pump selection and setting depth should be based on this data.

The inside diameter of the well casing should be checked to ensure that it is not smaller than the size of the pump and motor.

☑ **B. CONDITION OF THE WATER**

Submersible pumps are designed for pumping clear and cold water that is free of air and gases. Decreased pump performance and life expectancy can occur if the water is not cold and clear or contains air and gases.

Maximum water temperature should not exceed 102°F. Special consideration must be given to the pump and motor if it is to be used to pump water above 102°F.

The Grundfos stainless steel submersible is highly resistant to the normal corrosive environment found in some water wells. If water well tests determine the water has an excessive or unusual corrosive quality, or exceeds 102°F, contact your Grundfos representative for information concerning specially designed pumps for these applications.

☑ **C. INSTALLATION DEPTH**

A check should be made to ensure that the installation depth of the pump will always be at least three feet below the maximum draw-down level of the well. For flow rates exceeding 100 gpm, the NPSH may have to be considered. Refer to NPSH curves in the technical brochure.

The bottom of the motor should never be installed lower than the top of the well screen or within five feet of the well bottom.

If the pump is to be installed in a lake, pond, tank or large diameter well, the water velocity passing over the motor must be sufficient to ensure proper motor cooling. The minimum recommended water flow rates which ensure proper cooling are listed in Table A.

☑ **D. ELECTRICAL SUPPLY**

The motor voltage, phase and frequency indicated on the motor nameplate should be checked against the actual electrical supply.

SECTION 3.

Wire Cable Type

e wire cable used between the pump and control box or panel should be approved for submersible pump applications. The conductor may be solid or stranded. The cable may consist of individually insulated conductors twisted together, insulated conductors molded side by side in one flat cable or insulated conductors with a round overall jacket.

The conductor insulation should be type RW, RUW, TW, TWU or equivalent and must be suitable for use with submersible pumps. An equivalent Canadian Standards Association certified wire may also be used. See Table D for recommended sizes of cable lengths.

SECTION 4.

Splicing the Motor Cable

A good cable splice is critical to proper operation of the submersible pump and must be done with extreme care.

If the splice is carefully made, it will work as well as any other portion of the cable, and will be completely watertight.

Grundfos recommends using a heat shrink splice kit. The splice should be made in accordance with the kit manufacture's instructions. Typically a heat shrink splice can be made as follows:

1. Examine the motor cable and the drop cable carefully for damage.

2. Cut the motor leads off in a staggered manner. Cut the ends of the drop cable so that the ends match up with the motor leads (See Figure 4-A). On single-phase motors, **be sure to match the colors.**

Strip back and trim off ½ inch of insulation from each lead, making sure to scrape the wire bare to obtain a good connection. Be careful not to damage the copper conductor when stripping off the insulation.

4. Slide the heat shrink tubing on to each lead. Insert a properly sized "Sta-kon" type connector on each lead, making sure that lead colors are matched. Using a "Sta-kon" crimping pliers, indent the lugs (Figure 4-B). Be sure to squeeze hard on the pliers, particularly when using large cable.

5. Center the heat shrink tubing over the connector. Using a propane torch, lighter, or electric heat gun, uniformly heat the tubing starting first in the center working toward the ends (Figure 4-C).

6. Continue to apply the heat to the tubing using care not to let the flame directly contact the tubing. When the tubing shrinks and the sealant flows from the ends of the tubing, the splice is complete (Figure 4-D).

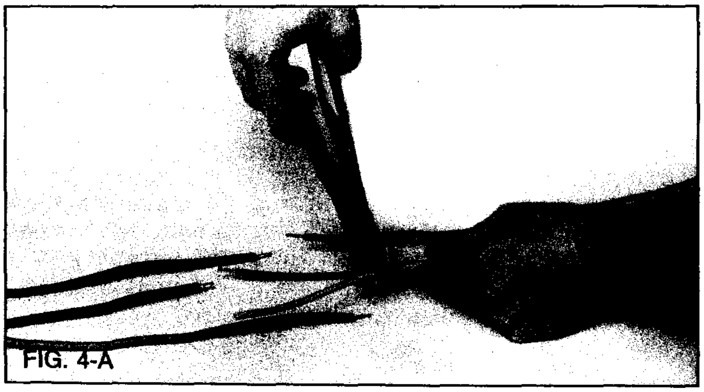
FIG. 4-A

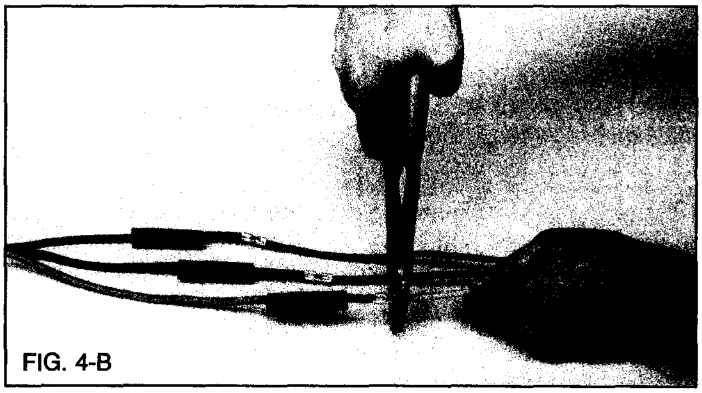
FIG. 4-B

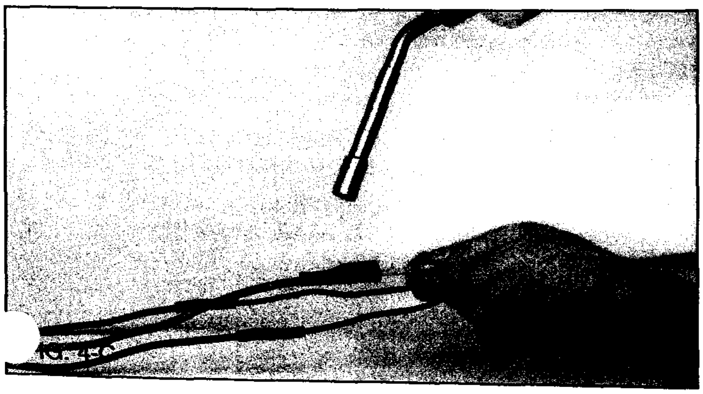
FIG. 4-C

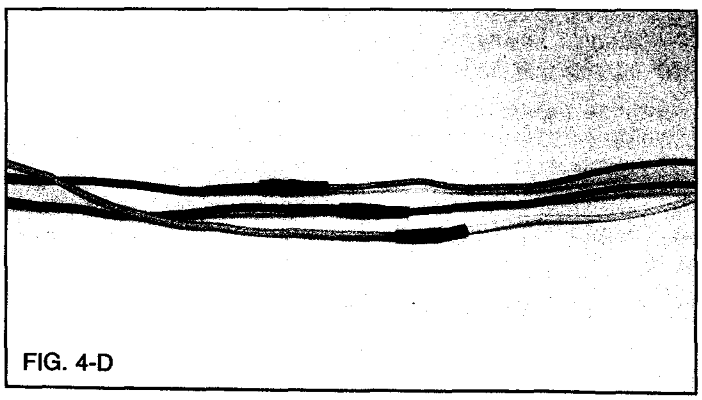
FIG. 4-D

SECTION 5.

Installation

The riser pipe or hose should be properly sized and selected based on estimated flow rates and friction-loss factors.

A back-up wrench should be used when the riser pipe is attached to the pump. The pump should be gripped only by the flats on the top of the discharge chamber. **The body of the pump, cable guard or motor should not be gripped under any circumstance.**

If Steel Riser Pipe is Used:

We recommend that steel riser pipes always be used with the larger submersibles. An approved pipe thread compound should be used on all joints. Make sure the joints are adequately tightened in order to resist the tendency of the motor to loosen the joints when stopping and starting.

When tightened, the first section of the riser pipe must not come in contact with the check valve retainer in the discharge chamber of the pump.

After the first section of the riser pipe has been attached to the pump, the lifting cable or elevator should be clamped to the pipe. **Do not clamp the pump.** When raising the pump and riser section, be careful not to place bending stress on the pump by picking it up by the pump-end only.

Make sure that the electrical cables are not cut or damaged in any way when the pump is being lowered in the well.

The drop cable should be secured to the riser pipe at frequent intervals to prevent sagging, looping or possible cable damage. Nylon cable clips or waterproof tape may be used. The cable splice should be protected by securing it with clips or tape just above and below the splice.

If Plastic or Flexible Riser Pipe is Used:

It is recommended that plastic type riser pipe be used **only** with the smaller domestic submersibles. The pipe manufacturer or representative should be contacted to insure the pipe type and physical characteristics are suitable for this use. Use the correct joint compound recommended by the pipe manufacturer. In addition to making sure that joints are securely fastened, the use of a torque arrester is recommended when using plastic pipe.

Do not connect the first plastic or flexible riser section directly to the pump. Always attach a metallic nipple or adapter into the discharge chamber of the pump. When tightened, the threaded end of the nipple or adapter must not come in contact with the check valve retainer in the discharge chamber of the pump.

The drop cable should be secured to the riser pipe at frequent intervals to prevent sagging, looping and possible cable damage. Nylon cable clips or waterproof tape may be used. The cable splice should be protected by securing it with clips or tape just above each joint.

IMPORTANT- Plastic and flexible pipe tend to stretch under load. This stretching must be taken into account when securing the cable to the riser pipe. Leave 3 to 4 inches of slack between clips or taped points to allow for this stretching. This tendency for plastic and flexible pipe to stretch will also affect the calculation of the pump setting depth. As a general rule, you can estimate that plastic pipe will stretch to approximately 2% of its length. For example, if you installed 200 feet of plastic riser pipe, the pump may actually be down 204 feet. If the depth setting is critical, check with the manufacturer of the pipe to determine how to compensate for pipe stretch.

When plastic riser pipe is used, it is recommended that a safety cable be attached to the pump to lower and raise it. The discharge piece of a Grundfos 4 inch submersible is designed to accommodate this cable (Figure 5-A).

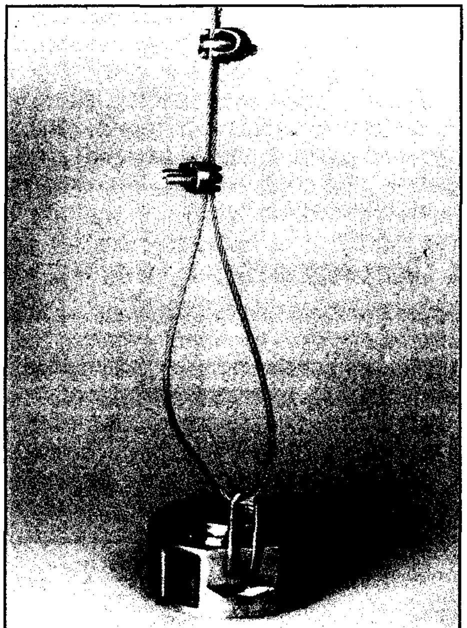

FIG. 5-A

Check valves:

A check valve should always be installed at the surface of the well. In addition, for installations deeper than 200 feet, check valves should be installed at no more than 200 foot intervals.

Protect the well from contamination:

To protect against surface water entering the well and contaminating the water source, the well should be finished off above grade, and a locally approved well seal or pitless adapter unit utilized.

SECTION 6.

Electrical

WARNING: A faulty motor or wiring can be a serious electrical shock hazard if it or surrounding water is accessible to human contact. To avoid this danger, connect the motor frame to the power supply grounding terminal with copper conductor no smaller than the circuit conductors unless the motor and surrounding water are inaccessible, as in a drilled well. In all installations connect above-ground metal plumbing to the power supply ground per National Electrical Code Article 250-80 to prevent electrical shock hazard.

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

Verification of the electrical supply should be made to ensure the voltage, phase and frequency match that of the motor. Motor voltage, phase, frequency and full-load current information can be found on the nameplate attached to the motor. Motor electrical data can be found in Table E.

If voltage variations are larger than ± 10%, do not operate the pump.

Direct on-line starting is used due to the extremely fast run-up time of the motor (0.1 second maximum), and the low moment of inertia of the pump and motor. Direct on-line starting current (locked rotor amp) is between 4 and 6.5 times the full-load current. If direct on-line starting is not acceptable and reduced starting current is required, an auto-transformer or resistant starters should be used for 5 to 30 HP motors (depending on cable length). For motors over 30 HP, use auto-transformer starters.

Engine-Driven Generators

If the submersible pump is going to be operated using an engine driven generator, we suggest the manufacturer of the generator be contacted to ensure the proper generator is selected and used. See Table B for generator sizing guide.

If power is going to be supplied through transformers, Table C outlines the minimum KVA rating and capacity required for satisfactory pump operation.

Control Box/Panel Wiring

1. Single-Phase Motors:

Single-phase motors must be connected as indicated in the motor control box. A typical single-phase wiring diagram using a Grundfos control box is shown (Figure 6-A).

2. Three-Phase Motors:

Three-phase motors must be used with the proper size and type of motor starter to ensure the motor is protected against damage from low voltage, phase failure, current unbalance and overload current. A properly sized starter with ambient-compensated extra quick-trip overloads must be used to give the best possible motor winding protection. **Each of the three motor legs must be protected with overloads.** The thermal overloads must trip in less than 10 seconds at locked rotor (starting) current. For starter and overload protection guide, see Table H. A three-phase motor wiring diagram is illustrated below (See Figure 6-B).

Pumps should NEVER be started to check rotation unless the pump is totally submerged. Severe damage may be caused to the pump and motor if they are run dry.

Single-Phase Wiring Diagram
for GRUNDFOS Control Boxes

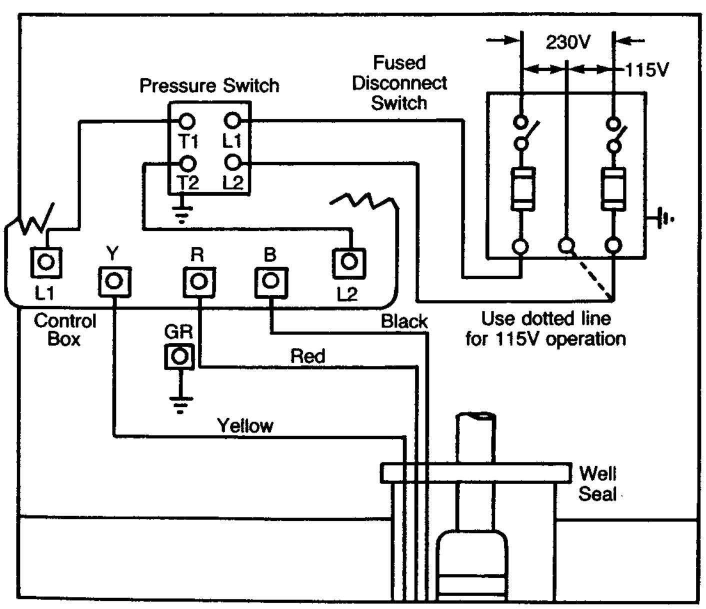

Figure 6-A

Three-Phase Wiring Diagram
for GRUNDFOS and FRANKLIN Control Boxes

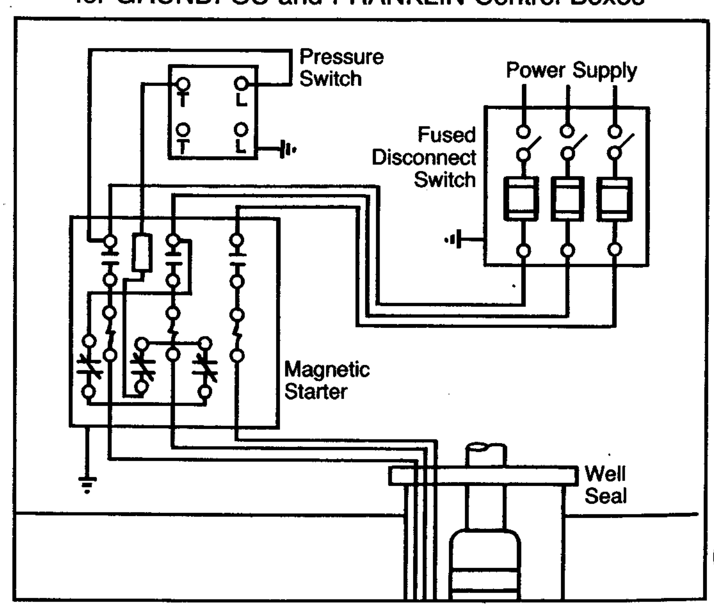

Figure 6-B

High Voltage Surge Arresters

A high voltage surge arrester should be used to protect the motor against lightning and switching surges. Lightning voltage surges in power lines are caused when lightning strikes somewhere in the area. Switching surges are caused by the opening and closing of switches on the main high-voltage distribution power lines.

The correct voltage-rated surge arrester should be installed on the supply (line) side of the control box (Figure 6-C and 6-D). **The arrester must be grounded in accordance with the National Electrical Code and local codes and regulations.**

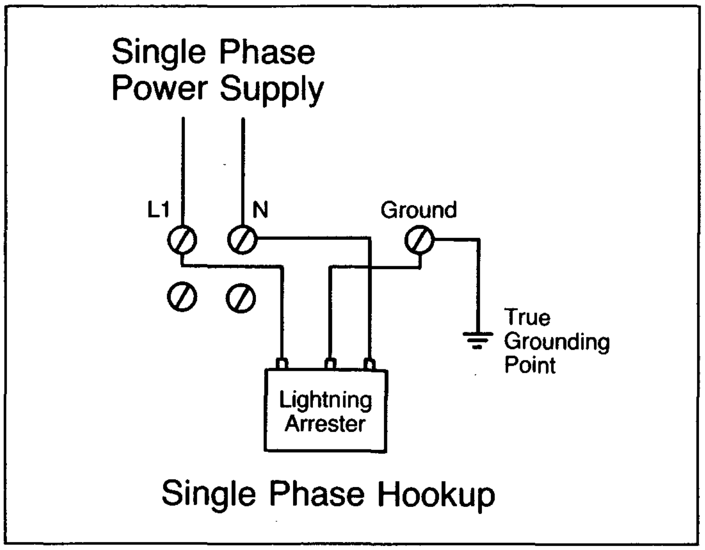

Figure 6-C

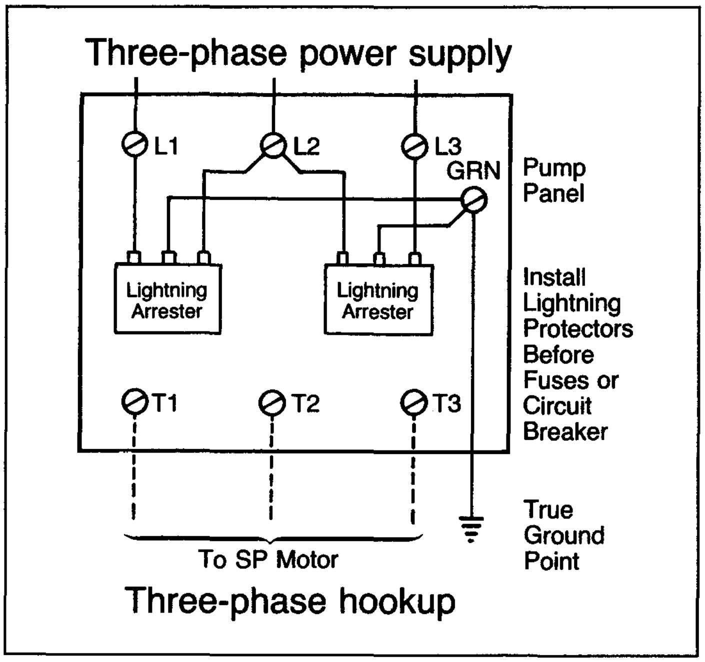

Figure 6-D

The warranty on all three-phase submersible motors is VOID if:

1. **The motor is operated with single-phase power through a phase converter.**
2. **Three-leg ambient compensated extra quick-trip overload protectors are not used.**
3. **Three-phase current unbalance is not checked and recorded. (See START-UP Section 7 for instructions.)**
4. **High voltage surge arresters are not installed.**

Control Box/Panel Grounding

The control box or panel shall be permanently grounded in accordance with the National Electrical Code and local codes or regulations. The ground wire should be a bare copper conductor at least the same size as the drop cable wire size. The ground wire should be run as short a distance as possible and be securely fastened to a true grounding point.

True grounding points are considered to be: a grounding rod driven into the water strata, steel well casing submerged into the water lower than the pump setting level, and steel discharge pipes without insulating couplings. If plastic discharge pipe and well casing are used or if a grounding wire is required by local codes, a properly sized bare copper wire should be connected to a stud on the motor and run to the control panel. Do not ground to a gas supply line. Connect the grounding wire to the ground point first and then to the terminal in the control box or panel.

Wiring Checks and Installation

Before making the final surface wiring connection of the drop cable to the control box or panel, it is a good practice to check the insulation resistance to ensure that the cable and splice are good. Measurements for a new installation must be at least 2,000,000 ohm. Do not start the pump if the measurement is less than this.

If it is higher than 2,000,000 ohm, the drop cable should then be run through the well seal by means of a conduit connector in such a way as to eliminate any possibility of foreign matter entering the well casing. Conduit should always be used from the pump to the control box or panel to protect the drop cable (See Figure 6-E). Finish wiring and verify that all electrical connections are made in accordance with the wiring diagram. Check to ensure the control box or panel and high voltage surge arrester have been grounded.

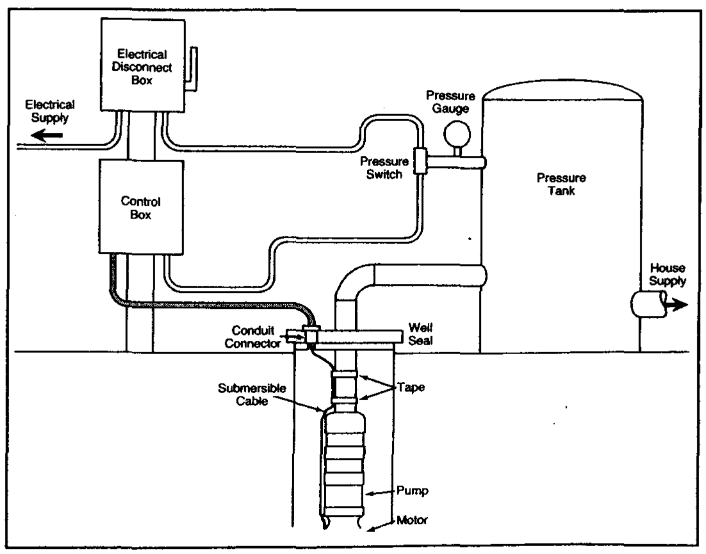

Figure 6-E

SECTION 7.

Start-Up

fter the pump has been set into the well and the wiring connections have been made, the following procedures should be performed:

A. Attach a temporary horizontal length of pipe with installed gate valve to the riser pipe.

B. Adjust the gate valve one-third of the way open.

C. On three-phase units, check direction of rotation and current unbalance according to the instructions below.

For single-phase units proceed directly to "Developing the Well".

D. Under no circumstances should the pump be operated for any prolonged period of time with the discharge valve closed. This can result in motor and pump damage due to overheating. A properly sized relief valve should be installed at the well head to prevent the pump from running against a closed valve.

Three-Phase Motors

1. Check the direction of rotation

Three-phase motors can run in either direction depending on how they are connected to the power supply. When the three cable leads are first connected to the power supply, there is a 50% chance that the motor will run in the proper direction. **To make sure the motor is running in the proper direction, carefully follow the procedures below:**

A. Start the pump and check the water quantity and pressure developed.

B. Stop the pump and interchange any two leads.

C. Start the pump and again check the water quantity and pressure.

D. Compare the results observed. The wire connection which gave the highest pressure and largest water quantity is the correct connection.

2. Check for current unbalance

Current unbalance causes the motor to have reduced starting torque, overload tripping, excessive vibration and poor performance which can result in early motor failure. It is very important that current unbalance be checked in all three-phase systems. **Current unbalance between the legs should not exceed 5% under normal operating conditions.**

The supply power service should be verfied to see if it is a two or three transformer system. If two transformers are present, the system is an "open" delta or wye. If three transformers are present, the system is true three-phase.

Make sure the transformer ratings in kilovolt amps (KVA) is sufficient for the motor load. See Table C.

The percentage of current unbalance can be calculated by using the following formulas and procedures:

$$\text{Average current} = \frac{\text{Total of current values measured on each leg}}{3}$$

$$\text{\% Current unbalance} = \frac{\text{Greatest amp difference from the average}}{\text{average current}} \text{X100}$$

determine the percentage of current unbalance:

A. Measure and record current readings in amps for each leg (hookup 1). Disconnect power.

B. Shift or roll the motor leads from left to right so the drop cable lead that was on terminal 1 is now on 2, lead on 2 is now on 3, and lead on 3 is now on 1 (hookup 2). Rolling the motor leads in this manner will not reverse the motor rotation. Start the pump, measure and record current reading on each leg. Disconnect power.

C. Again shift drop cable leads from left to right so the lead on terminal 1 goes to 2, 2 to 3 and 3 to 1 (hookup 3). Start pump, measure and record current reading on each leg. Disconnect power.

D. Add the values for each hookup.

E. Divide the total by 3 to obtain the average.

F. Compare each single leg reading from the average to obtain the greatest amp difference from the average.

G. Divide this difference by the average to obtain the precentage of unbalance

Use the wiring hookup which provides the lowest percentage of unbalance. (See Table F for a specific example of correcting for three-phase power unbalance.)

Developing the Well

After proper rotation and current unbalance have been checked, start the pump and let it operate until the water runs clear of sand, silt and other impurities.

Slowly open the valve in small increments as the water clears until the desired flow rate is reached. Do not operate the pump beyond its maximum flow rating. **The pump should not be stopped until the water runs clear.**

If the water is clean and clear when the pump is first started, the valve should still be **slowly opened until the desired flow rate is reached.** As the valve is being opened, the drawdown should be checked to ensure the pump is always submerged. **The dynamic water level should always be more than 3 feet above the inlet strainer of the pump.**

Disconnect the temporary piping arrangements and complete the final piping connections.

Under no circumstances should the pump be operated for any prolonged period of time with the discharge valve closed. This can result in motor and pump damage due to overheating. A properly sized relief valve should be installed at the well head to prevent the pump from running against a closed valve.

Start the pump and test the system. Check and record the voltage and current draw on each motor lead.

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Operation

1. The pump and system should be periodically checked for water quantity, pressure, drawdown, periods of cycling and operation of controls.

2. If the pump fails to operate, or there is a loss of performance, refer to Troubleshooting, Section 8.

SECTION 8.

Troubleshooting

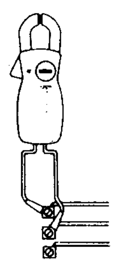
The majority of problems that develop with submersible pumps are electrical, and most of these problems can be corrected without pulling the pump from the well. The following chart covers most of the submersible service work. As with any troubleshooting procedure, start with the simplest solution first; always make all the above-ground checks before pulling the pump from the well.

Usually only two instruments are needed – a combination voltmeter/ammeter, and an ohmmeter. These are relatively inexpensive and can be obtained from most water systems suppliers.

WHEN WORKING WITH ELECTRICAL CIRCUITS, USE CAUTION TO AVOID ELECTRICAL SHOCK. It is recommended that rubber gloves and boots be worn and that care is taken to have metal control boxes and motors grounded to power supply ground or steel drop pipe or casing extending into the well. WARNING: Submersible motors are intended for operation in a well. When not operated in a well, failure to connect motor frame to power supply ground may result in serious electrical shock.

Preliminary Tests

SUPPLY VOLTAGE



How to Measure

By means of a voltmeter, which has been set to the proper scale, measure the voltage at the control box or starter.

On single-phase units, measure between line and neutral.

On three-phase units measure between the legs (phases.)

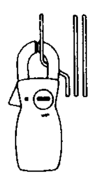
What it Means

When the motor is under load, the voltage should be within ± 10% of the nameplate voltage. Larger voltage variation may cause winding damage.

Large variations in the voltage indicate a poor electrical supply and the pump should not be operated until these variations have been corrected.

If the voltage constantly remains high or low, the motor should be changed to the correct supply voltage.

CURRENT MEASUREMENT



How to Measure

By use of an ammeter, set on the proper scale, measure the current on each power lead at the control box or starter. See Electrical Data, Table E, for motor amp draw information.

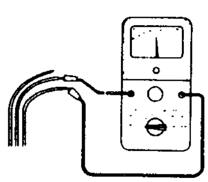
Current should be measured when the pump is operating at a constant discharge pressure with the motor fully loaded.

What it Means

If the amp draw exceeds the listed service factor amps (SFA) or if the current unbalance is greater than 5% between each leg on three-phase units, check for the following:

1. Burnt contacts on motor starter.
2. Loose terminals in starter or control box or possible cable defect. Check winding and insulation resistances
3. Supply voltage too high or low.
4. Motor windings are shorted.
5. Pump is damaged, causing a motor overload.

WINDING RESISTANCE



How to Measure

Turn off power and disconnect the drop cable leads in the control box or starter. Using an ohmmeter, set the scale selectors to Rx1 for values under 10 ohms and and Rx10 for values over 10 ohms.

Zero-adjust the meter and measure the resistance between leads. Record the values.

Motor resistance values can be found in Electrical Data, Table E. Cable resistance values are in Table G.

What it Means

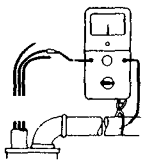
If all the ohm values are normal, and the cable colors correct, the windings are not damaged.

If any one ohm value is less than normal, the motor may be shorted.

If any one ohm value is greater than normal, there is a poor cable connection or joint. The windings or cable may also be open.

If some of the ohm values are greater than normal and some less, the drop cable leads are mixed. To verify lead colors, see resistance values in Electrical Data, Table E.

INSULATION RESISTANCE



How to Measure

Turn off power and disconnect the drop cable leads in the control box or starter. Using an ohm or mega ohmmeter, set the scale selector to Rx100K and zero-adjust the meter.

Measure the resistance between the lead and ground (discharge pipe or well casing, if steel).

What it Means

For ohm values, refer to table below. Motors of all HP, voltage, phase and cycle duties have the same value of insulation resistance.

OHM VALUE	MEGAOHM VALUE	CONDITION OF MOTOR AND LEADS
		Motor not yet installed:
2,000,000 (or more)	2.0	New Motor.
1,000,000 (or more)	1.0	Used motor which can be reinstalled in the well.
		Motor in well (Ohm readings are for drop cable plus motor):
500,000 - 1,000,000	0.5 - 1.0	A motor in reasonably good condition.
20,000 - 500,000	0.02 - 0.5	A motor which may have been damaged by lightning or with damaged leads. Do not pull the pump for this reason.
10,000 - 20,000	0.01 - 0.02	A motor which definitely has been damaged or with damaged cable. The pump should be pulled and repairs made to the cable or the motor replaced. The motor will still operate, but probably not for long.
less than 10,000	0 - 0.01	A motor which has failed or with completely destroyed cable insulation. The pump must be pulled and the cable repaired or the motor replaced. The motor will not run in this condition.

Troubleshooting Chart

FAULT	POSSIBLE CAUSES	HOW TO CHECK	HOW TO CORRECT
A. Pump Does Not Run	**1.** No power at pump panel.	Check for voltage at panel.	If no voltage at panel, check feeder panel for tripped circuits.
	2. Fuses are blown or circuit breakers are tripped.	Remove fuses and check for continuity with ohmmeter.	Replace blown fuses or reset circuit breaker. If new fuses blow or circuit breaker trips, the electrical installation and motor must be checked.
	3. Motor starter overloads are burnt or have tripped out (three-phase only).	Check for voltage on line and load side of starter.	Replace burnt heaters or reset. Inspect starter for other damage. If heater trips again, check the supply voltage and starter holding coil.
	4. Starter does not energize (three-phase only).	Energize control circuit and check for voltage at the holding coil.	If no voltage, check control circuit. If voltage, check holding coil for shorts. Replace bad coil.
	5. Defective controls.	Check all safety and pressure switches for operation. Inspect contacts in control devices.	Replace worn or defective parts.
	6. Motor and/or cable are defective.	Turn off power. Disconnect motor leads from control box. Measure the lead-to-lead resistances with the ohmmeter (Rx1). Measure lead-to-ground values with ohmmeter (Rx100K). Record measured values.	If open motor winding or ground is found, remove pump and recheck values at the surface. Repair or replace motor or cable.
	7. Defective capacitor (single-phase only).	Turn off the power, then discharge capacitor. Check with an ohmmeter (Rx100K). When meter is connected, the needle should jump forward and slowly drift back.	If there is no needle movement, replace the capacitor.

(con't)

Troubleshooting Chart (continued)

FAULT	POSSIBLE CAUSES	HOW TO CHECK	HOW TO CORRECT
B. Pump Runs But Does Not Deliver Water	**1.** Groundwater level in well is too low or well is collapsed.	Check well draw-down. Water level should be at least 3 ft. above pump inlet during operation.	If not, lower pump if possible, or throttle discharge valve and install water level control.
	2. Integral pump check valve is blocked.	Install pressure gauge, start pump, gradually close the discharge valve and read pressure at shut-off. After taking reading, open valve to its previous position. Convert PSI to feet (For water: PSI x 2.31 ft/PSI = ______ ft.), and add this to the total vertical distance from the pressure gauge to the water level in the well while the pump is running. Refer to the specific pump curve for the shut-off head for that pump model. If the measured head is close to the curve, pump is probably OK.	If not close to the pump curve, remove pump and inspect discharge section. Remove blockage, repair valve and valve seat if necessary. Check for other damage. Rinse out pump and re-install.
	3. Inlet strainer is clogged.	Same as B.2 above.	If not close to the pump curve, remove pump and inspect. Clean strainer, inspect integral check valve for blockage, rinse out pump and reinstall.
	4. Pump is damaged.	Same as B.2 above.	If damaged, repair as necessary. Rinse out pump and re-install.
C. Pump Runs But at Reduced Capacity	**1.** Wrong rotation (three-phase only).	Check for proper electrical connection in control panel.	Correct wiring and change leads as required.
	2. Draw-down is larger than anticipated.	Check draw-down during pump operation.	Lower pump if possible. If not, throttle discharge valve and install water level control.
	3. Discharge piping or valve leaking.	Examine system for leaks.	Repair leaks.
	4. Pump strainer or check valve are clogged.	Same as B.2 above.	If not close to the pump curve, remove pump and inspect. Clean strainer, inspect integral check valve for blockage, rinse out pump and reinstall.
	5. Pump worn.	Same as B.2 above.	If not close to pump curve, remove pump and inspect.
D. Pump Cycles Too Much	**1.** Pressure switch is not properly adjusted or is defective.	Check pressure setting on switch and operation. Check voltage across closed contacts.	Re-adjust switch or replace if defective.
	2. Level control is not properly set or is defective.	Check setting and operation.	Re-adjust setting (refer to manufacturer data.) Replace if defective.
	3. Insufficient air charging or leaking tank or piping.	Pump air into tank or diaphram chamber. Check diaphram for leak. Check tank and piping for leaks with soap and water solution. Check air to water volume.	Repair or replace damaged component.
	4. Plugged snifter valve or bleed orifice.	Examine valve and orifice for dirt or corrosion.	Clean and/or replace if defective.
	5. Tank is too small.	Check tank size. Tank volume should be approximately 10 gallons for each gpm of pump capacity.	If tank is too small, replace with proper size tank.

(con't)

Troubleshooting Chart (continued)

FAULT	POSSIBLE CAUSES	HOW TO CHECK	HOW TO CORRECT
E. Fuses Blow or Circuit Breakers Trip	1. High or low voltage.	Check voltage at pump panel. If not within ± 10%, check wire size and length of run to pump panel.	If wire size is correct, contact power company. If not, correct and/or replace as necessary.
	2. Three-phase current unbalance.	Check current draw on each lead. Unbalance must be within ± 5%.	If current unbalance is not within ± 5%, contact power company.
	3. Control box wiring and components (single-phase only).	Check that control box parts match the parts list. Check to see that wiring matches wiring diagram. Check for loose or broken wires or terminals.	Correct as required.
	4. Defective capacitor (single-phase only).	Turn off power and discharge capacitor. Check using an ohmmeter (Rx100K). When the meter is connected, the needle should jump forward and slowly drift back.	If no meter movement, replace the capacitor.
	5. Starting relay (Franklin single-phase motors only).	Check resistance of relay coil with an ohmmeter (Rx1000K). Check contacts for wear.	Replace defective relay.

SECTION 9. Technical Data

Table A

Minimum Water Flow Requirements for Submersible Pump Motors

MOTOR DIAMETER	CASING OR SLEEVE I.D. IN INCHES	MIN. FLOW PAST THE MOTOR (GPM)
4"	4	1.2
	5	7
	6	13
	7	21
	8	30
6"	6	10
	7	28
	8	45
	10	85
	12	140
	14	198
	16	275
8"	8	10
	10	55
	12	110
	14	180
	16	255
10"	10	30
	12	85
	14	145
	16	220
	18	305

NOTES:

1. A flow inducer or sleeve must be used if the water enters the well above the motor or if there is insufficient water flow past the motor.
2. The minimum recommended water velocity over 4" motors is 0.25 feet per second.
3. The minimum recommended water velocity over 6, 8, and 10" motors is 0.5 feet per second.

Table B

Guide for Engine-Driven Generators in Submersible Pump Applications

	MINIMUM KILOWATT RATING OF GENERATOR FOR THREE-WIRE SUBMERSIBLE PUMP MOTORS	
MOTOR HP FOR SINGLE OR THREE PHASE UNITS	EXTERNALLY REGULATED GENERATOR	INTERNALLY REGULATED GENERATOR
0.33 HP	1.5 KW	1.2 KW
0.50	2.0	1.5
0.75	3.0	2.0
1.0	4.0	2.5
1.5	5.0	3.0
2.0	7.5	4.0
3.0	10.0	5.0
5.0	15.0	7.5
7.5	20.0	10.0
10.0	30.0	15.0
15.0	40.0	20.0
20.0	60.0	25.0
25.0	75.0	30.0
30.0	100.0	40.0
40.0	100.0	50.0
50.0	150.0	60.0
60.0	175.0	75.0
75.0	250.0	100.0
100.0	300.0	150.0
125.0	375.0	175.0
150.0	450.0	200.0
200.0	600.0	275.0

NOTES:

1. Table is based on typical 80°C rise continuous duty generators with 35% maximum voltage dip during start-up of single-phase and three-phase motors.
2. Contact the manufacturer of the generator to assure the unit has adequate capacity to run the submersible motor.
3. If the generator rating is in KVA instead of kilowatts, multiply the above ratings by 1.25 to obtain KVA.

Table C

Transformer Capacity Required for Three-Phase Submersible Pump Motors

		MINIMUM KVA RATING FOR EACH TRANSFORMER	
THREE-PHASE MOTOR HP	MINIMUM TOTAL KVA REQUIRED*	2 TRANSFORMERS OPEN DELTA OR WYE	3 TRANSFORMERS DELTA OR WYE
1.5	3	2	1
2	4	2	1½
3	5	3	2
5	7½	5	3
7.5	10	7½	5
10	15	10	5
15	20	15	7½
20	25	15	10
25	30	20	10
30	40	25	15
40	50	30	20
50	60	35	20
60	75	40	25
75	90	50	30
100	120	65	40
125	150	85	50
150	175	100	60
200	230	130	75

* Pump motor KVA requirements only, and does not include allowances for other loads.

Table D

Submersible Pump Cable Selection Chart (60 Hz)

The following tables list the recommended copper cable sizes and various cable lengths for submersible pump motors.

These tables comply with the 1978 edition of the National Electric Table 310-16, Column 2 for 75°C wire. The ampacity (current carrying properties of a conductor) have been divided by 1.25 per the N.E.C., Article 430-22, for motor branch circuits based on motor amps at rated horsepower.

To assure adequate starting torque, the maximum cable lengths are calculated to maintain 95% of the service entrance voltage at the motor when the motor is running at maximum nameplate amps. Cable sizes larger than specified may always be used and will reduce power usage.

The use of cables smaller than the recommended sizes will void the warranty. Smaller cable sizes will cause reduced starting torque and poor motor operation.

SINGLE-PHASE MOTOR MAXIMUM CABLE LENGTH

(Motor to service entrance) (2)

MOTOR RATING		COPPER WIRE SIZE												
VOLTS	HP	14	12	10	8	6	4	2	0	00	000	0000	250	300
115	⅓	130	210	340	540	840	1300	1960	2910					
	½	100	160	250	390	620	960	1460	2160					
230	⅓	550	880	1390	2190	3400	5250	7960						
	½	400	650	1020	1610	2510	3880	5880						
	¾	300	480	760	1200	1870	2890	4370	6470					
	1	250	400	630	990	1540	2380	3610	5360	6520				
	1½	190	310	480	770	1200	1870	2850	4280	5240				
	2	150	250	390	620	970	1530	2360	3620	4480				
	3	120	190	300	470	750	1190	1850	2890	3610				
	5			180	280	450	710	1110	1740	2170				
	7½				200	310	490	750	1140	1410				
	10					250	390	600	930	1160				

CAUTION: Use of wire size smaller than listed will void warranty.

FOOTNOTES:

1. If aluminum conductor is used, multiply lengths by 0.5. Maximum allowable length of aluminum is considerably shorter than copper wire of same size.
2. The portion of the total cable which is between the service entrance and a 3Ø motor starter should not exceed 25% of the total maximum length to assure reliable starter operation. Single-phase control boxes may be connected at any point of the total cable length.
3. Cables #14 to #0000 are AWG sizes, and 250 to 300 are MCM sizes.

(con't)

THREE-PHASE MOTOR MAXIMUM CABLE LENGTH
(Motor to service entrance)(2)

MOTOR RATING		COPPER WIRE SIZE												
VOLTS	HP	14	12	10	8	6	4	2	0	00	000	0000	250	300
208	1½	310	500	790	1260									
	2	240	390	610	970	1520								
	3	180	290	470	740	1160	1810							
	5		170	280	440	690	1080	1660						
	7½			200	310	490	770	1180	1770					
	10				230	370	570	880	1330	1640				
	15					250	390	600	910	1110	1340			
	20						300	460	700	860	1050	1270		
	25							370	570	700	840	1030	1170	
	30							310	470	580	700	850	970	1110
230	1½	360	580	920	1450									
	2	280	450	700	1110	1740								
	3	210	340	540	860	1340	2080							
	5		200	320	510	800	1240	1900						
	7½			230	360	570	890	1350	2030					
	10				270	420	660	1010	1520	1870				
	15					290	450	690	1040	1280	1540			
	20						350	530	810	990	1200	1450		
	25						280	430	650	800	970	1170	1340	
	30							350	540	660	800	970	1110	1270
460	1½	1700												
	2	1300	2070											
	3	1000	1600	2520										
	5	590	950	1500	2360									
	7½	420	680	1070	1690	2640								
	10	310	500	790	1250	1960	3050							
	15			540	850	1340	2090	3200						
	20			410	650	1030	1610	2470	3730					
	25				530	830	1300	1990	3010	3700				
	30				430	680	1070	1640	2490	3060	3700			
	40						790	1210	1830	2250	2710	3290		
	50						640	980	1480	1810	2190	2650	3010	
	60							830	1250	1540	1850	2240	2540	2890
	75								1030	1260	1520	1850	2100	2400
	100									940	1130	1380	1560	1790
	125											1080	1220	1390
	150												1050	1190
	200												1080	1300
	250													1080
575	1½	2620												
	2	2030												
	3	1580	2530											
	5	920	1480	2330										
	7½	660	1060	1680	2650									
	10	490	780	1240	1950									
	15		530	850	1340	2090								
	20			650	1030	1610	2520							
	25			520	830	1300	2030	3110						
	30				680	1070	1670	2560	3880					
	40					790	1240	1900	2860	3510				
	50						1000	1640	2310	2840	3420			
	60						850	1300	1960	2400	2890	3500		
	75							1060	1600	1970	2380	2890	3290	
	100								1190	1460	1770	2150	2440	2790

CAUTION: Use of wire size smaller than listed will void warranty.

FOOTNOTES:

1. If aluminum conductor is used, multiply lengths by 0.5. Maximum allowable length of aluminum is considerably shorter than copper wire of same size.
2. The portion of the total cable which is between the service entrance and a 3Ø motor starter should not exceed 25% of the total maximum length to assure reliable starter operation. Single-phase control boxes may be connected at any point of the total cable length.
3. Cables #14 to #0000 are AWG sizes, and 250 to 300 are MCM sizes.

Table E

Electrical Data
Submersible Pump Motors - 60 Hz

GRUNDFOS MOTORS

4 INCH (Three Wire)

Rated HP	Volts	PH	Service Factor	Rated HP Amps	Service Factor Amps	Circuit Breaker or Standard Fuse	Dual Element Fuse	KVA Code	Locked Rotor Amps	Winding Resistance (Ohms) BY	Winding Resistance (Ohms) RY
⅓	230	1	1.75	3.8	4.8	15	5	M	15.1	5.8-7.1	19.3-23.5
½	230	1	1.60	4.9	6.4	15	7	L	19.9	4.3-5.3	18.6-22.8
¾	230	1	1.50	7.0	8.3	20	9	K	28.5	2.9-3.5	12.1-14.7
1	230	1	1.40	7.7	9.7	25	12	J	34.0	2.4-3.0	10.2-12.4
1½	230	1	1.30	10.2	12.5	30	15	H	44.0	2.0-2.4	4.1- 5.1
	230	3	1.30	5.7	6.8	20	8	K	31.0	3.8- 4.2	
	460	3	1.30	2.8	3.4	15	4	K	15.5	15.0-16.6	
	575	3	1.30	2.3	2.8	15	3	K	12.5	24.4-27.0	
2	230	3	1.25	6.8	8.3	20	10	J	39.0	2.8- 3.2	
	460	3	1.25	3.4	4.2	15	5	J	19.5	13.1-14.5	
	575	3	1.25	2.7	3.4	15	4	J	15.5	17.6-19.4	
3	230	3	1.15	9.7	11.2	30	15	H	51.0	2.1- 2.3	
	460	3	1.15	4.8	5.6	15	7	H	25.5	8.6- 9.4	
	575	3	1.15	3.9	4.5	15	6	H	20.5	12.4-13.6	
5	230	3	1.15	15.2	17.8	45	20	H	89.0	1.1- 1.3	
	460	3	1.15	7.6	8.9	25	10	H	45.0	4.8- 5.2	
	575	3	1.15	6.1	7.2	20	8	H	36.0	6.9- 7.7	

FRANKLIN MOTORS

4 INCH (Two Wire)

Rated HP	Volts	PH	Service Factor	Rated HP Amps	Service Factor Amps	Circuit Breaker or Standard Fuse	Dual Element Fuse	KVA Code	Locked Rotor Amps	Winding Resistance (Ohms)
⅓	115	1	1.75	7.0	8.9	25	10.0	S	48.4	1.5-1.9
	230	1	1.75	3.5	4.4	15	5.0	S	24.2	6.0-7.4
½	115	1	1.60	9.6	11.9	30	15.0	R	62.4	1.0-1.3
	230	1	1.60	4.8	5.9	15	7.0	R	31.2	4.2-5.2
¾	230	1	1.50	6.4	8.0	20	9.0	N	40.2	2.7-3.4
1	230	1	1.40	8.2	9.6	25	12.0	M	46.0	2.2-2.8
1½	230	1	1.30	10.6	13.1	35	15.0	L	56.8	1.5-1.9

4 INCH (Three Wire)

Rated HP	Volts	PH	Service Factor	Rated HP Amps	Service Factor Amps	Circuit Breaker or Standard Fuse	Dual Element Fuse	KVA Code	Locked Rotor Amps	Winding Resistance (Ohms) BY	Winding Resistance (Ohms) RY
⅓	115	1	1.75	7.0	8.9	20	8	N	32.8	1.5-1.9	5.7- 7.1
	230	1	1.75	3.5	4.4	15	5	N	16.4	6.0-7.4	23.4-28.6
½	115	1	1.60	9.6	11.9	30	15	M	46.0	1.0-1.3	3.8- 4.7
	230	1	1.60	4.8	5.9	15	7	M	23.1	4.2-5.2	15.5-19.6
¾	230	1	1.50	6.4	8.0	20	9	M	33.1	2.7-3.4	11.0-13.6
1	230	1	1.40	8.0	9.6	25	12	L	42.0	2.2-2.8	9.5-11.7
1½	230	1	1.30	10.0	11.6	30	15	J	52.8	1.5-1.9	6.2- 8.5
2	230	1	1.25	10.0	13.1	35	15	G	51.0	1.6-2.3	5.2- 7.1
3	230	1	1.15	14.0	16.5	45	20	F	71.0	0.9-1.5	3.0- 4.9
5	230	1	1.15	23.0	27.5	80	30	F	118.0	0.7-1.0	2.1- 2.8
1½	200	3	1.30	6.1	7.2	20	9	K	39.0	2.4- 3.4	
	230	3	1.30	5.3	6.3	20	8	K	34.0	3.2- 4.1	
	460	3	1.30	2.7	3.1	15	4	K	17.0	11.3-15.0	
	575	3	1.30	2.2	2.5	15	3	K	14.0	15.1-26.0	
2	200	3	1.25	7.8	9.2	25	10	K	39.0	1.9- 2.4	
	230	3	1.25	6.8	8.0	20	10	L	46.0	2.4- 3.0	
	460	3	1.25	3.4	4.0	15	5	L	23.0	9.7-12.0	
	575	3	1.25	2.8	3.2	15	4	L	18.0	13.6-18.9	

(con't)

FRANKLIN MOTORS (continued)

Rated HP	Volts	PH	Service Factor	Rated HP Amps	Service Factor Amps	Circuit Breaker or Standard Fuse	Dual Element Fuse	KVA Code	Locked Rotor Amps	Winding Resistance (Ohms)
4 INCH (Three Wire)										
3	200	3	1.15	10.9	12.2	35	15	K	70.0	1.3- 1.7
	230	3	1.15	9.5	10.6	30	15	K	61.0	1.8- 2.2
	460	3	1.15	4.8	5.3	15	7	K	31.0	7.0- 8.7
	575	3	1.15	3.8	4.2	15	6	K	24.0	11.0-13.6
5	200	3	1.15	18.3	20.0	50	25	K	120.0	0.7- 0.9
	230	3	1.15	15.9	17.4	45	20	K	104.0	0.9- 1.2
	460	3	1.15	8.0	8.7	25	10	K	52.0	3.6- 4.4
	575	3	1.15	6.4	7.0	20	8	K	42.0	5.6- 6.9
7½	200	3	1.15	26.5	29.3	80	35	J	158.0	0.55- 0.68
	230	3	1.15	23.0	25.5	70	30	J	143.0	0.76- 0.93
	460	3	1.15	11.5	12.8	35	15	J	72.2	2.4- 3.4
	575	3	1.15	9.2	10.2	30	12	J	57.0	3.5- 5.1
10	460	3	1.15	16.8	17.6	45	20	K	116.0	1.8- 2.3
	575	3	1.15	13.4	14.1	40	20	K	93.0	2.8- 3.5
6 INCH										BY RY
5	230	1	1.15	23.9	29.5	80	35	E	102.0	0.55-0.68 1.30-1.60
7½	230	1	1.15	36.5	42.0	100	45	F	165.0	0.36-0.50 0.92-1.20
10	230	1	1.15	45.0	51.0	150	60	E	204.0	0.27-0.33 0.80-0.99
5	200	3	1.15	17.5	19.1	50	25	H	98.9	0.70-0.80
	230	3	1.15	15.0	16.6	45	20	H	86.0	0.90-1.10
	460	3	1.15	7.5	8.3	25	10	H	43.0	3.50-4.40
	575	3	1.15	6.0	6.4	20	8	H	34.4	5.90-7.20
7½	200	3	1.15	25.1	28.3	70	30	H	149.5	0.40-0.50
	230	3	1.15	21.8	24.6	70	30	H	130.0	0.60-0.70
	460	3	1.15	10.9	12.3	30	15	H	65.0	2.20-2.70
	575	3	1.15	8.7	9.8	25	12	H	52.0	3.60-4.40
10	200	3	1.15	32.7	37.0	100	40	H	197.8	0.33-0.42
	230	3	1.15	28.4	32.2	80	35	H	172.0	0.44-0.55
	460	3	1.15	14.2	16.1	40	20	H	86.0	1.80-2.20
	575	3	1.15	11.4	12.9	35	15	H	68.8	2.90-3.50
15	200	3	1.15	47.8	54.5	150	60	H	306.0	0.22-0.27
	230	3	1.15	41.6	47.4	125	60	H	266.0	0.27-0.33
	460	3	1.15	20.8	23.7	60	30	H	133.0	1.10-1.30
	575	3	1.15	16.6	19.0	50	25	H	106.4	1.70-2.10
20	200	3	1.15	61.9	69.7	200	80	J	416.3	0.14-0.17
	230	3	1.15	53.8	60.6	175	70	J	362.0	0.20-0.25
	460	3	1.15	26.9	30.3	80	35	J	181.0	0.76-0.94
	575	3	1.15	21.5	24.2	70	30	J	144.8	1.20-1.50
25	200	3	1.15	77.1	86.3	225	100	J	552.0	0.11-0.14
	230	3	1.15	67.0	75.0	200	90	J	480.0	0.15-0.19
	460	3	1.15	33.5	37.5	100	45	J	240.0	0.59-0.73
	575	3	1.15	26.8	30.0	80	35	J	192.0	1.00-1.20
30	200	3	1.15	90.9	104.0	300	125	J	602.6	0.10-0.12
	230	3	1.15	79.0	90.4	250	100	J	524.0	0.12-0.15
	460	3	1.15	39.5	45.2	125	50	J	262.0	0.48-0.60
	575	3	1.15	31.6	36.2	100	40	J	209.6	0.78-0.95
40	460	3	1.15	53.5	62.0	150	70	J	397.0	0.32-0.40
	575	3	1.15	42.8	49.6	125	70	J	317.6	0.60-0.74
50	460	3	1.15	67.7	77.0	200	90	H	414.0	0.25-0.32
	575	3	1.15	54.2	61.6	150	70	H	331.2	0.39-0.48
8 INCH										
40	460	3	1.15	53.0	60.0	175	70	H	342	0.26-0.28
50	460	3	1.15	66.0	75.0	200	90	H	433	0.18-0.22
60	460	3	1.15	77.0	89.0	225	100	J	560	0.15-0.17
75	460	3	1.15	97.0	110.0	300	125	J	750	0.11-0.13
100	460	3	1.15	128.0	148.0	400	175	J	1000	0.08-0.09
125	460	3	1.15	165.0	189.0	500	225	K	1300	0.08-0.10
150	460	3	1.15	193.0	221.0	600	250	K	1600*	0.07-0.08

* For 6 lead wye connected motor, divide by 3.

HITACHI MOTORS

6 INCH

Rated HP	Volts	PH	Service Factor	Rated HP Amps	Service Factor Amps	Circuit Breaker or Standard Fuse	Dual Element Fuse	KVA Code	Locked Rotor Amps	Winding Resistance (Ohms) BY	Winding Resistance (Ohms) RY
5	230	1	1.15	23.8	27.1	80	35	F	124	0.49	2.0
	230	3	1.15	15.0	16.6	45	20	J	100	0.80	
	460	3	1.15	7.5	8.3	25	10	J	50	3.0	
7½	230	1	1.15	35.2	40.9	125	45	F	167	0.38	1.3
	230	3	1.15	21.8	24.4	70	30	J	144	0.69	
	460	3	1.15	10.9	12.2	35	15	J	72	2.6	
10	230	1	1.15	48.0	54.0	175	60	E	202	0.3	1.0
	230	3	1.15	28.6	32.0	90	35	K	208	0.44	
	460	3	1.15	14.3	16.0	45	20	K	104	1.6	
15	230	1	1.15	70.8	84.9	250	100	D	275	0.23	0.67
	230	3	1.15	41.4	46.2	125	50	K	320	0.31	
	460	3	1.15	20.7	23.1	60	25	K	160	1.1	
20	230	3	1.15	55.8	63.0	175	70	K	422	0.24	
	460	3	1.15	27.9	31.5	90	35	K	211	0.81	
25	230	3	1.15	67.2	75.4	200	80	J	488	0.21	
	460	3	1.15	33.6	37.7	100	40	J	244	0.66	
30	230	3	1.15	80.0	90.4	250	110	H	530	0.16	
	460	3	1.15	40.0	45.2	125	50	H	265	0.55	
40	460	3	1.15	51.7	58.5	175	70	G	290	0.46	
50	460	3	1.15	66.6	75.9	225	90	H	418	0.40	
60	460	3	1.15	80.1	90.0	250	100	G	435	0.34	

8 INCH

Rated HP	Volts	PH	Service Factor	Rated HP Amps	Service Factor Amps	Circuit Breaker or Standard Fuse	Dual Element Fuse	KVA Code	Locked Rotor Amps	Winding Resistance (Ohms)
40	460	3	1.15	50.6	57.4	175	70	H	331	0.35
50	460	3	1.15	62.6	71.2	225	90	H	401	0.29
60	460	3	1.15	74.5	84.8	250	100	G	470	0.24
75	460	3	1.15	94.7	108.0	350	150	H	648	0.22
100	460	3	1.15	125.5	140.0	450	175	G	763	0.17
125	460	3	1.15	172.0	192.0	600	200	F	827	0.13
150	460	3	1.15	187.0	216.0	600	250	E	850	0.13

10 INCH

Rated HP	Volts	PH	Service Factor	Rated HP Amps	Service Factor Amps	Circuit Breaker or Standard Fuse	Dual Element Fuse	KVA Code	Locked Rotor Amps	Winding Resistance (Ohms)
200	460	3	1.15	233.0	270.0	800	275	D	1100	0.09
250	460	3	1.15	294.0	344.0	900	350	D	1340	0.08

Table F

Example: Correcting for Three-Phase Power Unbalance

Example: Check for current unbalance for a 230 volt, 3 phase,) Hz submersible pump motor, 18.6 full load amps.

Solution: Steps 1 to 3 measure and record amps on each motor drop lead for Hookups 1, 2 and 3.

		Step 1 (Hookup 1)	Step 2 (Hookup 2)	Step 3 (Hookup 3)
(T_1)		DL_1 = 25.5 amps	DL_3 = 25 amps	DL_2 = 25.0 amps
(T_2)		DL_2 = 23.0 amps	DL_1 = 24 amps	DL_3 = 24.5 amps
(T_3)		DL_3 = 26.5 amps	DL_2 = 26 amps	DL_1 = 25.5 amps
Step 4		Total = 75 amps	Total = 75 amps	Total = 75 amps
Step 5		Average Current =	$\frac{\text{Total current}}{\text{3 readings}}$ =	$\frac{75}{3}$ = 25 amps
Step 6	Greatest amp difference from the average:		(Hookup 1) = 25-23 = 2 (Hookup 2) = 26-25 = 1 (Hookup 3) = 25.5-25 = .5	
Step 7	% Unbalance		(HOOKUP 1) = 2/25 X 100 = 8 (HOOKUP 2) = 1/25 X 100 = 4 (HOOKUP 3) = .5/25 X 100 = 2	

As can be seen, Hookup 3 should be used since it shows the least amount of current unbalance. Therefore, the motor will operate at maximum efficiency and reliability.

By comparing the current values recorded on each leg, you will note the highest value was always on the same leg, L_3. This indicates the unbalance is in the power source. If the high current values were on a different leg each time the leads were changed, the unbalance would be caused by the motor or a poor connection.

If the current is greater than 5%, contact your power company for help.

* For a detailed explanation of three-phase balance procedures, see Three-Phase Motor, section 2, page 6.

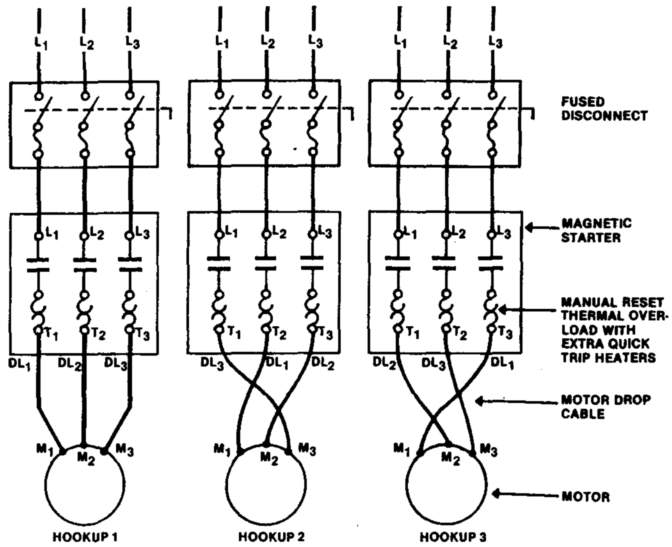


Table G

Total Resistance of Drop Cable (OHMS)

The values shown in this table are for copper conductors. Values are for the total resistance of drop cable from the **control box to the motor and back.**

To determine the resistance:

1. Disconnect the drop cable leads from the control box or panel.
2. Record the size and length of drop cable.
3. Determine the cable resistance from the table.
4. Add drop cable resistance to motor resistance. Motor resistances can be found in the Electrical Data Chart, Table E.
5. Measure the resistance between each drop cable lead using an ohmmeter. Meter should be set on Rx1 and zero-balanced for this measurement.
6. The measured values should be approximately equal to the calculated values.

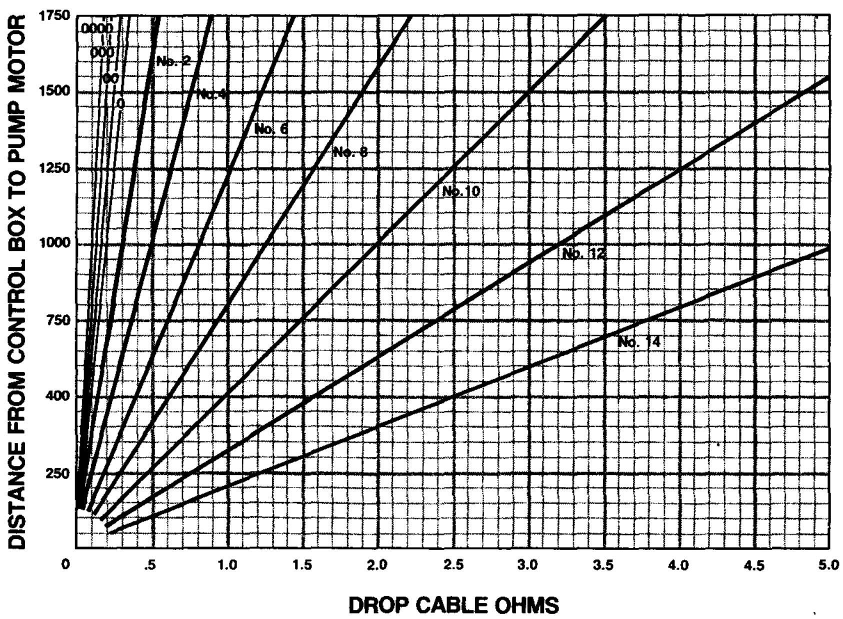


Table H

Overload Protection of Three-Phase Submersible Pump Motors

GRUNDFOS MOTORS

4" DIA. MOTORS

HP	Volts	Starter Size	Furnas Amb. Comp
1½	230	0	K41
	460	0	K32
	575	0	K28
2	230	0	K50
	460	0	K34
	575	0	K31
3	230	0	K54
	460	0	K37
	575	0	K36
5	230	1	K61
	460	0	K50
	575	0	K43

FRANKLIN MOTORS

4" DIA. MOTORS

HP	Volts	Starter Size	Furnas Amb. Comp
1½	200	00	K43
	230	00	K41
	460	00	K29
	575	00	K27
2	200	0	K50
	230	0	K49
	460	00	K33
	575	00	K29
3	200	0	K54
	230	0	K52
	460	0	K37
	575	0	K33
5	200	1	K61
	230	1	K61
	460	0	K49
	575	0	K42
7½	200	1	K68
	230	1	K67
	460	1	K55
	575	1	K52
10	460	1	K58
	575	1	K55

FRANKLIN MOTORS

6" DIA. MOTORS

HP	Volts	Starter Size	Furnas Amb. Comp
5	200	1	K61
	230	1	K61
	460	0	K49
	575	0	K42
7½	200	1	K68
	230	1	K67
	460	1	K55
	575	1	K52
10	200	1¾	K72
	230	1¾	K70
	460	1	K58
	575	1	K55
15	200	2½	K76
	230	2	K75
	460	1¾	K64
	575	1¾	K61
20	200	3	K78
	230	2½	K77
	460	2	K69
	575	2	K64
25	200	3	K86
	230	3	K83
	460	2	K72
	575	2	K69
30	200	3½	K88
	230	3	K87
	460	2½	K74
	575	2½	K72
40	460	3	K77
	575	3	K74
50	460	3	K83
	575	3	K77

8" DIA. MOTORS

HP	Volts	Starter Size	Furnas Amb. Comp
40	460	3	K77
50	460	3	K83
60	460	3½	K87
75	460	3½	K89
100	460	4	K94
125	460	5	K29
150	460	5	K32

HITACHI MOTORS

6" DIA. MOTORS

HP	Volts	Starter Size	Furnas Amb. Comp
5	230	1	K58
	460	1	K43
7½	230	1	K64
	460	1	K54
10	230	1¾	K68
	460	1	K58
15	230	2	K74
	460	1¾	K63
20	230	2½	K77
	460	2	K67
25	230	3	K78
	460	2	K72
30	230	3	K86
	460	2½	K73
40	460	3	K75
50	460	3	K78
60	460	3½	K86

8" DIA. MOTORS

HP	Volts	Starter Size	Furnas Amb. Comp
40	460	3	K75
50	460	3	K77
60	460	3½	K85
75	460	3½	K88
100	460	4	K89
125	460	4½	K29
150	460	4½	K29

10" DIA. MOTORS

HP	Volts	Starter Size	Furnas Amb. Comp
200	460	6	K23
250	460	6	K26

NOTE: Except for starter sizes 4-6, all heaters are for use with Furnas Innova 45 Magnetic Starters.

Limited Warranty

Products manufactured by GRUNDFOS PUMPS CORPORATION (GRUNDFOS) are warranted to the original user only to be free of defects in material and workmanship for a period of 18 months from date of installation, but not more than 24 months from date of manufacture. GRUNDFOS' liability under this warranty shall be limited to repairing or replacing at GRUNDFOS' option, without charge, F.O.B. GRUNDFOS' factory or authorized service station, any product of GRUNDFOS manufacture. GRUNDFOS will not be liable for any costs of removal, installation, transportation, or any other charges which may arise in connection with a warranty claim. Products which are sold but not manufactured by GRUNDFOS are subject to the warranty provided by the manufacturer of said products and not by GRUNDFOS' warranty. GRUNDFOS will not be liable for damage or wear to products caused by abnormal operating conditions, accident, abuse, misuse, unauthorized alteration or repair, or if the product was not installed in accordance with GRUNDFOS' printed installation and operating instructions.

To obtain service under this warranty, the defective product must be returned to the distributor or dealer of GRUNDFOS products from which it was purchased together with proof of purchase and installation date, failure date, and supporting installation data. Unless otherwise provided, the distributor or dealer will contact GRUNDFOS or an authorized service station for instructions. Any defective product to be returned to GRUNDFOS or a service station must be sent freight prepaid; documentation supporting the warranty claim and/or a Return Material Authorization must be included if so instructed.

GRUNDFOS WILL NOT BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES, LOSSES, OR EXPENSES ARISING FROM INSTALLATION, USE OR ANY OTHER CAUSES. THERE ARE NO EXPRESS OR IMPLIED WARRANTIES, INCLUDING MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, WHICH EXTEND BEYOND THOSE WARRANTIES DESCRIBED OR REFERRED TO ABOVE.

Some jurisdictions do not allow the exclusion or limitation of incidental or consequential damages and some jurisdictions do not allow limitations on how long implied warranties may last. Therefore, the above limitations or exclusions may not apply to you. This warranty gives you specific legal rights and you may also have other rights which vary from jurisdiction to jurisdiction.

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P-803 A and B

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P-805 A and C

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AURORA® PUMPS

INSTRUCTION MANUAL
INSTALLATION
FRAME MOUNTED

2

GENERAL. The life of your Aurora pump can be extended considerably by carefully following the installation instructions contained herein. Each step of the pump installation instructions plays a vital part in assuring long life, efficient operation, and reduced maintenance, from the initial location of the pump through prestarting directions.

UNPACKING YOUR PUMP. The crate containing your pump should be opened immediately upon receipt from the factory, and the pump generally inspected for damage and shortage of parts. Particular attention should be given to the discharge and suction nozzle threads or flanges. Any damage or shortage of parts should be reported to the carrier immediately.

CLEANING. If your pump is to be installed immediately, it will be necessary to remove the protective covers from all openings, and to clean the exposed metal parts thoroughly with white gasoline or other suitable solvent to remove the preservative coating.

STORAGE. If your pump is not to be put in service immediately it should be covered and stored in a clean dry area. The protective covers and preservative should be left intact until the pump is put into service. For extended storage, the pump should be dried internally with hot air or some other suitable means, and once free of moisture, filled with a protective fluid such as light oil or kerosene. Accordingly, at time of installation, the pump will have to be completely dismantled and thoroughly cleaned.

PLANNING THE PUMP LOCATION. You probably have spent considerable time planning where your pump will be located. However you may have overlooked some factor which may affect your pump operation or efficiency.

The pump should be located as close to the liquid source as possible so that the suction line can be

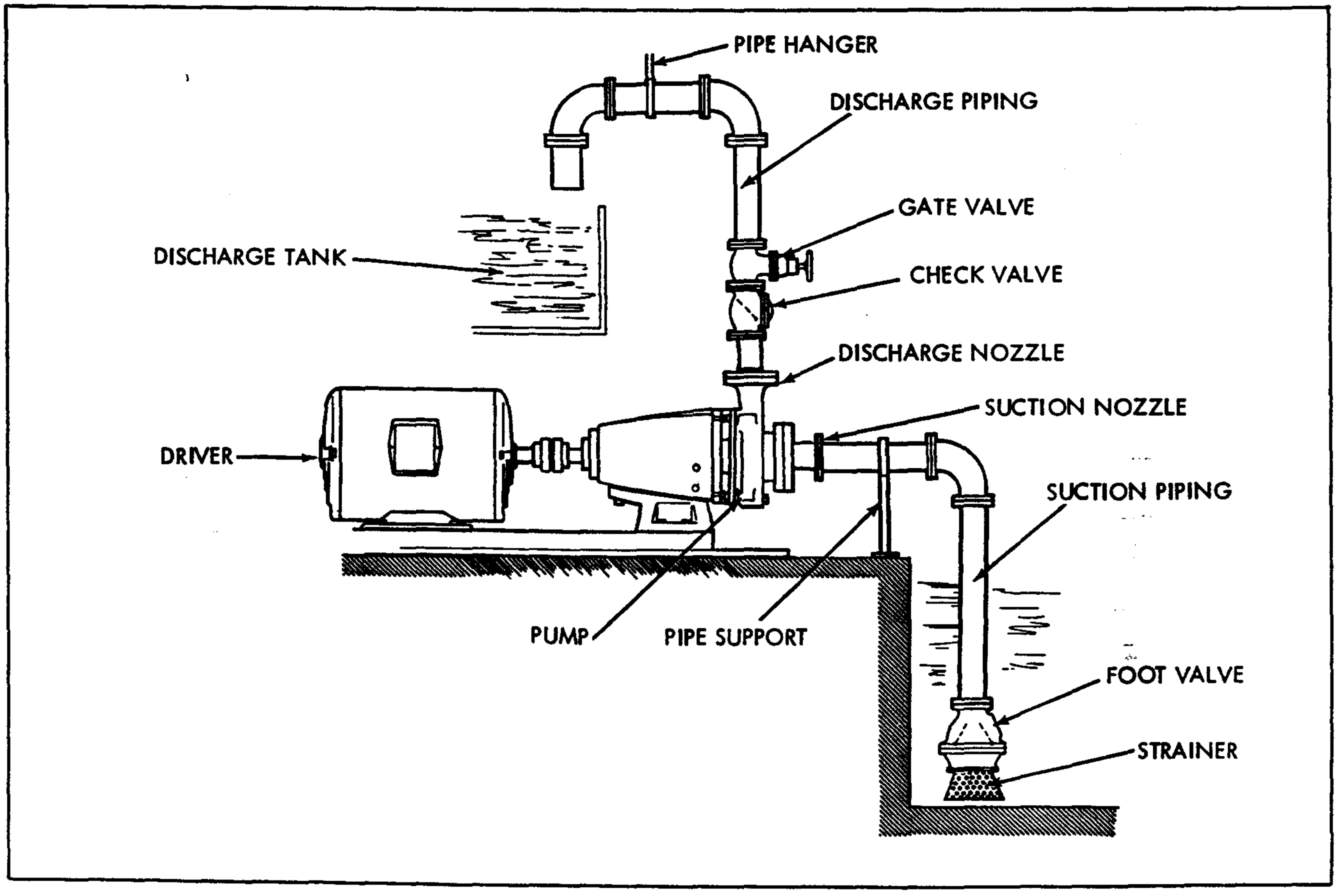


FIGURE 1. RECOMMENDED LOCATION - SHORT DIRECT SUCTION

short and direct. It should be located in a clean, open area, where it is easily accessible for inspection, lubrication, and repair. Pumps installed in dark, dirty areas or in cramped locations are often neglected which can result in premature failure of both the pump and the driver.

Your pump should be located so that a hoist or crane can be used to move it without interference from piping. This factor is often overlooked in the advance planning stage.

Protect your pump against the possibility of flooding. Although water will not seriously damage the pump, the drive motor can be damaged.

The pump should be located in an area where moisture, either from leakage through the packing or from condensation, can be adequately drained off. Moisture dripping on exposed metal or wood can cause rapid deterioration of the area. Also, wet floors produce safety hazards.

Adequate provisions should be made for electrical wiring to the pump motor. A switch and overload protection should be installed near the pump unless it is impractical. The electrical conduit should be positioned in such a way as to preclude the possibility of moisture entering the conduit or the motor and causing short circuits.

Outdoor installation will normally provide all of the above mentioned conditions. However it is advisable to provide a weather shelter for your pump.

FOUNDATION. The foundation for your pump must be sufficiently rigid to absorb any vibration and stress encountered during pump operation. A raised foundation of concrete is preferable for most floor mounted pumps. The raised foundation assures a satisfactory base, protects against flooding, simplifies moisture drainage, and facilitates keeping the area clean.

Your pump should be firmly bolted to the foundation, whether it is a raised concrete base, steelwork wall, or structural member. The mounting bolts or studs should be accurately located per the applicable Aurora dimension sheet. Foundation bolts should be enclosed by a sleeve 2 to 4 diameters larger than the bolt to allow movement for proper alignment with the pump mounting holes. Refer to figure 3.

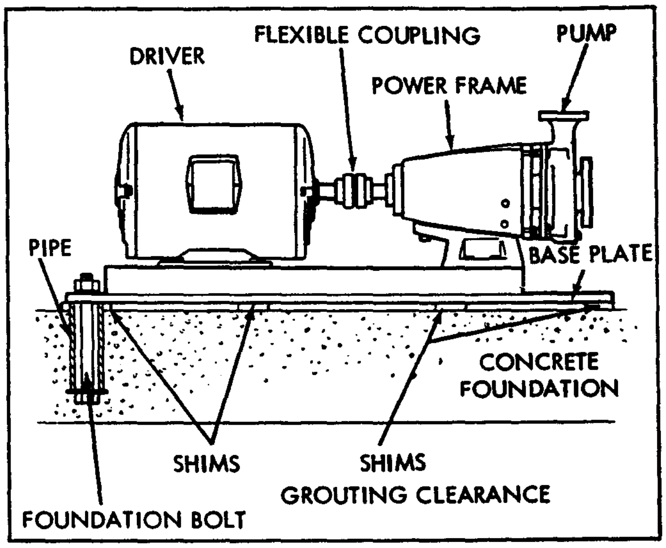


FIGURE 3. FOUNDATION FOR FRAME MOUNTED PUMPS

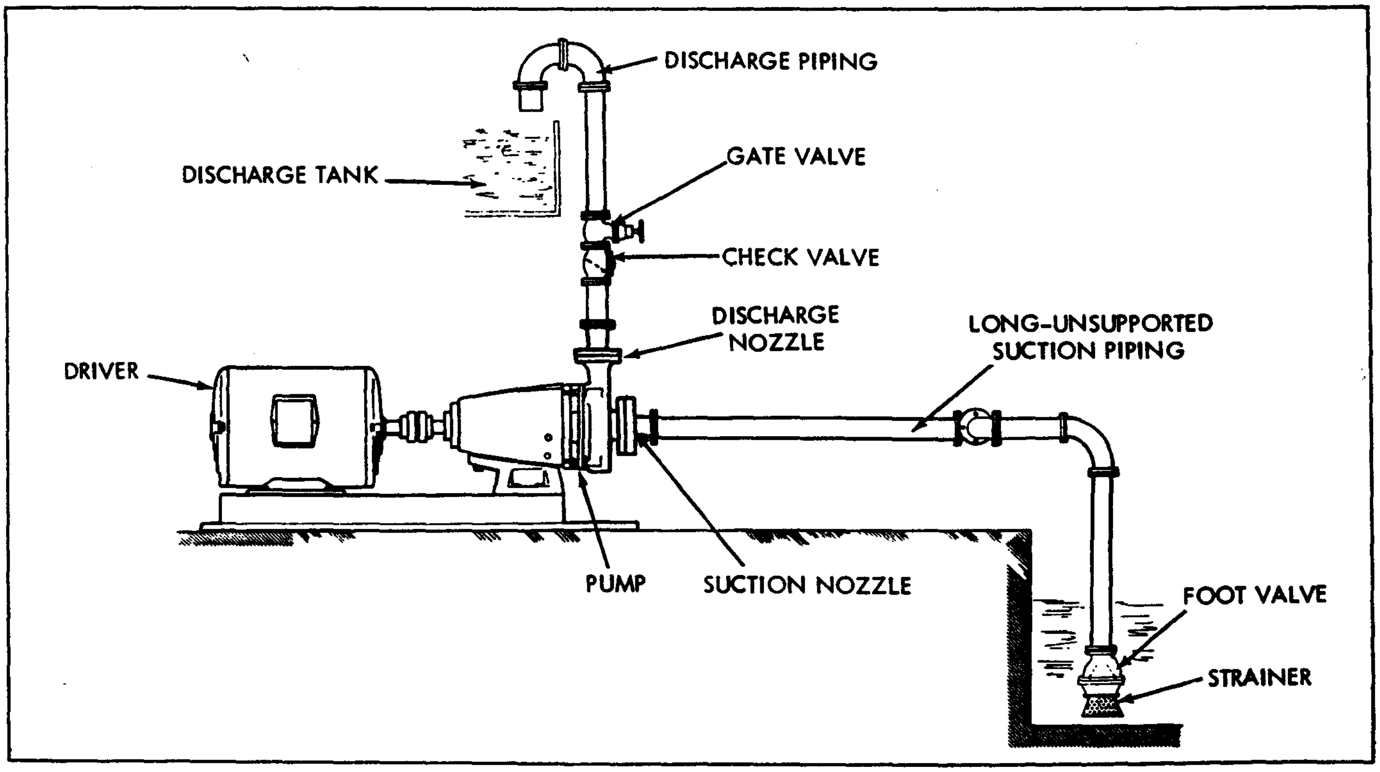


FIGURE 2. UNSATISFACTORY LOCATION - LONG INDIRECT SUCTION WITH NO SUPPORT

If the pump is to be mounted on steelwork or other structure, adequate support should be provided to prevent distortion of the base plate or the structure, which could produce excessive strain on the pump casing and piping, and seriously affect alignment of the pump and driver.

PREPARING TO INSTALL YOUR PUMP. Your pump and driver unit will normally be mounted on a common base plate. The unit has been accurately aligned and securely mounted to the base plate at the factory. However, the alignment cannot be maintained during shipping and the complete unit must be leveled and realigned at the time of installation.

LEVELING THE PUMP. Leveling the pump will require enough shims to support the base plate near the foundation bolts, and at any points of the base plate carrying a substantial weight load. The shims should be large enough to allow a gap of 3/4" to 1-1/2" between the base plate and foundation for grouting.

The pump unit should be set on the foundation, being careful not to damage the threads on the foundation bolts. The flexible coupling halves should then be disconnected. The shims should be inserted and the pump leveled. A spirit level should be used on the faces of the flexible coupling halves, and on the suc-

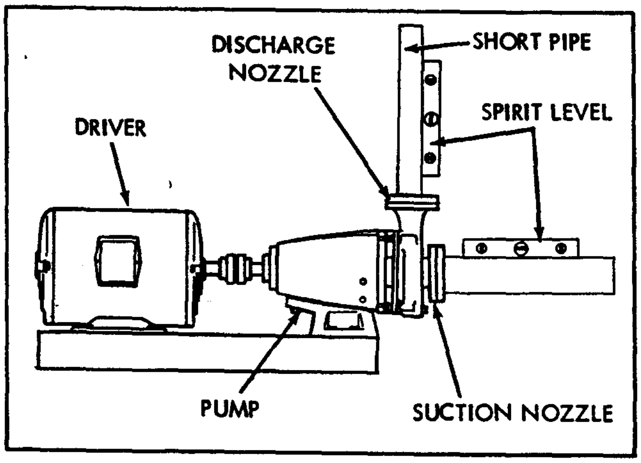


FIGURE 4. LEVELING PUMP UNIT WITH SPIRIT LEVEL AND SHORT LENGTHS OF PIPE

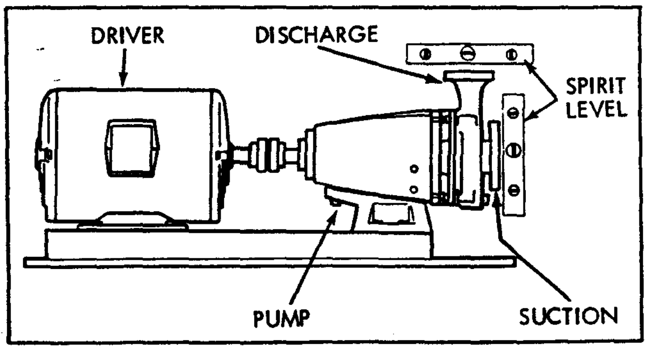


FIGURE 5. LEVELING PUMP UNIT WITH SPIRIT LEVEL ON PUMP FLANGES

tion and discharge flanges. If your pump has threaded nozzles, a short piece of pipe inserted in the nozzles will serve as a smooth surface for a leveling reference point. The shims should be adjusted until the pump is leveled horizontally and vertically. Tighten the foundation bolts finger tight.

INITIAL ALIGNMENT OF THE FLEXIBLE COUPLING. The pump and driver were accurately aligned at the factory. However, it is impossible to maintain this alignment during shipping and handling. Therefore it will be necessary for you to realign the pump and driver. Flexible couplings are not universal joints. They should not be used to compensate for misalignment of the pump and motor shafts. Their function is to transmit power from the driver to the pump while compensating for thermal expansion and shaft end movement. The coupling faces should be far enough apart so that they do not make contact when the motor shaft is forced to the limit of the bearing clearance toward the pump shaft.

In order to properly align the coupling, you will need a taper gauge or set of feeler gauges, and a straight edge, or if available, a dial indicator.

There are two types of misalignment encountered with flexible couplings: angular misalignment, in which the shafts are not parallel, and parallel misalignment where the shafts are parallel but not on the same axis.

To check angular alignment, insert a feeler gauge or taper gage at any four places 90° apart around the

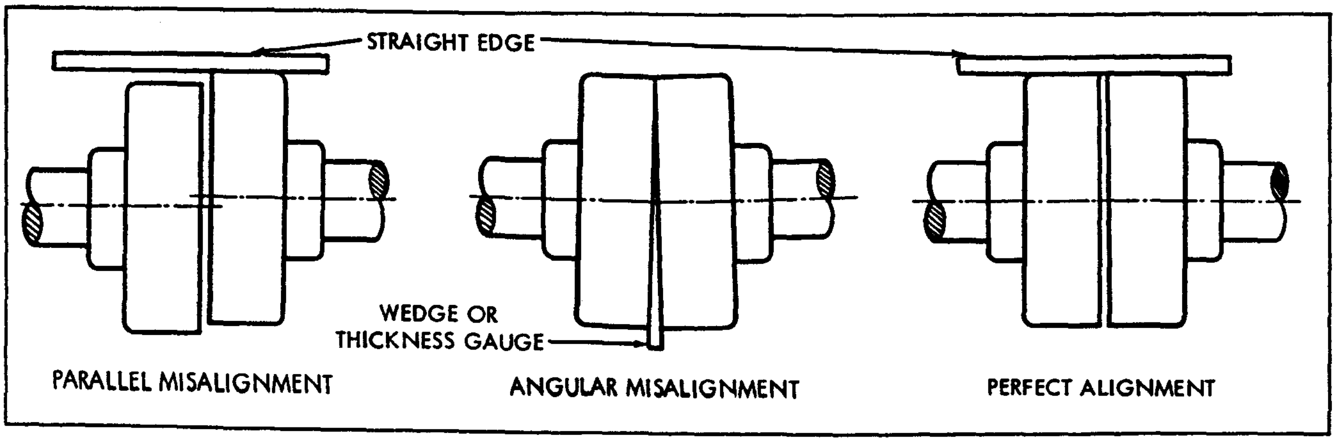


FIGURE 6. FLEXIBLE COUPLING ALIGNMENT

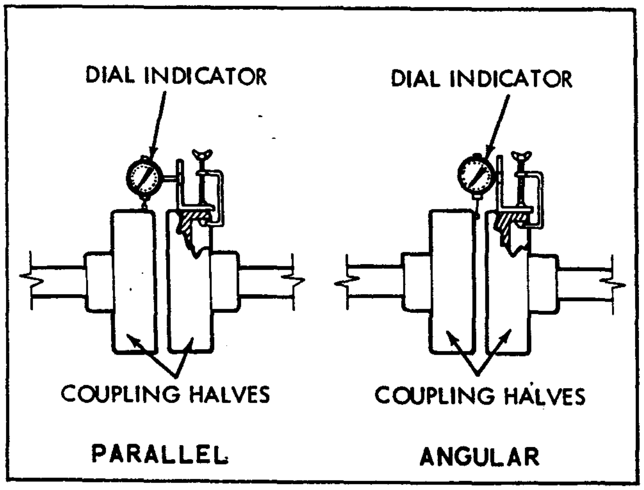


FIGURE 7. CHECKING ALIGNMENT WITH DIAL INDICATOR

coupling halves. Insert shims under the driver feet until the same reading is obtained at all four check points. The pump and driver will then be in angular alignment.

To check angular alignment with a dial indicator, clamp the dial indicator to the pump coupling half so that ball on the indicator just rests on the face of the motor coupling half. A chalk mark should be made at the point where the ball contacts the coupling half. Both the pump shaft and the motor shaft should be rotated an equal amount so that the reading is taken at all check points with the ball on the chalk mark. Insert shims as required.

To check parallel alignment, a straight edge should be held against the edges of the coupling halves at any four places 90° apart around the coupling. The straight edge should be parallel to the pump and driver shafts at all times. Insert shims until the straight edge lies flat against both coupling halves at all four check points. The pump and driver will then be in proper parallel alignment.

To check parallel alignment with the dial indicator, the ball should rest on periphery of the motor coupling half. A chalk mark should be made at the point of contact, and the shafts rotated equally so that the reading is taken with the ball on the chalk mark at all check points. Insert shims as required.

NOTE

Any adjustment to correct one direction of alignment may affect the other direction. Therefore, it is necessary to recheck both angular and parallel alignment after each adjustment.

When the unit is properly aligned, the foundation bolts should be tightened, but not too firmly. Waste material should be stuffed into the sleeves around the foundation bolts, to prevent grout from filling the sleeves during grouting.

GROUTING THE INSTALLATION. Grouting the base plate prevents lateral movement of the base plate, and improves the vibration absorbing characteristics of the foundation by increasing its mass. A wooden dam should be constructed around the base plate to contain the grout while it is being poured. The dam can be built tight against the base plate, or slightly removed from it as desired.

The entire base plate should be completely filled with grout. A non-shrinkable type grout, such as manufactured by EMBCO is recommended. The grout should be puddled frequently to remove any air bubbles from the grout.

The leveling shims can be grouted in place, or they can be removed after the grout has set usually from 48 to 72 hours after pouring.

After the grout has set, alignment of the unit should be checked and the foundation bolts firmly tightened down.

PIPING. Your pump unit is now ready to be piped. The piping practices you follow will directly affect the efficiency and power consumption of your pump.

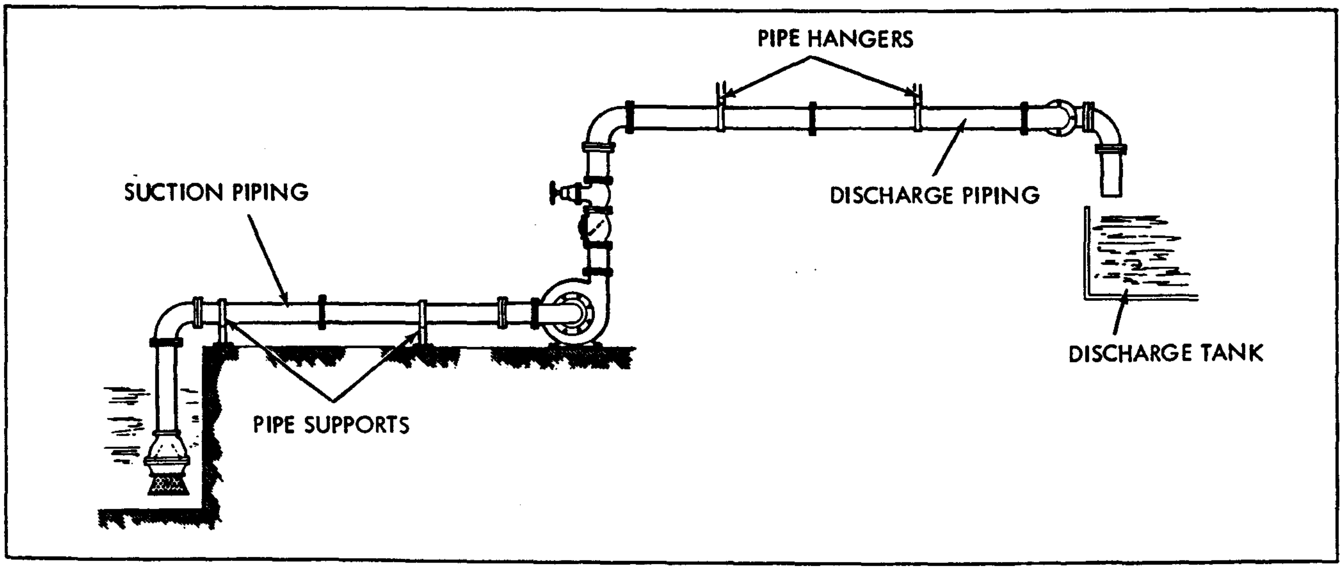


FIGURE 8. SUPPORTING PIPING

Pay particular attention to the seemingly insignificant details involved in piping your pump for they make the difference between a good and bad installation.

SUPPORTING THE PIPE. Both the suction and the discharge piping should be independently supported near the pump. Liberal use of pipe hangers and support blocks will prevent excessive strain on the pump casing and on the pipe joints.

SUCTION PIPING. The suction piping should be short, but no less than ten pipe diameters in length, and direct with as few elbows and fittings as possible, to keep head loss from friction at a minimum. However, the suction pipe should provide a minimum uninterrupted length, equal to ten pipe diameters, to the pump suction flange. A horizontal suction line should have a gradual rise to the pump, and pass under any interfering piping.

PIPE. The suction pipe diameter should be at least the same diameter as the suction nozzle on the pump, and preferably larger. Use of a smaller diameter pipe will result in loss of head due to friction. All joints must be tight to maintain prime on the pump.

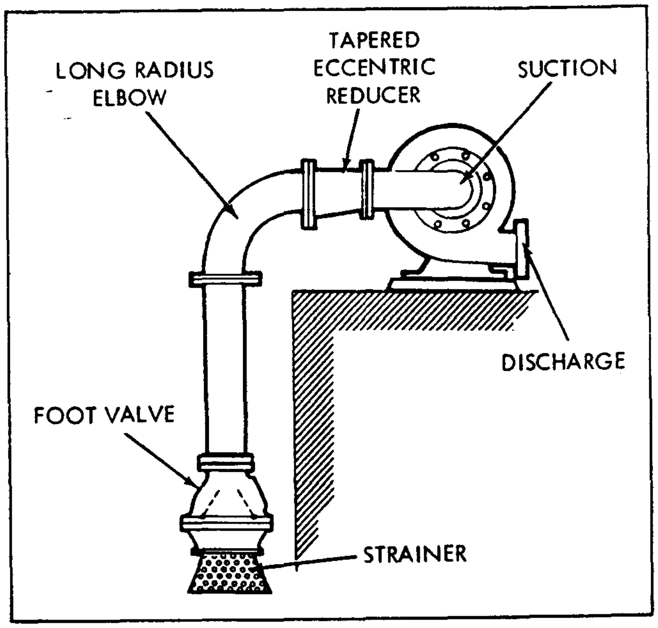


FIGURE 9. RECOMMENDED SUCTION LIFT PIPING - SHORT AND DIRECT

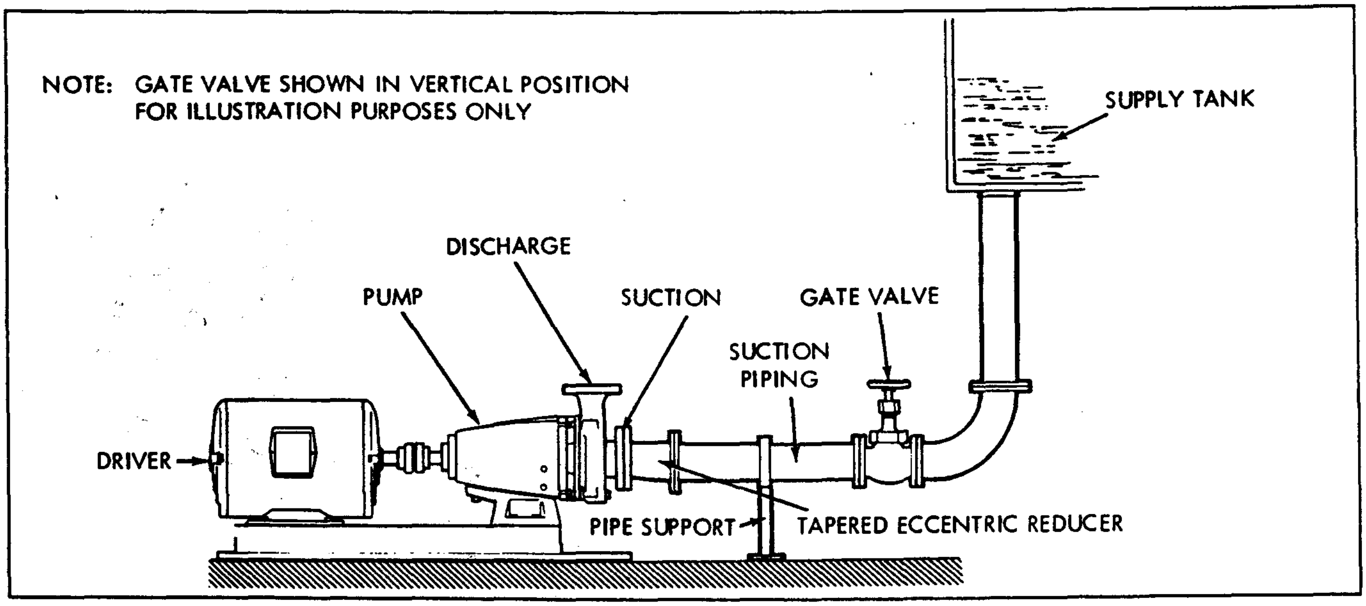


FIGURE 10. RECOMMENDED FLOODED SUCTION PIPING - SHORT AND DIRECT

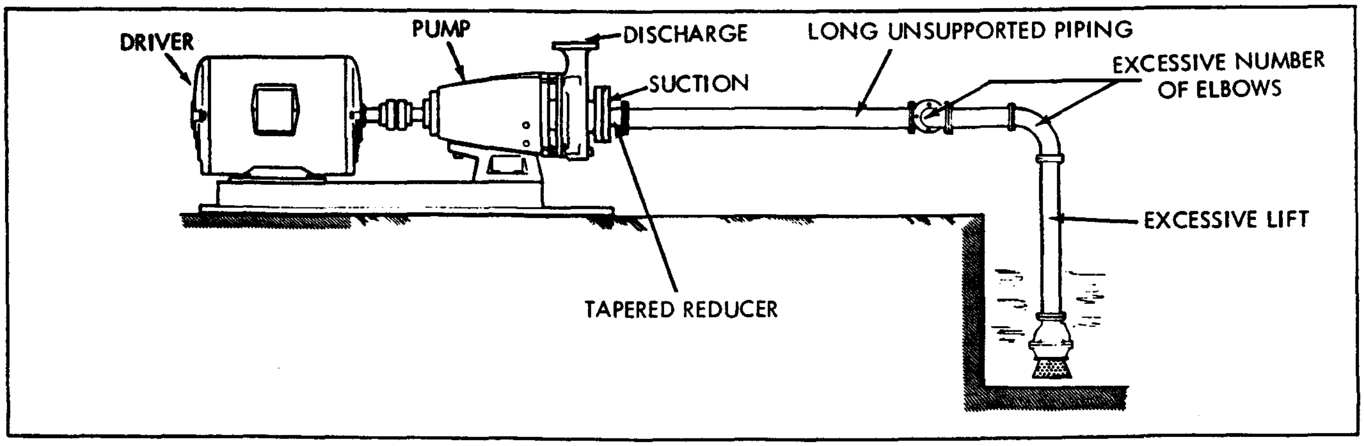


FIGURE 11. UNSATISFACTORY SUCTION LIFT PIPING - LONG AND INDIRECT WITH NO SUPPORT

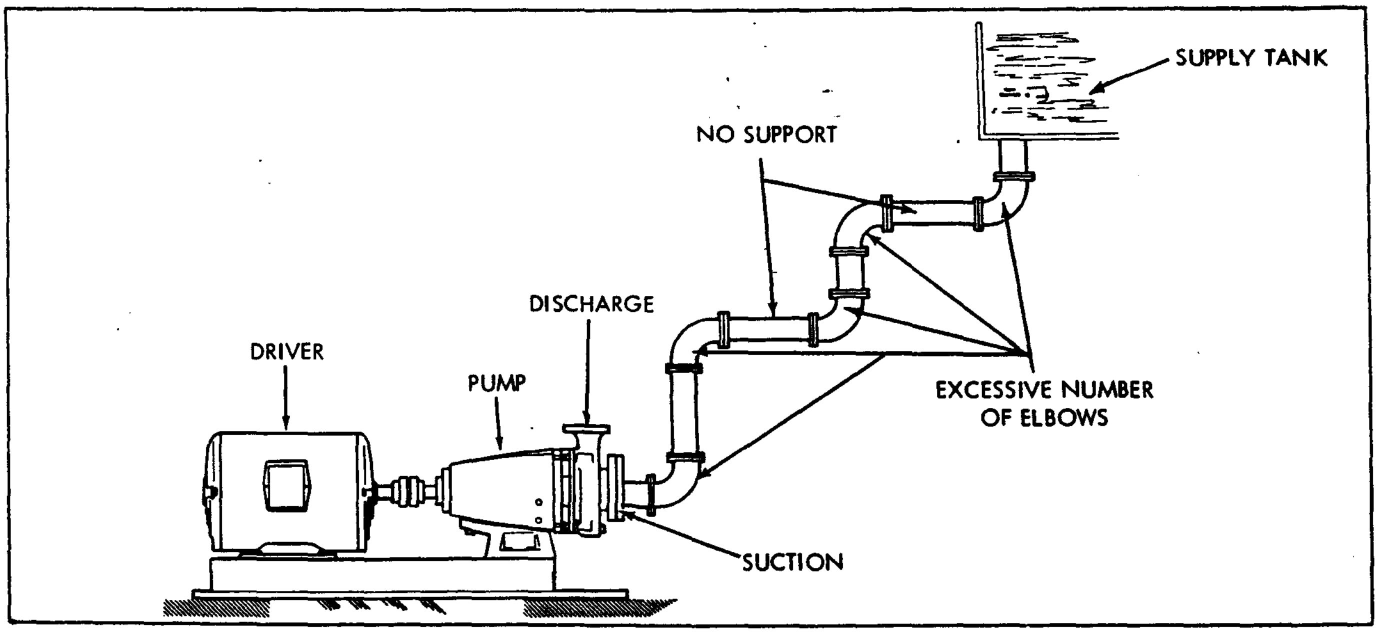


FIGURE 12. UNSATISFACTORY FLOODED SUCTION PIPING - LONG AND INDIRECT WITH NO SUPPORT

ELBOWS. Long radius elbows should be used in place of standard elbows wherever possible, because of their superior flow characteristics. For instance, head loss in a standard four inch elbow is equivalent to the head loss in a piece of pipe 11 feet long, while the head loss in a long radius elbow is approximately half as much. Elbows should not be used at the suction nozzle, but if it is unavoidable, they should be installed in a vertical position. Elbows installed in any position at the suction nozzle have a tendency to distribute the liquid unevenly in the impeller chamber, causing a reduction in capacity, and creating an undesirable thrust condition.

THE FRICTION LOSS IN A LONG RADIUS ELBOW IS APPROXIMATELY ONE-HALF THE FRICTION LOSS OF A SHORT RADIUS ELBOW.

FIGURE 13. LONG VERSUS SHORT RADIUS ELBOWS

REDUCERS. Eccentric reducers should be installed directly at the suction nozzle, with the taper at the bottom to prevent air pockets from forming. Straight taper reducers should never be used in a horizontal suction line because of the air pocket that is formed at the leg of the reducer and the pipe.

DISCHARGE PIPING. Discharge piping should also be short and direct as possible, with few elbows and fittings, to reduce head loss from friction.

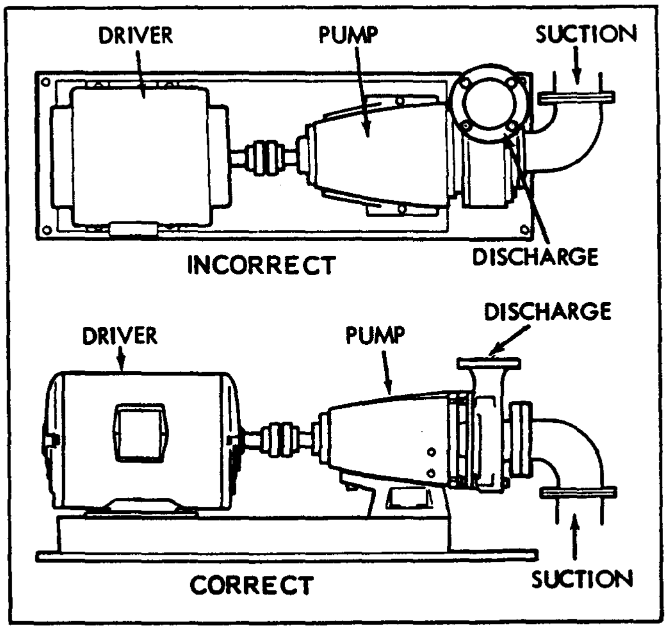
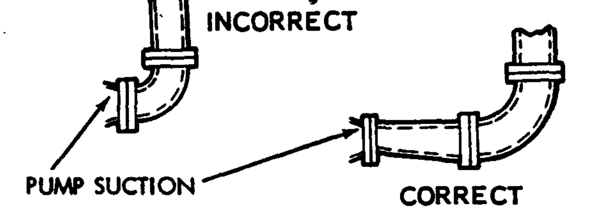


FIGURE 14. ELBOW INSTALLATION IN SUCTION NOZZLE

NOTE: FOR ADDITIONAL DETAILS SEE PAGE 12.



SPACER BETWEEN SUCTION AND ELBOW PERMITS EQUAL FLOW OF WATER TO EACH SIDE OF DOUBLE SUCTION IMPELLER, PREVENTS EXCESSIVE THRUST AND RESULTING WEAR ON BEARINGS, ETC.

FIGURE 15. REDUCER BETWEEN ELBOW AND PUMP SUCTION NOZZLE

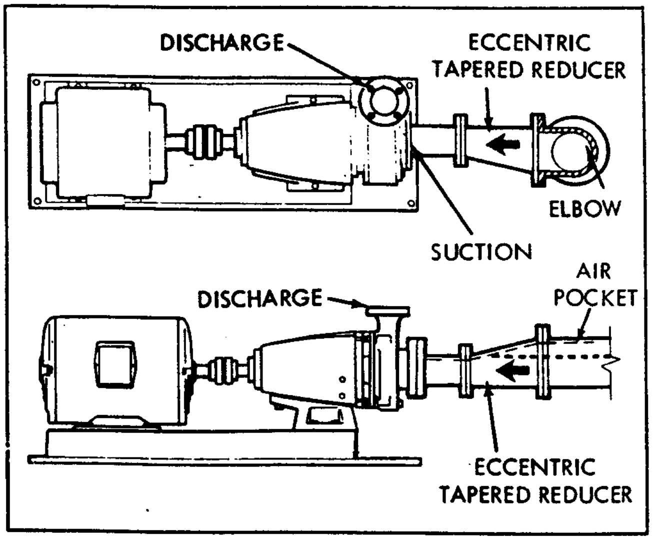


FIGURE 16. UNSATISFACTORY INSTALLATION OF TAPERED REDUCER

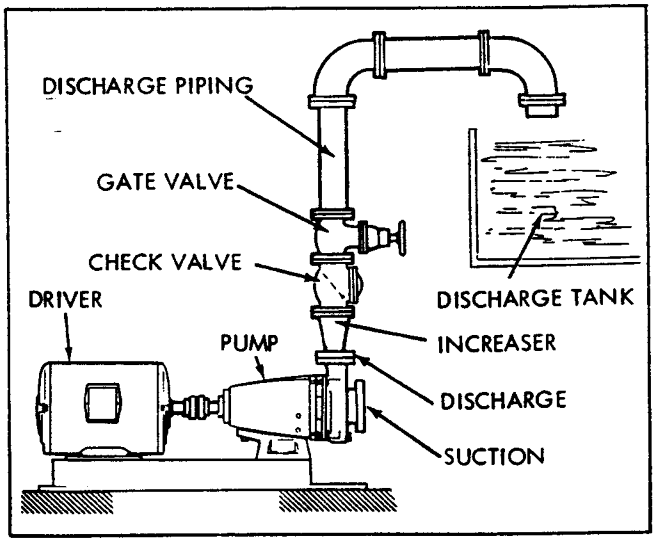


FIGURE 17. RECOMMENDED DISCHARGE PIPING - SHORT AND DIRECT

PIPE. The discharge pipe diameter should be the same as, or larger than, the discharge nozzle diameter. The size of discharge pipe to be used is dependent upon its application.

The recommended pipe diameter can be obtained from your nearest Aurora Pump Sales Office.

ELBOWS. Long radius elbows should be used in the discharge piping as well as in the suction piping to prevent excessive head loss due to friction. Whenever possible, elbows should not be installed directly at the discharge nozzle as the turbulence created by the elbow will affect pressure gauge readings.

REDUCERS AND INCREASERS. An increaser should be installed at the discharge nozzle if larger diameter

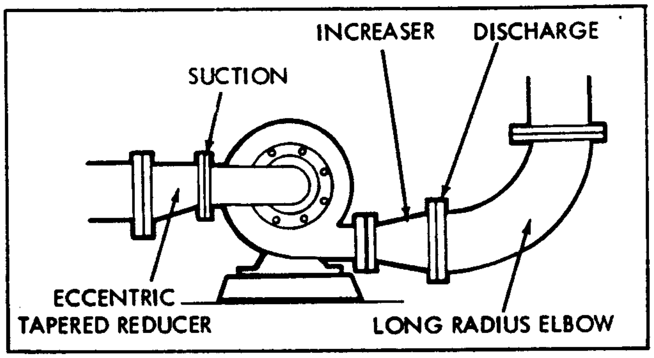


FIGURE 19. REDUCER AND INCREASER INSTALLATION

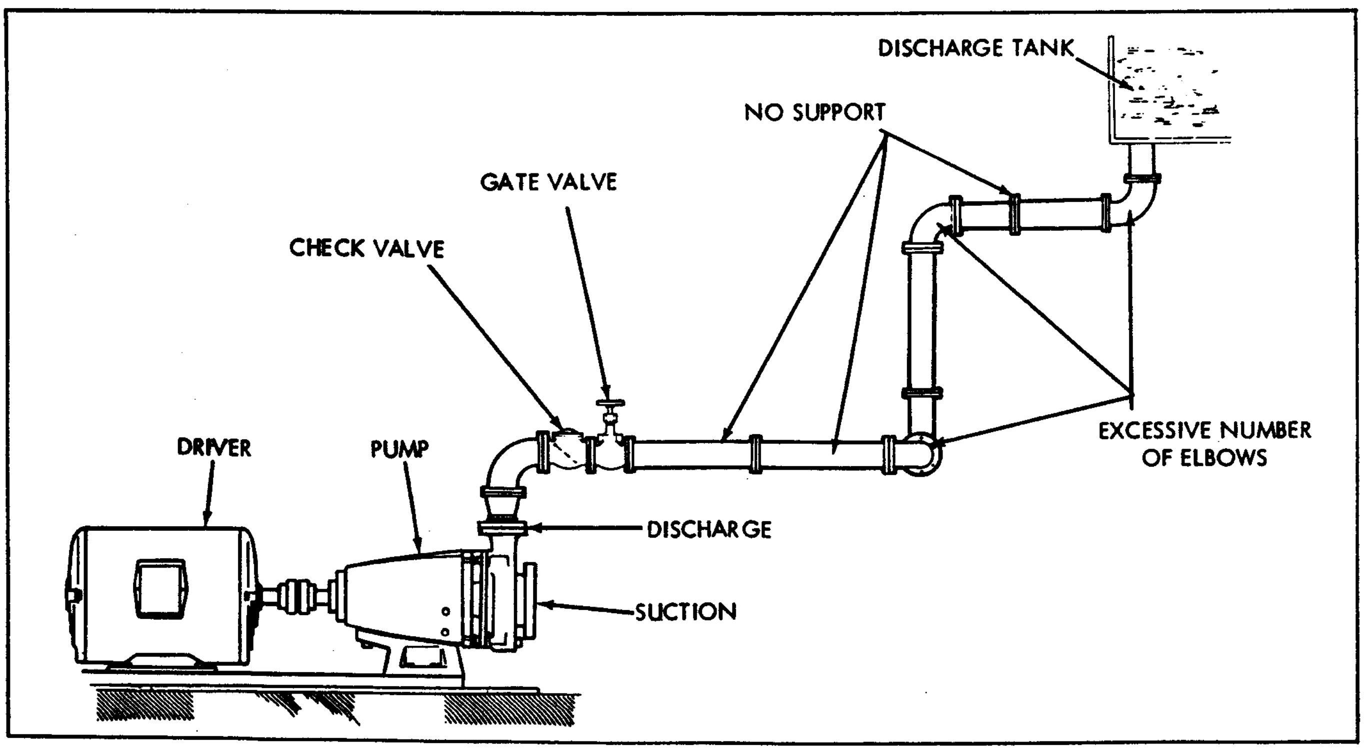


FIGURE 18. UNSATISFACTORY DISCHARGE PIPING - LONG WITH EXCESSIVE ELBOWS AND JOINTS AND NO SUPPORT

discharge piping is used. Straight taper increasers and/or reducers are satisfactory in discharge applications.

EXPANSION JOINTS. Expansion joints are used primarily to prevent the transmission of piping strain, caused by thermal expansion and contraction, piping misalignment, pressure changes, or other causes, to the pump casing. They are also used to suppress any noise that may be transmitted through the piping.

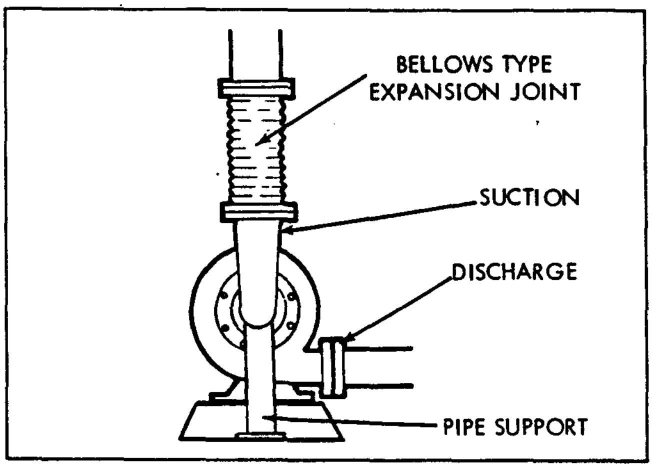


FIGURE 20. EXPANSION JOINT IN SUCTION LINE

It is recommended that the flexible metal type of expansion joint be used, because rubber expansion joints, while costing less, have a tendency to deteriorate, making frequent replacement necessary.

If an expansion joint must be used, an anchor or restraining device should be installed between the joint and the pump to prevent objectional forces from being transmitted to the pump. If an anchor is not installed at this point, a force equal to the area of the joint times the pressure in the pipe is developed and transmitted to the pump. This force may exceed the allowable flange loading, and could result in damage to the pump or piping.

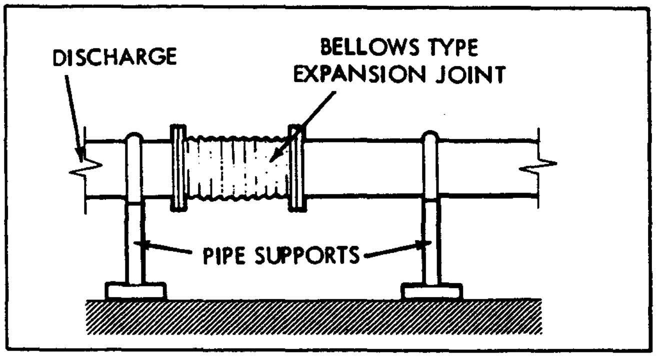


FIGURE 21. EXPANSION JOINT IN DISCHARGE PIPING

PIPE ALIGNMENT. Proper piping alignment is essential before connection is made. Piping alignment should never be achieved by force, this could produce strain on the piping and the pump casing. Proper supports should be installed for the piping to keep its weight off the pump casing.

When flange bolts are used, line up the piping first, then loosely install flange bolts. Check the piping alignment, and tighten the flange bolts until all bolts are tightened securely.

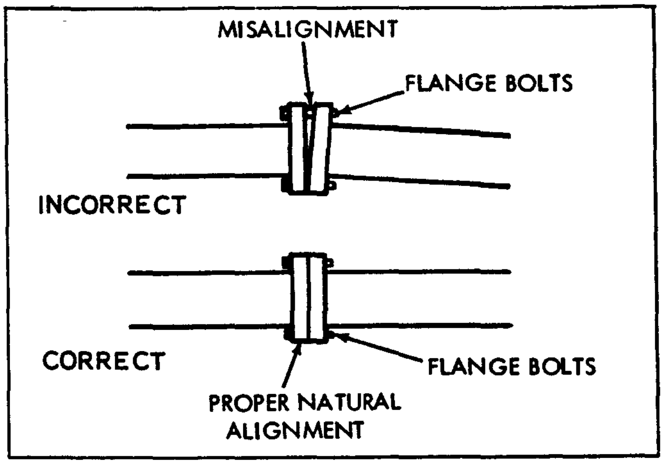


FIGURE 22. PIPE ALIGNMENT

AIR IN PIPING. One of the most common conditions affecting pump efficiency is the formation of air pockets in the suction line. The air pockets are a result of high points and improper installation of elbows, reducers, and valves in the suction piping.

For suction lift applications, lantern rings are required to prevent air from leaking into the pump through the stuffing box, or at the joints.

The pump packings or seal depend on the liquid being pumped for lubrication. Excessive air can prevent proper lubrication with resultant damage to them.

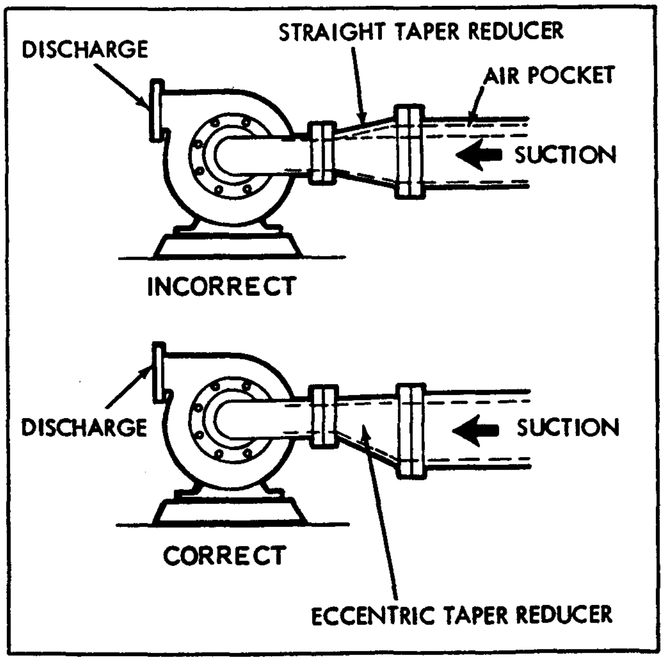


FIGURE 23. AIR POCKETS IN REDUCER

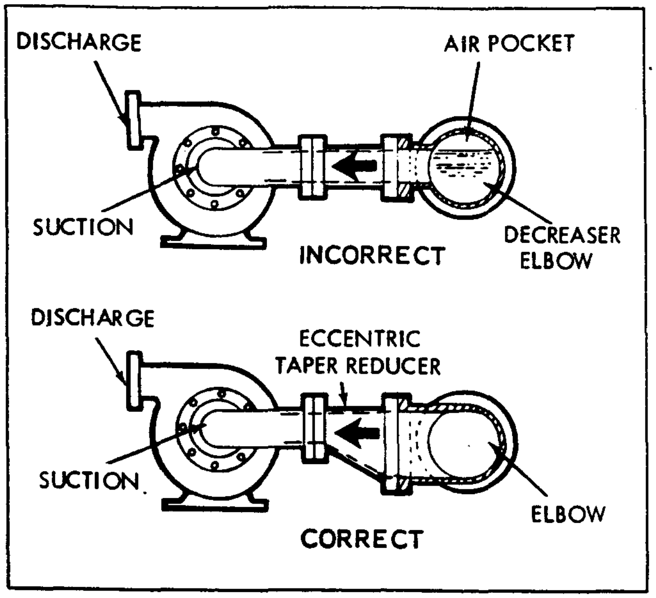


FIGURE 24. AIR POCKET IN ELBOW

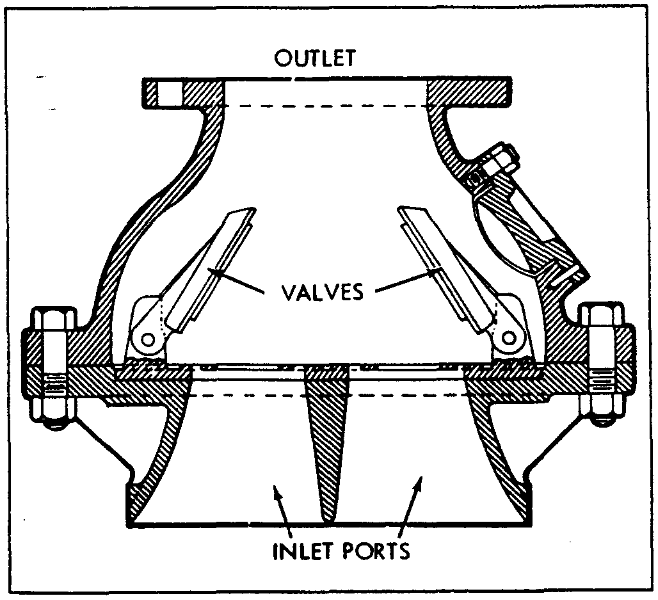


FIGURE 26. FOOT VALVE

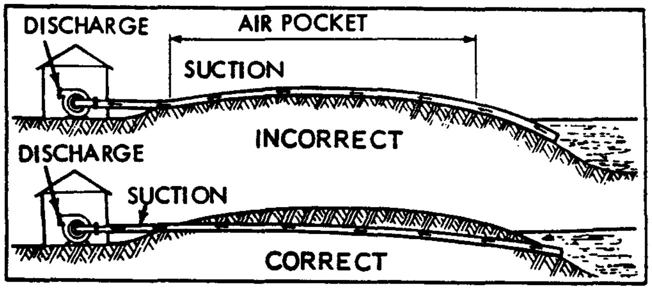


FIGURE 25. AIR POCKET IN HORIZONTAL SUCTION PIPING

In suction lift applications the suction pipe in the liquid well must be sufficiently submerged to prevent exposure of the end of the pipe when the well is at its minimum level and to prevent vortexing action (whirlpool effect) of the liquid at the suction pipe, which will draw air into the pipe. Also, care should be taken to keep the suction pipe located away from the well inlet since the incoming liquid may be carrying air bubbles. Another cause of air in the liquid is dropping of the liquid from too high a point into the well.

VALVES. Valves are an important part of your installation, for they facilitate priming of the pump, and control the volume of the pumped liquid.

SUCTION LIFT. In suction lift applications where the suction lift is low a foot valve can be installed, to maintain the prime on the pump. A foot valve is essentially a check valve, allowing flow in one direction only toward the pump. When the pump is shut down, the pressure of the liquid returning to the well, causes the valve to close, retaining the liquid in the suction line.

A slow closing check valve should be installed when the static discharge head is high. A foot valve should not be used under these conditions, as failure of the driver would allow the water to rush back rapidly thus causing a heavy water hammer.

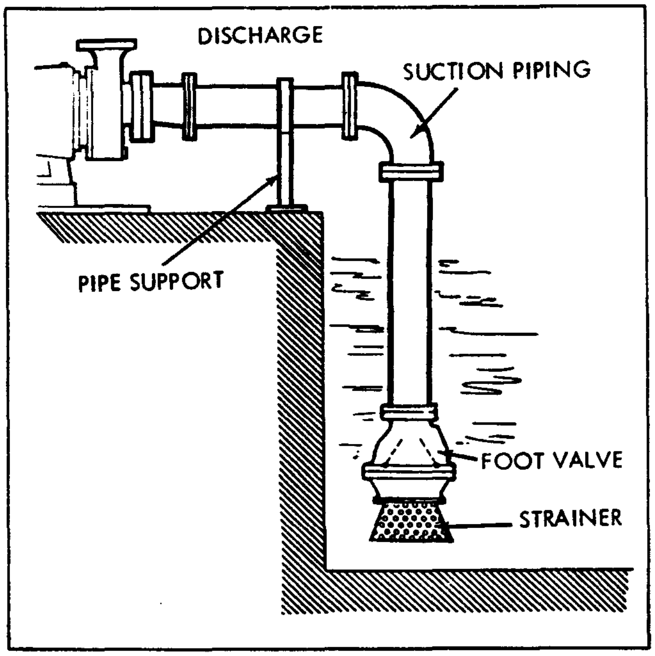


FIGURE 27. FOOT VALVE INSTALLED WITH SCREEN

Foot valves, when used, should be of the flat type rather than multiple spring type. The valve should have a large inlet area, because the friction loss in a foot valve is high. Install check and foot valves as indicated by arrow to ensure proper installation.

FLOODED SUCTION. When the liquid source is above the pump centerline, a flooded suction condition exists, and a gate valve is required to shut off the liquid supply for pump inspection and maintenance. The gate valve should be installed with the stem in a horizontal or downward position to prevent formation of an air pocket in the valve.

DISCHARGE VALVES. Tne discharge piping should include a check valve and a gate valve. The check

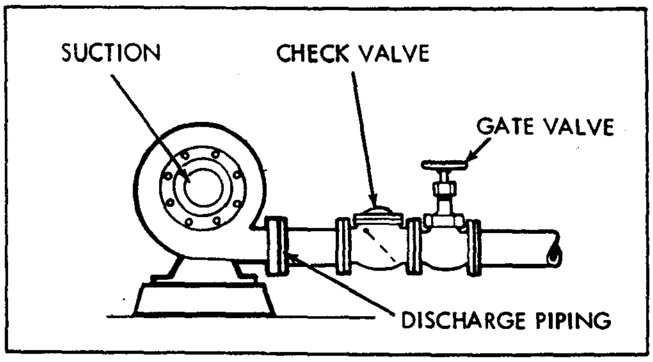


FIGURE 28. GATE VALVE AND CHECK VALVE

valve should be located between the gate valve and the pump. If an increaser is used in the discharge piping, the increaser should be installed between the pump nozzle and the check valve. The check valve protects against a reverse flow of the liquid if the driver fails.

The gate valve is used in the priming operation, as a throttling valve to control pump volume, and to shut down the pump for inspection and maintenance.

AIR VENT VALVE. Vent valves are installed at the high points in the pump casing to allow air or vapor to escape. These valves are used to release trapped air from the pump casing during priming and when pump becomes air bound.

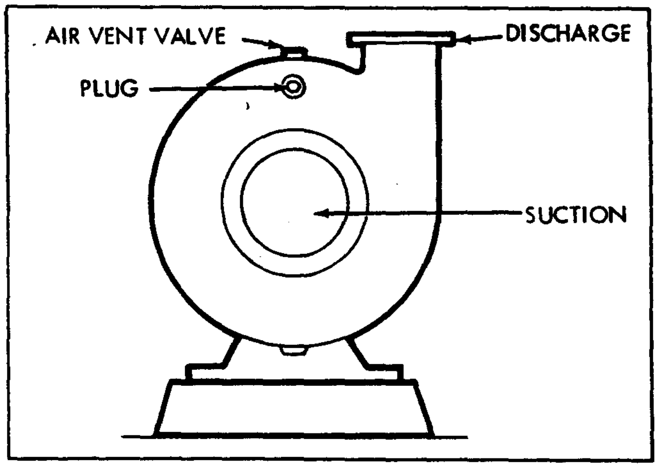


FIGURE 29. AIR VENT VALVE OR PLUG

STRAINERS AND SCREENS. It is important to screen the suction piping to remove foreign matter that can clog the pump and impair its capacity, or stop it completely. Small particles such as sand, dirt, scale from inside pipe and other extraneous materials can get into the close clearance parts of the pump and cause considerable damage to the parts.

Strainers should be selected so as to have a total area of holes equal to at least four times the suction pipe area.

In applications where sticks, twigs, leaves and other large debris are present, a larger outside screen should be placed around the suction inlet to prevent choking of the strainer. This screen should have sufficient openings so that flow velocity does not exceed two feet per second.

PRIMING THE PUMP. Your pump will not operate satisfactorily until it is primed. All air must be expelled from the suction piping and pump casing, and replaced by the liquid to be pumped. There are several methods of priming pumps. The one you select will depend on your specific requirements.

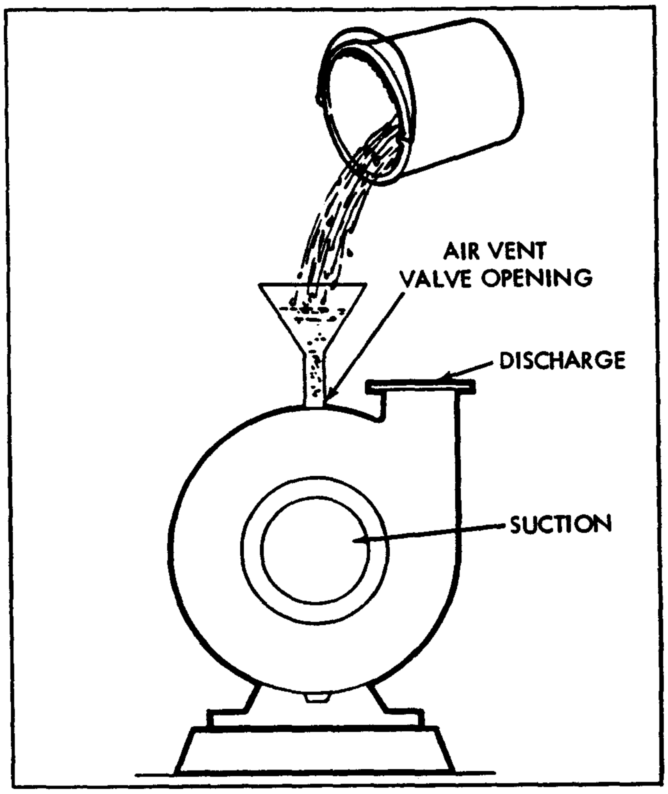


FIGURE 30. PRIMING BY HAND

FLOODED SUCTION PRIMING. This method of priming a pump is relatively simple. The liquid source is located above the pump, and all that is necessary to prime the pump is to open the air vent valve or plug in the pump casing, and to crack the gate valve in the suction line. The suction line and pump should be filled slowly until a steady stream of liquid is observed flowing from the air vent. After your pump is operating, it is recommended that the air vent valve or plug be opened again to insure that all air has been expelled from the pump casing.

FOOT VALVE PRIMING. A foot valve can be used for priming on suction lift applications. The foot valve located at the bottom end or foot of the suction piping, functions as a check valve which allows flow in one direction only, toward the pump.

Initial priming is accomplished by completely filling the suction piping and pump casing with the liquid to be pumped. This can be done by removing the air vent valve or plug at the top of the pump casing and inserting a pipe nipple in the orifice, with an appropriate increaser to accommodate a hose connection.

A priming line can also be inserted in the discharge piping between the check valve and the pump or the priming can be done with a bucket and funnel. The important thing is to completely fill the suction pipe and pump casing with liquid.

When the pump is started, the vacuum created by pumping the priming fluid, combined with atmospheric pressure in the liquid well, forces liquid into the suction piping, thus opening the foot valve and keeping it open until the pump is shut down. When the pump is shut down, the liquid being pumped reverses its flow, causing the foot valve to close, trapping the liquid in the suction piping and pump casing, thus maintaining a prime on the pump.

VACUUM PRIMING. Vacuum priming consists of removing air from the pump casing and suction piping and drawing liquid into them by means of a vacuum creating device. The types of vacuum equipment range from a simple hand pump to complex central priming systems. Your specific priming requirements will govern what type of vacuum primer to use.

AIR EJECTOR. One type of vacuum primer is the air ejector. If liquid under pressure or steam is available, an ejector can be used. The ejector is connected to the air vent orifice. A stream of the ejecting medium is passed through the ejector creating a vacuum in the ejector, and drawing air from the pump casing and suction piping. When liquid flows steadily from the ejector discharge pipe, the pump is primed.

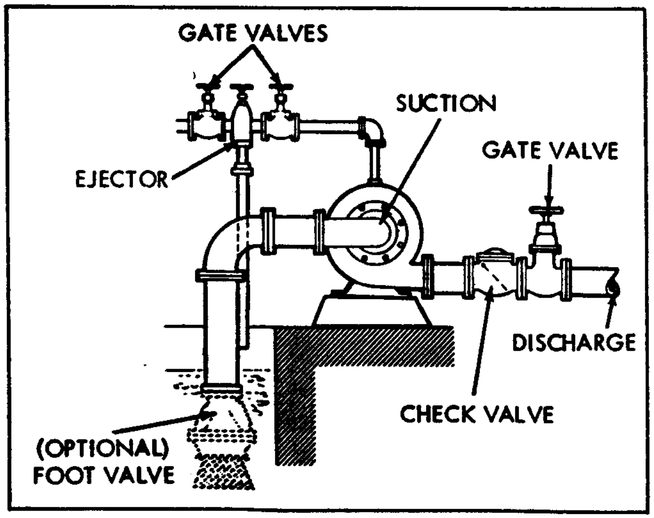


FIGURE 31. PRIMING BY EJECTOR

VACUUM PUMPS. Rotary or reciprocating pumps are frequently used as vacuum pumps. They fall into two categories, wet-vacuum and dry-vacuum. The principle of operation is essentially the same, however, the dry-vacuum pump cannot accommodate a liquid and air mixture while the wet-vacuum pump can accommodate liquid, air or a combination of both.

Vacuum pumps can be installed as part of a central priming system servicing many pumps, as an auto-

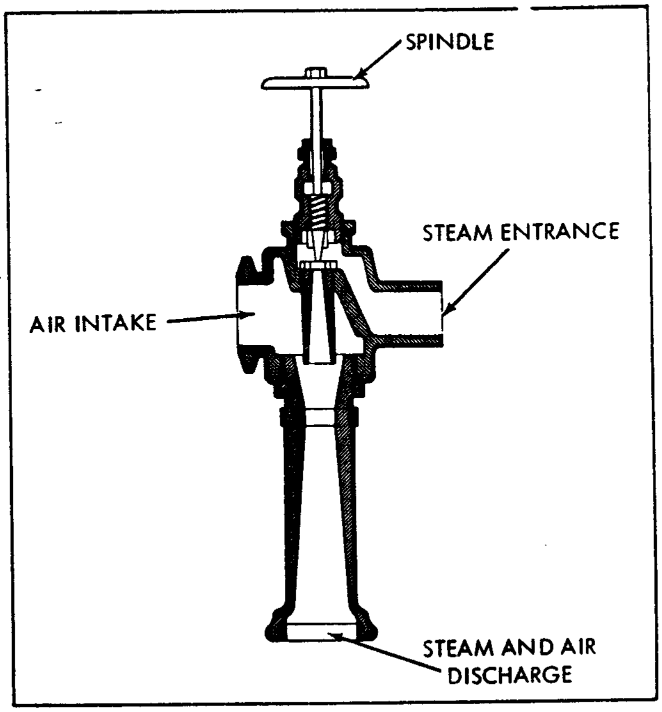


FIGURE 32. EJECTOR CUTAWAY

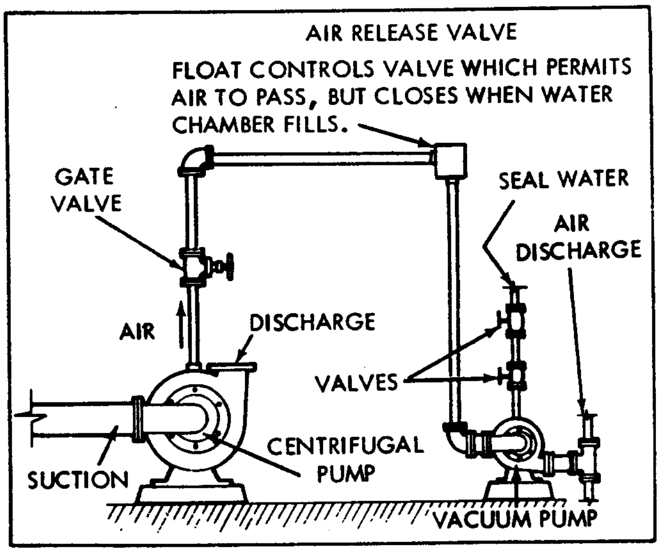


FIGURE 33. PRIMING BY VACUUM PUMP

matic priming system, or as a manually controlled independently driven pump.

The suction piping of the vacuum pump is connected to the air vent orifice on the pump to be primed. The vacuum produced by the vacuum pump removes air from the centrifugal pump suction piping and casing, and draws liquid from the liquid well into the centrifugal pump. Dry-vacuum pumps must be installed so that no liquid is taken into the air pump. Installation of a water trap, or use of a vacuum tank are recommended for dry vacuum pumps.

INDUCTOR PRIMING. On suction lift applications it may be desirable to prime your pump with a priming inductor. This type of primer is comprised of a liquid nozzle and an inductor at the foot end of the

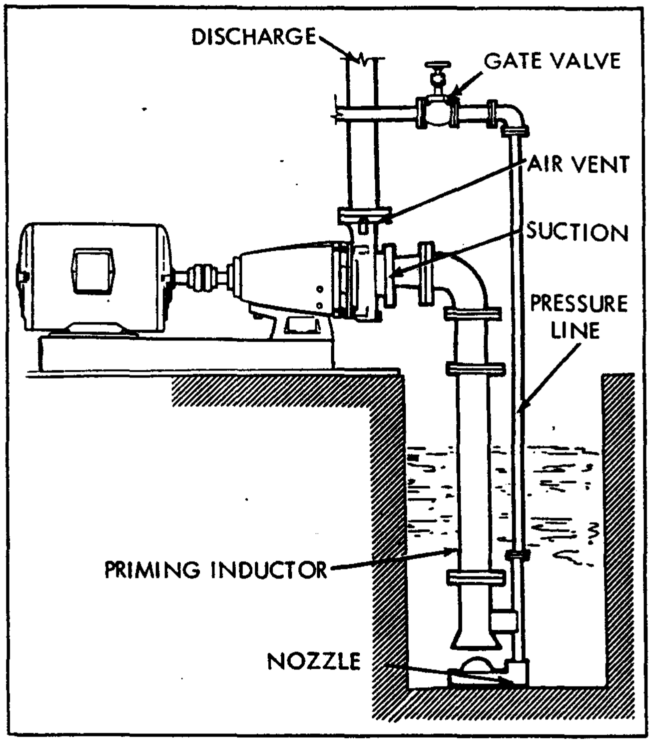


FIGURE 34. PRIMING BY INDUCTOR

suction piping. The nozzle and inductor are connected to a high pressure liquid supply such as a city water service.

The pump is primed by opening the valve in the pressure line, which allows the liquid to flow through the nozzle into the inductor. The velocity of the high pressure liquid drives the liquid into the suction piping and up to the pump, priming it.

ELECTRICAL WIRING. Normally, your pump will be supplied with an attached drive motor. The motor should be wired in accordance with the wiring diagram found on the motor name plate. Be sure the voltage, frequency, and phase of your power supply corresponds with the name plate data. It is advisable to provide a separate switch and overload protection for your pump motor to protect against power failure in some other area. Conversely, if the pump motor develops electrical problems, it will be isolated from other equipment.

PRESTARTING INSTRUCTION. The coupling halves should be connected. Prior to connection however, the drive motor should be started to make sure the direction of roatation is the same as the direction indicated by the arrow on the pump casing.

The suction and discharge piping should now be connected to the pump, and the pump primed.

CAUTION

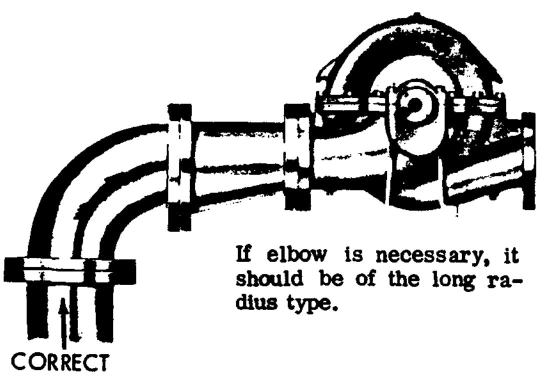
Do not operate the pump without liquid. Pump seals or packing depend on the liquid being pumped for lubrication.

Open or close the various valves as required by your specific application. Start the pump and bring it up to operating temperature. After the temperature has stabilized, the pump should be shut down and the alignment rechecked. It will be necessary to check the alignment with the coupling halves both connected and disconnected.

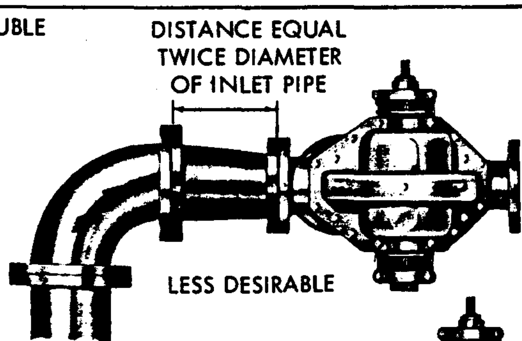
Remember, any alignment adjustment made in one direction may affect the other direction so extreme care should be taken when final adjustment is made.

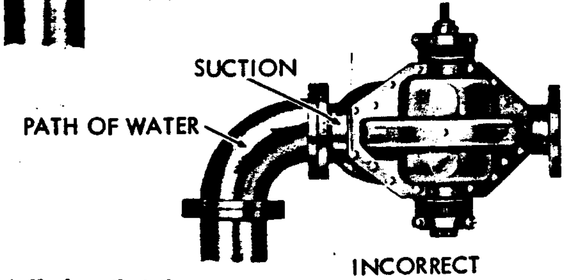
Make sure all pump, motor and base plate mounting bolts are firmly tightened down.

SPECIAL SUCTION PIPING SPECIFICATIONS FOR HORIZONTAL DOUBLE SUCTION PUMPS FOR ADDITIONAL DETAILS SEE PAGE 6



If elbow is necessary, it should be of the long radius type.





Discharge piping and suction piping should be supported close to the pump flange to prevent vibration and strain on pump casing.

The suction pipe on horizontal double suction pumps, should not be installed so that there is an elbow close to the suction nozzle unless the elbow is mounted vertically. There is always an uneven flow of liquid through an elbow and when the elbow is installed at any angle other than vertical more water will enter one side of the impeller than enters the other side. This causes a reduction in capacity and efficiency and creates an axial thrust load which may over heat and possibly cause rapid wear of the thrust bearing.

A UNIT OF GENERAL SIGNAL GS

AURORA PUMP

INSTRUCTION MANUAL
REPAIR
MODELS 341A, 342A, 344A

6

NOTE

This repair manual is applicable to pump Models 341A, 342A, 344A. All photos illustrate Model 344A.

SERVICE

Your Aurora pump requires no maintenance other than periodic inspection, occasional cleaning and lubrication of bearings. The intent of inspection is to prevent breakdown, thus obtaining optimum service life. The liquid end of the pump is lubricated by the fluid being pumped and therefore does not require periodic lubrication. The motor, however may require lubrication, in which case, the motor manufacturer's recommendation should be followed.

LUBRICATION OF IMPELLER SHAFT BEARINGS

The MODEL 344 pump is available with two options for lubricating the shaft bearings. They are:

1. Regreasable (standard)
2. Oil Lubrication

Regreasable bearings will require periodic lubrication and can be accomplished by using the zerk or lubrication fittings in the cartridge cap and power frame. Lubricate the bearings at regular intervals using a grease of high quality. Lithium, lithium soda or calcium base grease is recommended as lubricants for pumps operating in both wet and dry locations. Mixing of different brands of grease should be avoided due to possible chemical reactions between the brands which could damage the bearings. Accordingly, avoid grease of vegetable or animal base which can develop acids, as well as grease containing rosin, graphite, talc and other impurities. Under no circumstances should used grease be reused.

Over lubrication should be avoided as it may result in overheating and possible bearing failure. Under normal application, adequate lubrication is assured if the amount of grease is maintained at 1/3 to 1/2 the capacity of the bearing and adjacent space surrounding it.

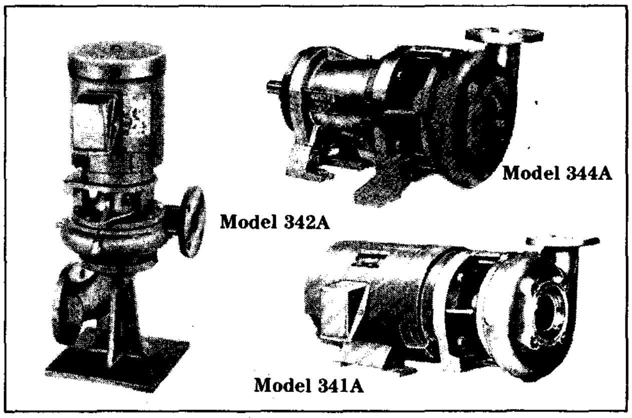
In dry locations, each bearing will need lubrication at least every 600 hours of running time or every 6 to 12 months, whichever is more frequent. In wet locations the bearings should be lubricated at least after every 300 hours of running time or every 4 to 6 months, whichever is more frequent. A unit is considered to be installed in a wet location if the pump and motor are exposed to dripping water, to the weather, or to heavy condensation such as is found in unheated and poorly ventilated underground locations.

Oil lubricated bearings are optional on MODEL 344 pumps. A fixed oil level is maintained with the power frame by an oiler which allows visual indications of reserve oil.

At initial installation and before starting a unit that has been shut down for repairs or for any extended length of time, run enough 10W-30 weight motor oil through the oiler to maintain a constant oil level to insure that the bearing will never be without an oil supply. Oil will have to be added at intervals to maintain a constant level in the oiler. This interval can only be determined by experience.

Under working conditions, oil will breakdown and need to be replaced at regular intervals. The length of these intervals will depend on many factors. Under normal operation, in clean and dry locations, the oil should be changed about once a year. However, when the pump is exposed to dirt contamination, high temperatures (200° F. or above) or a wet location, the oil may have to be changed every 2 to 3 months.

At times it may be necessary to clean the bearings due to accumulated dirt or deteriorated lubricants. This can be accomplished by flushing the bearing with a light oil heated to 180 to 200°F. While rotating it on a spindle, wipe the bearing housing with a clean rag soaked in a cleaning solvent and flush all surfaces.



A. Assembled Units.

Dry bearing thoroughly before relubricating. Compressed air can be used to speed drying, but care should be taken not to let bearings rotate while being dried.

CAUTION

Use normal fire caution procedures when using any petroleum cleaner.

REPAIRS

The pump may be disassembled using the illustrations and text provided. Although complete disassembly is covered, it will seldom be necessary to completely disassemble your Aurora pump.

The illustrations accompanying the disassembly instructions show the pump at various stages of disassembly. The illustrations are intended to aid in the correct identification of the parts mentioned in the text.

Inspect removed parts at disassembly to determine their reusability. Cracked castings should never be reused. Gaskets should be replaced at reassembly simply as a matter of economy; they are much less expensive to replace routinely than to replace as the need occurs. In general it is economical to return to the manufacturer for repair only the motor and motor controller.

DISASSEMBLY

Disassemble only what is needed to make repairs or accomplish inspection. (See Figure 2 for Model 341A, Figure 3 for Model 342A and Figure 3 for Model 344A.)

1. Break electrical connections to prevent drive unit from being energized during disassembly.

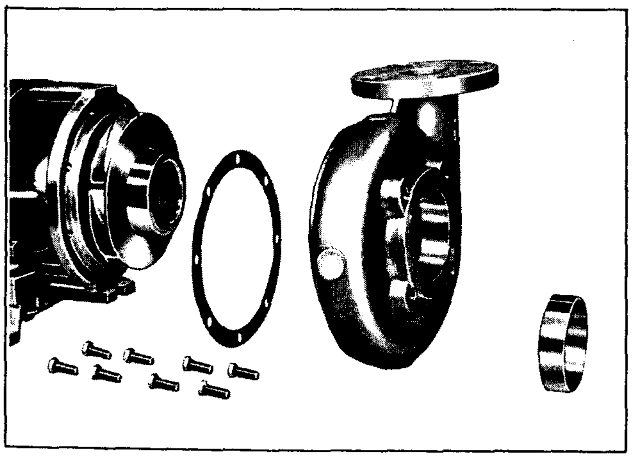
2. Unscrew the two drain plugs (4) from the casing (6). On Model 342A pumps, remove plugs (74 and 75) to drain pump. Also unscrew the two plugs (4) from casing (6).

3. Remove all relief, cooling, flushing or drain lines from pump, including compression connections (1 and 2) and tubing (3). Break suction and discharge connections unless it is intended to remove the power frame or motor assembly and leave casing (6) in the line. On Model 342A pumps, break discharge connections only, unless it is desired to remove base (73). Remove capscrews (39) and lift pump assembly from base (73). Remove gasket (72).

4. On Model 344A pumps, remove the flexible coupling from between the pump and motor. Next unscrew the bolts that hold support(s) (41 & 64) to the base and slide the pump out to be worked on.

5. Remove capscrews (5) and pull casing (6) from bracket (35). Remove gasket (8).

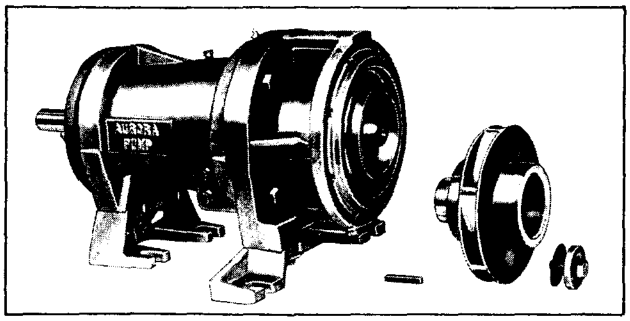
6. Unscrew impeller screw (9) and remove washer (9A), taking care not to damage gasket (9B).



B. Casing, Gasket, and Wearing Ring Removed.

7. Slide impeller (11) and impeller key (12) from the shaft, again taking care not to damage gasket (10) located behind impeller. Remove gasket (10).

8. Wearing ring(s) (7 & 16) are pressed into their housings with an interference fit and must be removed with a puller. New ring(s) should be used for reassembly since it is likely that during removal this fit will be lost.



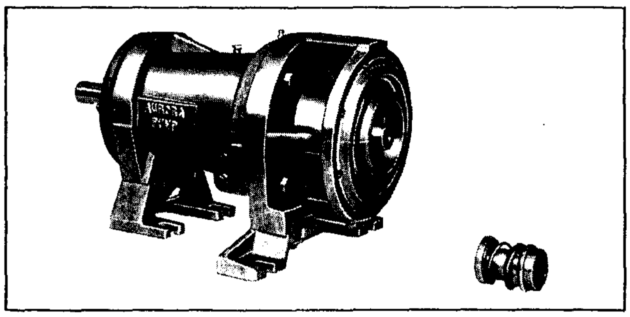
C. Impeller and Key Removed.

9. Impeller wearing rings (optional - 14 and 15) are pressed on and must be cut off if replacement is necessary. If they are turned off in a lathe, take care not to cut into the impeller.

10. Slide sleeve (25) with rotating parts of mechanical seal (27) from the shaft. The sleeve should be carefully cleaned to remove any residue that may be remaining in the seal area. The rubber in seal (27) may have become partially adhered to the sleeve. The sleeve must also be checked for abrasion or corrosion that can occur when fluid residue penetrates between the seal (27) and sleeve (25). The sleeve under the seal may be polished lightly to a 32 RMS finish before reassembly. Do not reuse a pitted sleeve. Pin (61) may be removed if necessary.

CAUTION

The mechanical seal is a precision product and must be treated as such. During removal great care must be taken to avoid dropping any part of the seal. Take particular care not to scratch the lapped faces on the washer or the sealing seat. Do not put a seal back into service until the sealing faces of the washer and seat have been lapped or replaced. (SEE FIGURE 1.)

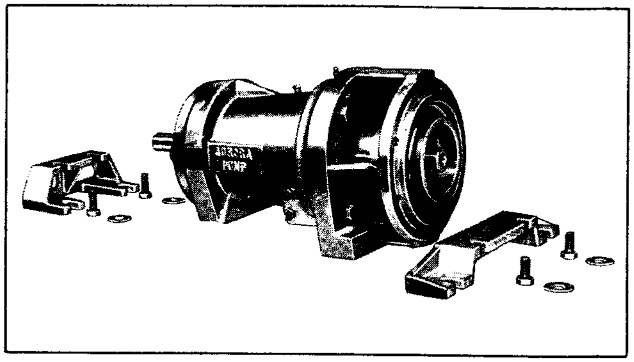


D. Mechanical Seal Removed.

11. On Model 344A pumps, remove capscrews (39 and 62) and washers (40 and 63) to take off support feet (41 and 64). On Model 341A frame size 143 thru 184-JM only. Unscrew capscrews (39) washers (40) and remove support (41) from bracket (35).

12. Unscrew capscrews (32) to remove bracket (35) from frame (57) or motor on Models 341A and 342A.

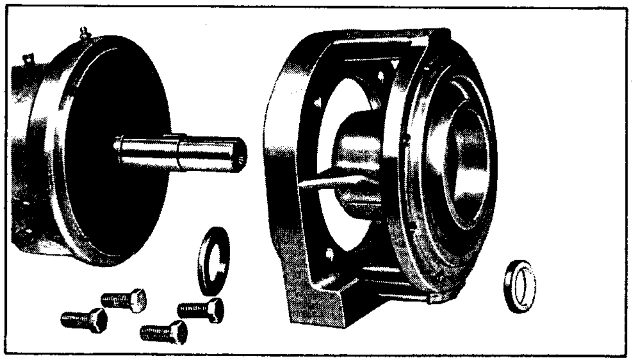
13. The seal flexible cup and stationary seat should be pressed out of the bracket (35) and the cavity cleaned of all residue. Make sure that the 1/32 inch radius in the seal seat cavity is not damaged during disassembly since a sharp edge can easily cut the flexible cup during reassembly.



E. Support Feet Removed.

14. On Model 344A pumps, remove key (42) from the shaft and remove slingers (47) and (47A).

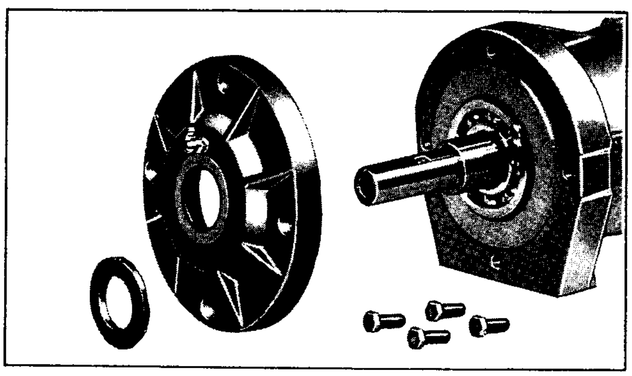
15. Unscrew capscrews (48) and remove bearing cap (49). Remove o-ring (oil lubed only) (50) and retainer ring (52).



F. Bracket and Slinger Seal Flexible Cup and Stationary Seat Removed.

16. Slide out shaft (55) and bearings (53 and 54). Since bearings (53 and 54) are press fitted on the shaft, they will have to be pulled or pressed off the shaft. Remove grease seals (51) from frame (57), and bearing cap (49).

17. Remove nameplate (34) and screws (33) only if replacement is needed.



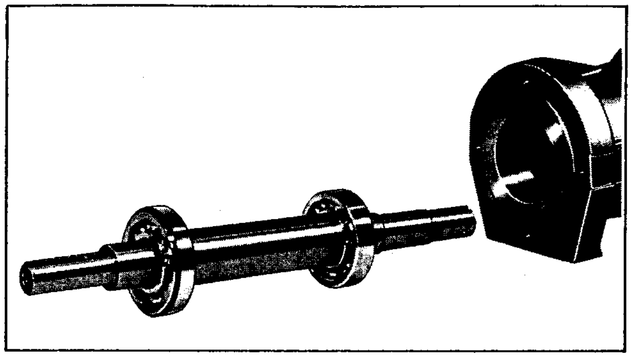
G. Bearing Cap and Slinger Removed.

REASSEMBLY

Reassembly will generally be in reverse order of disassembly. If disassembly was not complete, use only those steps related to your particular repair program.

1. Press grease seals (51) into frame (57) (344A).

2. Press bearings (53 and 54) onto shaft (55). Snap retainer ring (52) into place. (344A)



H. Shaft Assembly Removed.

3. Slide shaft (55) and bearings (53 and 54) into frame (57) and place o-ring (oil lubed only) (50) in place. (344A)

4. Fasten bearing cap (49) in position with capscrews (48). Insert grease seals (51) and position slingers (47) and (47A) on the shaft. (344A)

5. The mechanical seal (27) (see Figure 1) cannot be installed as an assembly. It is necessary to have the seal seat properly in place before the balance of parts can be added.

Thoroughly inspect the seal cavity in seal bracket, checking for burrs or nicks which could damage flexible cup of mechanical seal. Apply a film of liquid dishwashing detergent (do not use oil or grease) to the flexible cup and seal seat. Insert seat in cup and install in seal bracket, taking care to seat it evenly and squarely.

NOTE

If it is not possible to insert seat with fingers, place the cardboard protecting ring furnished with seal over lapped face of seat and press into place with a piece of tubing having end cut square. Tubing should be slightly larger than the diameter of the shaft. Remove cardboard after seat is firmly seated.

6. On Model 344A pumps, mount bracket (35) by screwing capscrews (32) evenly into frame (57) to assure proper alignment. Turn all capscrews in an even amount. Fasten the bracket and frame to supports (41 and 64) by placing washers (40 and 63) over capscrews (39 and 62) and screwing them into position.

On Model 341A and 342A pumps position bracket (35) on the motor and secure with capscrews (32). Tighten screws evenly to assure proper alignment.

Secure support (41) to bracket (35) with capscrews (39) and washers (40). Frame sizes 143 thru 184-JM Model 341A only.

7. If nameplate (34) was removed, install and attach with screws (33).

8. Wipe the sealing faces of the seat and seal washer clean. Replace pin (61) in sleeve if it was removed during disassembly. Apply a film of liquid dishwashing detergent to the washer and bellows of the seal and slide the remaining seal parts onto the sleeve making sure the washer is seated against the seal seat. Check the proper sequence of assembly as indicated in figure 1. The shaft sleeve with the seal rotating assembly on it may now be replaced onto the motor shaft. Spring tension will probably prevent the sleeve from remaining in position axially until the impeller is locked against it.

9. Press wearing ring(s) (7 & 16) in casing (6) and bracket (35). Rings should not be hammered into place. Use a press, or clamp the parts in a bench vise, using wooden blocks to protect the rings. It may be necessary to pin or dowel the rings after assembly if the insert or casing has had rings replaced before, since each reassembly can stretch or tear metal and thereby loosen the fits. If the facilities are available, it is good practice to take a very light finish cut or to ream the inside diameter of the casing rings after pressing to restore roundness. When rings are pressed, they may get squeezed out of shape.

10. Coat the mating surfaces of impeller wear ring(s) (optional - 14 and 15) and impeller (11) with Locktite sealant grade 271. Replace wear rings, using the same care as for the case wear ring(s). If the rings are to be trued on a lathe, do not clamp the impeller so tightly that it is permanently distorted.

11. Carefully replace gasket (10) on motor end of impeller. Assemble key (12) and impeller (11) to motor shaft. Secure impeller with gasket (9B), washer (9A), and impeller screw (9).

12. Install the two pipe plugs (4) in the pump casing. Position the gasket (8) and casing (6) against the motor bracket and secure with screws (5). On Model 342A pumps position gasket (72) and set pump assembly in place. Tighten pump to base (73) with capscrews (39).

13. Replace all relief, cooling, flushings, or drain lines from the pump including compression connections (1 and 2) and tubing (3). Replace all grease fittings pipe plugs, tube vents and oiler assembly for oil lubricated units. Connect discharge piping and suction piping, if required. Make sure to install gaskets on the flanged connections. On Model 342A pumps replace plugs (74) and (75) in base elbow (73).

14. Read carefully the section of the manual titled INSTALLATION, especially those paragraphs referring to pump and coupling alignment.

15. Connect electricity to the motor.

STARTING PUMP AFTER REASSEMBLY

Do not start pump until all air and vapor has been bled and until making sure that there is liquid in the pump to provide the necessary lubrication. Without the fluid around it, the seal may be ruined in a few seconds of operation. It is possible that the mechanical seal may drip during the first few minutes to one hour of operation.

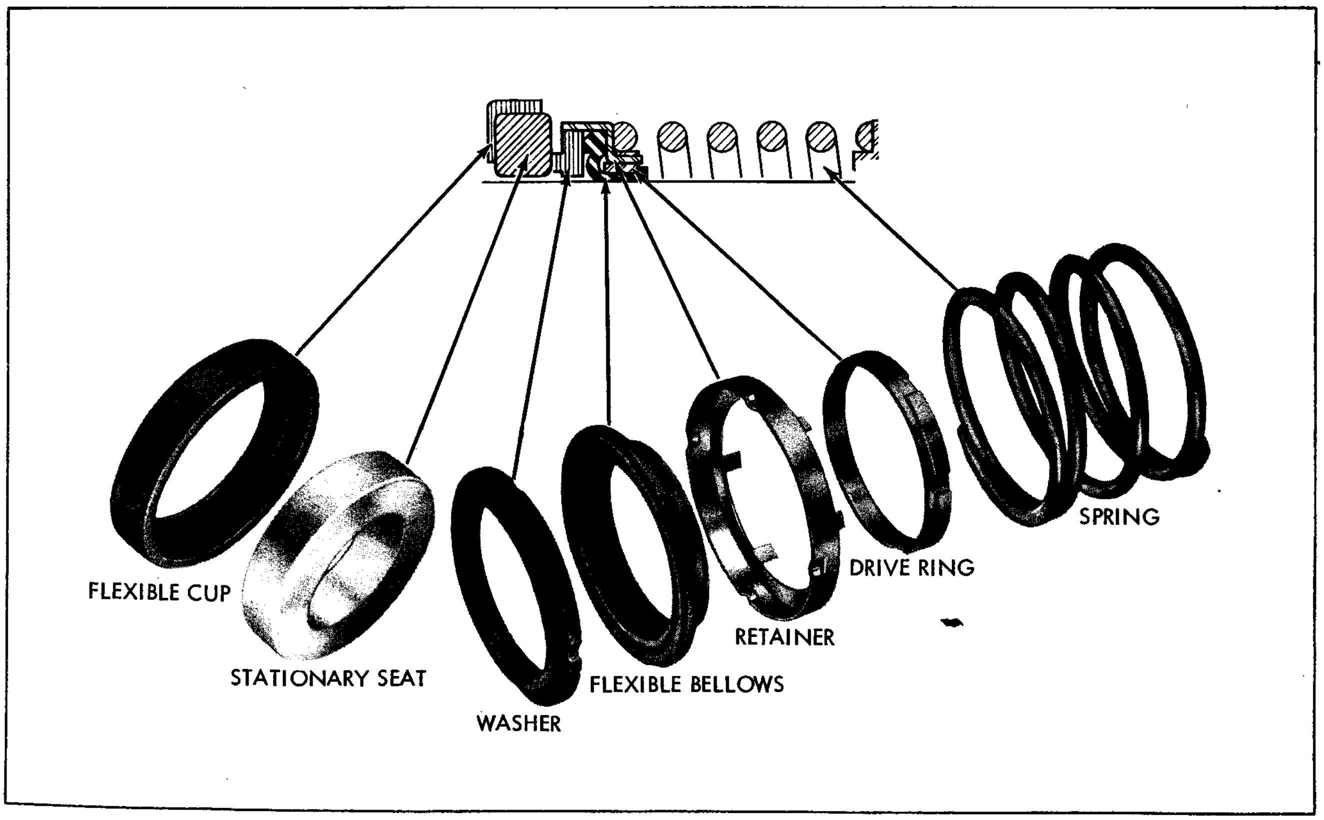


Figure 1. Mechanical Seal

MODEL 341A LIST OF PARTS

1. Elbow	9A. Washer	27. Seal
2. Connector	9B. Gasket	32. Capscrew
3. Tubing	10. Gasket	33. Screw
4. Plug, Pipe	11. Impeller	34. Nameplate
5. Capscrew	12. Impeller Key	35. Bracket
6. Casing	14. Wear Ring	39. Capscrew
7. Wear Ring	15. Wear Ring	40. Washer
8. Gasket	16. Wear Ring	41. Support
9. Impeller Screw	25. Sleeve	61. Pin

MODEL 342A LIST OF PARTS

1. Elbow	9B. Gasket	33. Screw
2. Connector	10. Gasket	34. Nameplate
3. Tubing	11. Impeller	35. Bracket
4. Plug, Pipe	12. Impeller Key	39. Capscrew
5. Capscrew	14. Wear Ring	61. Pin
6. Casing	15. Wear Ring	72. Gasket
7. Wear Ring	16. Wear Ring	73. Base
8. Gasket	25. Sleeve	74. Plug, Pipe
9. Impeller Screw	27. Seal	75. Plug, Pipe
9A. Washer	32. Capscrew	

MODEL 344A LIST OF PARTS

1. Elbow	16. Wear Ring	49. Bearing Cap
2. Connector	25. Sleeve	50. O-Ring
3. Tubing	27. Seal	51. Seal
4. Plug, Pipe	32. Capscrew	51A. Seal
5. Capscrew	33. Screw	52. Retaining Ring
6. Casing	34. Nameplate	53. Bearing
7. Wear Ring	35. Bracket	54. Bearing
8. Gasket	39. Capscrew	55. Shaft
9. Impeller Screw	40. Washer	56. Plug, Pipe
9A. Washer	41. Support	57. Frame
9B. Gasket	42. Key	58. Grease Fitting
10. Gasket	43. Grease Fitting	59. Plug, Pipe
11. Impeller	44. Tube, Vent	60. Oiler Assembly
12. Impeller Key	46. Plug, Pipe	61. Pin
14. Wear Ring	47. Slinger	62. Capscrew
15. Wear Ring	47A. Slinger	63. Washer
	48. Capscrew	64. Support

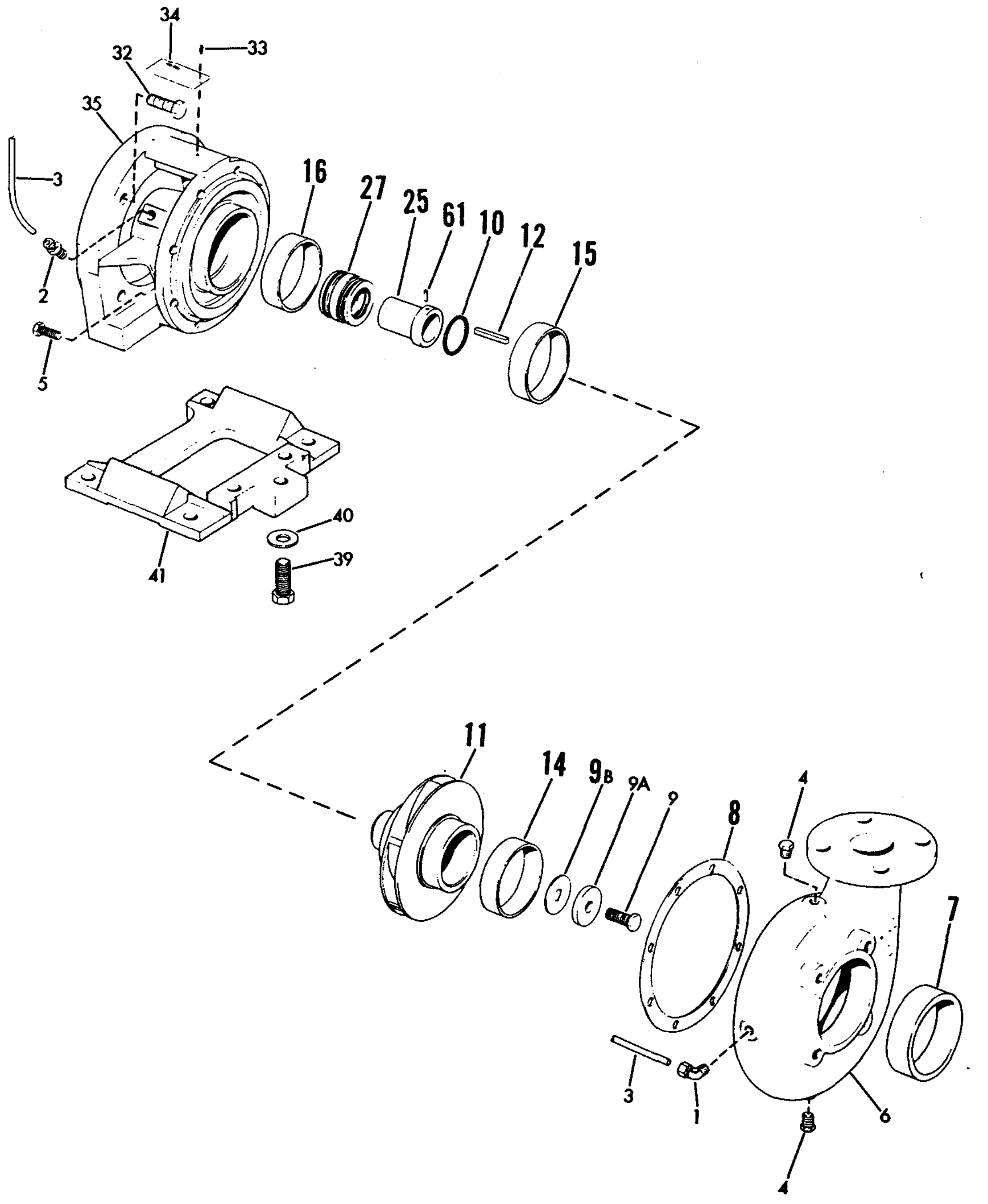
NOTES:

1. STANDARD FITTED CONSTRUCTION WILL BE FURNISHED AS STANDARD UNLESS SPECIFIED.
2. REFER TO FACTORY FOR SPECIAL ALLOYS.
3. AURORA PUMP RESERVES THE RIGHT TO SUBSTITUTE MATERIALS WITHOUT NOTICE
4. PIECE NUMBERS 14 AND 15 ARE NOT FURNISHED AS STANDARD, WHEN FURNISHED IMPELLER MUST BE MODIFIED.
5. PIECE NUMBERS 39, 40, 41 USED ONLY WITH MOTOR FRAMES 143 THRU 184-JM ON MODEL 341A PUMPS.

NOTE

WHEN ORDERING SPARE PARTS ALWAYS INCLUDE THE PUMP TYPE, SIZE, SERIAL NUMBER, AND THE PIECE NUMBER FROM THE EXPLODED VIEW IN THIS MANUAL.

ORDER ALL PARTS FROM YOUR LOCAL AUTHORIZED DISTRIBUTOR, FACTORY BRANCH SALES OFFICE OR THE FACTORY AT NORTH AURORA, ILLINOIS.



BOLD FACE NUMBERS INDICATE
RECOMMENDED SPARE PARTS.

Figure 2. Model 341A Exploded View

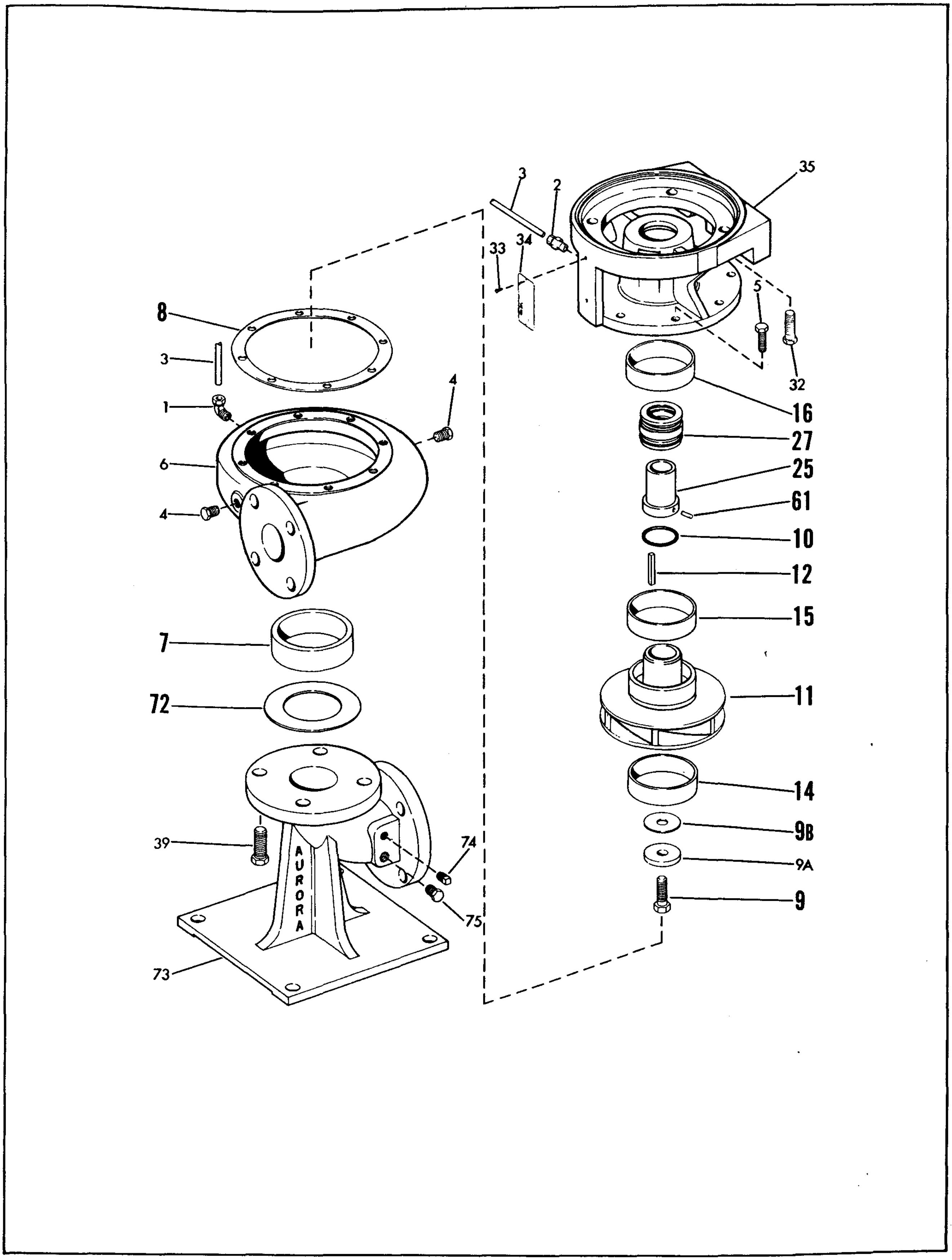


Figure 3. Model 342A Exploded View

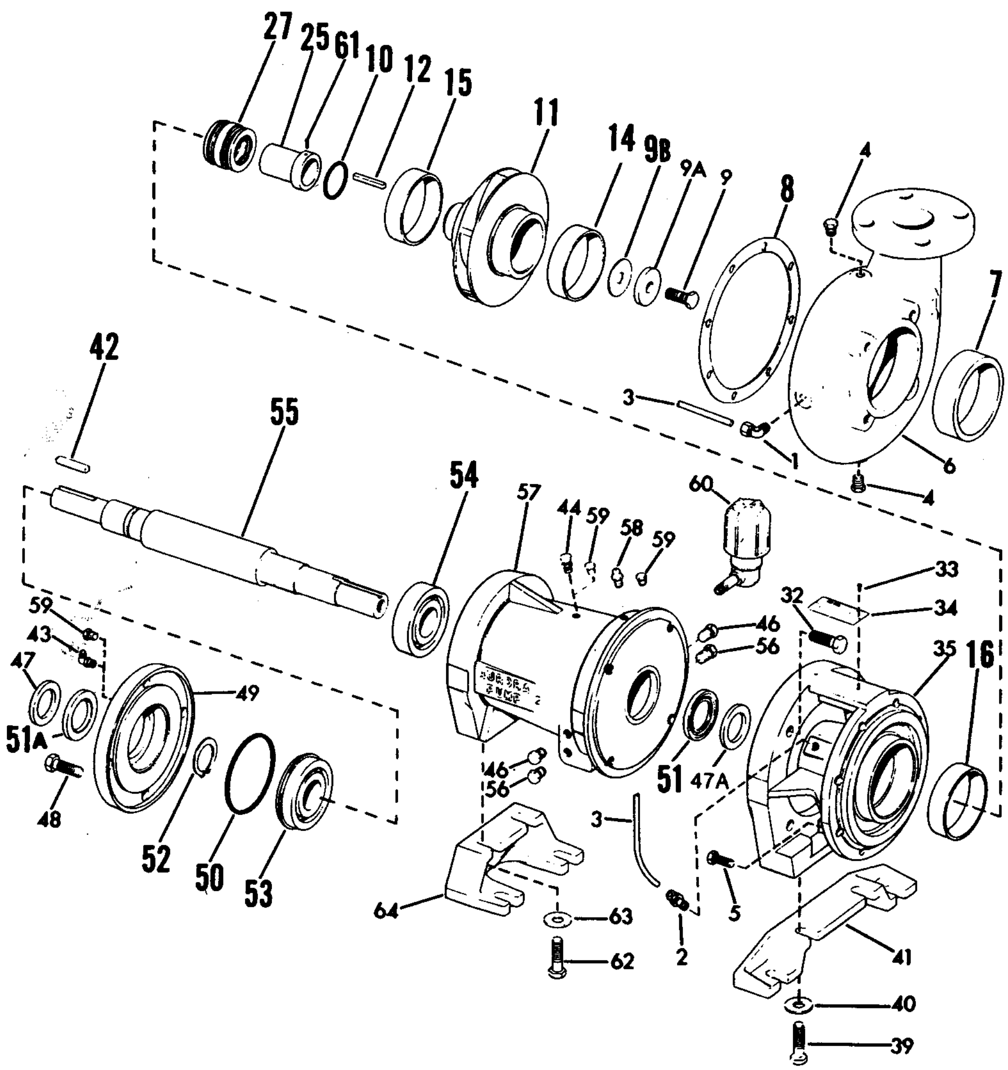


Figure 4. Model 344A Exploded View

Building Sump Pumps

P-804A, B

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GOULDS PUMPS

Waste Water Pumps
Dewatering, Effluent and Sewage

Installation, Operation and Trouble Shooting Manual

Owner's Information

Pump Model Number: ____________________

Pump Serial Number: ____________________

Control Model Number: ____________________

Dealer: ____________________

Dealer Phone No. ____________________

Date of Purchase: __________ Installation: __________

Current Readings at Startup:

1Ø	3Ø	L1-2	L2-3	L3-1
Amps: ______	Amps:	______	______	______
Volts: ______	Volts:	______	______	______

Table of Contents

Goulds Pumps

ITT Industries

IM107R00

www.goulds.com

SAFETY INSTRUCTIONS

TO AVOID SERIOUS OR FATAL PERSONAL INJURY OR MAJOR PROPERTY DAMAGE, READ AND FOLLOW ALL SAFETY INSTRUCTIONS IN MANUAL AND ON PUMP.

THIS MANUAL IS INTENDED TO ASSIST IN THE INSTALLATION AND OPERATION OF THIS UNIT AND MUST BE KEPT WITH THE PUMP.

⚠ This is a SAFETY ALERT SYMBOL. When you see this symbol on the pump or in the manual, look for one of the following signal words and be alert to the potential for personal injury or property damage.

⚠ DANGER Warns of hazards that WILL cause serious personal injury, death or major property damage.

⚠ WARNING Warns of hazards that CAN cause serious personal injury, death or major property damage.

⚠ CAUTION Warns of hazards that CAN cause personal injury or property damage.

NOTICE: INDICATES SPECIAL INSTRUCTIONS WHICH ARE VERY IMPORTANT AND MUST BE FOLLOWED.

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

MAINTAIN ALL SAFETY DECALS.

⚠ WARNING All electrical work must be performed by a qualified technician. Always follow the National Electrical Code (NEC), or the Canadian Electrical Code, as well as all local, state and provincial 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 electrical shock, fire hazard, personal injury or death, damaged equipment, provide unsatisfactory performance, and may void manufacturer's warranty.

⚠ WARNING Standard units are not designed for use in swimming pools, open bodies of water, hazardous liquids, or where flammable gases exist. These fluids and gases may be present in containment areas.

Pumps specifically Listed for Class 1, Division 1 are allowable in hazardous liquids and where flammable gases may exist. *See specific pump catalog bulletins or pump nameplate for all agency Listings.*

⚠ WARNING Disconnect and lockout electrical power before installing or servicing any electrical equipment. Many pumps are equipped with automatic thermal overload protection which may allow an overheated pump to restart unexpectedly.

PRE-INSTALLATION CHECKS

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

Verify that all equipment is the correct voltage and phase. Warranty does not cover damage caused by connecting pumps and controls to an incorrect power source (voltage/phase supply).

Record the model numbers and serial numbers from the pumps and control panel on the front of this instruction manual for future reference. Give it to the owner or affix it to the control panel when finished with the installation.

LIFTING OF PUMP

⚠ WARNING

DO NOT LIFT, CARRY OR HANG PUMP BY THE ELECTRICAL CABLES. DAMAGE TO THE ELECTRICAL CABLES CAN CAUSE SHOCK, BURNS OR DEATH.

Lift the pump with an adequately sized chain or cable attached to the lifting eye bolt. DO NOT damage electrical and sensor cables while raising and lowering unit.

SLIDE RAIL SYSTEM

Typical waste water collection systems are possibly dangerous environments due to gases collected in the wet well. Most codes do not allow personnel to enter a wetwell without the correct protective equipment and training. Slide rail systems are designed to allow easy removal of the pump without the need for entry into the wetwell or need to disturb piping.

An optional slide rail system facilitates pump installation and removal for inspection and maintenance. Slide rails eliminate this safety concern. They save time as there is no need to disturb piping to pull a pump for service.

NOTICE: FOLLOW THE INSTALLATION INSTRUCTIONS THAT ARE SUPPLIED WITH THE SLIDE RAIL SYSTEM.

Installation of the slide rail should locate the pump opposite the influent opening preventing stagnate areas where solids can settle.

The pit floor must be flat under the slide rail base and have sufficient loading capacity to support the entire weight of the slide rail, discharge piping, and the pump. *See Typical Installations Drawings.*

PIPING

Discharge piping should be no smaller than the pump discharge diameter and kept as short as possible, avoiding unnecessary fittings to minimize friction losses.

Install an adequately sized check valve matched to the solids handling capability of the pump to prevent fluid backflow. Backflow can allow the pump to "turbine" backwards and may cause premature seal and/or bearing wear. If the pump is turning backwards when it is called on to start the increased torque may cause damage to the pump motor and/or motor shaft and some single-phase pumps may actually run backwards.

Install an adequately sized gate valve **AFTER** the check valve for pump, plumbing and check valve maintenance.

Important – Before pump installation. Drill a 3/16" (4.8mm) relief hole in the discharge pipe. It should be located within the wetwell, 2" (51mm) above the pump discharge but below the check valve. The relief hole allows any air to escape from the casing. Allowing liquid into the casing will insure that the pump can start when the liquid level rises. Unless a relief hole is provided, a bottom intake pump could "air lock" and will not pump water even though the impeller turns.

All piping must be adequately supported, so as not to impart any piping strain or loads on the pump.

The pit access cover must be of sufficient size to allow for inspection, maintenance and crane or hoist service.

LIQUID LEVEL CONTROLS

There are two basic float switch designs; single-action and wide-angle. Single-action switches operate over a range of 15° so they open and close quickly. Wide-angle floats operate over a 90° swing with the tether length between the float body and the pivot point controlling the On-Off range. The design determines how many floats are required with different systems or controls.

Floats may be normally open (NO) for pump down applications or to empty a tank. Normally closed (NC) switches are used to pump up or to fill a tank.

A single-action control switch may be used only with a control panel, never direct connected to a pump.

The wide-angle, pump down switches may be used as direct connected pump switches or as control switches.

Setting the Float Switches

There are no absolute rules for where to set the float switches, it varies from job to job.

Suggested Rules to Follow:

All floats should be set below the Inlet pipe!

Off Float: Best: set so the water level is always above the top of the pump (motor dome). **Next Best:** set so the water level is not more than 6" below the top of the pump.

On Float: set so the volume of water between the On and Off floats allows pumps of 1 ½ hp and under to operate for 1 minute minimum. Two (2) HP and larger pumps should run a minimum of 2 minutes. Basin literature states the gallons of storage per inch of basin height.

Lag/Alarm Float(s): should be staggered above the Off and On floats. Try to use most of the available storage provided by the basin, save some space for reserve storage capacity. *See Diagrams and Charts in Float Switch Chart Section.*

WIRING AND GROUNDING

Important notice: Read Safety Instructions before proceeding with any wiring.

⚠ Use only stranded copper wire to pump/motor and ground. The ground wire must be at least as large as the power supply wires. Wires should be color coded for ease of maintenance and troubleshooting.

⚠ Install wire and ground according to the National Electrical Code (NEC), or the Canadian Electrical Code, as well as all local, state and provincial codes.

⚠ Install an all leg disconnect switch where required by code.

⚠ Disconnect and lockout electrical power before performing any service or installation.

⚠ The electrical supply voltage and phase must match all equipment requirements. Incorrect voltage or phase can cause fire, motor and control damage, and voids the warranty.

All splices must be waterproof. If using splice kits follow manufacturer's instructions.

Select the correct type and NEMA grade junction box for the application and location. The junction box must insure dry, safe wiring connections.

Seal all controls from gases present which may damage electrical components.

⚠WARNING Hazardous voltage	FAILURE TO PERMANENTLY GROUND THE PUMP, MOTOR AND CONTROLS BEFORE CONNECTING TO POWER CAN CAUSE SHOCK, BURNS OR DEATH.

SELECTING AND WIRING PUMP CONTROL PANELS AND SWITCHES

PANEL WIRING DIAGRAMS:
Our control panels are shipped with instructions and wiring diagrams. Use those instructions in conjunction with this IOM. Electrical installation should be performed only by qualified technicians. *See Figure 6.*

ALARMS:
We recommend the installation of an alarm on all Waste Water pump installations. Many standard control panels come equipped with alarm circuits. If a control panel is not used, a stand alone high liquid level alarm is available. The alarm alerts the owner of a high liquid level in the system so they can contact the appropriate service personnel to investigate the situation.

MATCH EQUIPMENT TO POWER SUPPLY:
Important: Always match the pump nameplate Amps, Voltage, Phase, and HP ratings to your control panel and power supply. Any problem or questions pertaining to another brand control must be referred to that control supplier or manufacturer. Our technical people have no technical schematics or trouble shooting information for other companies' controls. All three phase (3Ø) control panels for submersible pumps must provide Class 10, quick-trip, overload protection.

SINGLE PHASE PUMPS:
Single phase (1Ø) pumps may be operated using a piggyback or hard wired float switch, a simple contactor, or a Simplex or Duplex control panel. *See Figures 1, 2 and 5.*

All 1/3 and 1/2 hp, 115 or 230 volt pumps, and some 3/4 and 1 hp pumps, are supplied with plug style power cords. They may be plugged into piggyback float switches for simple installations. It is allowable to remove the plugs in order to hardwire or connect to a Simplex or Duplex controller. Removing the plug neither voids the warranty nor violates the agency Listings. *See Figure 5.*

Pumps with bare lead power cords can be hard-wired to a float switch, wired to a 1Ø contactor, or Simplex/Duplex controller. Always verify that the float switch is rated for the maximum run amperage, maximum starting amperage, and the HP rating on the pump. Single-phase waste water pumps contain on-winding overloads, unless noted on the pump nameplate. *See Figures 1 and 2.*

THREE PHASE PUMPS:
As a Minimum a 3Ø pump requires a 3 pole circuit breaker/fused circuit, an across the line magnetic starter rated for the pump hp, and ambient compensated Quick Trip Class 10 overloads.

SINGLE AND THREE PHASE CONTROL PANELS:
Control panels are available as Simplex (controls 1 pump) or Duplex (controls 2 pumps). Our standard panel offerings are called SES Series Panels. They are available with many standard features and can be built with our most popular options. We also custom build panels which offer many more design options than the SES panels. Custom control panels are available in many different configurations. Custom panel quote requests should be faxed only by an authorized distributor to our Customer Service Department.

All "SES" Duplex panels feature a solid-state printed circuit board design with standard high level alarm circuits. Other standard features are: an auxiliary dry alarm contact for signaling a remote alarm, float switch position indicator lights, and 3Ø panels have built-in, adjustable, Class 10 overloads. The adjustable overloads on all our 3Ø panels mean less labor for the installer and no need to order specific overloads. Most SES panels are in stock for immediate delivery.

On pumps equipped with overheat sensors or seal fail sensors it is recommended that our control panel be used. The pump overheat sensor must be connected to a "matched control circuit". Pump seal fail sensors, three types are used, must also be connected to a matched control seal fail circuit. These circuits will notify the operator of a seal failure before major damage occurs. See the panel options listed on the control panel catalog bulletins for available seal fail circuits.

INSTALLATION

Many of our sewage pumps are oil-filled. If there are any signs of oil leakage or if the unit has been stored for an extended period check the oil level in the motor dome and the seal housing, if so equipped.

If the pump is experiencing overload and/ or over temperature conditions this creates pressure inside the motor dome. Use extreme caution if removing the oil fill plug or the cord seal, especially after high load conditions.

Check the motor cover oil level through the pipe plug on top of the unit. The motor chamber oil should just cover the motor. Do not overfill, leave room for expansion!

To check the seal housing oil level, where used, lay the unit on its side with the fill plug at 12 o'clock. Remove the plug. The oil should be within ½" (13mm) of the top. If low, refill with an ASTM 150 turbine oil. Replace the plug.

We sell the oil in 5 gallon cans through our distributors. You can also source oil locally at motor repair shops.

Typical oil brands are: Shell Turbo 32, Sunoco Sunvis 932, Texaco Regal R&O 32, Exxon Nuto 32 and Mobil DTE Light.

Check the strain relief nut on power cable strain assemblies. Power cables should be torqued to 75 in. lbs. for #16 cables and 80 in. lbs. for all other cable assemblies. Seal/heat sensor cables, where used, should be torqued to 75 in. lbs.

THREE PHASE — CHECK ROTATION:
Three phase units – it is advisable to jog 3Ø units to check for proper rotation before installing them in the wetwell. Rotation is indicated on the casing or motor cover. Check both pumps in a duplex installation. Incorrect rotation is a major cause of poor performance. If the 3Ø motor rotation is backwards reverse any two motor leads at the control panel. Correct rotation of the impeller vanes is always towards the discharge in the same direction as the increasing area of the pump volute or casing.

NOTICE: DO NOT SWITCH PRIMARY POWER LEADS COMING INTO ANY THREE PHASE PANEL, THIS WILL REVERSE ROTATION ON ALL THREE PHASE MOTORS CONNECTED TO THE PANEL.

NOTICE: MOTOR STARTUP TORQUE, "KICKBACK", WILL CAUSE THE MOTOR TO TWIST IN THE DIRECTION OPPOSITE ROTATION. INSURE THAT THE PUMP ASSEMBLY IS ADEQUATELY RESTRAINED.

DO NOT PLACE HANDS IN PUMP SUCTION WHILE CHECKING MOTOR ROTATION. TO DO SO WILL CAUSE SEVERE PERSONAL INJURY.

Connect the pumps to the slide rails or to the system piping. Lower the pump into the wetwell being very careful not to damage any wiring.

OPERATION

Once the piping connections are made and checked you can test the pumps.

Fill the wetwell with water at least up to the On float switch. If the floats are properly set this should provide enough water for a 1 or 2 minute run cycle. Use the H-O-A (Hand-Off-Automatic) switch on Hand (manual) to operate the pumps. If they run but do not pump they are probably air locked. Air locked means the pump casing and pipes are full of air that cannot escape due to the check valve in the line. If you did not drill the 3⁄16" relief hole in the discharge pipe below the check valve as suggested in the *Piping Section* the pump is air locked. Place the H-O-A in Off. Remove pump(s) and drill the relief holes now. Reinstall the pumps. Turn pumps On (hand) again. Drilling the relief hole will probably save you a future service call if the fluid level ever gets low enough to allow air to enter the casing.

You can often clear an air locked pump by starting it several times. Be careful not to overheat the motor by making multiple rapid starts, wait a minimum of 30-40 seconds between starts. Starting current is 3 –5 times running current and generates heat quickly.

Check Voltage and Amperage (current) now:

Three phase: amperage should be checked for three-phase unbalance. This is a good time to perform that check. Once the system is balanced write the voltage and current (amp) readings on the front of this IOM. *See Checking for Three-Phase Unbalance in Technical Data.*

Single phase: check the current (amperage) on single phase pumps and write it on the front of the manual.

When everything operates well in Hand position, switch over to Automatic. Refill the wetwell to test automatic operation. The lead pump should come on when the water reaches the On float. It should go Off when the water level reaches the lowest (Off) float. The alternator will switch pumps on the Off signal. The next cycle will run the other pump to empty the pit. Run times should be equal. If not look for line restrictions or improper rotation.

Important Tip: On single phase 230 volt panels the Major cause of failure to operate in Automatic mode is the lack of a Neutral wire to the panel from the power supply. If there is no neutral there is no 115 volt control circuit. Run the neutral wire now to comply with electrical codes.

Partially close one shut-off valve and continue filling the basin. This should allow the level to rise past the Lead pump On float to reach the Lag/Alarm float. This should turn both pumps and the alarm On. Press the alarm Silence button. The pumps should easily pump down the wetwell and turn off. The alarm must be manually reset on all our Duplex panels. Simplex panel alarms will automatically reset and turn off when the water level goes below the alarm float setting. Be sure to fully open the shut-off valve at the completion of this test.

Reset the alarm switch, place the HOA switch(es) in Auto, place the Control switch in the On position. The system is now set for automatic operation.

It is advisable to explain the function of the HOA switches, alarm silence, alarm test, and control switch to the end user. Place your business card or a weatherproof sticker with your company name and phone number on the control panel being careful not to cover important model numbers. Make sure that you fill in the pump, control, and switch information on the front of this manual. Leave this manual and the panel information attached to the panel if indoors. If outdoors you should give the information to the owner for safekeeping.

FLOAT SWITCH AND PANEL CHART

The purpose of this chart is to show the required switch quantities and the function of each switch in a typical waste water system. The quantities required vary depending on the switch type, single-action or wide-angle. Switch quantities also vary by panel type: simplex with and without alarms, and duplex with alarms.

Duplex Panels using single-action switches:

Three Float Panel Wiring

SW1	Bottom	Pumps Off
SW2	Middle	1st Pump On
SW3	Top	2nd Pump & Alarm On

Four Float Panel Wiring ②

SW1	Bottom	Pumps Off
SW2	2nd	1st Pump On
SW3	3rd	2nd Pump On
SW4	Top	Alarm On

Duplex Panels using wide-angle switches:

Three Float Panel Wiring

SW1	Bottom	1st Pump On/Both Off
SW2	Top	2nd Pump & Alarm On

Four Float Panel Wiring

SW1	Bottom	1st Pump On/Both Off
SW2	Middle	2nd Pump On
SW3	Top	Alarm On

Simplex Panel using single-action switches:

Simplex Panel with Alarm ①

SW1	Bottom	Pump Off
SW2	Middle	Pump On
SW3	Top	Alarm On/Off

Simplex Panel with No Alarm

SW1	Bottom	Pump Off
SW2	Top	Pump On

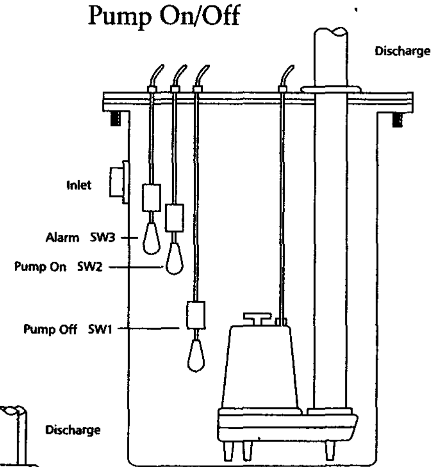
Simplex Panel using wide-angle switches

Simplex Panel with Alarm

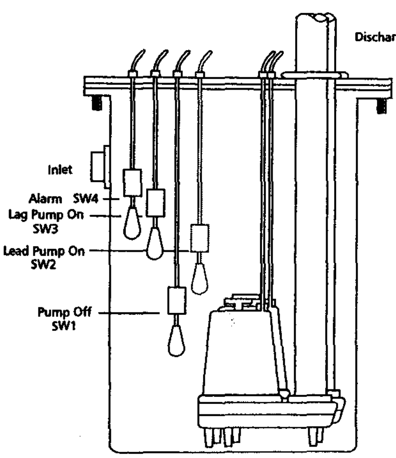
SW1	Bottom	Pump On/Off
SW2	Top	Alarm On/Off

Simplex Panel with No Alarm

SW1		Pump On/Off



Simplex ①



Duplex ②

THREE PHASE POWER UNBALANCE

A full three phase supply consisting of three individual transformers or one three phase transformer is recommended. "Open" delta or wye connections using only two transformers can be used, but are more likely to cause poor performance, overload tripping or early motor failure due to current unbalance.

Check the current in each of the three motor leads and calculate the current unbalance as explained below.

If the current unbalance is 2% or less, leave the leads as connected.

If the current unbalance is more than 2%, current readings should be checked on each leg using each of the three possible hook-ups. Roll the motor leads across the starter in the same direction to prevent motor reversal.

To calculate percent of current unbalance:

A. Add the three line amp values together.

B. Divide the sum by three, yielding average current.

C. Pick the amp value which is furthest from the average current (either high or low).

D. Determine the difference between this amp value (furthest from average) and the average.

E. Divide the difference by the average. Multiply the result by 100 to determine percent of unbalance.

Current unbalance should not exceed 5% at service factor load or 10% at rated input load. If the unbalance cannot be corrected by rolling leads, the source of the unbalance must be located and corrected. If, on the three possible hookups, the leg farthest from the average stays on the same power lead, most of the unbalance is coming from the power source.

Contact your local power company to resolve the imbalance.

	Hookup 1			Hookup 2			Hookup 3		
Starter Terminals	L1	L2	L3	L1	L2	L3	L1	L2	L3
	⊥	⊥	⊥	⊥	⊥	⊥	⊥	⊥	⊥
	T	T	T	T	T	T	T	T	T
Motor Leads	R	B	Y	Y	R	B	B	Y	R
	T3	T1	T2	T2	T3	T1	T1	T2	T3

Example:

T3-R = 51 amps	T2-Y = 50 amps	T1-B = 50 amps
T1-B = 46 amps	T3-R = 48 amps	T2-Y = 49 amps
T2-Y = <u>53</u> amps	T1-B = <u>52</u> amps	T3-R = <u>51</u> amps
Total = 150 amps	Total = 150 amps	Total = 150 amps
÷ 3 = 50 amps	÷ 3 = 50 amps	÷ 3 = 50 amps
— 46 = 4 amps	— 48 = 2 amps	— 49 = 1 amps
4 ÷ 50 = .08 or 8%	2 ÷ 50 = .04 or 4%	1 ÷ 50 = .02 or 2%

INSULATION RESISTANCE READINGS

Normal Ohm and Megohm Values between all leads and ground

Condition of Motor and Leads	Ohm Value	Megohm Value
A new motor (without drop cable).	20,000,000 (or more)	20 (or more)
A used motor which can be reinstalled in well.	10,000,000 (or more)	10 (or more)
Motor in well. Readings are for drop cable plus motor.		
New motor.	2,000,000 (or more)	2 (or more)
Motor in good condition.	500,000 - 2,000,000	.5 - 2
Insulation damage, locate and repair.	Less than 500,000	Less than .5

Insulation resistance varies very little with rating. Motors of all HP, voltage and phase ratings have similar values of insulation resistance.

Insulation resistance values above are based on readings taken with a megohmmeter with a 500V DC output. Readings may vary using a lower voltage ohmmeter, consult factory if readings are in question.

This table was reprinted through the courtesy of Franklin Electric.

ENGINEERING DATA

Engineering data for specific models may be found in your catalog and on our website (address is on the cover).

Control panel wiring diagrams are shipped with the control panels. Please use the control panel drawings in conjunction with this instruction manual to complete the wiring.

PUMP CONSTRUCTION

Minimum Submergence	
Continuous Duty	Fully Submerged
Intermittent Duty	6" Below Top of Motor

Maximum Fluid Temperature	
Continuous Operation	104° F 40° C
Intermittent Operation	140° F 60° C

Pumpmaster and Pumpmaster Plus - Hard Wired

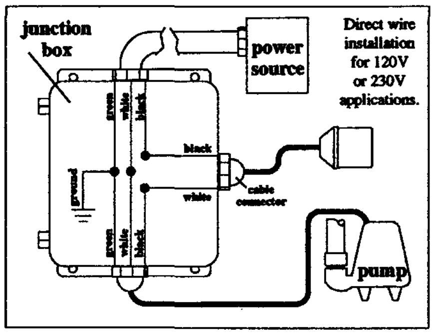


Fig. 1

Single-Action Float Switch "Typical" Installation

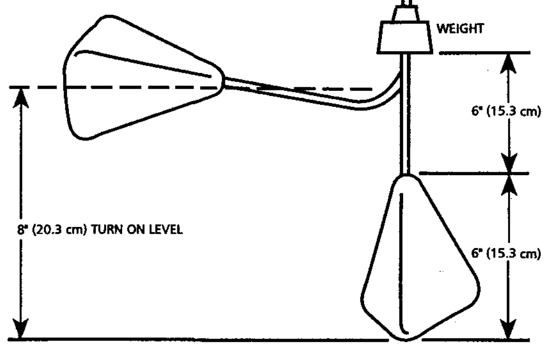


Fig. 4

Double Float - Hard Wired

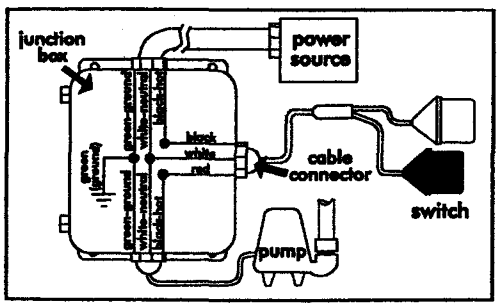


Fig. 2

Wide-Angle Float Switch

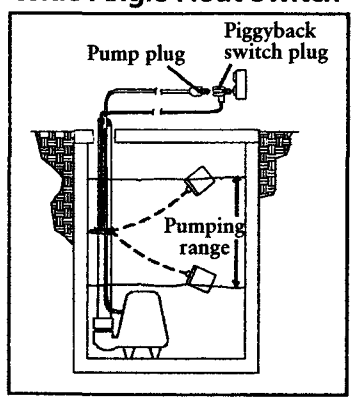


Fig. 5

Determining Pumping Range

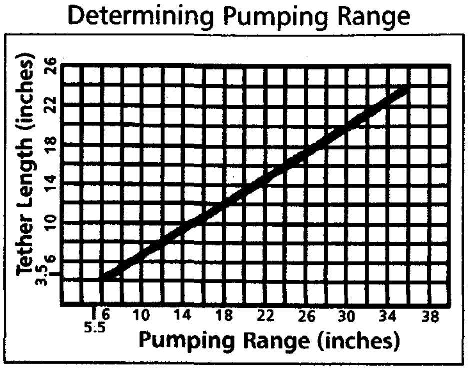


Fig. 3

Three Phase Connection Diagram

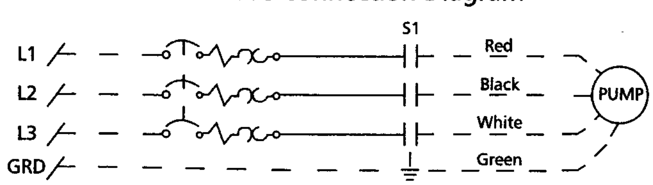
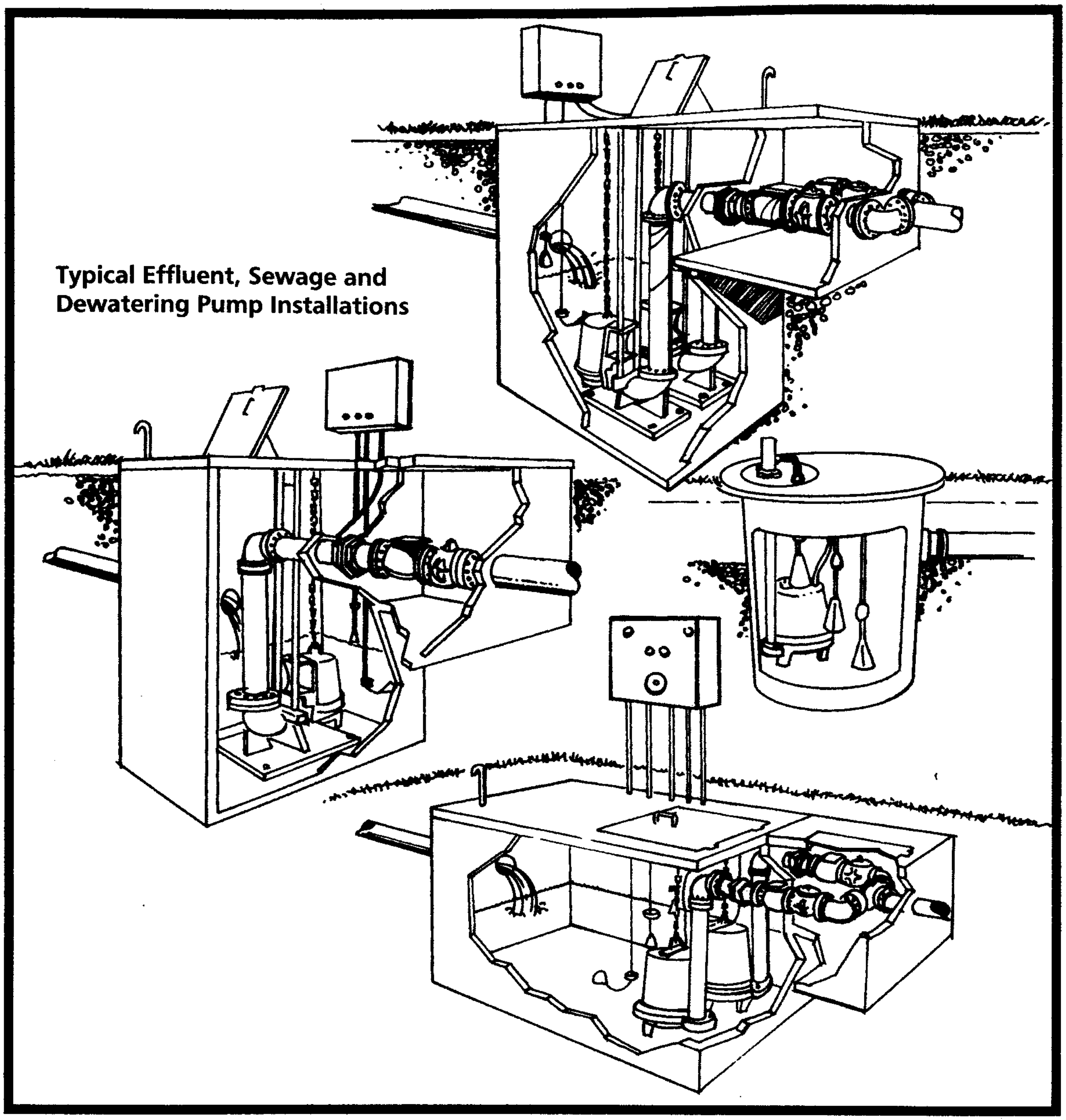


Fig. 6

TROUBLE SHOOTING

⚠WARNING Hazardous voltage	FAILURE TO DISCONNECT AND LOCKOUT ELECTRICAL POWER BEFORE ATTEMPTING ANY SERVICE CAN CAUSE SHOCK, BURNS OR DEATH.

SYMPTOM	PROBABLE CAUSE	RECOMMENDED ACTION
MOTOR NOT RUNNING	Motor thermal protector tripped.	Allow motor to cool. Insure minimum pump submergence. Clear debris from casing and impeller.
NOTE: If circuit breaker "OPENS" repeatedly, DO NOT reset. Call qualified electrician.	Open circuit breaker or blown fuse.	Determine cause, call a qualified electrician.
	Pump impeller binding or jammed.	Check motor amp draw. If two or more times higher than listed on pump nameplate, impeller is locked, motor bearings or shaft is damaged. Clear debris from casing and impeller, consult with dealer.
a) Manual operation	Power cable is damaged.	
	Inadequate electrical connection in control panel.	Resistance between power leads and ground should read infinity. If any reading is incorrect, call a qualified electrician.
b) Automatic operation	No neutral wire connected to control panel.	
	Inadequate electrical connection in control panel.	Inspect control panel wiring. Call a qualified electrician.
NOTE: Check the pump in manual mode first to confirm operation. If pump operates, the automatic control or wiring is at fault. If pump does not operate, see above.	Defective liquid level switch.	With switch disconnected, check continuity while activating liquid level switch. Replace switch, as required.
	Insufficient liquid level to activate controls.	Allow liquid level to rise 3" to 4" (76 mm - 101 mm) above turn-on level.
	Liquid level cords tangled.	Untangle cords and insure free operation.
PUMP WILL NOT TURN OFF	Liquid level cords tangled.	Untangle cords and insure free operation.
	Pump is air locked.	Shut off pump for approximately one minute, then restart. Repeat until air lock clears. If air locking persists in a system with a check valve, a 3/16" (4.8 mm) hole may be drilled in the discharge pipe approximately 2" (51 mm) above the discharge connection.
	Influent flow is matching pump's discharge capacity.	Larger pump may be required.
LITTLE OR NO LIQUID DELIVERED BY PUMP	Check valve installed backwards, plugged or stuck closed.	Check flow arrow on valve and check valve operation.
	Excessive system head.	Consult with dealer.
	Pump inlet plugged.	Inspect and clear as required.
	Improper voltage or wired incorrectly.	Check pump rotation, voltage and wiring. Consult with qualified electrician.
	Pump is air locked.	See recommended action, above.
	Impeller is worn or damaged.	Inspect impeller, replace as required.
	Liquid level controls defective or improperly positioned.	Inspect, readjust or replace as required.
PUMP CYCLES CONSTANTLY	Discharge check valve inoperative.	Inspect, repair or replace as required.
	Sewage containment area too small.	Consult with dealer.
	Liquid level controls defective or improperly positioned.	Inspect, readjust or replace as required.
	Influent excessive for this size pump.	Consult with dealer.


Typical Effluent, Sewage and
Dewatering Pump Installations

GOULDS PUMPS LIMITED WARRANTY

This warranty applies to all water systems pumps manufactured by Goulds Pumps.

Any part or parts found to be defective within the warranty period shall be replaced at no charge to the dealer during the warranty period. The warranty period shall exist for a period of twelve (12) months from date of installation or eighteen (18) months from date of manufacture, whichever period is shorter.

A dealer who believes that a warranty claim exists must contact the authorized Goulds Pumps distributor from whom the pump was purchased and furnish complete details regarding the claim. The distributor is authorized to adjust any warranty claims utilizing the Goulds Pumps Customer Service Department.

The warranty excludes:

(a) Labor, transportation and related costs incurred by the dealer;
(b) Reinstallation costs of repaired equipment;
(c) Reinstallation costs of replacement equipment;
(d) Consequential damages of any kind; and,
(e) Reimbursement for loss caused by interruption of service.

For purposes of this warranty, the following terms have these definitions:

(1) "Distributor" means any individual, partnership, corporation, association, or other legal relationship that stands between Goulds Pumps and the dealer in purchases, consignments or contracts for sale of the subject pumps.
(2) "Dealer" means any individual, partnership, corporation, association, or other legal relationship which engages in the business of selling or leasing pumps to customers.
(3) "Customer" means any entity who buys or leases the subject pumps from a dealer. The "customer" may mean an individual, partnership, corporation, limited liability company, association or other legal entity which may engage in any type of business.

THIS WARRANTY EXTENDS TO THE DEALER ONLY.

Goulds Pumps

ITT Industries

Installation and
Service Manual

HYDROMATIC OSP33
Submersible Sump/Effluent Pump

NOTE!
To the installer: Please make sure you provide this manual to the owner of the pumping equipment or to the responsible party who maintains the system.

GS AURORA PUMP
A UNIT OF GENERAL SIGNAL

Table of Contents

1 Introduction

Warning: Read all instructions before starting any operation on pump. Always disconnect the pump and controls from its power source before handling or making any adjustments. Always wear rubber boots when there is water on the floor and you must unplug the pump or make any adjustments.

Before operation, read the following instructions carefully. Reasonable care and safe methods should be practiced. Check local codes and requirements before installation. Servicing should be performed by knowledgeable pump service contractors or authorized service stations.

Warning:

Risk of Electrical Shock — This pump has not been investigated for use in swimming pool areas.

To Reduce Risk of Electrical Shock:

1. Connect only to a properly grounded, grounding-type receptacle.
2. Septic tank to be vented in accordance with local plumbing codes.
3. Do not smoke or use sparkable electrical devices or flame in a septic (gaseous) or possible septic sump.
4. A septic sump condition may exist and if entry into sump is necessary, then (a) provide proper safety precautions per OSHA requirements and (b) do not enter sump until these precautions are strictly adhered to.

   Do not install pump in location classified as hazardous per N.E.C., ANSI/NFPA 70 - 1984.

Failure to heed above cautions could result in injury or death.

2 Installation

These important instructions must be followed for satisfactory performance of your pump:

1. Provide proper sump (recommended minimum sump diameter is 18").
2. Do not set pump directly on the bottom of the sump if it is not solid. Raise the pump by placing bricks or concrete blocks underneath it.
3. Make sure sump is free of string, cloth, nails, gravel, etc. before installing pump.
4. Pump to be connected to a properly grounded, grounding-type receptacle only.
5. Do not remove ground pin from electrical plug.
6. Do not use an extension cord.
7. For proper automatic operation, make sure the pump power cord is plugged into the "piggy-back" receptacle on the diaphragm switch cord.
8. Connect to separate electrical circuit taken directly from main switch.
9. Use steel or plastic pipe for all connecting lines between pump and sewer outlet.

   Note: Some city regulations do not allow installing a pump with plastic pipe. Check local regulations.
10. In applications where the pump may sit idle for months at a time, it is recommended that the pump(s) be cycled every month to insure the pumping system is working properly when needed.
11. Hydromatic check valve should be installed in discharge pipe at least 12" above the discharge outlet of the pump.
12. An audible alarm, such as the Q Alert system for high water conditions, should be installed in every pump for greater protection.

    Note: The Q Alert panel is for indoor use only. For outdoor application contact your Hydromatic distributor for additional Q panels.

3 Typical Installation

OSP33

4 Service

Servicing should be performed only by knowledgeable pump service contractors or authorized service stations.

Warning: Always disconnect the pump from power source before handling or making any adjustments. Always wear rubber boots when there is water on the floor and you must unplug the pump or make any adjustments.

1. **Removing pump from sump.** Before removing pump from sump for repair, check to see if the trouble could simply be a blown fuse, tripped circuit breaker, or a power cord not completely inserted into the receptacle.

   Note: Automatic thermal overload protects the sealed-in-oil motor. Running dry may overheat the motor and activate the overload protector. This will close the circuit when the motor cools and allow pump to restart. If condition continues to exist, it may cause premature pump failure.

   Unplug the power cord and pull the pump, by the handle, from the sump. Sandblast, if possible, any dirt or trash from the outside of the pump before dismantling.

2. **Check diaphragm switch.** If the unit is being operated by the automatic diaphragm switch, unplug the pump from the "piggyback" receptacle and plug the pump directly into the power source. If the pump starts each time it is plugged directly into the receptacle and does not start each time when plugged into the piggyback switch with the diaphragm switch pressed into a start position, replace the complete piggyback switch assembly and retest with the new assembly.

3. **Check for impeller blockage.** Check for an obstruction in the impeller cavity by laying the pump on its side and inserting a screwdriver through the hole in the foot and baffle plate (28) and the bottom plate (26) and turning the rotor and shaft (16). It should turn freely. If the impeller hangs up or there is an indication of impeller blockage, the foot and baffle plate must be removed by removing the three hex head cap screws (29) and the bottom plate removed by removing the five hex head cap screws (27). Clear the impeller of its obstruction and clean the impeller, and reassemble.

4. **Check power cord.** Check the power cord (5) for brittleness or for any cuts or nicks in the insulation. Using an ohmmeter, check the continuity of the power cord. If any of these tests fail, the power cord should be replaced. To replace power cord unscrew the nut on the cord, pull cord up and discard damaged power cord. Add pipe sealant to threads and reinstall by pushing cord onto pins and tighten nut.

5. **Check for air lock.** A sump pump is said to be air locked if water traps in the pump and it cannot get out, thus preventing pump from operating.

   Hydromatic pumps have a small air vent hole in the impeller cavity to let out trapped air. If this hole becomes plugged, pump may air lock. To break the air lock, use a small screwdriver to clear hole in the impeller cavity.

   As a secondary precaution in installations of this type — 1/16" hole should be drilled in the discharge pipe below the check valve. The check valve should be 12 to 18 inches above pump discharge. Do not put check valve directly into pump discharge opening.

   Note: In sumps where the pump is operating daily, air locking rarely occurs.

6. **Check the oil.** Remove the pipe plug (4) in the top of the motor cover and drain oil into a clean, dry container. A milky appearance to the oil indicates that water has entered through either worn out or damaged seals (23, 24), seal ring (20), or cord nut.

7. **Remove the motor cover.** Remove the four hex head cap screws (22). Use a screwdriver to pry the motor cover (19) from the volute case (21) at the fastening ears, being careful not to cut the seal ring (20) with the screwdriver or crack the motor cover. Lift the motor cover until it clears the stator (15).

8. **Check for short.** Disconnect the stator leads (7, 8, 9) from the connector (6). Use an ohmmeter to check the continuity of the stator. If stator fails to pass the continuity test, it must be replaced.

9. **Remove the stator.** To remove the stator, remove the four hex head screws (12) and the stator plate (13). Lift the stator off the volute case (21) and set aside.

10. **Remove the impeller.** To remove the impeller (25), hold the rotor (16) in your hand and tap the impeller with a plastic or rubber mallet so as to turn the impeller counter clockwise.

4 Service Continued

11. **Check the seal.** Remove the rotating portion of seal (24) from shaft by inserting a screwdriver under the edge of the seal and lifting it off without damaging seal. Inspect the seal face for any nicks or an uneven seating of seal face. If any are present, replace the seal. (See Step 14.)

12. **Remove rotor and shaft.** Tap the rotor shaft (16) at the impeller end of the shaft with a plastic mallet to remove the rotor and shaft. Inspect the bearings (17). If they do not rotate freely and smoothly, they should be replaced. When new bearings are ready to be added onto the shaft, do not push on outer race of bearings. This will damage bearings. If a rotor and shaft is ordered from Hydromatic, the bearings will be supplied already pressed on the shaft.

13. **Remove seal.** Remove the old stationary portion of the seal (23) from the case (21) by inserting a screwdriver into the seal housing of the case from the top of the case and tapping lightly with a hammer. Clean the seal area of the case with a clean cloth.

14. **Reinstall the rotor and shaft assembly.** Push on outer race to seat bearing in volute case.

15. **Reinstall seal.** Apply an oil lubricant to the new stationary portion of the seal (23) and press into the case (21). Coat the new rotating portion of seal with lubricant and press into place on the rotor shaft with the rubber ring facing the impeller.

16. **Reinstall impeller.** Add a drop of Locktite 277 to the shaft and screw the impeller on hand tight. The impeller will force the rotating portion of seal into position.

17. **Replace seal ring.** Remove the old square seal ring (20) from the volute and stretch on a new ring coated with O-ring lube.

    Do not roll the ring onto the volute or improper seating and water leakage into the motor housing will result.

18. **Reinstall the stator.** Place the stator (15) in the volute case (21) so the stator bolt holes line up. Lay the stator plate (13) on the stator (15) and line up with stator bolt holes. Put in the stator bolts (12) and tighten evenly to prevent cocking of the stator. Push the connectors of the power cord onto the stator terminals.

19. **Reinstall motor housing.** Tighten down the four hex head cap screws (22) evenly to prevent cocking of motor housing and achieving an uneven seal on the seal ring (20).

20. **Oil.** Fill the motor cap with high grade transformer oil such as Sohio Factopure SE40 oil or equivalent to at least ¼" over motor windings (.38 gallon).

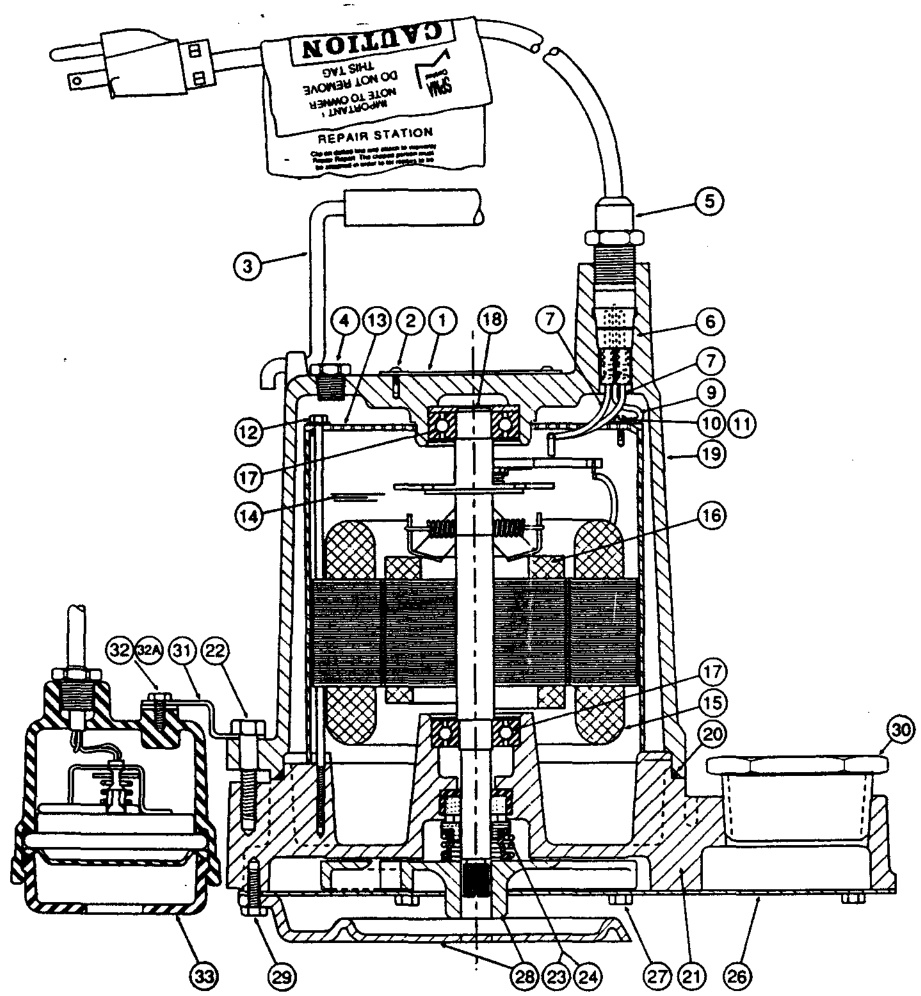
    Do not fill the motor housing completely — allow airspace for oil expansion.

21. **Reinstall oil pipe plug.** Coat pipe threads with thread sealant before installing.

22. **Check pump.** Plug the power cord into a grounded outlet and start pump by applying pressure to the switch diaphragm (automatic only — manual should start when power is applied). Motor should run smoothly, be free of vibration and stop when pressure is removed.

*Loctite 277 is a registered trademark of Loctite Corp.

5 Parts List



Ref. No.	Part No.	Description	Qty.	Ref. No.	Part No.	Description	Qty.
1		Nameplate, 115V	1	19	56-008-2	Housing, Motor	1
1		Nameplate, 230V	1		56-026-2	Date Code 11/90	
2	4580-001-1	Drivescrew	2	20	77-003-1	Seal Ring	1
3	60-000-5	Handle	1	21	12328-002-2	Volute	1
4	119-002-1	Pipe Plug	1	22	101-007-1	Bolt, 5/16-18 x 1" Lg.	4
5	12585-004-5	Power Cord Assembly, 115V-10'	1	23	83-002-1	Seal (Stationary Seat)	1
5	12585-005-5	Power Cord Assembly, 115V-20'	1	24	83-007-1	Seal (Rotating Seat)	1
5	12585-003-5	Power Cord Assembly, 230V-20'	1	25	16-000-2	Impeller	1
6	4209-004-5	Connector Assembly	1	26	18-002-1	Bottom Plate	1
7	6000-061-5	Lead Wire/Terminal Assembly (Blk, 625")	1	27	19-002-1	Screw, 10-24 x 3/8" Lg.	5
9	6000-060-5	Grnd Wire/Terminal Assembly (Grn, 5")	1	28	21-000-2	Foot & Baffle Plate	1
10	12845-001-1	Screw, 8-32 Self Tapping	1	29	19-004-1	Screw, 10-24 x 5/8" Lg.	3
11	995-002-1	Lockwasher, #8	1	30	12185-001-1	Reducer Bushing, 2" x 1-1/2"	1
12	145-003-1	Bolt, Stator - 8-32 x 55/8" Lg. (Prior to 11/90)	4			**AUTOMATIC MODELS**	
13	70-000-1	Plate, Stator (Prior to 11/90)	1	31	5502-004-1	Bracket	1
*14		Oil	.38 gal.	32	176-015-1	Screw, 1/4-20 x 3/8" Lg.	1
15	13348-001-1	Stator, 115V	1	32A	995-008-1	Lockwasher	1
	13349-000-1	Date Code 11/90		33	12752-004-5	Diaphragm Switch (6-1/2" Range), 115V-10'	1
15	9994-001-1	Stator, 230V	1	33	12752-005-5	Diaphragm Switch (6-1/2" Range), 115V-20'	1
16	13348-011-5	Rotor & Shaft w/Bearings	1	33	12752-006-5	Diaphragm Switch (6-1/2" Range), 230V-20'	1
	13349-010-1	Date Code 11/90		33	12752-008-5	Diaphragm Switch (8-1/2" Range), 115V-20'	1
17	65-001-1	Bearing	2	33	12752-009-5	Diaphragm Switch (8-1/2" Range), 115V-20'	1
18	64-001-1	Load Spring	1	33	12752-010-5	Diaphragm Switch (8-1/2" Range), 115V-20'	1

*Purchase locally.

6 Warranty

Aurora/Hydromatic, a Unit of General Signal, warrants to the original purchaser of each of Hydromatic Pump product(s) that any part thereof which proves to be defective in material or workmanship within one year from date of installation or 18 months from manufacture date, whichever comes first, will be replaced at no charge with a new or remanufactured part, F.O.B. factory. Purchaser shall assume all responsibility and expense for removal, reinstallation and freight. Any item(s) designated as manufactured by others shall be covered only by the express warranty of the manufacturer thereof. This warranty does not apply to damage resulting from accident, alteration, design misuse or abuse.

If the material furnished to the Buyer shall fail to conform to this contract or to any of the terms of this written warranty, Aurora Pump shall replace such nonconforming material at the original point of delivery and shall furnish instruction for its disposition. Any transportation charges involved in such disposition shall be for the Buyer's account. The Buyer's exclusive and sole remedy on account or in respect of the furnishing of material that does not conform to this contract, or to this written warranty, shall be to secure replacement thereof as aforesaid. Aurora Pump shall not in any event be liable for the cost of any labor expended on any such material or for any incidental or consequential damages to anyone by reason of the fact that such material does not conform to this contract or to this written warranty.

ALL IMPLIED WARRANTIES, INCLUDING THE IMPLIED WARRANTY OF MERCHANTABILITY AND THE IMPLIED WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE, ARE LIMITED IN DURATION TO THE SAME EXTENT AS THE EXPRESS WARRANTY CONTAINED HEREIN. Some States do not allow limitations on how long an implied warranty lasts, so the above limitation may not apply.

MANUFACTURER EXPRESSLY DISCLAIMS AND EXCLUDES ANY LIABILITY FOR CONSEQUENTIAL OR INCIDENTAL DAMAGES FOR BREACH OF ANY EXPRESS OR IMPLIED WARRANTY ARISING IN CONNECTION WITH THIS PRODUCT. INCLUDING WITHOUT LIMITATION, WHETHER IN TORT, NEGLIGENCE, STRICT LIABILITY CONTRACT OR OTHERWISE. Some States do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you.

This warranty gives you specific legal rights, and you may also have other rights which vary from State to State.

NOTE:
PUMP MUST BE REPAIRED BY AUTHORIZED AURORA/ HYDROMATIC REPAIR CENTER OR WARRANTY WILL BE VOID. IF REPAIR CENTER IS NOT AVAILABLE, RETURN PUMP TO PLACE OF PURCHASE.

Bulletin HW-105.1

OSP33 Submersible Sump/Effluent Pump

Installation & Service Manual

HYDROMATIC PUMPS

Before operation, read the following instructions carefully. Reasonable care and safe methods should be practiced. Check local codes and requirements before installation. Servicing should be performed by knowledgeable pump service contractors or authorized service stations.

WARNING: Read all instructions before starting any operation on pump.

Always disconnect the pump and controls from its power source before handling or making any adjustments. Always wear rubber boots when there is water on the floor and you must unplug the pump or make any adjustments.

WARNING:
TO REDUCE RISK OF ELECTRICAL SHOCK:

1) RISK OF ELECTRICAL SHOCK — This pump has **NOT** been investigated for use in swimming pool areas.
2) RISK OF ELECTRICAL SHOCK — Connect only to a **PROPERLY** grounded, grounding-type receptacle.

Septic tank to be vented in accordance with local plumbing codes.

Do not smoke or use sparkable electrical devices or flame in a septic (gaseous) or possible septic sump.

A septic sump condition may exist and if entry into sump is necessary, then 1) provide proper safety precautions per OSHA requirements and 2) do not enter sump until these precautions are strictly adhered to.

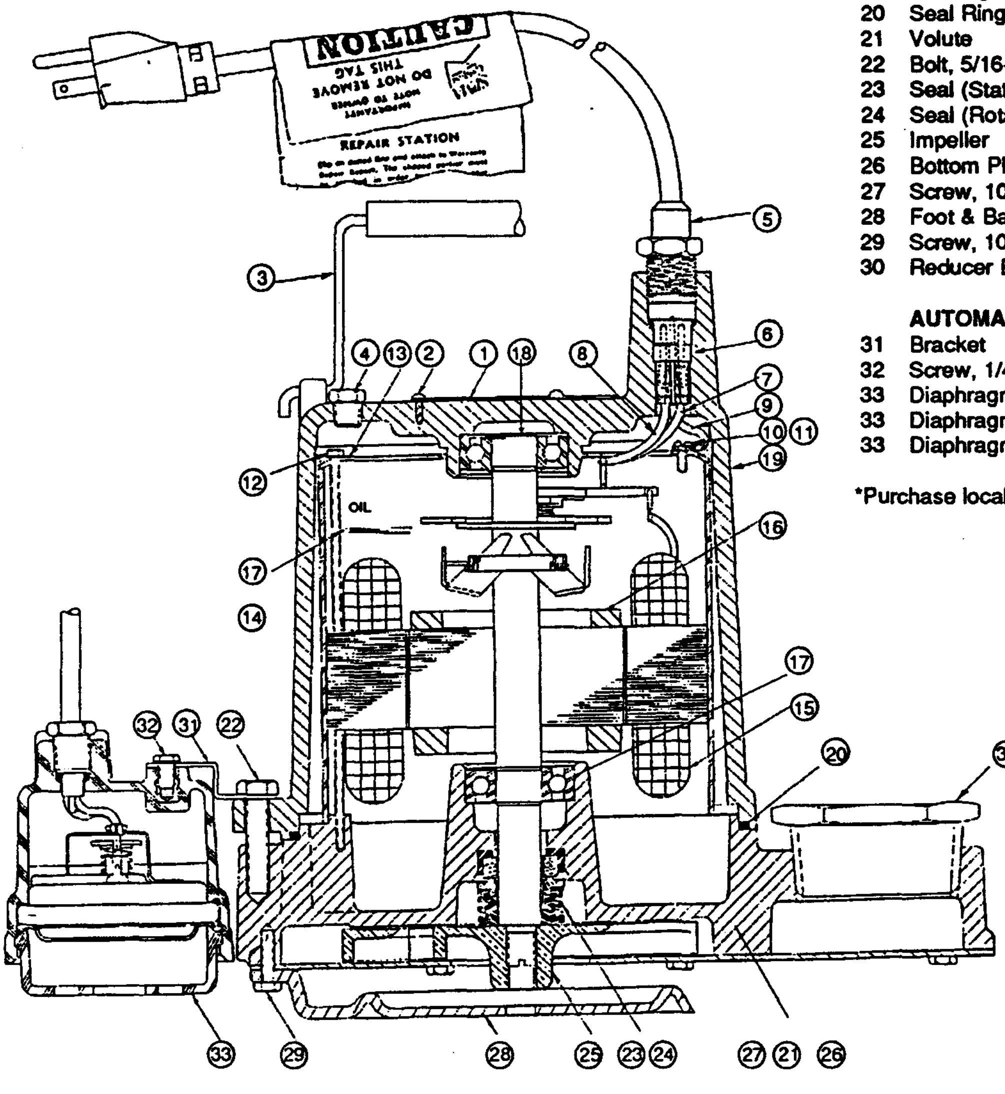
Do not install pump in location classified as hazardous per N.E.C., ANSI/NFPA 70 - 1984.

Failure to heed above cautions could result in injury or death.

Installation Instructions

THESE IMPORTANT INSTRUCTIONS MUST BE FOLLOWED FOR SATISFACTORY PERFORMANCE OF YOUR PUMP:

1) Provide proper sump (minimum sump diameter of 12").
2) DO NOT set pump directly on the bottom of sump if it is NOT solid. Raise the pump by using bricks or concrete blocks underneath it.
3) MAKE SURE SUMP IS FREE OF STRING, CLOTH, NAILS, GRAVEL, ETC. BEFORE INSTALLING PUMP.
4) Risk of electrical shock - connect only to a PROPERLY grounded, grounding-type receptacle.
5) DO NOT remove ground pin from electrical plug.
6) DO NOT use an extension cord.
7) For proper automatic operation, make sure the pump power cord is plugged into the "piggy-back" receptacle on the diaphragm switch cord.
8) Connect to separate electrical circuit taken directly from main switch.
9) Use steel or plastic pipe for all connecting lines between pump and sewer outlet.
   (NOTE: Some city regulations do not allow installing a pump with plastic pipe. Check local regulations.)
10) Hydromatic check valve should be installed in discharge pipe.



Parts List
OSP33 Submersible Sump/Effluent Pump

Ref. No.	Description	Quantity
1	Nameplate, 115V	1
1	Nameplate, 230V	1
2	Drivescrew	2
3	Handle	1
4	Pipe Plug	1
5	Power Cord Assembly, 115V-10'	1
5	Power Cord Assembly, 115V-20'	1
5	Power Cord Assembly, 230V-20'	1
6	Connector Assembly	1
7	Lead Wire/Terminal Assembly (Black, 5")	1
8	Lead Wire/Terminal Assembly (Black, 6-1/4")	1
9	Ground Wire/Terminal Assembly (Green, 5")	1
10	Screw, #6 x 3/8 Lg.	1
11	Lockwasher, #6	1
12	Bolt, Stator - 8-32 x 55/8" Lg.	4
13	Plate, Stator	1
*14	Oil	.38 gal.
15	Stator, 115V	1
15	Stator, 230V	1
16	Rotor & Shaft w/Bearings	1
17	Bearing	2
18	Load Spring	1
19	Housing, Motor	1
20	Seal Ring	1
21	Volute	1
22	Bolt, 5/16-18 x 1" Lg.	4
23	Seal (Stationary Seat)	1
24	Seal (Rotating Seat)	1
25	Impeller	1
26	Bottom Plate	1
27	Screw, 10-24 x 3/8" Lg.	5
28	Foot & Baffle Plate	1
29	Screw, 10-24 x 5/8" Lg.	3
30	Reducer Bushing, 2" x 1-1/2"	1
	AUTOMATIC MODELS	
31	Bracket	1
32	Screw, 1/4-20 x 3/8" Lg.	1
33	Diaphragm Switch (6-1/2" Range), 115V-10'	1
33	Diaphragm Switch (6-1/2" Range), 115V-20'	1
33	Diaphragm Switch (6-1/2" Range), 230V-20'	1

*Purchase locally.

Service Instructions

SERVICING SHOULD BE PERFORMED ONLY BY KNOWLEDGEABLE PUMP SERVICE CONTRACTORS OR AUTHORIZED SERVICE STATIONS.

1) REMOVE PUMP FROM SUMP. Before removing pump from sump for repair, check if the trouble could simply be a blown fuse, tripped circuit breaker, or a power cord not completely inserted into the receptacle.

2) CHECK DIAPHRAGM SWITCH. If the unit is being operated by the automatic diaphragm switch, unplug the pump from the "piggyback" receptacle and plug the pump directly into the power source. If the pump starts each time it is plugged directly into the receptacle and does not start each time when plugged into the piggyback switch with the diaphragm switch pressed into a start position, replace the complete piggyback switch assembly and retest with new assembly.

3) CHECK FOR IMPELLER BLOCKAGE. Check for an obstruction in the impeller cavity by laying the pump on its side and inserting a screwdriver through the hole in the foot and baffle plate (28) and the bottom plate (26) and turning the rotor and shaft (16). It should turn freely. If the impeller hangs up or there is an indication of impeller blockage, the foot and baffle plate must be removed by removing the three hex head cap screws (29) and the bottom plate removed by removing the five hex head cap screws (27). Clear the impeller of its obstruction and clean the impeller cavity walls before reassembly. If you have determined there is no impeller blockage or have cleared the blockage and the pump still will not operate properly, the following steps should be followed to find the cause of the problem and remedy it.

4) CHECK POWER CORD. Check the power cord (5) for brittleness or for any cuts or nicks in the insulation. Using an ohmmeter, check the continuity of the power cord.

5) CHECK THE OIL. Remove the pipe plug (4) in the top of the motor cover and drain oil into a clean, dry container. A milky appearance to the oil indicates that water has entered through either worn out or damaged seals (23,24) or seal ring (20).

6) REMOVE THE MOTOR COVER. Remove the four hex head cap screws (22). Use a screwdriver to pry the motor cover (19) from the volute case (21) at the fastening ears, being careful not to cut the seal ring (20) with the screwdriver or crack the motor cover. Lift the motor cover until it clears the stator (15).

7) CHECK FOR SHORT. Disconnect the stator leads (7, 8, 9) from the connector (6). Use an ohmmeter to check the continuity of the stator. If stator fails to pass the continuity test, it must be replaced.

8) REMOVE THE STATOR. To remove the stator, remove the four hex head screws (12) and the stator plate (13). Lift the stator off the volute case (21) and set aside.

9) REMOVE THE IMPELLER. To remove the impeller (25), hold the rotor (16) in your hand and tap the impeller with a plastic or rubber mallet so as to turn the impeller counter clockwise.

10) CHECK THE SEAL. Remove the rotating portion of seal (24) from shaft by inserting a screwdriver under the edge of the seal and lifting it off. Inspect the seal face for any nicks or an uneven seating of seal face. If any are present, replace the seal. (See Step 14).

11) REMOVE ROTOR AND SHAFT. Tap the rotor shaft (16) at the impeller end of the shaft with a plastic mallet to remove the rotor and shaft. Inspect the bearings (17). If they do not rotate freely and smoothly, they should be replaced. When new bearings are ready to be added onto the shaft, DO NOT PUSH ON OUTER RACE OF BEARINGS. This will damage bearings. If a rotor and shaft is ordered from HYDROMATIC, the bearings will be supplied already pressed on the shaft.

12) REMOVE SEAL. Remove the old stationary portion of the seal (23) from the case (21) by inserting a screwdriver into the seal housing of the case from the top of the case and tapping lightly with a hammer. Clean the seal area of the case with a clean cloth.

13) REINSTALL THE ROTOR AND SHAFT ASSEMBLY. Push on outer race to seat bearing in volute case.

14) REINSTALL SEAL. Apply a good lubricant to the new stationary portion of the seal (23) and press into the case (21). Coat the new rotating portion of seal with lubricant and press into place on the rotor shaft with the rubber ring facing the impeller.

15) REINSTALL IMPELLER. Add a drop of Locktite 222 to the shaft and screw the impeller on hand tight. The impeller will force the rotating portion of seal into position.

16) REPLACE SEAL RING. Remove the old square seal ring (20) from the volute and stretch on a new ring coated with O-ring lube. DO NOT ROLL THE RING ONTO THE VOLUTE OR IMPROPER SEATING AND WATER LEAKAGE INTO THE MOTOR HOUSING WILL RESULT.

17) REINSTALL THE STATOR. Place the stator (15) in the volute case (21) so the stator bolt holes line up. Lay the stator plate (13) on the stator (15) and line up with stator bolt holes. Put in the stator bolts (12) and tighten evenly to prevent cocking of the stator. Push the connectors of the power cord onto the stator terminals.

18) REINSTALL MOTOR HOUSING. Tighten down the four hex head cap screws (22) evenly to prevent cocking of motor housing and achieving an uneven seal on the seal ring (20).

19) OIL. Fill the motor cap with high grade transformer oil such as Sohio Factopure SE40 oil or equivalent to at least 1/4" over motor windings (.38 gallon). DO NOT FILL THE MOTOR HOUSING COMPLETELY—ALLOW AIRSPACE FOR OIL EXPANSION.

20) REINSTALL OIL PIPE PLUG. Coat pipe threads with thread sealant before installing.

21) CHECK PUMP. Plug the power cord into a grounded outlet and start pump by applying pressure to the switch diaphragm (automatic only - manual should start when power is applied). Motor should run smoothly, be free of vibration and stop when pressure is removed.

Your Pump Warranty Is Void

If • • • Power cord has been cut or spliced.

If • • • Pump has been used to pump mud, cement, mortar, plaster, heavy oils, grease, tar, abrasives or chemicals.

If • • • Pump has been used for continous pumping of hot water (above 140° F).

If • • • Pump has been dismantled by customer. (Knowledgeable pump service contractors or authorized service stations only can dismantle pump for field service.)

Limited Warranty

The Hydromatic Pump Company warrants to the original purchaser of each of The Hydromatic Pump Company's product(s) that any part thereof which proves to be effective in material or workmanship within one year from date of installation or 18 months from manufacture date, whichever comes first, will be replaced at no charge with a new or remanufactured part, F.O.B. factory. Purchaser shall assume all responsibility and expenser for removal, reinstallation and freight. Any item(s) designated as manufactured by others shall be covered only by the express warranty of the manufacturer thereof. This warranty does not apply to damage resulting from accident, alteration, design, misuse or abuse.

If the material furnished to the Buyer shall fail to conform to this contractor or to any of the terms of this written warranty, The Hydromatic Pump Company shall replace such nonconforming material at the original point of delivery and shall furnish instruction for its disposition. Any transportation charges involved in such disposition shall be for the Buyer's account. The Buyer's exclusive and sole remedy on account or in respect to the furnishing of material that does not conform to this contract, or to this written warranty, shall be to secure replacement thereof as aforesaid. The Hydromatic Pump Company shall not in any event be liable for the cost of any labor expended on any such material or for any incidental or consequential damages to anyone by reason of the fact that such material does not conform to this contract or to this written warranty.

ALL IMPLIED WARRANTIES, INCLUDING THE IMPLIED WARRANTY OF MERCHANTABILITY AND THE IMPLIED WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE, ARE LIMITED IN DURATION TO THE SAME EXTENT AS THE EXPRESS WARRANTY CONTAINED HEREIN. Some states do not allow limitations on how long an implied warranty lasts, so the above limitation may not apply to you.

MANUFACTURER EXPRESSLY DISCLAIMS AND EXLUDES ANY LIABILITY FOR CONSEQUENTIAL OR INCIDENTAL DAMAGES FOR BREACH OF ANY EXPRESS OR IMPLIED WARRANTY ARISING IN CONNECTIONS WITH THIS PRODUCT, INCLUDING WITHOUT LIMITATION, WHETHER IN TORT, NEGLIGENCE, STRICT LIABILITY CONTRACT OR OTHERWISE. Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you.

This warranty gives you specific legal rights, and you may also have other rights which vary from State to State.

Bulletin HW-105.1
New 9/88 (Replaces 118.6)
Printed in U.S.A.

HYDROMATIC PUMPS
1840 Baney Road • Ashland, OH 44805 • 419/289-3042

OSP33
Submersible Sump/Effluent Pump

Parts List

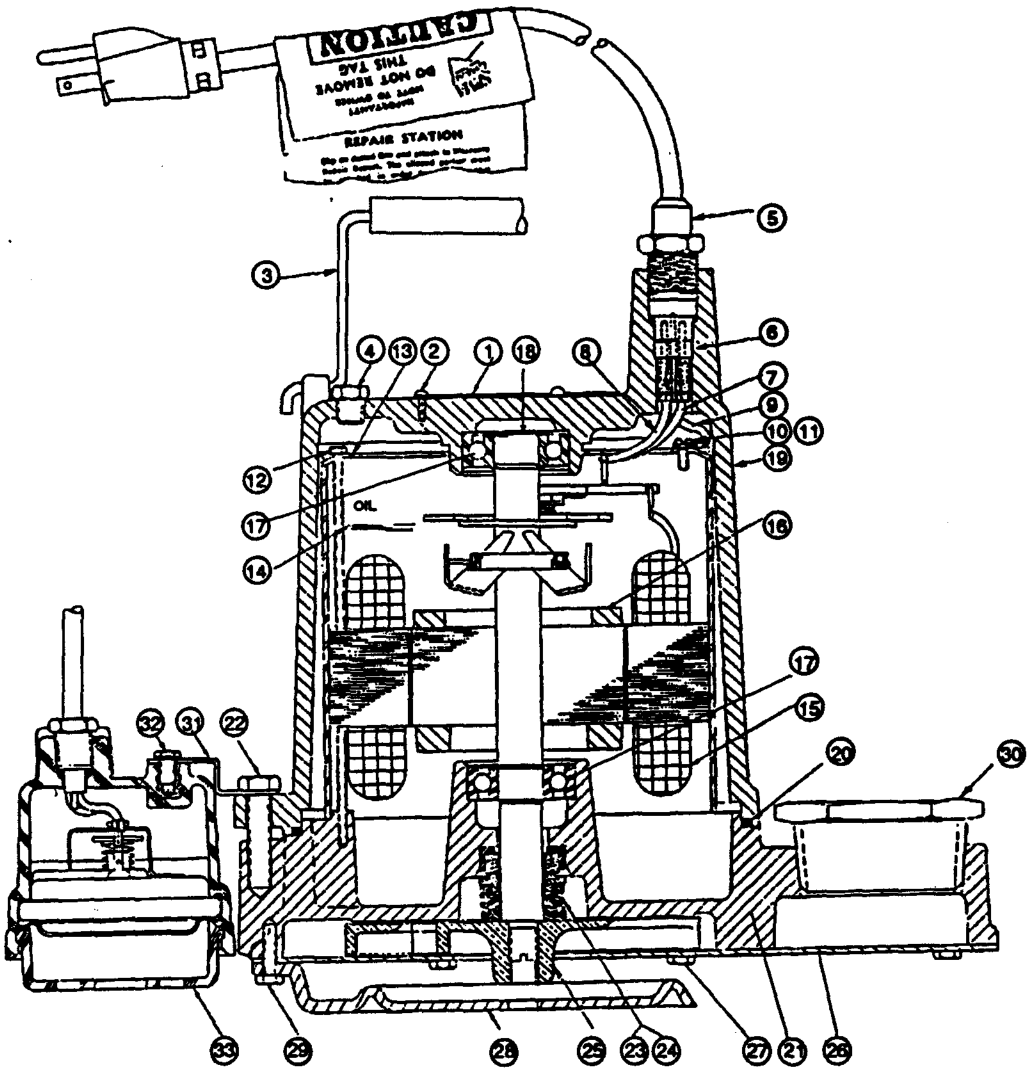
HYDROMATIC PUMPS

Ref. No.	Part No.	Description	Qty.
1	58-010-3	Nameplate, 115V	1
1	374-010-3	Nameplate, 230V	1
2	4580-001-1	Drivescrew	2
3	60-000-5	Handle	1
4	119-002-1	Pipe Plug	1
5	12585-004-5	Power Cord Assembly, 115V-10'	1
5	12585-005-5	Power Cord Assembly, 115V-20'	1
5	12585-003-5	Power Cord Assembly, 230V-20'	1
6	4209-004-5	Connector Assembly	1
7	6000-059-5	Lead Wire/Terminal Assembly (Black, 5")	1
8	6000-061-5	Lead Wire/Terminal Assembly (Black, 6-1/4")	1
9	6000-060-5	Ground Wire/Terminal Assembly (Green, 5")	1
10	2056-003-1	Screw, #6 x 3/8 Lg.	1
11	995-001-1	Lockwasher, #6	1
12	145-003-1	Bolt, Stator - 8-32 x 5-5/8" Lg.	4
13	70-000-3	Plate, Stator	1
*14		Oil	.38 gal.
15	9993-001-1	Stator, 115V	1
15	9994-001-1	Stator, 230V	1
16	9993-011-5	Rotor & Shaft w/Bearings	1
17	65-001-1	Bearing	2
18	64-001-1	Load Spring	1
19	56-008-2	Housing, Motor	1

*Purchase locally.

Ref. No.	Part No.	Description	Qty.
20	77-003-1	Seal Ring	1
21	12328-002-2	Volute	1
22	101-007-1	Bolt, 5/16-18 x 1" Lg.	4
23	83-002-1	Seal (Stationary Seat)	1
24	83-007-1	Seal (Rotating Seat)	1
25	16-000-2	Impeller	1
26	18-002-3	Bottom Plate	1
27	19-002-1	Screw, 10-24 x 3/8" Lg.	5
28	21-000-2	Foot & Baffle Plate	1
29	19-004-1	Screw, 10-24 x 5/8" Lg.	3
30	12185-001-1	Reducer Bushing, 2" x 1-1/2"	1
		AUTOMATIC MODELS	
31	5502-004-1	Bracket	1
32	176-015-1	Screw, 1/4-20 x 3/8" Lg.	1
33	12752-004-5	Diaphragm Switch (6-1/2" Range), 115V-10'	1
33	12752-005-5	Diaphragm Switch (6-1/2" Range), 115V-20'	1
33	12752-006-5	Diaphragm Switch (6-1/2" Range), 230V-20'	1
33	12752-008-5	Diaphragm Switch (8-1/2" Range) 115V-10'	1
33	12752-009-5	Diaphragm Switch (8-1/2" Range) 115V-20'	1
33	12752-010-5	Diaphragm Switch (8-1/2" Range) 230V-20'	1

OSP33



Bulletin HW-105.2
New 9/88 (Replaces 119.7D)
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HYDROMATIC PUMPS
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SPDES Discharge Pumps

P-810A, B

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SECTION 6 ITEM 340
DATED MARCH 1992
SUPERSEDES ITEMS 341, 342, 344
DATED JUNE 1985

A UNIT OF GENERAL SIGNAL

AURORA PUMP

INSTRUCTION MANUAL

REPAIR

MODELS 341A, 342A, 344A

6

NOTE

This repair manual is applicable to pump Models 341A, 342A, 344A. All photos illustrate Model 344A.

SERVICE

Your Aurora pump requires no maintenance other than periodic inspection, occasional cleaning and lubrication of bearings. The intent of inspection is to prevent breakdown, thus obtaining optimum service life. The liquid end of the pump is lubricated by the fluid being pumped and therefore does not require periodic lubrication. The motor, however may require lubrication, in which case, the motor manufacturer's recommendation should be followed.

LUBRICATION OF IMPELLER SHAFT BEARINGS

The MODEL 344 pump is available with two options for lubricating the shaft bearings. They are:

1. Regreasable (standard)
2. Oil Lubrication

Regreasable bearings will require periodic lubrication and can be accomplished by using the zerk or lubrication fittings in the cartridge cap and power frame. Lubricate the bearings at regular intervals using a grease of high quality. Lithium, lithium soda or calcium base grease is recommended as lubricants for pumps operating in both wet and dry locations. Mixing of different brands of grease should be avoided due to possible chemical reactions between the brands which could damage the bearings. Accordingly, avoid grease of vegetable or animal base which can develop acids, as well as grease containing rosin, graphite, talc and other impurities. Under no circumstances should used grease be reused.

Over lubrication should be avoided as it may result in overheating and possible bearing failure. Under normal application, adequate lubrication is assured if the amount of grease is maintained at 1/3 to 1/2 the capacity of the bearing and adjacent space surrounding it.

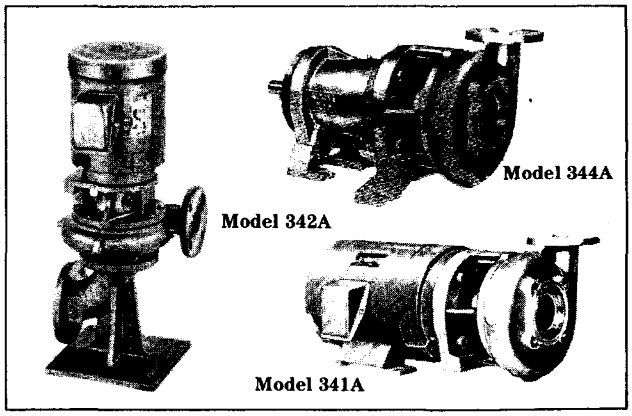
In dry locations, each bearing will need lubrication at least every 600 hours of running time or every 6 to 12 months, whichever is more frequent. In wet locations the bearings should be lubricated at least after every 300 hours of running time or every 4 to 6 months, whichever is more frequent. A unit is considered to be installed in a wet location if the pump and motor are exposed to dripping water, to the weather, or to heavy condensation such as is found in unheated and poorly ventilated underground locations.

Oil lubricated bearings are optional on MODEL 344 pumps. A fixed oil level is maintained with the power frame by an oiler which allows visual indications of reserve oil.

At initial installation and before starting a unit that has been shut down for repairs or for any extended length of time, run enough 10W-30 weight motor oil through the oiler to maintain a constant oil level to insure that the bearing will never be without an oil supply. Oil will have to be added at intervals to maintain a constant level in the oiler. This interval can only be determined by experience.

Under working conditions, oil will breakdown and need to be replaced at regular intervals. The length of these intervals will depend on many factors. Under normal operation, in clean and dry locations, the oil should be changed about once a year. However, when the pump is exposed to dirt contamination, high temperatures (200° F. or above) or a wet location, the oil may have to be changed every 2 to 3 months.

At times it may be necessary to clean the bearings due to accumulated dirt or deteriorated lubricants. This can be accomplished by flushing the bearing with a light oil heated to 180 to 200°F. While rotating it on a spindle, wipe the bearing housing with a clean rag soaked in a cleaning solvent and flush all surfaces.



A. Assembled Units.

Dry bearing thoroughly before relubricating. Compressed air can be used to speed drying, but care should be taken not to let bearings rotate while being dried.

CAUTION

Use normal fire caution procedures when using any petroleum cleaner.

REPAIRS

The pump may be disassembled using the illustrations and text provided. Although complete disassembly is covered, it will seldom be necessary to completely disassemble your Aurora pump.

The illustrations accompanying the disassembly instructions show the pump at various stages of disassembly. The illustrations are intended to aid in the correct identification of the parts mentioned in the text.

Inspect removed parts at disassembly to determine their reusability. Cracked castings should never be reused. Gaskets should be replaced at reassembly simply as a matter of economy; they are much less expensive to replace routinely than to replace as the need occurs. In general it is economical to return to the manufacturer for repair only the motor and motor controller.

DISASSEMBLY

Disassemble only what is needed to make repairs or accomplish inspection. (See Figure 2 for Model 341A, Figure 3 for Model 342A and Figure 3 for Model 344A.)

1. Break electrical connections to prevent drive unit from being energized during disassembly.

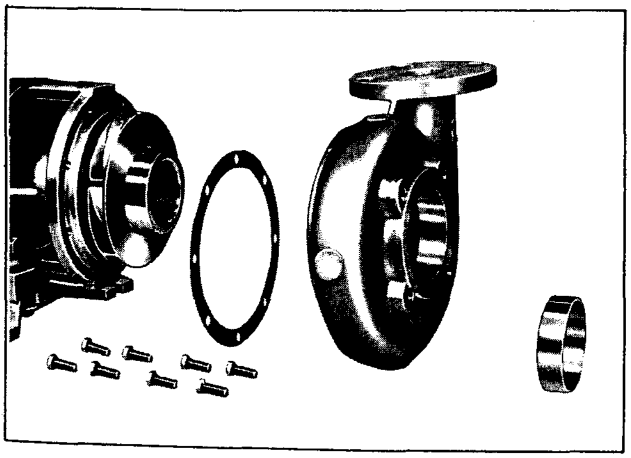
2. Unscrew the two drain plugs (4) from the casing (6). On Model 342A pumps, remove plugs (74 and 75) to drain pump. Also unscrew the two plugs (4) from casing (6).

3. Remove all relief, cooling, flushing or drain lines from pump, including compression connections (1 and 2) and tubing (3). Break suction and discharge connections unless it is intended to remove the power frame or motor assembly and leave casing (6) in the line. On Model 342A pumps, break discharge connections only, unless it is desired to remove base (73). Remove capscrews (39) and lift pump assembly from base (73). Remove gasket (72).

4. On Model 344A pumps, remove the flexible coupling from between the pump and motor. Next unscrew the bolts that hold support(s) (41 & 64) to the base and slide the pump out to be worked on.

5. Remove capscrews (5) and pull casing (6) from bracket (35). Remove gasket (8).

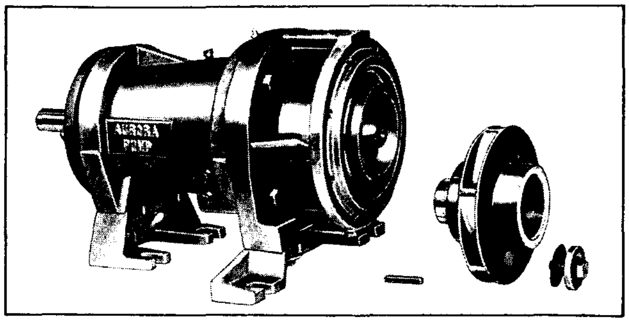
6. Unscrew impeller screw (9) and remove washer (9A), taking care not to damage gasket (9B).



B. Casing, Gasket, and Wearing Ring Removed.

7. Slide impeller (11) and impeller key (12) from the shaft, again taking care not to damage gasket (10) located behind impeller. Remove gasket (10).

8. Wearing ring(s) (7 & 16) are pressed into their housings with an interference fit and must be removed with a puller. New ring(s) should be used for reassembly since it is likely that during removal this fit will be lost.



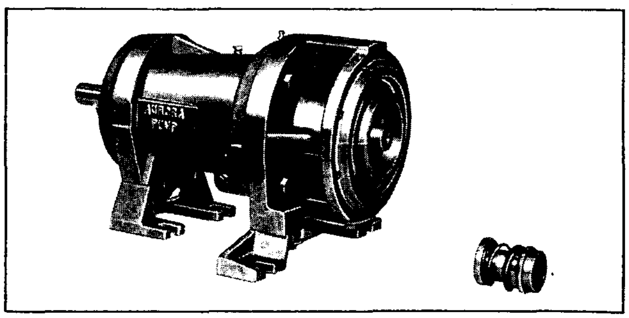
C. Impeller and Key Removed.

9. Impeller wearing rings (optional - 14 and 15) are pressed on and must be cut off if replacement is necessary. If they are turned off in a lathe, take care not to cut into the impeller.

10. Slide sleeve (25) with rotating parts of mechanical seal (27) from the shaft. The sleeve should be carefully cleaned to remove any residue that may be remaining in the seal area. The rubber in seal (27) may have become partially adhered to the sleeve. The sleeve must also be checked for abrasion or corrosion that can occur when fluid residue penetrates between the seal (27) and sleeve (25). The sleeve under the seal may be polished lightly to a 32 RMS finish before reassembly. Do not reuse a pitted sleeve. Pin (61) may be removed if necessary.

CAUTION

The mechanical seal is a precision product and must be treated as such. During removal great care must be taken to avoid dropping any part of the seal. Take particular care not to scratch the lapped faces on the washer or the sealing seat. Do not put a seal back into service until the sealing faces of the washer and seat have been lapped or replaced. (SEE FIGURE 1.)

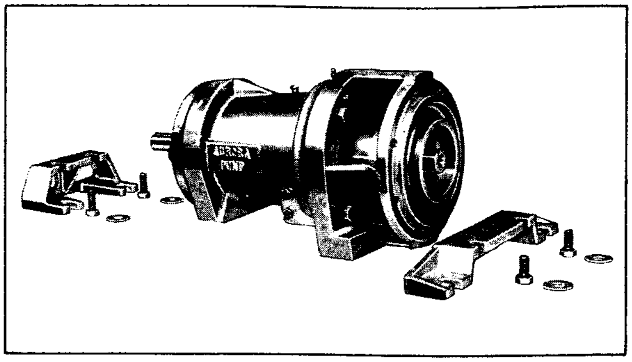


D. Mechanical Seal Removed.

11. On Model 344A pumps, remove capscrews (39 and 62) and washers (40 and 63) to take off support feet (41 and 64). On Model 341A frame size 143 thru 184-JM only. Unscrew capscrews (39) washers (40) and remove support (41) from bracket (35).

12. Unscrew capscrews (32) to remove bracket (35) from frame (57) or motor on Models 341A and 342A.

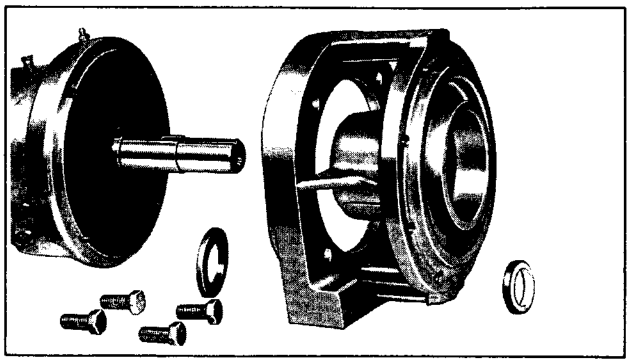
13. The seal flexible cup and stationary seat should be pressed out of the bracket (35) and the cavity cleaned of all residue. Make sure that the 1/32 inch radius in the seal seat cavity is not damaged during disassembly since a sharp edge can easily cut the flexible cup during reassembly.



E. Support Feet Removed.

14. On Model 344A pumps, remove key (42) from the shaft and remove slingers (47) and (47A).

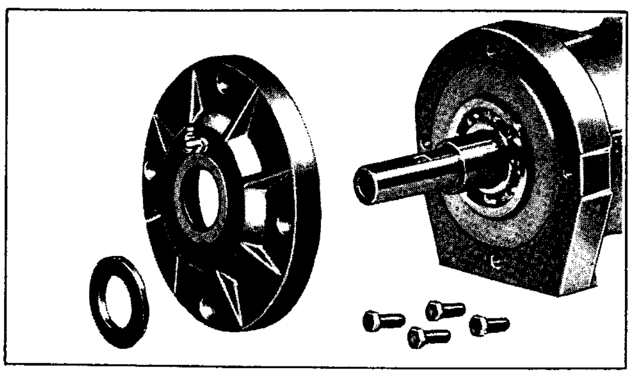
15. Unscrew capscrews (48) and remove bearing cap (49). Remove o-ring (oil lubed only) (50) and retainer ring (52).



F. Bracket and Slinger Seal Flexible Cup and Stationary Seat Removed.

16. Slide out shaft (55) and bearings (53 and 54). Since bearings (53 and 54) are press fitted on the shaft, they will have to be pulled or pressed off the shaft. Remove grease seals (51) from frame (57), and bearing cap (49).

17. Remove nameplate (34) and screws (33) only if replacement is needed.



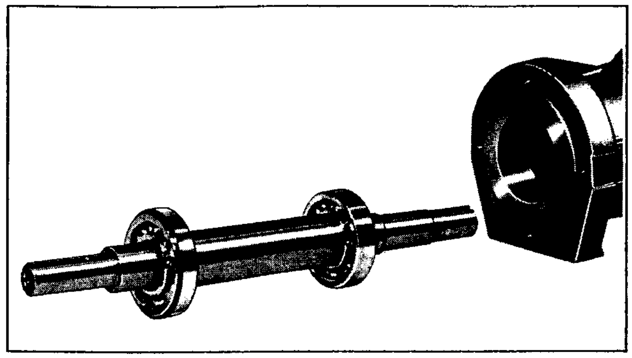
G. Bearing Cap and Slinger Removed.

REASSEMBLY

Reassembly will generally be in reverse order of disassembly. If disassembly was not complete, use only those steps related to your particular repair program.

1. Press grease seals (51) into frame (57) (344A).

2. Press bearings (53 and 54) onto shaft (55). Snap retainer ring (52) into place. (344A)



H. Shaft Assembly Removed.

3. Slide shaft (55) and bearings (53 and 54) into frame (57) and place o-ring (oil lubed only) (50) in place. (344A)

4. Fasten bearing cap (49) in position with capscrews (48). Insert grease seals (51) and position slingers (47) and (47A) on the shaft. (344A)

5. The mechanical seal (27) (see Figure 1) cannot be installed as an assembly. It is necessary to have the seal seat properly in place before the balance of parts can be added.

Thoroughly inspect the seal cavity in seal bracket, checking for burrs or nicks which could damage flexible cup of mechanical seal. Apply a film of liquid dishwashing detergent (do not use oil or grease) to the flexible cup and seal seat. Insert seat in cup and install in seal bracket, taking care to seat it evenly and squarely.

NOTE

> If it is not possible to insert seat with fingers, place the cardboard protecting ring furnished with seal over lapped face of seat and press into place with a piece of tubing having end cut square. Tubing should be slightly larger than the diameter of the shaft. Remove cardboard after seat is firmly seated.

6. On Model 344A pumps, mount bracket (35) by screwing capscrews (32) evenly into frame (57) to assure proper alignment. Turn all capscrews in an even amount. Fasten the bracket and frame to supports (41 and 64) by placing washers (40 and 63) over capscrews (39 and 62) and screwing them into position.

On Model 341A and 342A pumps position bracket (35) on the motor and secure with capscrews (32). Tighten screws evenly to assure proper alignment.

Secure support (41) to bracket (35) with capscrews (39) and washers (40). Frame sizes 143 thru 184-JM Model 341A only.

7. If nameplate (34) was removed, install and attach with screws (33).

8. Wipe the sealing faces of the seat and seal washer clean. Replace pin (61) in sleeve if it was removed during disassembly. Apply a film of liquid dishwashing detergent to the washer and bellows of the seal and slide the remaining seal parts onto the sleeve making sure the washer is seated against the seal seat. Check the proper sequence of assembly as indicated in figure 1. The shaft sleeve with the seal rotating assembly on it may now be replaced onto the motor shaft. Spring tension will probably prevent the sleeve from remaining in position axially until the impeller is locked against it.

9. Press wearing ring(s) (7 & 16) in casing (6) and bracket (35). Rings should not be hammered into place. Use a press, or clamp the parts in a bench vise, using wooden blocks to protect the rings. It may be necessary to pin or dowel the rings after assembly if the insert or casing has had rings replaced before, since each reassembly can stretch or tear metal and thereby loosen the fits. If the facilities are available, it is good practice to take a very light finish cut or to ream the inside diameter of the casing rings after pressing to restore roundness. When rings are pressed, they may get squeezed out of shape.

10. Coat the mating surfaces of impeller wear ring(s) (optional - 14 and 15) and impeller (11) with Locktite sealant grade 271. Replace wear rings, using the same care as for the case wear ring(s). If the rings are to be trued on a lathe, do not clamp the impeller so tightly that it is permanently distorted.

11. Carefully replace gasket (10) on motor end of impeller. Assemble key (12) and impeller (11) to motor shaft. Secure impeller with gasket (9B), washer (9A), and impeller screw (9).

12. Install the two pipe plugs (4) in the pump casing. Position the gasket (8) and casing (6) against the motor bracket and secure with screws (5). On Model 342A pumps position gasket (72) and set pump assembly in place. Tighten pump to base (73) with capscrews (39).

13. Replace all relief, cooling, flushings, or drain lines from the pump including compression connections (1 and 2) and tubing (3). Replace all grease fittings pipe plugs, tube vents and oiler assembly for oil lubricated units. Connect discharge piping and suction piping, if required. Make sure to install gaskets on the flanged connections. On Model 342A pumps replace plugs (74) and (75) in base elbow (73).

14. Read carefully the section of the manual titled INSTALLATION, especially those paragraphs referring to pump and coupling alignment.

15. Connect electricity to the motor.

STARTING PUMP AFTER REASSEMBLY

Do not start pump until all air and vapor has been bled and until making sure that there is liquid in the pump to provide the necessary lubrication. Without the fluid around it, the seal may be ruined in a few seconds of operation. It is possible that the mechanical seal may drip during the first few minutes to one hour of operation.

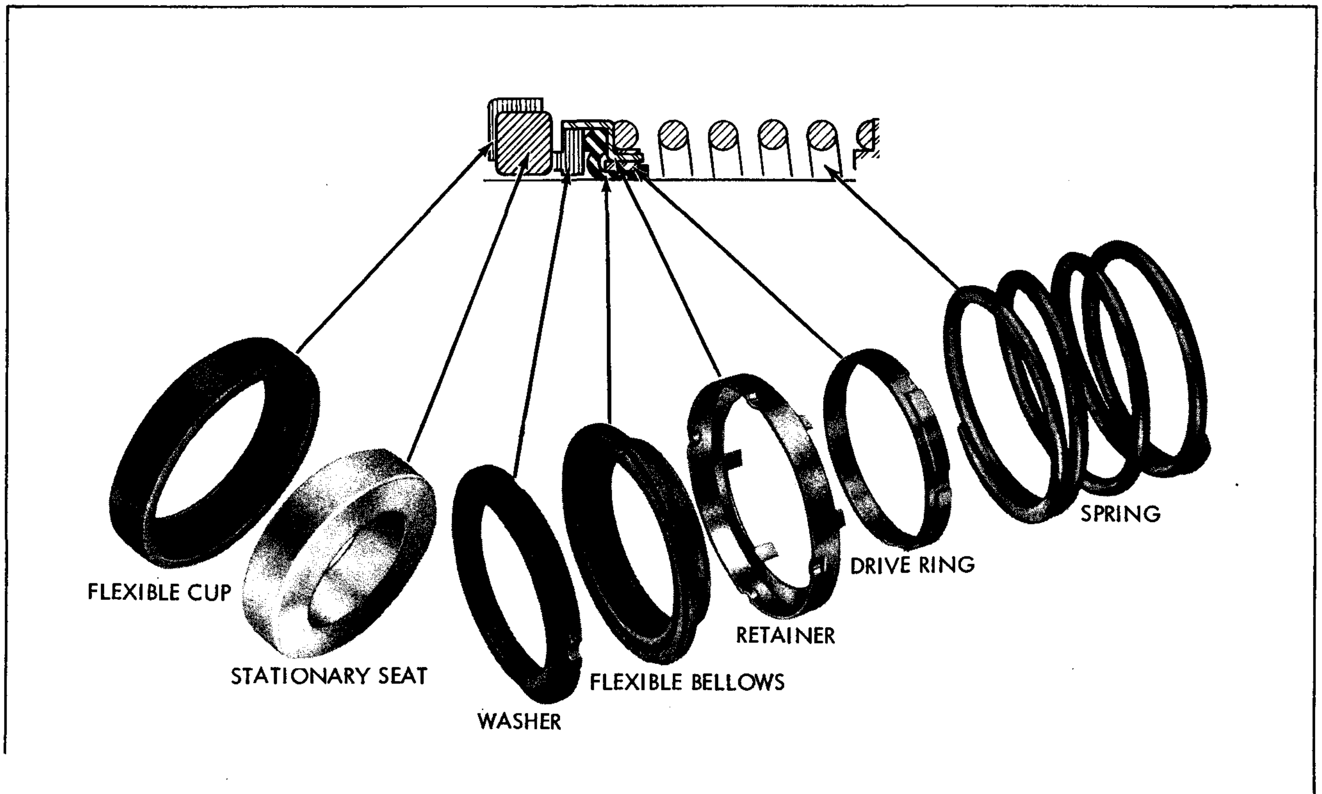


Figure 1. Mechanical Seal

MODEL 341A LIST OF PARTS

1. Elbow
2. Connector
3. Tubing
4. Plug, Pipe
5. Capscrew
6. Casing
7. Wear Ring
8. Gasket
9. Impeller Screw
9A. Washer
9B. Gasket
10. Gasket
11. Impeller
12. Impeller Key
14. Wear Ring
15. Wear Ring
16. Wear Ring
25. Sleeve
27. Seal
32. Capscrew
33. Screw
34. Nameplate
35. Bracket
39. Capscrew
40. Washer
41. Support
61. Pin

MODEL 342A LIST OF PARTS

1. Elbow
2. Connector
3. Tubing
4. Plug, Pipe
5. Capscrew
6. Casing
7. Wear Ring
8. Gasket
9. Impeller Screw
9A. Washer
9B. Gasket
10. Gasket
11. Impeller
12. Impeller Key
14. Wear Ring
15. Wear Ring
16. Wear Ring
25. Sleeve
27. Seal
32. Capscrew
33. Screw
34. Nameplate
35. Bracket
39. Capscrew
61. Pin
72. Gasket
73. Base
74. Plug, Pipe
75. Plug, Pipe

MODEL 344A LIST OF PARTS

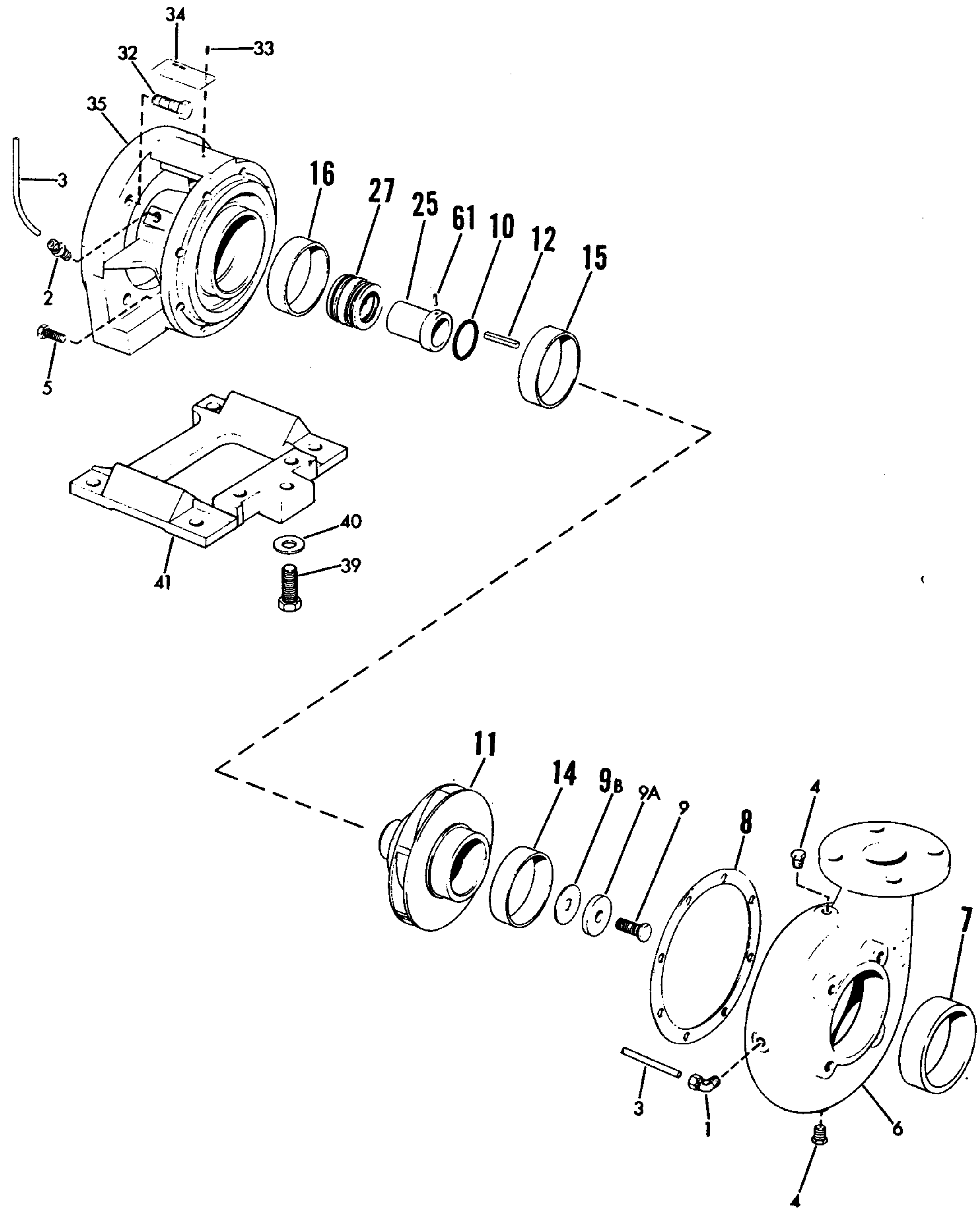
1. Elbow
2. Connector
3. Tubing
4. Plug, Pipe
5. Capscrew
6. Casing
7. Wear Ring
8. Gasket
9. Impeller Screw
9A. Washer
9B. Gasket
10. Gasket
11. Impeller
12. Impeller Key
14. Wear Ring
15. Wear Ring
16. Wear Ring
25. Sleeve
27. Seal
32. Capscrew
33. Screw
34. Nameplate
35. Bracket
39. Capscrew
40. Washer
41. Support
42. Key
43. Grease Fitting
44. Tube, Vent
46. Plug, Pipe
47. Slinger
47A. Slinger
48. Capscrew
49. Bearing Cap
50. O-Ring
51. Seal
51A. Seal
52. Retaining Ring
53. Bearing
54. Bearing
55. Shaft
56. Plug, Pipe
57. Frame
58. Grease Fitting
59. Plug, Pipe
60. Oiler Assembly
61. Pin
62. Capscrew
63. Washer
64. Support

NOTES:
1. STANDARD FITTED CONSTRUCTION WILL BE FURNISHED AS STANDARD UNLESS SPECIFIED.
2. REFER TO FACTORY FOR SPECIAL ALLOYS.
3. AURORA PUMP RESERVES THE RIGHT TO SUBSTITUTE MATERIALS WITHOUT NOTICE
4. PIECE NUMBERS 14 AND 15 ARE NOT FURNISHED AS STANDARD, WHEN FURNISHED IMPELLER MUST BE MODIFIED.
5. PIECE NUMBERS 39, 40, 41 USED ONLY WITH MOTOR FRAMES 143 THRU 184-JM ON MODEL 341A PUMPS.

NOTE

WHEN ORDERING SPARE PARTS ALWAYS INCLUDE THE PUMP TYPE, SIZE, SERIAL NUMBER, AND THE PIECE NUMBER FROM THE EXPLODED VIEW IN THIS MANUAL.

ORDER ALL PARTS FROM YOUR LOCAL AUTHORIZED DISTRIBUTOR, FACTORY BRANCH SALES OFFICE OR THE FACTORY AT NORTH AURORA, ILLINOIS.



BOLD FACE NUMBERS INDICATE
RECOMMENDED SPARE PARTS.

Figure 2. Model 341A Exploded View

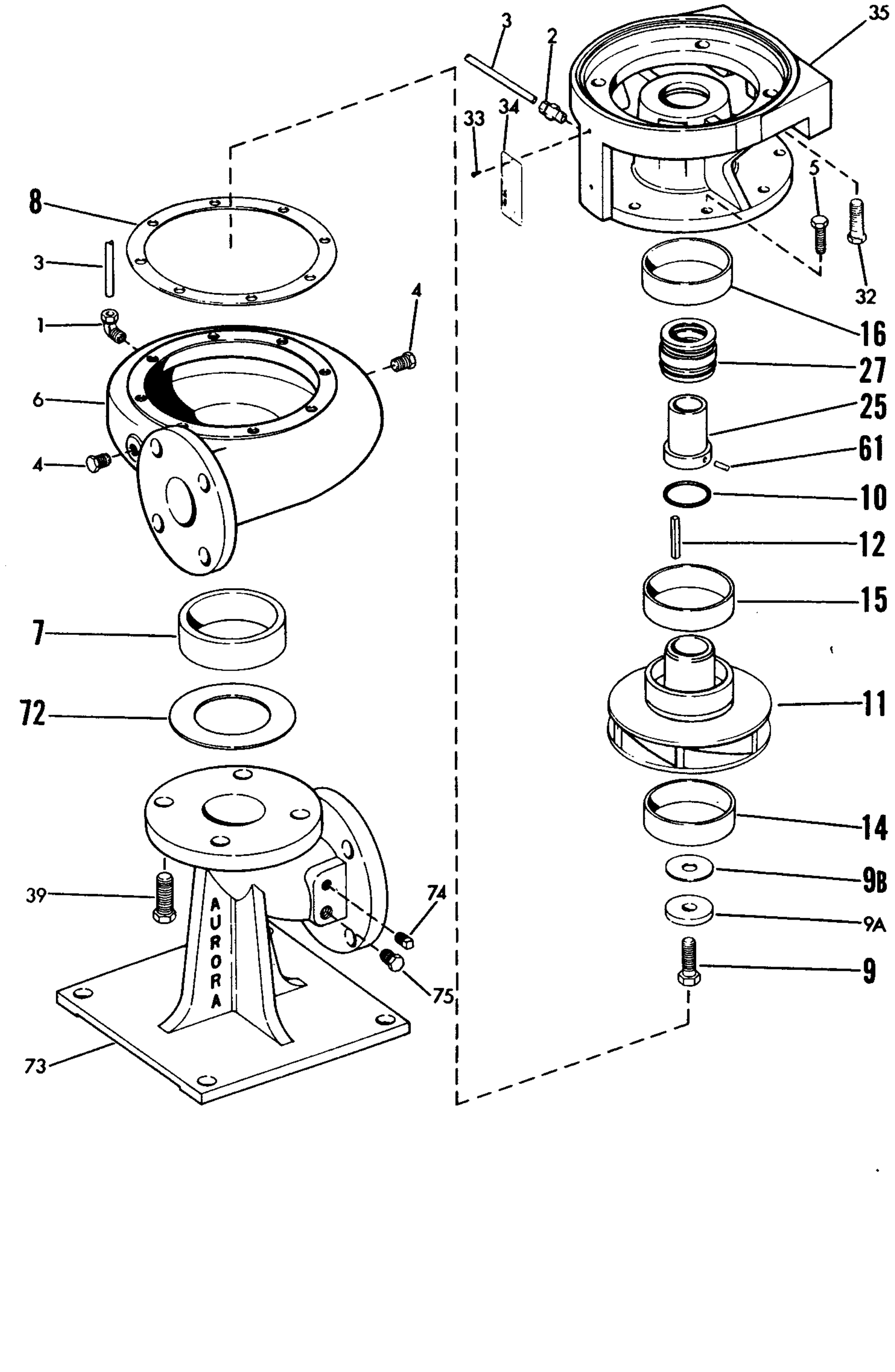


Figure 3. Model 342A Exploded View

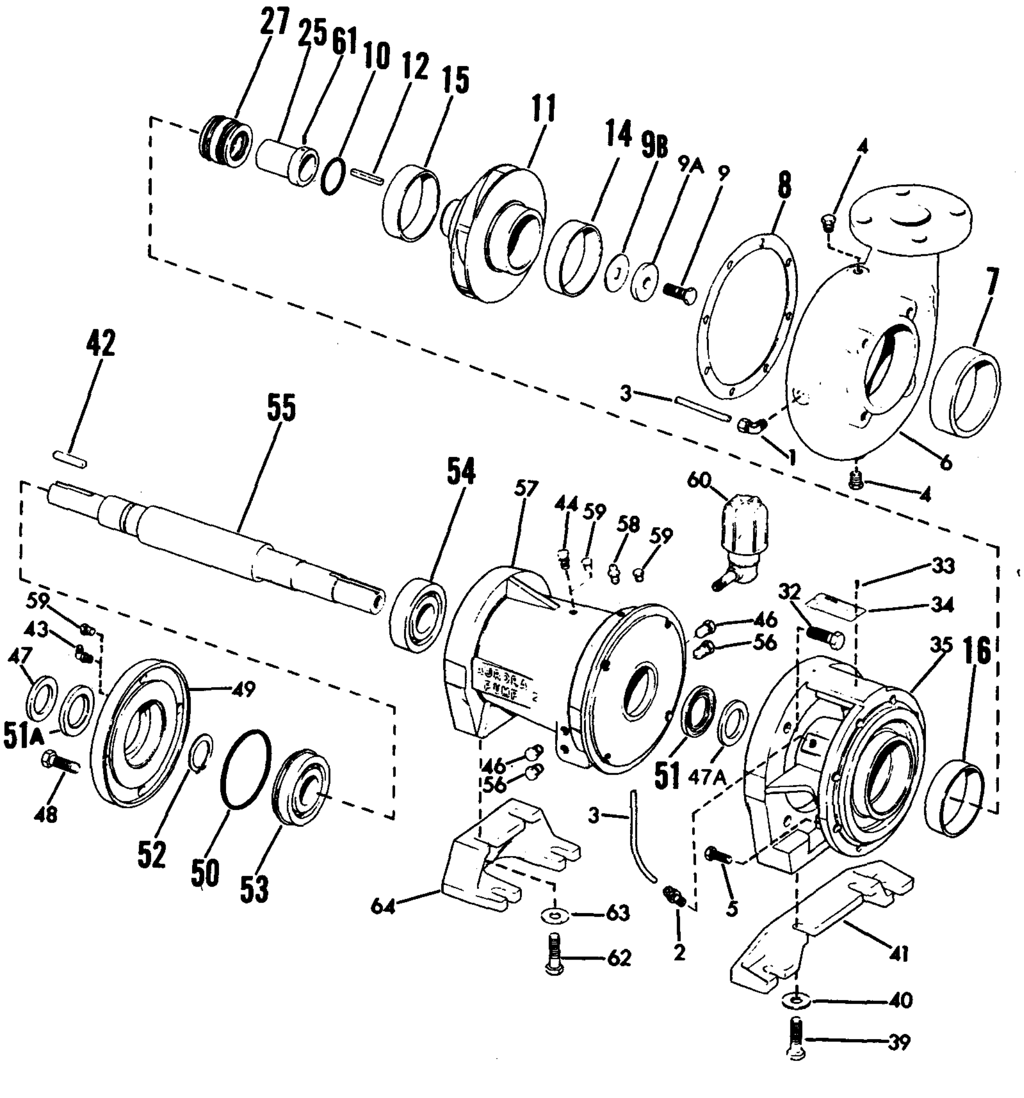


Figure 4. Model 344A Exploded View

Equalization Tank
T-801

Effluent Tank
T-802

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SNYDER INDUSTRIES, INC.
4700 Fremont St. • Mailing address: P.O. Box 4583 • Lincoln, Nebraska 68504 • (402) 467-5221

BULK STORAGE TANK

GUIDELINES FOR USE AND INSTALLATION

1. General use recommendations.

1.1 Continuous service temperatures exceeding those published by Snyder, are not recommended. Currently, the published temperature is 150 F (65 C), in accordance with the recommendation of the resin supplier.

1.2 Most chemicals and non-stress cracking agents can safely be used in polyethylene tanks. The Chemical Resistance Chart provided by Snyder should always be consulted before use to ensure chemical compatability. Fittings and gaskets should also be checked for compatibility. Snyder service staff can provide a correlation between colors and materials used in the fittings, upon request. Chemical combinations not specifically listed in the Chart should be pretested for compatibility.

Follow all instructions from your chemical manufacturer for the handling and use of your chemicals. Avoid spilling chemicals on the exterior of your equipment. Rinse well before and after each use, and before filling with each different chemical or solution.

Due to the ever-changing methods and chemicals being introduced for use, care must be given to investigate and comply with all regulations and laws which may apply in your locale, especially relating to fire and explosion protection, environmental concerns and health protection.

1.3 Snyder bulk storage tanks are designed for storage of chemicals at atmospheric conditions. Tanks should not be used for pressure or vacuum applications unless special design consideration has been given to the application.

1.4 Snyder bulk storage tanks are U.V. stabilized and may be used outdoors.

1.5 Agitators, heaters and other heavy equipment must be mounted upon independent structural members or upon Snyder equipment support frames.

1.6 Immersion heaters must be installed more than twelve (12) inches from the walls or bottom shell of the tank.

recorded.

9.2 Annual inspection should include the following:

9.2.1 Visual examination to discover any corroded areas, tank degradation, damage to piping, valves and gaskets, and structural damage.

9.2.2 Verification of proper functioning of all mechanical devices and valves used with the tank.

9.2.3 Review legible condition of operating and warning markings and labels on the tank. If markings or labels have become illegible, contact Snyder for replacements.

9.3 Two-year inspection should additionally include disassembly of any fittings, piping or gaskets, and replacement as necessary.

9.4 Written maintenance records should be kept for all tanks and recorded by serial number.

9.5 Inspection should be made routinely, and prior to refillings, checking the fittings to see that no deterioration has occurred. Connection valves should also be checked regularly.

10. Repairs.

10.1 Snyder should be contacted prior to undertaking repairs to a tank, to ensure use of proper procedures.

10.2 Repair instructions are available from Snyder.

tkb/A:install
11-10-89t

likely to distort gaskets, causing leaks.

6.2 The tank should be anchored to the site using the molded tie-down lugs on the tank as tie points, held under moderate tension. Avoid excessive tension on the lugs, since tank must be free to move as it expands or shrinks. One option for tie-down of the tank is synthetic webbing slightly longer than the tank's tie-down lug (for the unfilled tank). This webbing may be equipped with a metal ring, which, in turn, may be secured to the ground using metal wire and turnbuckles. Installation should meet all local, state and federal regulations.

6.3 Where a Snyder equipment support frame is used with the tank, the uniformly distributed and concentrated loads in any case should not exceed 500 lbs. and 350 lbs., respectively.

6.4 Bulk storage tanks equipped with conical bottom stands, FRP splashguard cones and FRP casings require additional assembly.

6.5 Any U-Vents and flange adapters should be installed in bulkhead fittings by tightening by hand and then using wrench to tighten approximately another quarter turn.

7. Pre-use testing.

7.1 To be sure that fittings are secure, and that no damage has been incurred in handling and shipping, water test all plumbed-in tanks for a minimum of 5 hours before using. If leaks are identified, repair and repeat water test.

7.2 Flush all tanks well with water before and after each use.

8. Change of use and relocation of tanks.

8.1 If tanks are moved after initial installation, installation procedures should be repeated for installation.

9. Maintenance.

9.1 Routine inspection, beginning with the time of tank installation, should include visual inspection for leakage, especially at the fittings areas, once a day for the first week; once a week for the first month; once a month thereafter. As mentioned below, these inspections should be structural damage during shipment or handling of the tank, which may have affected the integrity of the tank or its fittings.

4. Site selection and preparation.

4.1 The site should be above any known flood plain, or possible water saturation level.

4.2 The tank must be located on a smooth, level surface, free of foreign objects.

4.3 Complete bottom support must be maintained at all times, regardless of the type of tank being installed.

4.4 If the tank is to be placed upon soil, the site must be unsaturated, stable and compact. Vertical tanks, 7,000 gallons and greater, and all conical tanks, must be located upon a reinforced concrete base. It is preferrable for all tanks to be installed on a concrete base, taking into account for design purposes, both the tank weight and the contents. Concrete base design for the specific installation site is the purchaser's responsibility, and should be given specific consideration. Snyder recommends that a concrete pad, at least four inches thick, and reinforced with 6" by 6", 10-10 steel mesh, be used for permanent installations.

5. Erection.

5.1 The use of a crane is recommended, both in lifting and in erecting the tank. The clearance between the head shackle of the crane and the tank should at least equal the overall length of the tank. If this is not possible, a spreader bar must be used to approximate the same angle in lifting. <u>Under no conditions should chains or cables be but around the tank</u>. Do not lift by using any of the fittings. Make or obtain a lifting beam. Attach the lifting wire or chain to the center opening of the tank. (See figure 1A for all tanks except ribbed top tanks; for ribbed top tanks, see figure 1B.)

5.2 A second method for uprighting a tank, is to use a padded collar, and a forklift or hoist, to both pull the tank upright and pivot it into position.

6. Preparations for use.

6.1 All fittings should be hand tightened and then given an additional one-quarter turn. Excessive tightening will be

1.7 Any piping or other plumbing connected to a tank should be independently supported. Strainers, heavy shut-off valves and pipe, and the like should not be carried by the tank connections. Flexible connectors or expansion joints should be used to provide relief from expansion and contraction of piping and tank, to prevent damage at fittings.

2. Delivery, unloading and handling.

2.1 Care must be used to ensure that a tank is not dropped, allowed to fall, or caused to slide as a means of movement. In general, polyethylene should be treated with no less care than a steel tank.

2.2 Unloading from a truck or rail car bed should be assisted by the use of planks forming a ramp for the tank. The tank should be eased down slowly using a fork lift with protected or padded forks.

2.3 A forklift may be used to move the tanks at the proposed site; however, the forks must be protected or padded and will work best when fork extensions are used.

2.4 When storing your tank on the ground on its side, prior to installation, it must be blocked and tied so that it cannot roll due to winds or sloping elevations. The tank should not be temporarily stored in the upright position without being tied down using the molded tie down lugs.

Your tank must not be rolled or slid on rough surfaces, should never be rolled over a fitting.

In working around your tank, care should be taken to prevent tools, scaffolding or other objects from striking the tank or being dropped inside the tank. Soft soled shoes must be worn by workmen entering the tank. Ladders used inside the tank, or outside in contact with the tank, must be wooden or have cushion protection on both ends, and must not be permitted to scratch or point load the tank surface.

3. Inspection.

3.1 All fittings should be checked for looseness that could result from transporting, and tightened as necessary.

3.2 The tank should be visually inspected to assure legible condition of operational and hazard warnings (including any manufacturers data) marked or labelled on the tank.

3.3 The tank should be visually inspected for signs of

SNYDER INDUSTRIES'

GUIDELINES FOR USE

AND

INSTALLATION

INSTRUCTIONS

SNYDER industries, inc.

P.O. BOX 4583, LINCOLN, NE 68504

1. TANK LOADING, UNLOADING, AND POSITIONING

1.1 HORIZONTAL TANKS

1.1.1 Tanks shall be wrapped according to customer instructions if ordered by the customer.

1.1.2 Tanks should be hand carried, moved with a handling cart, or moved with a forklift with rounded fork extensions (to prevent sharp forks from damaging tanks and to provide adequate support for the tank being moved).

1.1.3 Tanks should be loaded and unloaded from a horizontal position in the truck with a minimal amount of sliding. The tank shall be hand carried, moved with a handling cart, or moved with a forklift with rounded fork extensions to limit sliding to a minimum.

1.1.4 Tanks should be loaded or unloaded from a dock of proper height or with a forklift with rounded fork extensions. NEVER drop a tank out of a truck onto the ground since this may damage the tank and void the warranty.

1.1.5 Upon arrival at the destination, the purchaser and/or his agent shall be responsible for inspection for damage in transit. If damage has occurred, a claim should be filed with the carrier by the purchaser, and the manufacturer should be notified prior to the tank being put into service.

1.2 SMALL VERTICAL TANKS (LESS THAN 2000 GALLON CAPACITY)

1.2.1 Tanks shall be wrapped according to customer instructions if ordered by the customer.

1.2.2 Tanks should be hand carried, moved with a handling cart, or moved with a forklift with rounded fork extensions (to prevent sharp forks from damaging tanks and to provide adequate support for the tank being moved).

1.2.3 Tanks should be loaded and unloaded from a horizontal or vertical position in the truck with a minimal amount of sliding. The tank shall be hand carried, moved with a handling cart, or moved with a forklift with rounded fork extensions to limit sliding to a minimum.

1.2.4 Tanks should be loaded or unloaded from a dock of proper height or with a forklift with rounded fork extensions. NEVER drop a tank out of a truck onto the ground since this may damage the tank and void the warranty.

1.2.5 Upon arrival at the destination, the purchaser and/or his agent shall be responsible for inspection for damage in transit. If damage has occurred, a claim should be filed with the carrier by the purchaser, and the manufacturer should be notified prior to the tank being put into service.

1.3 LARGE VERTICAL TANKS (GREATER THAN OR EQUAL TO 2000 GALLONS)

1.3.1 Tanks shall be wrapped according to customer instructions if ordered by the customer.

1.3.2 Tanks should be moved, loaded, and unloaded in a horizontal position with a forklift with rounded fork extensions or a crane with a spreader bar and 2 slings of appropriate size positioned on each tank as shown in Figure 1.1. NEVER drop a tank out of a truck onto the ground since this may damage the tank and void the tank warranty.

1.3.3 Tank lifting lugs provided are intended for moving the tank from a horizontal position to a vertical position from a firm surface. Lifting lugs should not be used to load or unload tanks from trailers. This is a dangerous situation since the tank could roll off of the shifting trailer surface as the load is being moved.

1.3.4 After the tank has been placed on a firm, level surface in a horizontal position, the lifting lugs may be used to put the tank in a vertical position and position the tank on an appropriate support pad. The tank should be lifted using a symmetrical arrangement of lugs to disperse the load evenly through out the tank. A minimum of 3 lugs should be attached with equal length cables using straight clevises with 1" diameter pins. The tank should be positioned with 2 lugs closest to the ground prior to lifting the tank to the vertical position. Refer to Figure 1.2 for additional information.

1.3.5 Upon arrival at the destination, the purchaser and/or his agent shall be responsible for inspection for damage in transit. If damage has occurred, a claim should be filed with the carrier by the purchaser, and the manufacturer should be notified prior to the tank being put into service.

1.4 INSULATED TANKS (ADDITIONAL INSTRUCTIONS)

1.4.1 Insulated tanks must be moved with devices that have large padded contact surfaces to prevent damage to the foam insulation. NEVER allow the tank to drop or roll on rough surfaces as this may damage the foam insulation. When transporting foam insulated tanks, use a 30" wide PE sheet 1/4" or more thick conforming to the curvature of the insulated tank as banding supports. This will assist in decreasing the stress on the foam caused by the banding straps.

2. PRE-INSTALLATION NOTES

2.1 FOUNDATIONS AND SUPPORTS

2.1.1 Vertical flat bottom tanks should be positioned an a concrete pad providing adequate support and a method to attach a tank restraint system. Concrete pad design must be completed by the construction site engineer based on the specific application.

2.1.2 Cone bottom or horizontal tanks require specifically designed support structures. Inadequate or improperly designed support structures may cause premature tank failure. Therefore, any support structure that is not of SII manufacture must be approved by SII in writing or ALL WARRANTIES ARE VOID.

2.2 TANK FITTINGS AND CONNECTIONS

2.2.1 Tank fittings are not installed in the tank since road vibrations, temperature changes, and shipping damage may cause fitting damage and leaks. Customer job site fitting installation insures proper gasket compression and minimizes fitting damage potential.

FIGURE 1.1

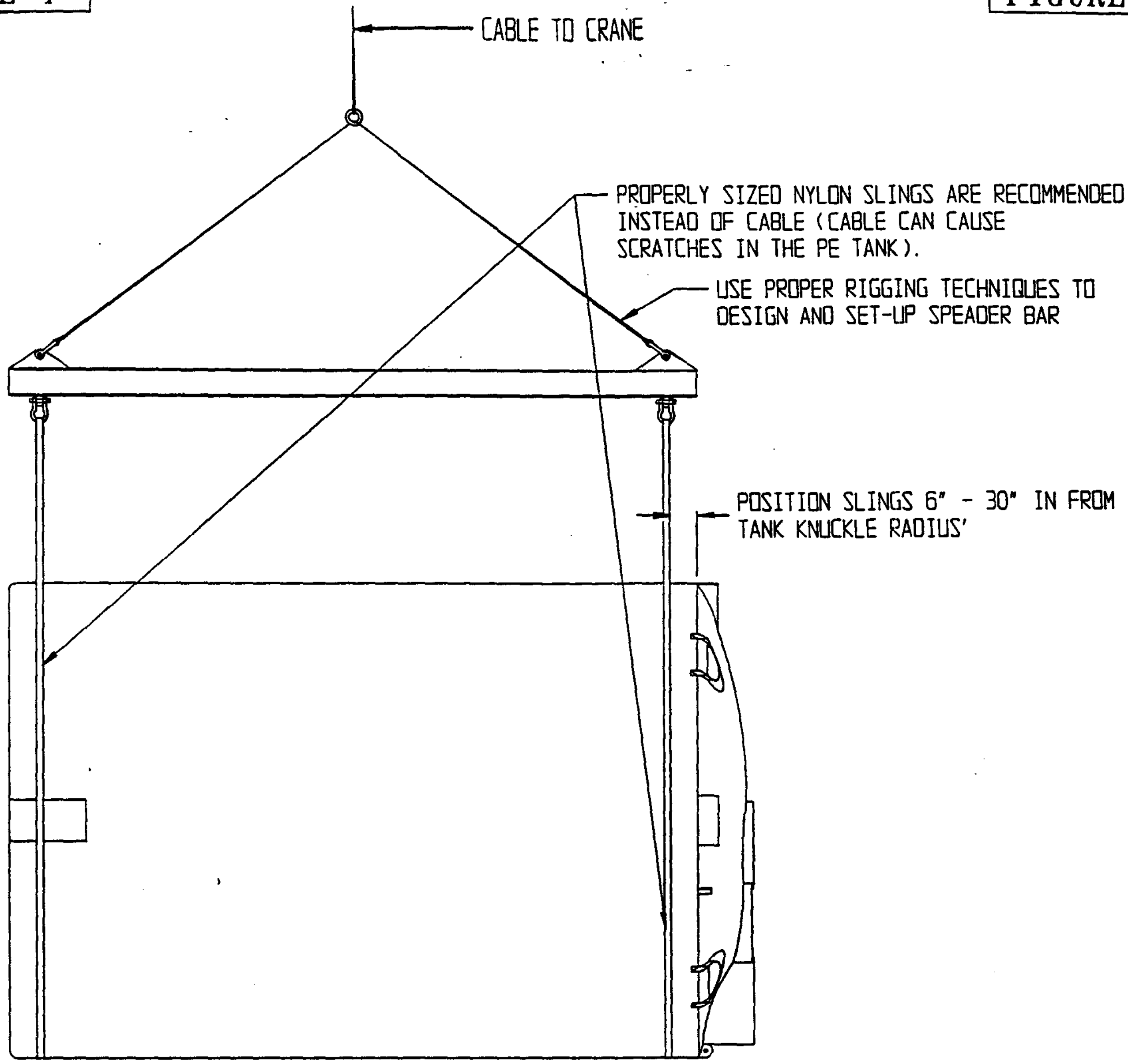
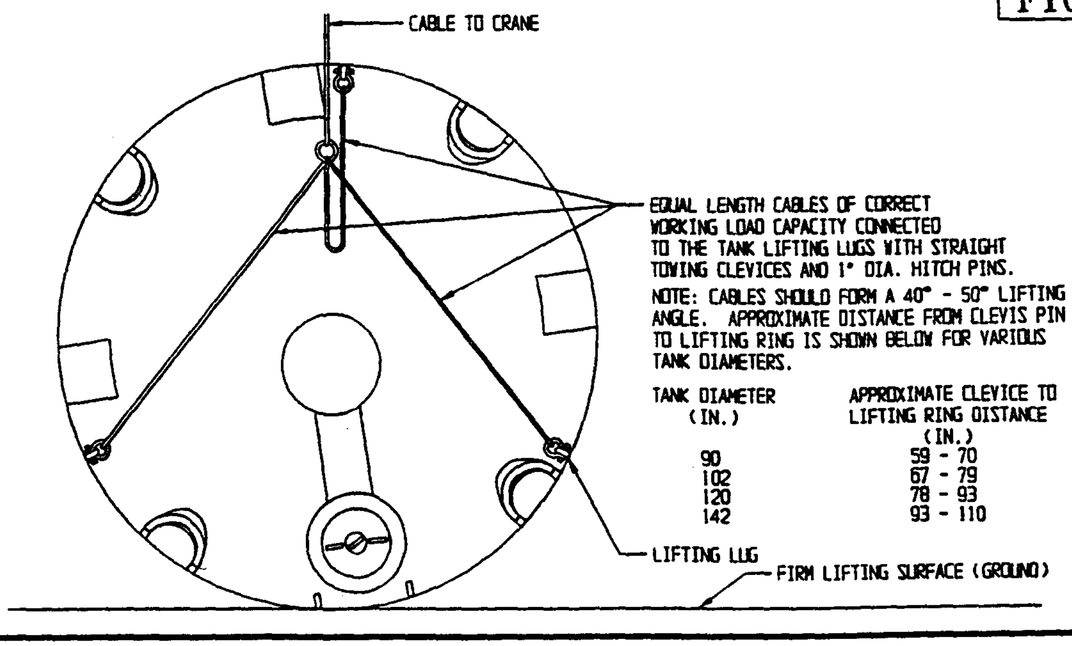


FIGURE 1.1



2.2.2 All tank connections must have adequate provisions for tank expansion/contraction due to temperature and load changes. These provisions should allow +/- 10% dimensional movement. Rigid piping should not be directly connected to tank outlets. SII recommends using expansion joints for all tank connections.

2.3 TESTING AND FINAL INSPECTION

2.3.1 After all fittings are installed and all connections to the tank have been made, fill the tank with water and hold for at least 5 hours to identify any leaks. A record of the water pre-test must be submitted to SII to validate the tank warranty.

2.4 LOOSE PARTS

2.4.1 Various parts must be shipped "loose" to prevent damage during transportation. These parts are usually bagged or boxed inside the tank to prevent loss or damage. Please check inside the tank for invoiced parts.

3. FITTINGS

3.1 THREADED BULKHEAD FITTING

3.1.1 Remove the large hexagonal nut (C) from the fitting body (A) and gasket (B). See Figure 3.1 for part identification.

3.1.2 Working from inside the tank, slide the fitting body (A) through the hole in the tank. The gasket (B) should be between the fitting body flange and the inside tank wall. Install the nut (C) on the fitting threads protruding on the outside of the tank.

3.1.3 To obtain proper gasket compression for bulkhead fitting installation, tighten the fitting nut hand tight (check to see if it engages the tank wall). Tighten the nut an additional 3/4 turn for fittings less than 1 in. or 1/3 turn for fittings 1 in. or larger. A light lubricating oil may be necessary to prevent thread seizing on certain bulkhead fitting materials. Inspect the gasket to make sure it is fully contacting the inner surface of the fitting body flange and the inside tank wall. Gasket compression should be between 25 - 50%.

3.2 SELF-ALIGNING THREADED BULKHEAD FITTING

3.2.1 Follow the same procedures as detailed under threaded bulkhead fitting installation steps 3.1.1 - 3.1.3.

3.2.2 Piping should be installed into the fitting ball with an appropriate thread sealant. Adjust the piping to the required angle (within the limits of the fitting). When the piping has been located as required, tighten the PVC ball retainer ring located on top of the PVC ball.

3.3 BOLTED DOUBLE 150 LB. FLANGE FITTINGS

3.3.1 The bolted double flange fitting shall be constructed with 2 ea. 150 lb. flanges (C), 2 ea. 150 lb. flange gaskets (D), the correct number of all-thread bolts (A), bolt gaskets (B),

FIGURE 3.1

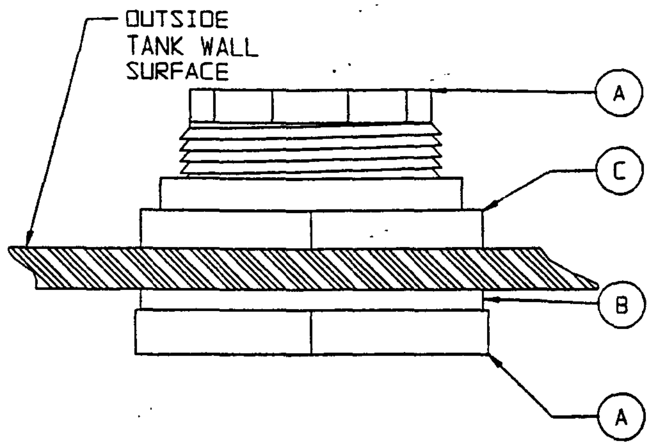


FIGURE 3.2

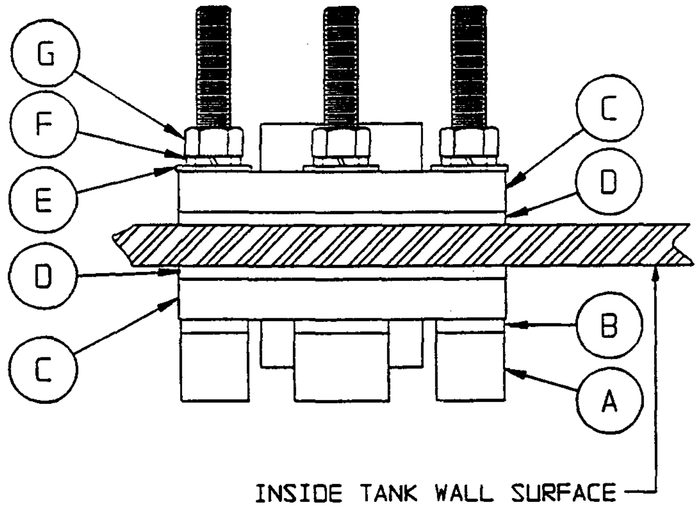
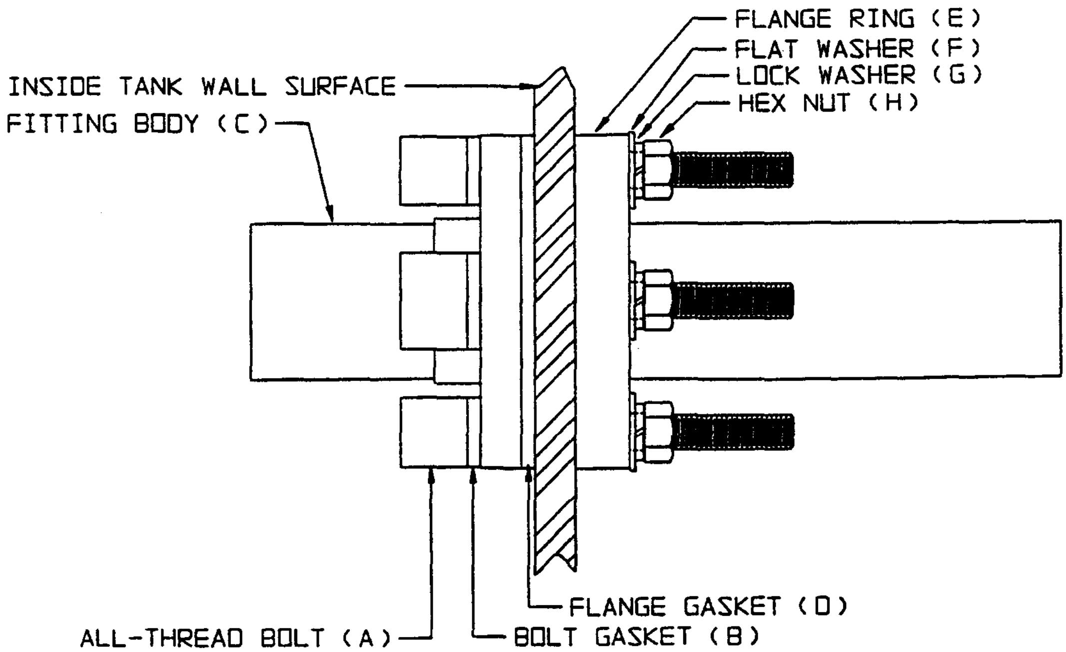


FIGURE 3.3



flat washers (E), lock washers (F), and hex nuts (G) for the flange specified. Refer to Figure 3.2 for part identification.

3.3.2 Disassemble the fitting as shipped by removing the bolt's hex nuts, lock washers, flat washers, outer flange, and outer flange gasket. Locate the fitting hole on the inside of the tank and insert the bolts (still installed on the inner flange and inner flange gasket) through the drilled holes in the tank. Place the outer flange gasket over the bolts on the outside surface to the tank. Place the outer flange over the outer gasket and bolts. Install the flat washers, lock washers, and hex nuts on the bolts. Check to make sure the fitting assembly appears as shown in Figure 3.2.

3.3.3 To obtain proper gasket compression, tighten all the fitting nuts hand tight with a socket in an opposing bolt pattern until the gaskets engage the tank wall and the lock washers are compressed. Tighten each nut an additional 3 turns using the opposing bolt pattern (do not tighten more than 1 turn at a time). A light application of lubricating oil is necessary to prevent thread seizing on 304 S.S. bolts. Due to material cold flow it may be necessary to recheck tightness after 1 week. Gasket compression should be between 25 - 50%.

3.4 BOLTED DOUBLE WALL 150 LB. FLANGE FITTINGS

3.4.1 The bolted double wall flange fitting shall be constructed with 1 ea. 150 lb. flanged fitting body (C), 1 ea. 150 lb. flange gaskets (D), 1 ea. 150 lb. flange ring (E), the correct number of all-thread bolts (A), bolt gaskets (B), flat washers (F), lock washers (G), and hex nuts (H) for the flange specified. Refer to Figure 3.3 for part identification.

3.4.2 Disassemble the fitting as shipped by removing the bolt's hex nuts, lock washers, flat washers, and flange ring. Locate the fitting hole on the inside of the tank and insert the bolts (still installed on the flanged fitting body and flange gasket) through the drilled holes in the tank. Place the flange ring over the bolts. Install the flat washers, lock washers, and hex nuts on the bolts. Check to make sure the fitting assembly appears as shown in Figure 3.3.

3.4.3 To obtain proper gasket compression, tighten all the fitting nuts hand tight with a socket in an opposing bolt pattern until the gasket engages the tank wall and the lock washers are compressed. Tighten each nut an additional 2 turns using the opposing bolt pattern (do not tighten more than 1 turn at a time). A light application of lubricating oil is necessary to prevent thread seizing on 304 S.S. bolts. Due to material cold flow it may be necessary to recheck tightness after 1 week. Gasket compression should be between 25 - 50%.

3.5 BOLTED STAINLESS STEEL FITTINGS

3.5.1 The bolted stainless steel fitting shall be constructed with 1 ea. fitting body with welded studs (A), 1 ea. fitting gasket (B), 1 ea. fitting cover plate (C), and the correct number of lock washers (D), and hex nuts (E) for the flange specified. Refer to Figure 3.4 for part identification.

3.5.2 Disassemble the fitting as shipped by removing the hex nuts, lock washers, and cover

FIGURE 3.4

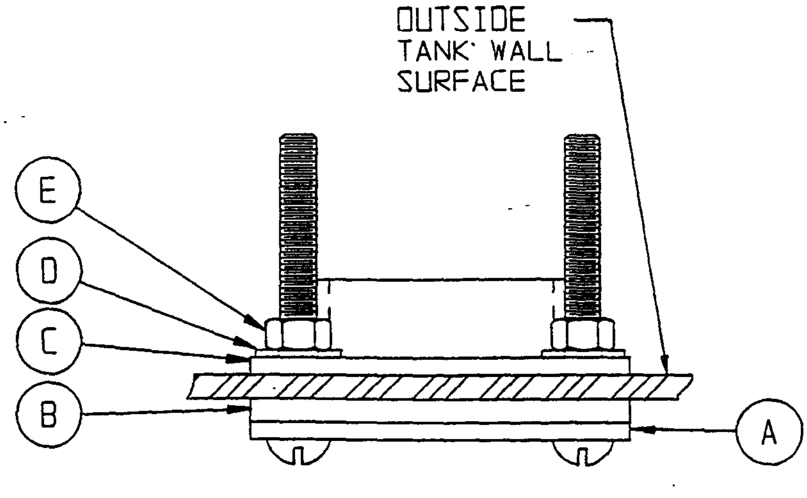
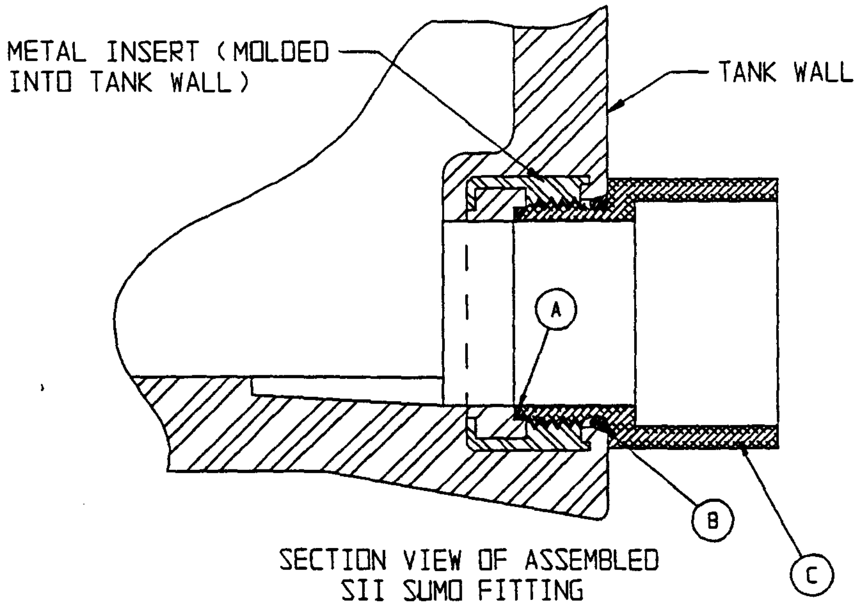
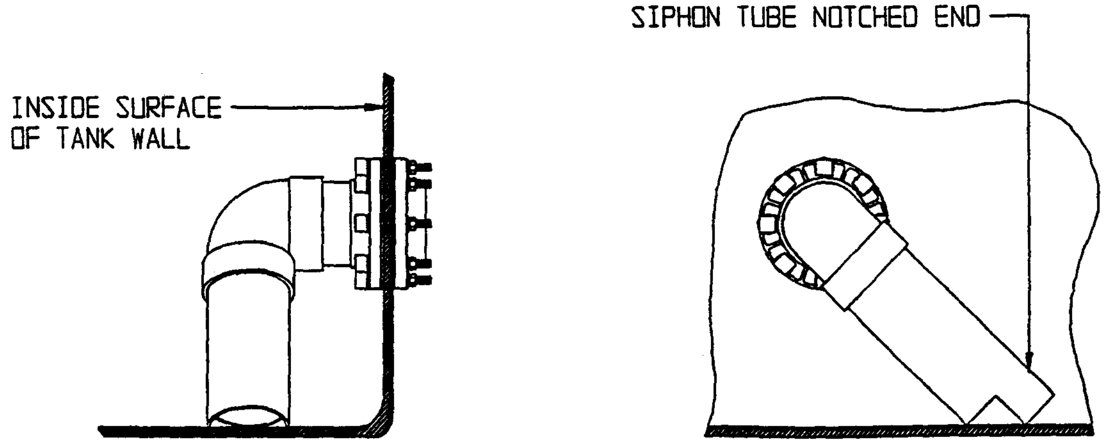


FIGURE 3.5



SECTION VIEW OF ASSEMBLED
SII SUMO FITTING

FIGURE 3.6



SECTIONAL SIDE VIEW

SECTIONAL END (INSIDE OF TANK) VIEW

plate. Locate the fitting hole on the inside of the tank and insert the fitting's studs through the drilled holes in the tank. Place the cover plate over the studs on the outside surface of the tank. Install the lock washers and hex nuts on the studs. Check to make sure the fitting assembly appears as shown in Figure 3.4.

3.5.3 To obtain proper gasket compression, tighten all the fitting nuts hand tight with a socket in an opposing bolt pattern until the gasket engages the tank wall and the lock washers are compressed. Tighten each nut an additional 1-1/4 - 2 turns using the opposing bolt pattern (do not tighten more than 1 turn at a time). Do not apply more than 15 ft. - lbs. of torque. A light application of lubricating oil is necessary to prevent thread seizing on 304 S.S. bolts. Due to material cold flow it may be necessary to recheck tightness after 1 week. Gasket compression should be between 25 - 50%.

3.6 SNYDER UNITIZED MOLDED OUTLET - (SUMO™) (PATENT PENDING)

3.6.1 The SUMO fitting shall be constructed with 1 ea, smaller o-ring (A), 1 ea. larger o-ring (B), and 1 ea. PVC SUMO adapter (C). Refer to Figure 3.5 for part identification. NOTE - The tank is shipped with a shipping stabilizer installed in the SUMO outlet. NEVER move the container without the shipping stabilizer installed.

3.6.2 Once the tank has been placed on its foundation correctly, remove the shipping stabilizer and clean away any dirt or debris from the SUMO outlet threads and o-ring seats. Use only a soft moist cloth. NEVER USE A TOOL THAT COULD SCRATCH THE O-RING SEATS.

3.6.3 Install the smaller o-ring inside the SUMO molded-in fitting. Make sure it is placed in the o-ring seat area evenly. Carefully stretch the larger o-ring enough to install it on the PVC adapter. The o-ring may be lubricated with a suitable lubricant such as water. Screw the adapter in until the step on the adapter is flush with the tank wall. Do not over-torque the adapter (25 ft. - lbs. of torque maximum). Figure 3.5 shows a sectional view of an assembled SUMO fitting to assist with assembly.

3.6.4 Once the SUMO adapter is installed, other PVC components may be solvent welded to the adapter. A union or flange adapter with a flexible expansion joint should be installed as close to the tank as possible to allow for future disassembly.

3.7 SIPHON TUBE FITTINGS

3.7.1 Siphon tubes may be added to the fittings specified in sections 3.1, 3.3, 3.4, and 3.5. Siphon tubes shall be customer installed after the fitting has been installed.

3.7.2 PVC and CPVC siphon tubes need to be solvent welded with the proper solvent cement into the socket of a previously installed fitting. Threaded siphon tubes need to be threaded in place with teflon pipe sealant applied to the threads.

3.7.3 Siphon tubes should be located with the cut notch corner in close proximity with the floor of the tank for maximum drainage and the siphon tube tilted to the side of the fitting. Refer to Figure 3.6 for proper placement of the siphon tube in the tank.

4. TANK ATTACHMENTS

4.1 U-VENTS

4.1.1 Standard u-vents are constructed from schedule 40 PVC and are provided with a loose male adapter. This allows the customer to cut the u-vent to desired height and use the u-vent in a threaded or solvent weld socket fitting.

4.1.2 When installing the u-vent in a PVC solvent weld socket fitting, solvent weld the u-vent with the proper solvent cement in the desired position into a previously installed fitting. If the u-vent is to be used in a threaded fitting, solvent weld the male adapter provided to the u-vent and install the u-vent assembly into a previously installed threaded fitting. Refer to Figure 4.1 for an exploded illustration of this assembly.

4.2 DOWN PIPES - EXTERNAL AND/OR INTERNAL

4.2.1 Down pipes are shipped loose and have been cut to size to meet customer specifications. All down pipes shall be supported at 5 ft. maximum intervals with the support structures provided. NOTE - It is easier to install down pipes with the tank lying horizontally on a clean smooth surface chocked to prevent tank movement.

4.2.2 Assemble the piping loosely using Figure 4.2, the guidelines detailed below, and the customer approved tank drawing to ensure all parts are present and cut to meet the customer's requirements. As soon as all parts have been checked, assembly with solvent weld cement and/or threaded connections may begin.

4.2.3 Assemble and install support structures as shown in Figure 4.2 (without the saddle clamp cover caps and clips). Make sure support clamp orientation is correct (with the small width of the wedge toward the top of the tank) and that plugged the support pipes are installed with the plugged end as close to the support fitting as possible. Assemble and install piping as per the customer approved drawing. As piping is being installed on the tank, lock it in place with the saddle clamp cover caps and clips provided (make sure that the sealing o-rings are in the proper position as the pipe is positioned into the saddle support body). Seal all threaded pipe connections with teflon pipe sealant and connect solvent weld sockets with the correct solvent cement.

4.3 SIGHT LEVEL GAGES

4.3.1 Sight level gage assemblies are shipped loose and have been cut to size to meet customer specifications. Sight gages may be ordered with no valves, 1`, 2, or 3 valves. Please refer to the customer approved drawing to determine the number of valves required.

4.3.2 Using the assembly drawings shown in Figure 4.3, verify that all parts are present and assemble the unit per the appropriate drawing. Seal all threaded pipe connection with teflon pipe sealant. Gallonage decals may be purchased as separate items and customer applied to the tank to assist in indication of tank gallonage.

4.4 FLANGE ADAPTERS

4.4.1 Standard flange adapters are constructed from schedule 40 PVC and may be purchased for solvent weld socket fittings or threaded fittings. Flange adapters for threaded fittings are provided with loose male adapter to allow the customer to adjust adapter length and

FIGURE 4.1

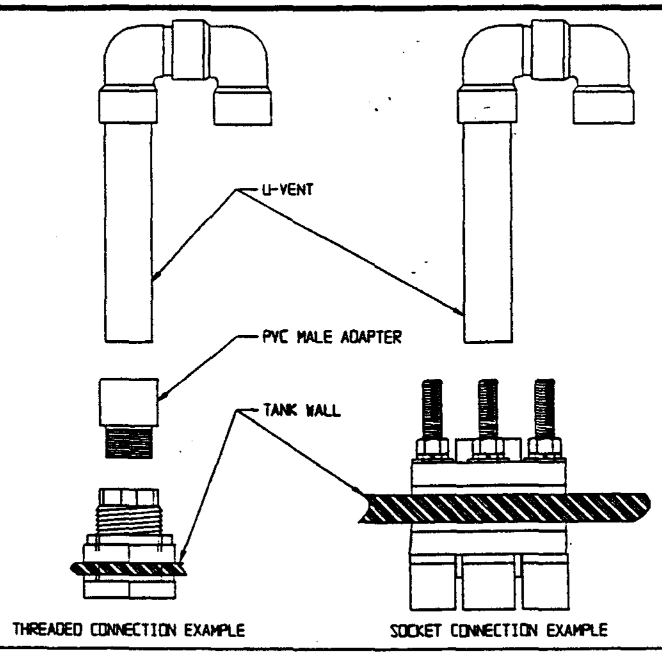


FIGURE 4.2

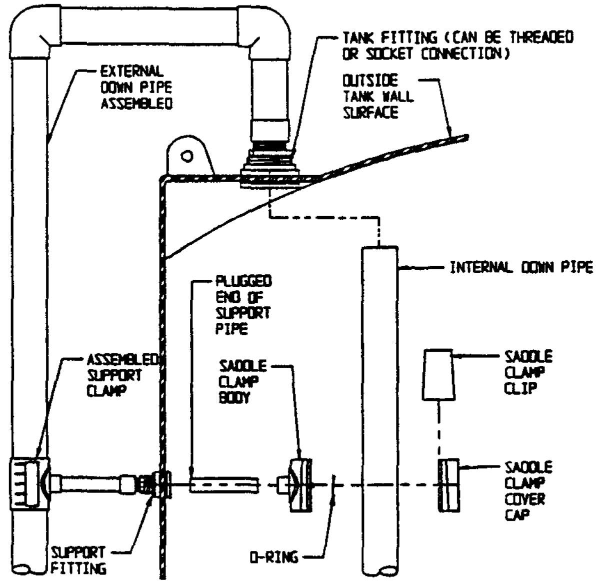
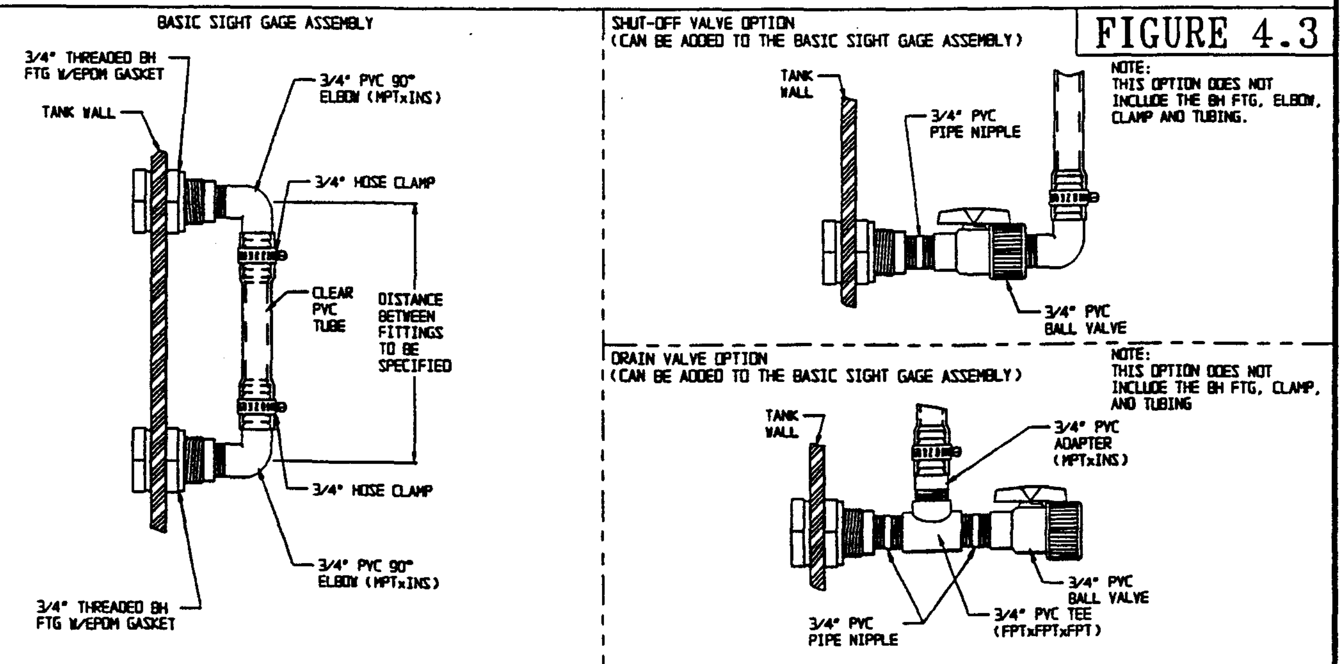


FIGURE 4.3



flange position to match the piping at the installation. Refer to Figure 4.4 for an illustration of a flange adapter.

4.4.2 When installing the flange adapter in a PVC solvent weld socket fitting, cut the flange adapter to desired length and solvent weld the flange adapter with the proper solvent cement in the desired position in a previously installed fitting. If the flange adapter is to be used in a threaded fitting, install the male adapter into the fitting with teflon pipe sealant, cut the flange adapter to the desired length, and solvent weld the flange adapter to the desired length, and solvent weld the flange adapter to the male adapter in the desired position with the proper PVC solvent cement.

5. TANK ACCESSORIES

5.1 LATERAL RESTRAINT SYSTEM

5.1.1 The lateral restraint system is designed for tank position restraint on a concrete pad inside of an enclosed building. It is not designed for wind or seismic restraint capabilities. Using the assembly drawing and table shown in Figure 5.1, verify that all parts are present.

5.1.2 Locate the tank on the concrete pad as desired. Lay out the bands around the tank (alternate long bands and short bands if both lengths are provided) with the studs and angle ends sticking out away from the tank. Fasten the bands together with the 3/8" - 16 x 4" hex head bolts as shown in the drawing. Raise the bands 17" and loosely install the anchor clips using the 1/2" - 13 hex nuts and 1/2" washers provided. Tighten the 3/8" - 16 x 4" hex head bolts to remove band looseness. Mark the slot locations of the anchor clips and install the required number of 1/2" anchor bolts. Anchor bolts are not provided by the manufacturer and must be purchased by the customer.

5.1.3 Replace the anchor clips and secure the clips to both bands and the concrete pad. Do not over tighten the bands to the tank. The band tension should only remove looseness and not cause any tank deflection.

5.2 WIND/SEISMIC TANK RESTRAINT SYSTEM

5.2.1 The wind/seismic tank restraint system is designed for tank restraint on an appropriate concrete pad under 110 MPH wind and seismic conditions. Using the assembly drawing and table shown in Figure 5.2, verify that all parts are present.

5.2.2 Locate the tank on the concrete pad as desired. Lay out all anchors required (4 or 8) equally spaced, (4 anchors must be directly below the tank tie down locations). Make sure all anchors are located next to the tank with the 2 ea. eye bolt holes of the anchor on top of the weldment and the plate face of the anchor weldment located next to the tank. Mark all the anchor bolt locations, remove the anchors and install the required Hilti adhesive model HVA anchor bolts as specified by the assembly drawing and the SII seismic restraint drawings B-2686 through B-2688. These anchor bolts are not provided by the manufacturer and must be purchased by the customer.

5.2.3 Replace the anchors and secure the anchors to the concrete. Install the 3/4" eyebolts

FIGURE 4.4

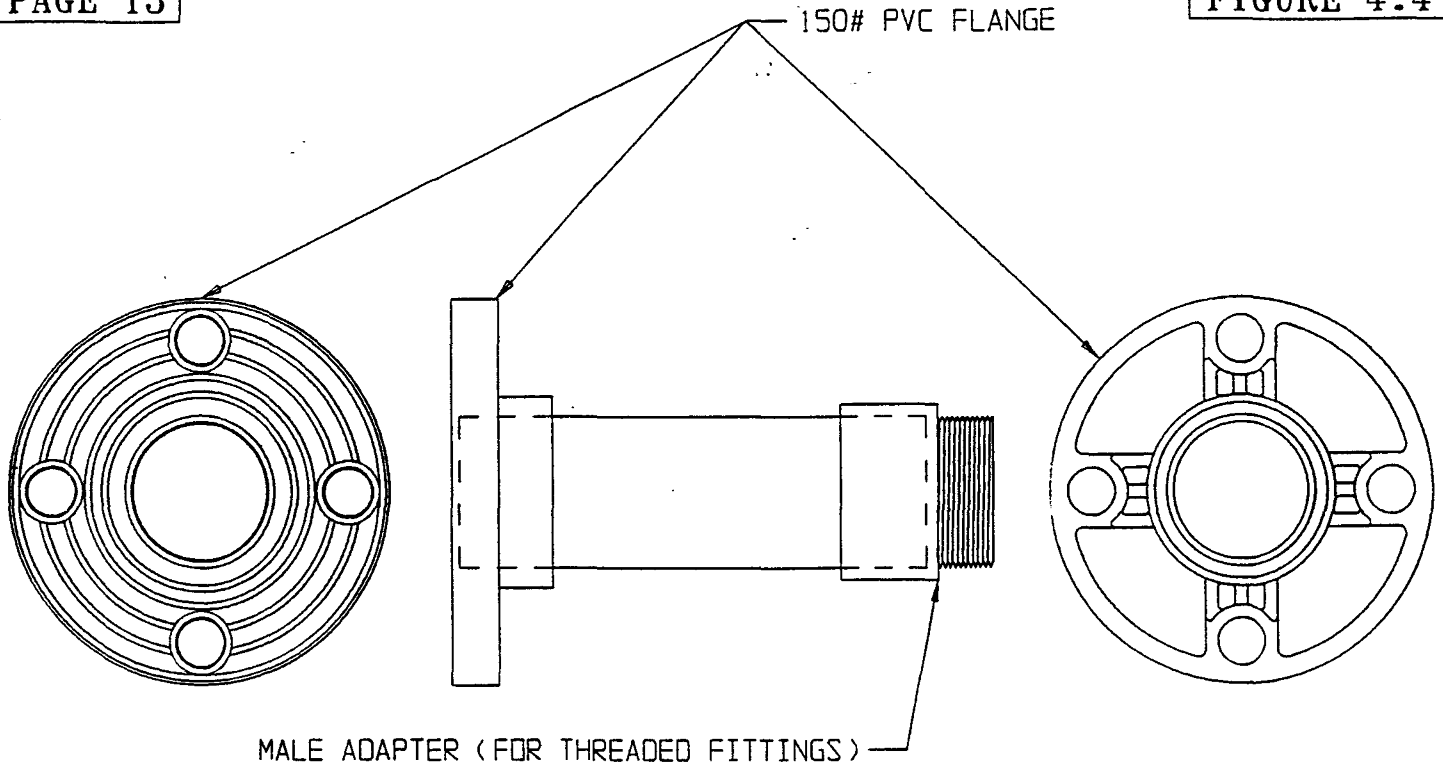
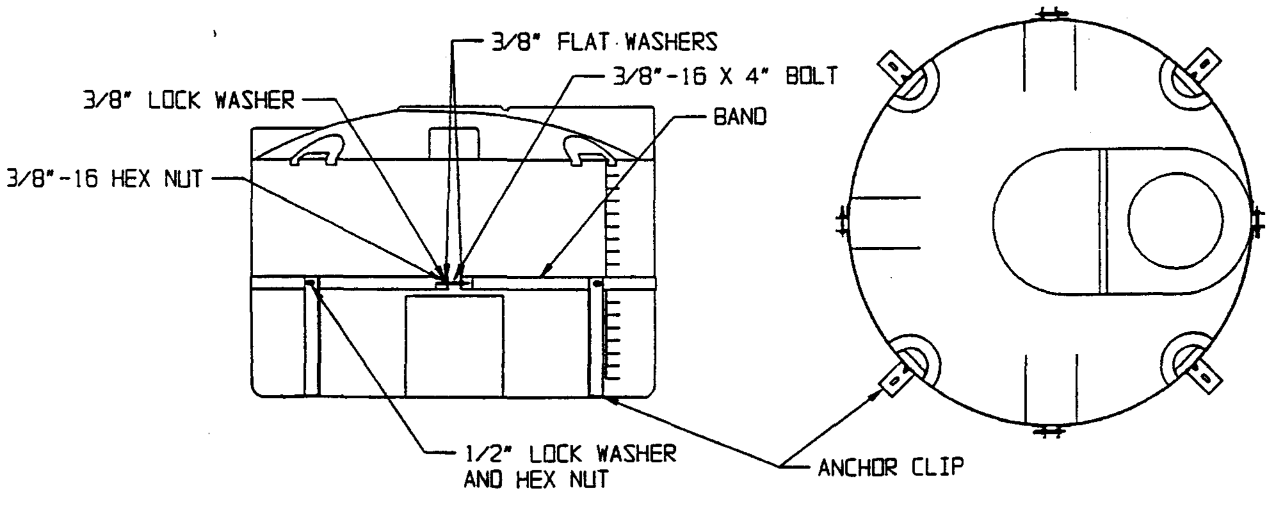
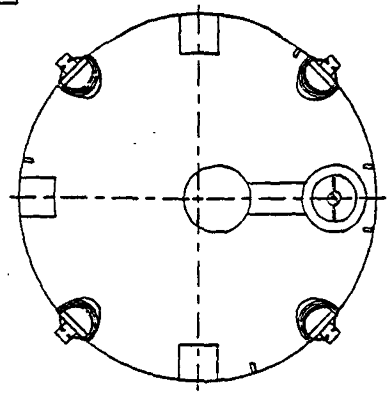


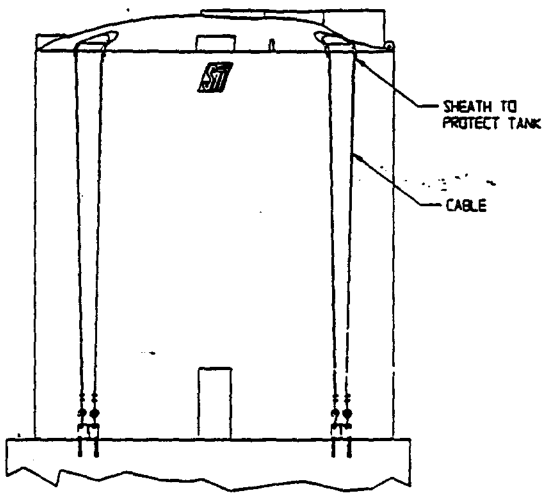
FIGURE 5.1

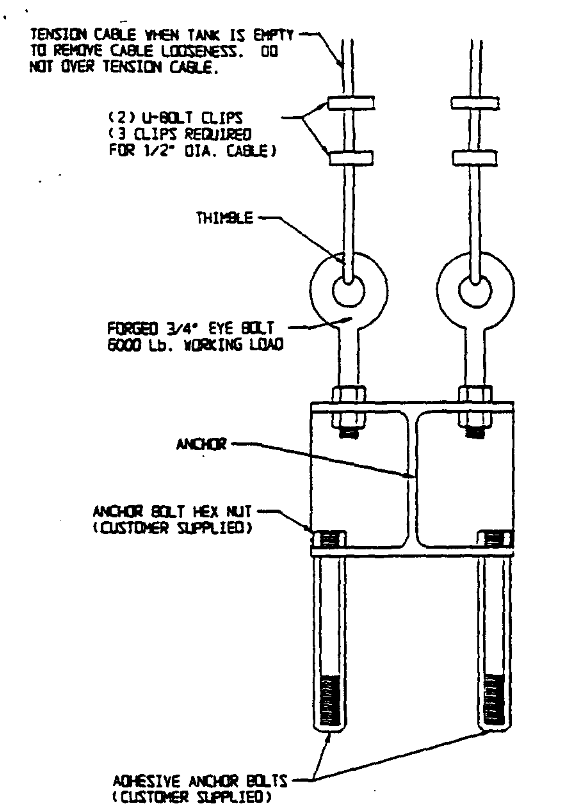


TANK DIA. (IN.)	QUANTITY REQUIRED BAND 44 IN.	BAND 48 IN.	ANCHOR CLIPS	3/8"-16 X 4" BOLTS AND HEX NUTS	3/8" FLAT WASHERS	1/2" HEX NUTS AND FLAT WASHERS
48	0	3	3	3	6	3
64	0	4	4	4	8	4
86	5	0	5	5	10	5
90	3	3	6	6	12	6
102	7	0	7	7	14	7
120	4	4	8	8	16	8
137	4	5	9	9	18	9
142	0	9	9	9	18	9

FIGURE 5.2







ANCHOR ASSEMBLY DETAIL VIEW

TANK	TANK	1.5 SPECIFIC GRAVITY FLUID				1.9 SPECIFIC GRAVITY FLUID			
SIZE (GALLONS)	DIAMETER (INCHES)	ANCHOR REQUIRED	ANCHOR QUANTITY	ANCHOR BOLT MATERIAL	CABLE DIA. (INCHES)	ANCHOR REQUIRED	ANCHOR QUANTITY	ANCHOR BOLT MATERIAL	CABLE DIA. (INCHES)
375	45	A-2678	4 EA.	4 EA. 1/2" DIA. HAS STANDARD	1/4"	A-2678	4 EA.	4 EA. 1/2" DIA. HAS STANDARD	1/4"
550	48	A-2678	4 EA.	4 EA. 1/2" DIA. HAS STANDARD	1/4"	A-2678	4 EA.	4 EA. 1/2" DIA. HAS STANDARD	1/4"
550	64	A-2678	4 EA.	4 EA. 1/2" DIA. HAS STANDARD	1/4"	A-2678	4 EA.	4 EA. 1/2" DIA. HAS STANDARD	1/4"
850	48	A-2678	4 EA.	4 EA. 1/2" DIA. HAS STANDARD	1/4"	A-2678	4 EA.	4 EA. 1/2" DIA. HAS STANDARD	1/4"
1100	64	A-2678	4 EA.	4 EA. 1/2" DIA. HAS STANDARD	1/4"	A-2678	4 EA.	4 EA. 1/2" DIA. HAS STANDARD	1/4"
1100	86	A-2678	4 EA.	4 EA. 1/2" DIA. HAS STANDARD	1/4"	A-2678	4 EA.	4 EA. 1/2" DIA. HAS STANDARD	1/4"
1225	86	A-2678	4 EA.	4 EA. 1/2" DIA. HAS STANDARD	1/4"	A-2678	4 EA.	4 EA. 1/2" DIA. HAS STANDARD	1/4"
1500	86	A-2678	4 EA.	4 EA. 1/2" DIA. HAS STANDARD	1/4"	A-2678	4 EA.	4 EA. 1/2" DIA. HAS STANDARD	1/4"
1550	64	A-2678	4 EA.	4 EA. 1/2" DIA. HAS STANDARD	1/4"	A-2678	4 EA.	4 EA. 1/2" DIA. HAS STANDARD	1/4"
1650	86	A-2678	4 EA.	4 EA. 1/2" DIA. HAS STANDARD	1/4"	A-2678	4 EA.	4 EA. 1/2" DIA. HAS STANDARD	1/4"
2000	90	A-2678	4 EA.	4 EA. 1/2" DIA. HAS STANDARD	1/4"	A-2678	4 EA.	4 EA. 1/2" DIA. HAS STANDARD	1/4"
2500	90	A-2678	4 EA.	4 EA. 1/2" DIA. HAS STANDARD	1/4"	A-2678	4 EA.	4 EA. 1/2" DIA. HAS SUPER	1/4"
3000	90	A-2678	4 EA.	4 EA. 1/2" DIA. HAS SUPER	1/4"	A-2678	4 EA.	4 EA. 1/2" DIA. HAS SUPER	1/4"
3400	90	A-2678	4 EA.	4 EA. 1/2" DIA. HAS SUPER	1/4"	A-2678	4 EA.	4 EA. 1/2" DIA. HAS SUPER	3/8"
3900	90	A-2678	4 EA.	4 EA. 1/2" DIA. HAS SUPER	3/8"	A-2679	4 EA.	4 EA. 3/4" DIA. HAS STANDARD	3/8"
4400	90	A-2679	4 EA.	4 EA. 3/4" DIA. HAS STANDARD	1/2"	A-2679	4 EA.	4 EA. 3/4" DIA. HAS STANDARD	1/2"
4900	90	A-2679	4 EA.	4 EA. 3/4" DIA. HAS STANDARD	1/2"	-NA-	-NA-	-NA-	-NA-
5100	102	A-2679	4 EA.	4 EA. 3/4" DIA. HAS STANDARD	3/8"	A-2679	4 EA.	4 EA. 3/4" DIA. HAS SUPER	3/8"
6200	102	A-2679	4 EA.	4 EA. 3/4" DIA. HAS STANDARD	1/2"	-NA-	-NA-	-NA-	-NA-
5500	120	A-2679	4 EA.	4 EA. 3/4" DIA. HAS STANDARD	1/4"	A-2679	4 EA.	4 EA. 3/4" DIA. HAS SUPER	1/4"
6500	120	A-2679	4 EA.	4 EA. 3/4" DIA. HAS SUPER	1/4"	A-2679	4 EA.	4 EA. 3/4" DIA. HAS SUPER	3/8"
5600	142	A-2679	4 EA.	4 EA. 3/4" DIA. HAS STANDARD	1/4"	A-2679	4 EA.	4 EA. 3/4" DIA. HAS SUPER	1/4"
7000	142	A-2679	4 EA.	4 EA. 3/4" DIA. HAS SUPER	1/4"	A-2679	4 EA.	4 EA. 3/4" DIA. HAS SUPER	1/4"
8750	142	A-2679	4 EA.	4 EA. 3/4" DIA. HAS SUPER	1/4"	A-2679	8 EA.	4 EA. 3/4" DIA. HAS STANDARD	1/4"
10500	142	A-2679	4 EA.	4 EA. 3/4" DIA. HAS SUPER	3/8"	A-2679	8 EA.	4 EA. 3/4" DIA. HAS STANDARD	3/8"
12500	142	A-2679	8 EA.	4 EA. 3/4" DIA. HAS STANDARD	1/2"	-NA-	-NA-	-NA-	-NA-

loosely as shown by the drawing. Fasten the tank to the concrete pad with the required cable (make sure the cable sheath is on the cable and located on top of the ear locations) as shown by the assembly drawing utilizing the cable thimbles and clamps provided. Tension the cable <u>before</u> filling the tank to remove cable looseness. Do not over-tension the cables as this may cause tank damage. The cable tension will change with tank loading and temperature changes - <u>DO NOT</u> re-tension the cables.

5.3 STEEL LADDERS

5.3.1 Steel ladders are designed to be mounted next to the tank on a concrete pad at the same elevation as the bottom of the tank. The ladder mounting system is designed to allow for tank expansion and contraction due to temperature and loading changes. Using the assembly drawing and table shown in Figure 5.3, verify that all parts are present and assemble accordingly.

NOTE: This ladder is provided for tank inspection only. At no time should the operator step off this ladder onto the tank unless stepping onto an approved work platform with guard rails or utilizing some other approved safety device. Proper safety equipment (i.e. guard rails, safety harness, etc.) must be used to step onto the tank. Consult applicable regulations to determine proper equipment for other than inspection work.

5.3.2 Insert the pivoting foot assembly into the rail tube and fasten with 1 ea. 1/4" bolt, lock washer and hex nut provided at the height shown in the drawing. Attach the top pivoting attachment arms to the ladder using 1ea. 1/2"-13 x 2" hex head bolt and 2 ea. 1/2" - 13 hex nuts. Double nut each bolt by tightening the first nut to 85 ft. - lbs. of torque and then jamming the second nut to the first nut by holding the first nut and tightening the second to 85 ft. - lbs. of torque. Position the ladder on the tank and attach the top pivoting attachment arms to the tank with the ladder attachment tube and cotter pins provided (see Figure 5.3). NOTE: 120" diameter tanks require a spacer tube to be placed between the ladder lugs and the cotter pin hole positions on the attachment tube (2 spacers required). Position the ladder parallel with the side of the tank and mark the 1/4" anchor bolt locations. Install appropriate 1/4" anchor bolts and attach the bottom of the ladder to the concrete pad. Anchor bolts are not provided by the manufacturer and must be purchased by the customer.

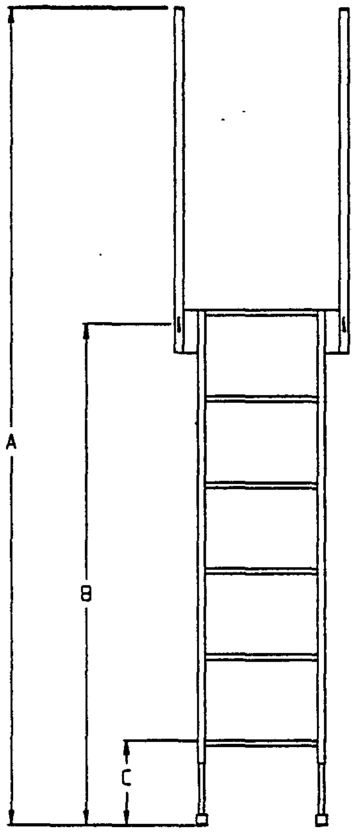
5.3.3 Ladder rung height may be adjusted by the customer if desired by using another mounting hole for the pivoting assembly. However, the bottom rung height must never exceed 12" due to OSHA requirements. Also do not adjust the ladder too high, since lower ladder settings are best for ladder operation.

5.4 STEEL LADDER CAGES

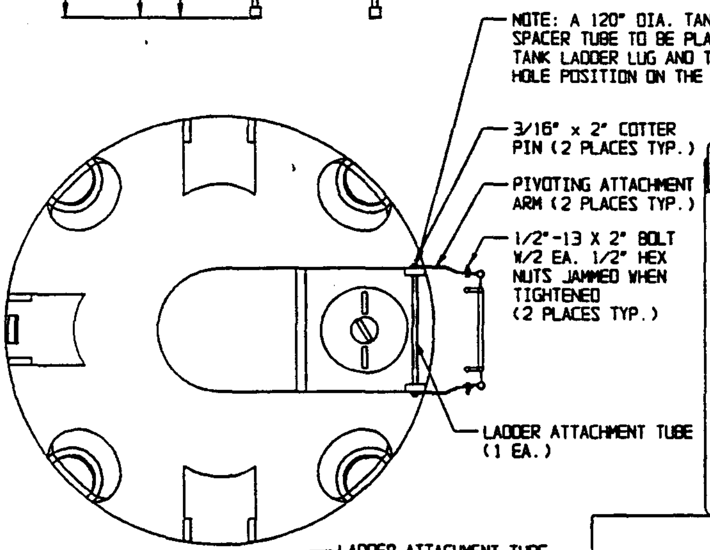
5.4.1 Using the instructions in section 5.4.2, verify that all parts are present. These cages are designed for use only with the SII steel ladder design. Cages are required for ladders used to ascend to heights exceeding 20 ft.

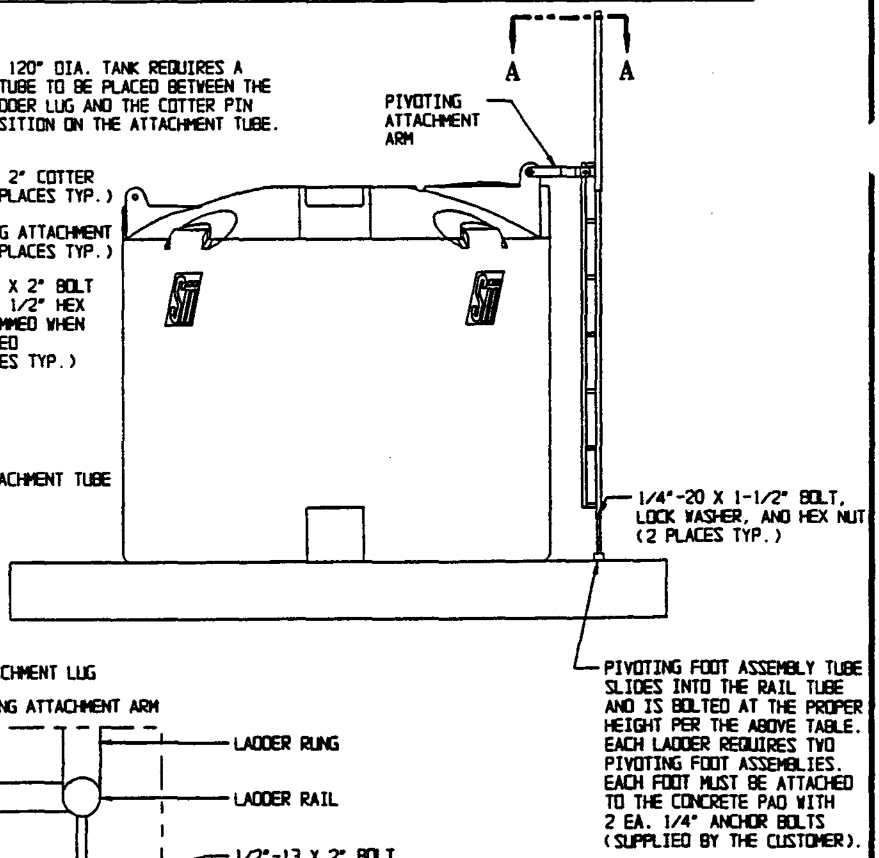
NOTE: Assembly is easier if the cages are installed on the ladder before the ladder installation to the tank.

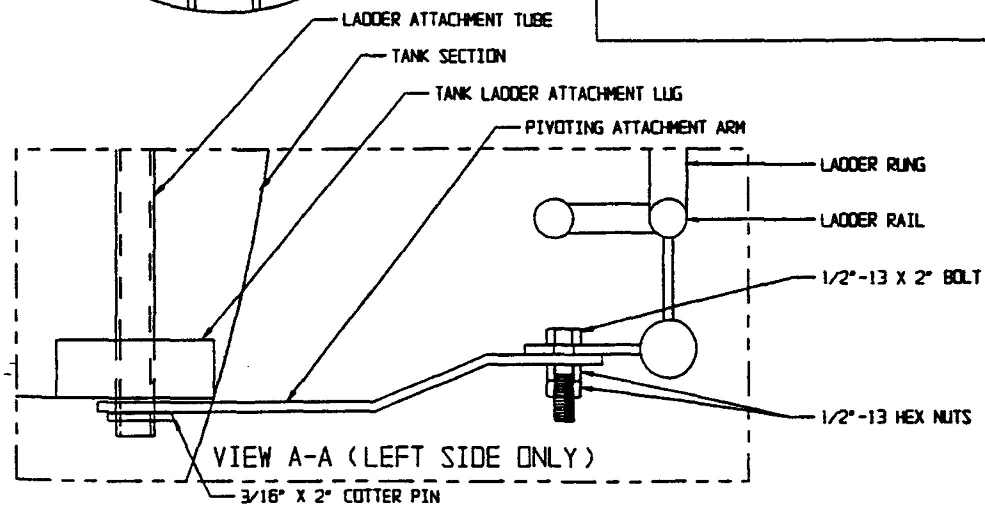
FIGURE 5.3



TANK SIZE	TANK P/N	A	B	C	CAGE	SPACER
2000 X 90	505XXX	126.0	84.0	12	NO	NO
2500 X 90	509XXX	145.0	103.0	7	NO	NO
3000 X 90	513XXX	162.0	122.0	12	NO	NO
3400 X 90	517XXX	181.0	140.0	7	NO	NO
3900 X 90	519XXX	198.0	158.0	12	NO	NO
4400 X 90	521XXX	219.0	178.0	9	NO	NO
4900 X 90	548XXX	239.0	197.0	5	NO	NO
5100 X 102	522XXX	203.0	158.0	5	NO	NO
5500 X 90	702XXX	258.0	215.0	12	NO	NO
5500 X 120	700XXX	159.0	119.0	9	NO	8-3008
5600 X 142	525XXX	126.0	85.0	12	NO	NO
6000 X 90	708XXX	277.0	234.0	7	NO	NO
6200 X 102	526XXX	234.0	189.0	12	NO	NO
6500 X 120	714XXX	181.0	140.0	7	NO	8-3008
7000 X 142	530XXX	147.0	105.0	9	NO	NO
7000 X 90	722XXX	313.0	271.0	7	YES	NO
7400 X 90	728XXX	330.0	289.0	12	YES	NO
7900 X 90	734XXX	351.0	308.0	9	YES	NO
8400 X 90	738XXX	366.0	326.0	12	YES	NO
8750 X 142	536XXX	169.0	129.0	7	NO	NO
10500 X 142	533XXX	193.0	152.0	7	NO	NO
12500 X 142	535XXX	222.0	181.0	12	NO	NO
15000 X 142	537XXX	258.0	217.0	12	NO	NO
22000 X 142	539XXX	359.0	316.0	5	YES	NO







VIEW A-A (LEFT SIDE ONLY)

5.4.2 Install the cages loosely using the u-bolts provided starting with the top cage unit (4 ft. unit with a larger bolt pattern). The bottom cage unit must have a larger diameter at the bottom than at the top of the unit and the bottom edge of the unit be located a minimum of 7 feet and a maximum of 8 feet above the ground. When the cage units have been properly located and spaced evenly, tighten the u-bolts securely.

5.5 FRP LADDERS (up to 300" height)

5.5.1 FRP ladders are designed to be mounted next to the tank on a concrete pad at the same elevation as the bottom of the tank. The ladder mounting system is designed to allow for tank expansion and contraction due to temperature and loading changes. Using the assembly drawing and table shown in Figure 5.4, verify that all parts are present and assemble accordingly.

NOTE: This ladder is provided for tank inspection only. At no time should the operator step off this ladder onto the tank unless stepping onto an approved work platform with guard rails or utilizing some other approved safety device. Proper safety equipment (i.e. guard rails, safety harness, etc.) must be used to step onto the tank. Consult applicable regulations to determine proper safety equipment.

5.5.2 Attach the stainless steel top pivoting attachment arms to the ladder using the 1/2" bolt and 3/4" bushing assemblies (2 required) as shown in Figure 5.4. Position the ladder on the tank and attach the top pivoting attachment arms to the tank with the ladder attachment tube and cotter keys provided (see assembly drawing). Position the ladder parallel with the side of the tank and mark 4 ea. 5/8" anchor bolt locations. Install appropriate 5/8" anchor bolts and attach the bottom of the ladder to the concrete pad. Anchor bolts are not provided by the manufacturer and must be purchased by the customer.

5.6 FRP LADDER CAGES

5.6.1 Using the instructions in section 5.6.2, verify that the correct number of fasteners have been shipped to attach the FRP cage unit. These cages are designed for use only with the SII FRP ladder design. Cages are required for ladders used to ascend to heights exceeding 20 ft.

NOTE: Assembly is easier if the cage unit is installed on the ladder before the ladder installation to the tank.

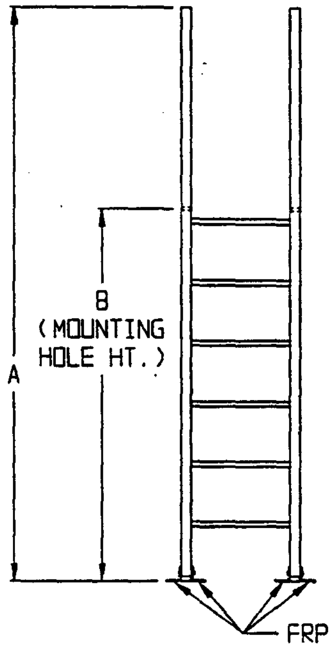
5.6.2 Position the cage unit on the ladder with the flared end toward the ladder base. Attach the cage to the ladder using the 3/8" stainless steel bolts provided (4 bolt assemblies per horizontal cage hoop).

5.7 HORIZONTAL TANK SUPPORT SADDLES

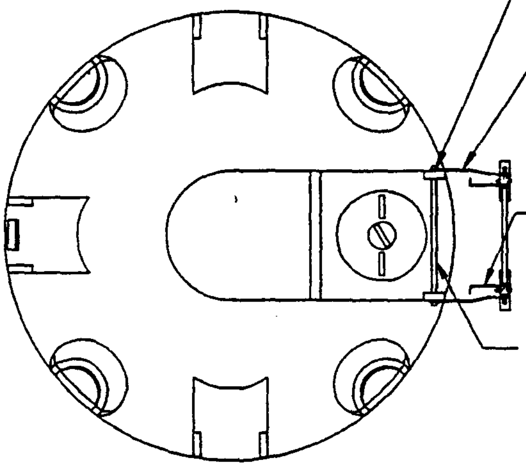
5.7.1 Horizontal tank support saddles are designed to provide adequate support for SII horizontal tanks (up to 500 gallon size). Additional structural attachments may be necessary depending upon the specific application. Use the assembly drawing shown in Figure 5.5 to assist in part identification and assembly.

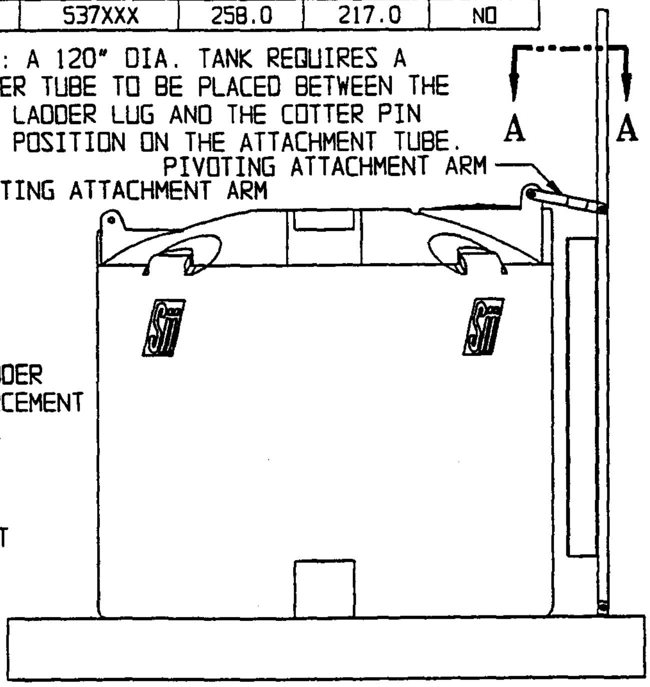
FIGURE 5.4

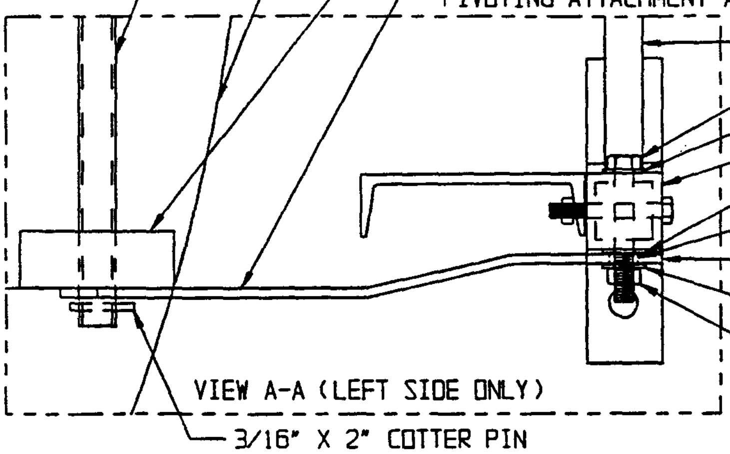
TANK SIZE	TANK P/N	A	B	SPACER
2000 X 90	505XXX	126.0	85.5	NO
2500 X 90	509XXX	145.0	105.0	NO
3000 X 90	513XXX	166.0	122.0	NO
3400 X 90	517XXX	181.0	141.0	NO
3900 X 90	519XXX	202.0	158.0	NO
4400 X 90	521XXX	219.0	178.0	NO
4900 X 90	548XXX	238.0	197.0	NO
5100 X 102	522XXX	204.0	158.0	NO
5500 X 90	702XXX	258.0	214.0	NO
5500 X 120	700XXX	160.0	120.0	YES
5600 X 142	525XXX	126.0	87.0	NO
6000 X 90	708XXX	277.0	233.0	NO
6200 X 102	526XXX	234.0	190.0	NO
6500 X 120	714XXX	181.0	140.0	YES
7000 X 142	530XXX	147.0	106.0	NO
8750 X 142	536XXX	170.0	130.0	NO
10500 X 142	533XXX	193.0	152.0	NO
12500 X 142	535XXX	222.0	181.0	NO
15000 X 142	537XXX	258.0	217.0	NO



NOTE: A 120" DIA. TANK REQUIRES A SPACER TUBE TO BE PLACED BETWEEN THE TANK LADDER LUG AND THE COTTER PIN HOLE POSITION ON THE ATTACHMENT TUBE.







VIEW A-A (LEFT SIDE ONLY)

5.7.2 Position the saddle(s) provided in the desired location. If two saddles are required, position the saddles as close to the end of the cylindrical part of the tank as possible lining up a band mounting hole with the center of the band location on the tank. Place a galvanized tank cradle on the saddles if more than one saddle is required (this is an optional item that must be used for liquids with a specific gravity greater than 1.0 or for elevated tank applications). Place the padding provided over the saddle locations on top of the cradle (if a cradle is not used, place directly on the saddle(s)). Place the tank on top of the padding and adjust the position of the components as necessary. Install bands with j-bolts provided and tension firmly. Tension the bands enough to remove looseness, but not enough to cause visible tank deflection. Mount saddle/tank assembly to structural supports as required per the application. Recheck band tension after the tank has been filled.

5.8 HORIZONTAL TANK SKIDS

5.8.1 Horizontal tank skids are designed to provide adequate support for SII horizontal tanks (200-1000 gallons) and a structural support frame which provides easy attachment for a variety of stationary applications. Use the assembly drawing shown in Figure 5.6 to assist in part identification and assembly.

5.8.2 Position the skid provided in the desired location and attach as necessary for the application. Place the pads provided on the cradle of the skid lined up with band mounting hole locations. Place the tank on top of the padding. Install bands with j-bolts provided and tension firmly. Tension the bands enough to remove looseness, but not enough to cause visible tank deflection. Recheck band tension after the tank has been filled.

5.9 HORIZONTAL LEG TANK SKIDS

5.9.1 Horizontal leg tank skids are designed to provide adequate support for SII horizontal leg tanks (750-1685 gallons) and a structural support frame which provides easy attachment for a variety of stationary applications. Use the assembly drawing shown in Figure 5.7 to assist in part identification and assembly.

5.9.2 Position the skid provided in the desired location and attach as necessary for the application. Position the tank on the skid with the legs centered over the hoop mounting holes in the top of the skid (NOTE: the 1685 x 60 horizontal leg tank requires 2 ea. baffle tanks and baffle tank support plates to be positioned between the tank and the skid with the baffle tanks fitting up into the molded locations of the 1685 x 60 tank).

5.9.3 With one person on each side of the tank, insert J-bolts into the hoop holes and lift the hoops into position directly above the tank legs. Spread the hoops slightly while sliding the hoops (centered in the pipe guide channel formed into the tank legs) onto the tank. Insert the J-bolts into the proper holes in the top of the skid. Install the bevel washer, lock washer, and hex hut on each of the J-bolts loosely. Do not tighten the hex nuts yet. See view A-A shown in Figure 5.7 for an illustration of the loosely assembled J-bolt/hoop assembly.

5.9.4 Repeat the procedure as detailed in section 5.9.3 for each of the remaining hoops required. When all hoops have been loosely installed, check the tank and hoop

FIGURE 5.5

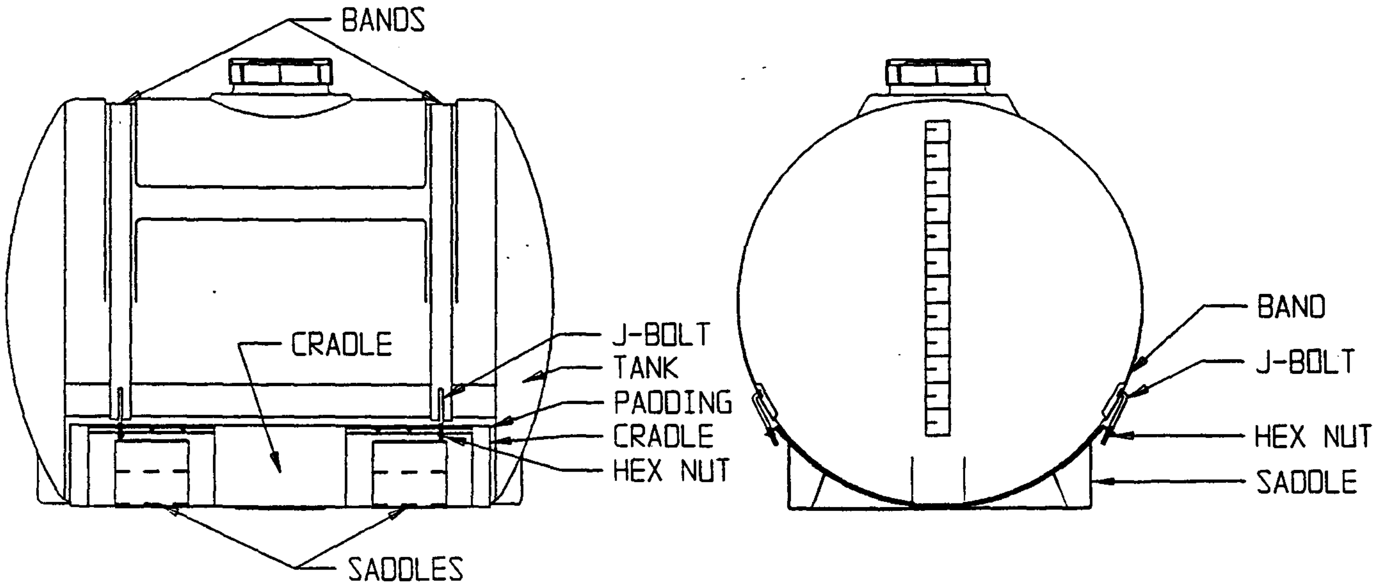
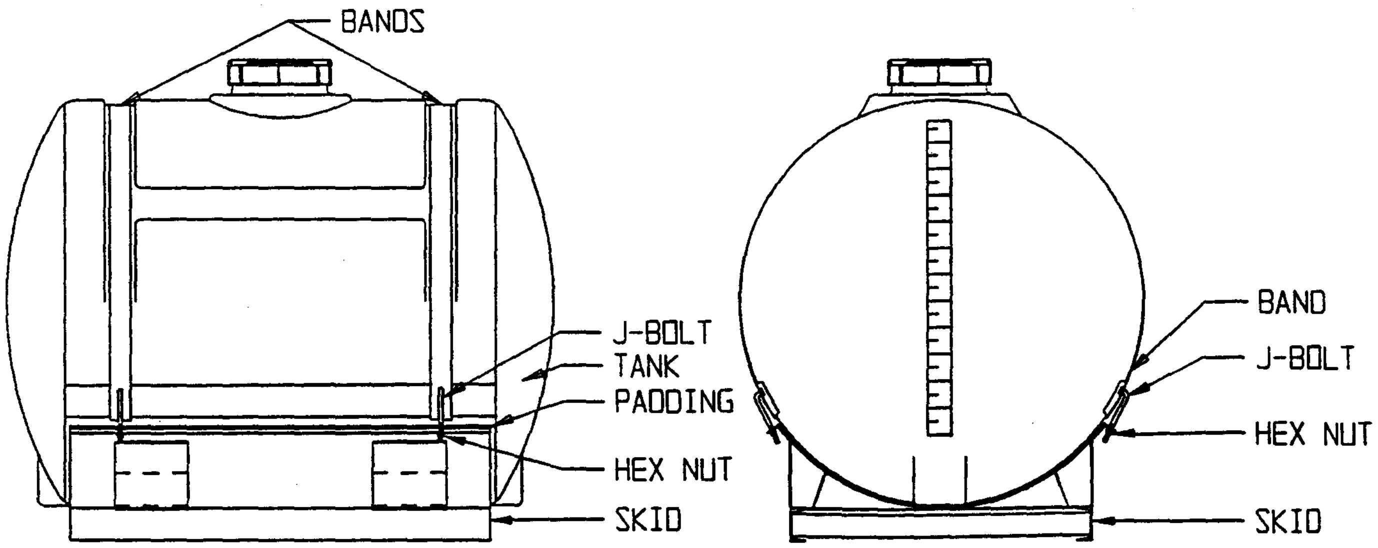


FIGURE 5.6



alignment to make sure the placement is correct. When proper alignment has been established, start tightening the hex nuts on each hoop. Tighten both sides of the hoop equally until the top of the hoop is tight all the way around the top of the tank and proper tension is obtained. Proceed to the next hoop and repeat the tightening procedure until all of the hoops have proper tension. Recheck the hoop tension after the tank has been filled.

5.10 CONE BOTTOM TANK STANDS

5.10.1 Cone bottom tank stands are designed specifically for use with SII cone bottom tanks (500 to 11,500 gallons) to provide support necessary for proper tank operation. The stands are provided as one piece welded units for minimal assembly requirements.

5.10.2 Position the cone stand provided in the desired location on a properly designed concrete pad. Stand mounting holes have been provided to secure the structure as required depending upon the tank application. (Consult site engineer for anchoring requirements.) Position the tank in the stand and complete the tank installation as necessary.

5.11 CONE BOTTOM TANK STAND EXTENSIONS

5.11.1 Cone bottom tank stand extensions are designed specifically for use with SII cone bottom tank stands. The extensions are provided in 20" and 40" welded units and are used to increase cone bottom tank clearance 20" or 40".

5.11.2 Install the extensions onto the cone stand legs with the bolt assemblies provided. Tighten bolts to 300 ft.-lbs of torque. With the extensions in place, proceed with the cone stand installation as previously described.

5.12 EQUIPMENT PLATFORMS

5.12.1 Equipment platforms are designed to provide structural support for tank fittings, piping, mixers, etc. The platforms relocate the load caused by tank accessories to the tank wall for maximum tank support. Tanks with diameters of 86" or less have equipment platforms with a rated load capacity of 400 lbs. Tanks with diameters of 90" or more have equipment platforms with a rated load capacity of 600 lbs. Refer to the assembly drawing shown in Figure 5.8 for assistance in part identification and assembly information.

5.12.2 Position the equipment platform structural components as shown in the assembly drawing on the ground. Using the fasteners provided, assemble the equipment platform and tighten the fasteners on the ground. When all fasteners have been properly installed, position the equipment platform on the tank with appropriate lifting equipment (when properly installed the platform feet should be locked behind the tank tie-down lugs). Using appropriate safety equipment, position the spacer bars appropriately to connect the tank equipment requiring support to the spacer bars and tighten U-bolts to secure the spacer bars in place. Other support pieces may be necessary to connect the tank equipment to the spacer bars and will have to be provided by the customer for the specific application.

FIGURE 5.7

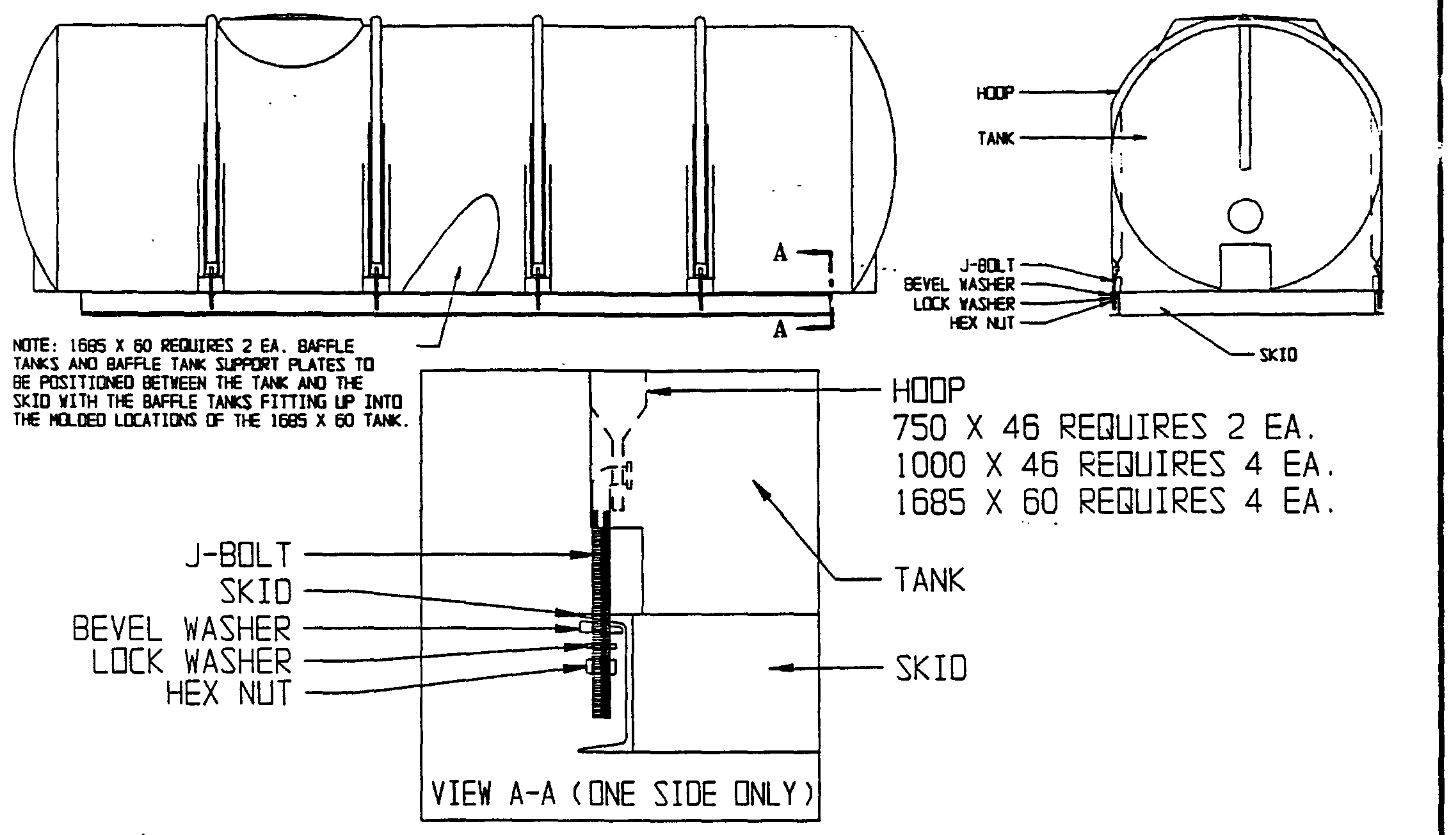


FIGURE 5.8

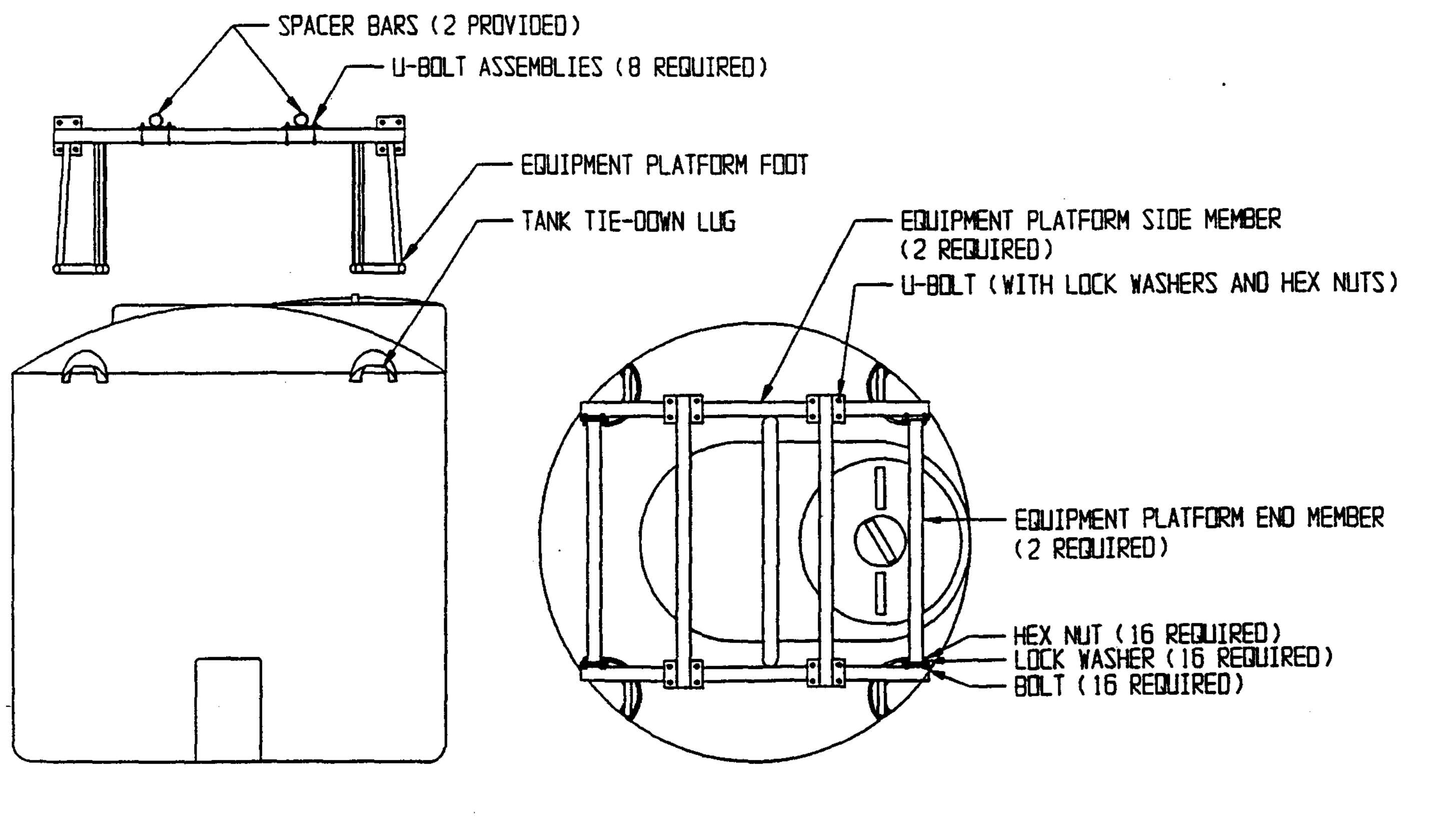
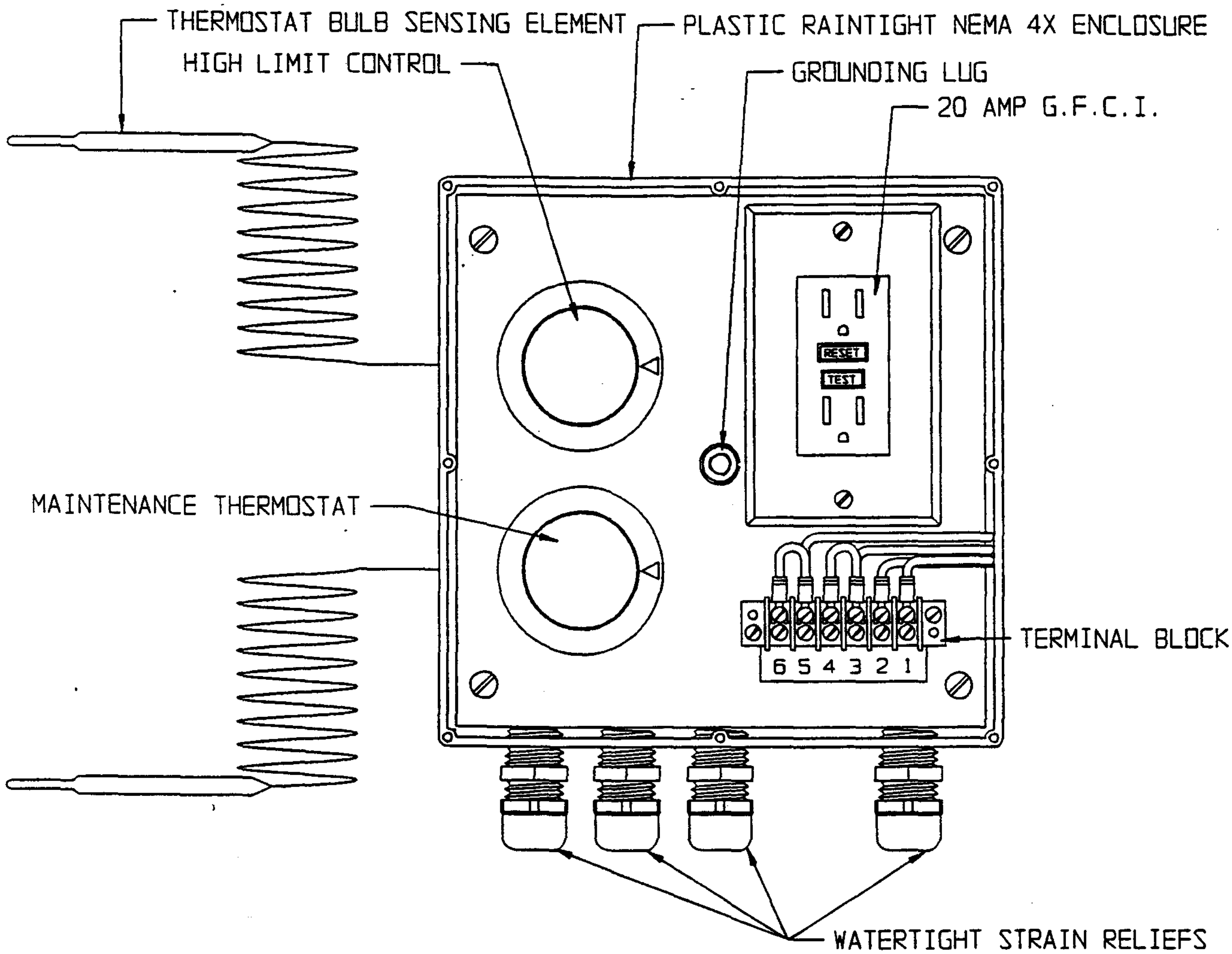
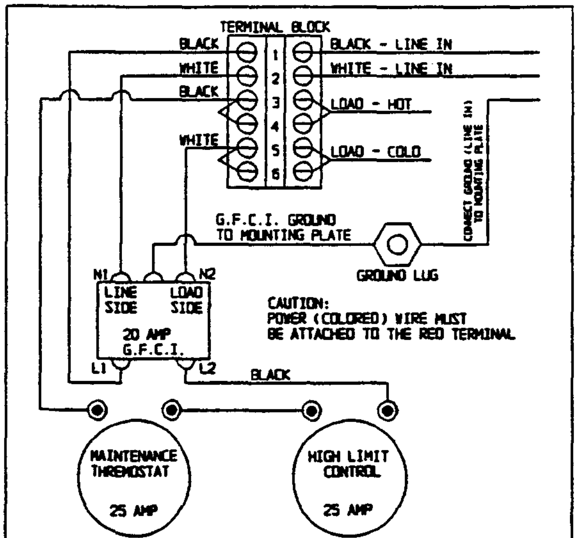


FIGURE 5.9





WIRING DIAGRAM - STANDARD 110VAC CONTROL BOX

5.13 HEATED TANKS

5.13.1 Heated tanks are insulated with a minimum of 2" of 2-3 lb./ft.^{3} polyurethane foam material with an "R" valve of 8.33/in. The insulation is sealed with 2 coats of acrylic latex mastic. Although this appears to be a tough, resilient covering, it can be easily torn or broken if the tank is not properly transported. Use only carpeted and padded equipment to move an insulated tank. Do not allow the tank to drop or roll on rough surface as this may damage the insulation.

5.13.2 Heated tanks are equipped with at least 1 control box with two thermostat controls. One thermostat regulates the maintenance temperature setting and the other thermostat control regulates the high limit temperature setting. The maintenance temperature setting should be set at the desired maintenance temperature. The high limit temperature setting should be adjusted to 10 degrees above the desired maintenance temperature to a maximum of 140 degrees Fahrenheit. The Figure 5.8 shows a standard 110 VAC control box with the cover removed. Figure 5.8 also shows the wiring diagram for the standard 110 VAC control box. Each control box has a decal attached to the inside surface of the cover with a printed wiring diagram for that specific control box.

6. TANK MAINTENANCE

6.1 TANK INSPECTION

6.1.1 Simple periodic inspections of the tank installation can prevent problems and chemical loss from occurring. Inspection intervals should be consistent with site usage (the more times liquid is processed through the tank site, the more frequent the inspections). The checking procedure should follow the following steps:

1. Inspect the tank for physical damage such as cuts, impacts, cracks, swelling, softening of tank walls, and stress cracks (caused by long term exposure to environmental conditions and stress). NOTE: A tank test kit may be purchased for stress crack analysis through the Customer Service Department at SII.

2. Inspect the fittings for broken parts, cracks, wear marks, or other signs of potential leaks.

3. Inspect gaskets for deterioration. They have a shorter life than the tank itself. Look for discoloration, bulges, checking or crazing. All of these symptoms could indicate potential failure.

4. Inspect any valves and/or pumps that may be connected to the tank. Also inspect the hoses and connections for any signs of wear.

7. SII PRODUCT POLICY STATEMENTS

7.1 SII STANDARD LIMITED WARRANTY

7.1.1 Distributor accounts and their authorized distribution have the responsibility of calling to the attention of their customer the following Snyder Industries, Inc. standard limited warranty, prior to acceptance of an order from the customer for any Snyder Industries, Inc. product.

7.1.2 Snyder Industries, Inc. warrants to the purchaser for use that if any manufactured tank product is proven to be defective in material or workmanship within 3 YEARS from the date of original invoice from factory, and Snyder Industries, Inc. is notified within 15 days after such defect is discovered, Snyder Industries, Inc. will (at company option) either replace or repair said part. This Snyder Industries Standard Limited Warranty does not apply to damage resulting from misuse, improper application of recommended materials, neglect, material wear, accident, or improper installation or maintenance. Said part will not be considered defective if it substantially fulfills performance specifications. THE FOREGOING STANDARD LIMITED WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES OF MERCHANTABILITY, FITNESS FOR PURPOSE AND OF ANY OTHER TYPE, WHETHER EXPRESSED OR IMPLIED. Snyder Industries, Inc. neither assumes nor authorizes anyone to assume for it any other obligation or liability in connection with said tank product and will not be liable for incidental or inconsequential damages. THE REMEDIES STATED HEREIN SHALL BE THE EXCLUSIVE REMEDIES AVAILABLE UNDER THIS STANDARD WARRANTY. CLAIMS UNDER THIS STANDARD LIMITED WARRANTY SHALL BE HANDLED UNDER THE SNYDER INDUSTRIES, INC. SERVICE POLICY. Snyder Industries, Inc. will not be responsible for any charges incurred in repairing or servicing any Snyder Industries, Inc. product except as such repairs are made at Snyder Industries, Inc. or by Snyder Industries, Inc. personnel or as approved in writing from Snyder Industries, Inc. Customer Service.

7.2 SII ONE YEAR LIMITED WARRANTY

7.2.1 Distributor accounts and their authorized distribution have the responsibility of calling to the attention of their customer the following Snyder Industries, Inc. ONE YEAR limited warranty, prior to acceptance of an order for a tank that is used for storage of sodium hypochlorite, sulfuric acid, hydrochloric acid and other caustic materials as SII deems appropriate.

7.3 RETURN MERCHANDISE/WARRANTY CLAIM PROCEDURE

7.3.1 SII has specific procedures for return merchandise and warranty claims. To make a claim, please contact the Customer Service Department at SII by mail or by phone:

Snyder Industries, Inc.
P.O. BOX 4583
Lincoln, NE 68504
(402) 467-5221

The following information will be required to assist in making your claim:

1. Product identification (tank size, part number, serial number, etc.)
2. SII customer order number
3. Name and phone number of person making the claim
4. Distributor/company name, address, and phone number
5. Description of reason for claim

TANK

AND

TANK ACCESSORY

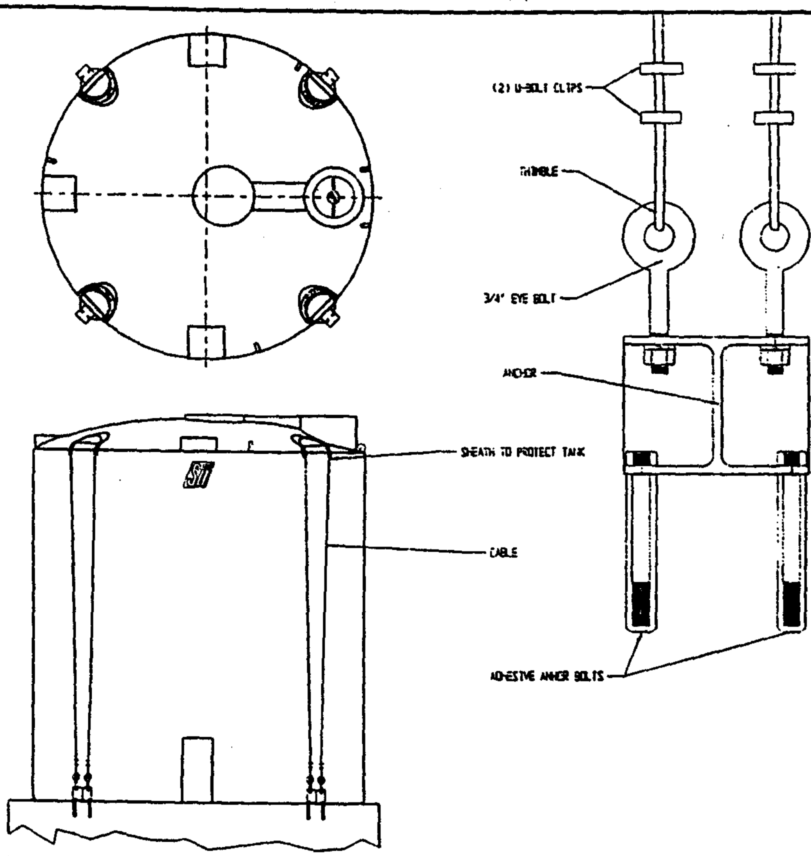
INSTALLATION

INSTRUCTIONS

SNYDER industries, inc.

P.O. BOX 4583, LINCOLN, NE 68504

SII SNYDER
industries, inc.
4700 FREMONT ST.
P.O. BOX 4583
LINCOLN, NE 68504
(402) 467-5221



WIND DESIGN:
1991 UBC SECTION 2316
110 MPH WIND
EXPOSURE Ce=1.22 (OPEN, FLAT, 0-20 FT)
CYLINDRICAL SHAPE Cq=.8
DESIGN PRESSURE: 34 PSF

SEISMIC DESIGN:
1991 UBC SECTION 2335(b) ZONE 4, HAZARDOUS, ON GRADE
Fp=ZI Cp Wp=(.4X1.5X2/3X.75)Wp
Fp=.3 Wp

GENERAL:
1. ALL DESIGN WORK IS BASED ON THE 1991 EDITION OF THE UNIFORM BUILDING CODE.
2. ALL CONSTUCTION MUST MEET LOCAL BUILDING CODE REQUIREMENTS AND BE APPROVED BY THE CONSTRUCTION SITE ENGINEER.
3. THESE GUIDELINES HAVE BEEN PROVIDED TO SPECIFY THE RESTRAINT RECOMMENDATIONS FOR SNYDER INDUSTRY BULK STORAGE TANKS.

CONCRETE MATERIAL.
1. CONCRETE SHALL ATTAIN A MINIMUM ULTIMATE 28 DAY COMPRESSIVE STRENGTH OF Fc=3000 PSI

CONCRETE REINFORCEMENT:
1 REINFORCING STEEL SHALL CONFORM TO THE REQUIREMENTS OF ASTM A615 GRADE 40 (Fy 40,000 PSI) AND/OR WELDED WIRE FABRIC PER ASTM A185.
2 LAP ALL BARS A MINIMUM OF 40 BAR DIAMETERS. LAP WIRE FABRIC 8" MINIMUM.
3 MINIMUM COVER FOR REINFORCING BARS SHALL BE AS FOLLOWS
- 3" FOR CONCRETE DEPOSITED DIRECTLY AGAINST EARTH
- 2" FOR CONCRETE DEPOSITED IN FORMS.
4 CONCRETE PAD DESIGN SHOULD BE COMPLETED BY THE CONSTRUCTION SITE ENGINEER BASED ON SPECIFIC APPLICATION.

STUCTURAL STEEL:
1. ALL STUCTURAL STEEL COMPONENTS SHALL BE NEW AND OF BASIC OPEN HEARTH PROCESS STEEL CONFORMING TO ALL APPLICABLE REQUIREMENTS OF ASTM A36 (STUCTURAL STEEL FOR BRIDGES AND BUILDINGS - Fy = 36,000 PSI.).
2. ALL ARC WELDING ELECTRODES SHALL CONFORM TO ASTM A233 FOR STEEL ARC WELDING ELECTRODES. ELECTRODES SHALL BE AS RECOMENDED BY THE MANUFACTURES FOR THE POSITIONS AND OTHER CONDITIONS OF ACTUAL USE. WELDING SHALL CONFORM TO REQUIREMENTS OF AMERICAN WELDING SOCIETY AWS D1.1.
3. ALL SHARP EDGES AND CORNERS SHALL BE REMOVED ON ALL STRUCTURAL STEEL COMPONENTS.
4. CABLES TO BE 7X19 STRANDED CORE CONSTUCTION SIZED PER CHART. MATERIAL TO BE SPECIFIED BY CUSTOMER ORDER (MINIMUM BREAKING STRENGTH EQUAL TO OR GREATER THAN 304 SS RATING).
5. ANCHOR BOLTS TO BE HILTI ADHESIVE ANCHORS, MODEL HVA WITH SIZE AND MATERIAL AS SPECIFIED PER SPECIFICATION CHART. ALL 1/2" DIA. HVA ANCHORS TO HAVE 4-1/4" EMBEDMENT. ALL 3/4" DIA. HVA ANCHORS TO HAVE 6-5/8" EMBEDMENT. ALL OTHER FASTENER MATERIALS MUST CORRESPOND TO THE TYPE OF ANCHOR SELECTED.

8/27/92

REGISTERED PROFESSIONAL ENGINEER
JAI IK CHOI
NO. 2049
EXP. 12/31/93
STRUCTURAL
STATE OF CALIFORNIA

TANK SIZE (GALLONS)	TANK DIAMETER (INCHES)	1.5 SPECIFIC GRAVITY FLUID				1.9 SPECIFIC GRAVITY FLUID			
		ANCHOR REQUIRED	ANCHOR QUANTITY	ANCHOR BOLT MATERIAL	CABLE DIA. (INCHES)	ANCHOR REQUIRED	ANCHOR QUANTITY	ANCHOR BOLT MATERIAL	CABLE DIA. (INCHES)
375	45	A-2678	4 EA.	4 EA. 1/2" DIA. HAS STANDARD	1/4"	A-2678	4 EA.	4 EA. 1/2" DIA. HAS STANDARD	1/4"
550	48	A-2678	4 EA.	4 EA. 1/2" DIA. HAS STANDARD	1/4"	A-2678	4 EA.	4 EA. 1/2" DIA. HAS STANDARD	1/4"
550	64	A-2678	4 EA.	4 EA. 1/2" DIA. HAS STANDARD	1/4"	A-2678	4 EA.	4 EA. 1/2" DIA. HAS STANDARD	1/4"
650	48	A-2678	4 EA.	4 EA. 1/2" DIA. HAS STANDARD	1/4"	A-2678	4 EA.	4 EA. 1/2" DIA. HAS STANDARD	1/4"
1100	64	A-2678	4 EA.	4 EA. 1/2" DIA. HAS STANDARD	1/4"	A-2678	4 EA.	4 EA. 1/2" DIA. HAS STANDARD	1/4"
1100	86	A-2678	4 EA.	4 EA. 1/2" DIA. HAS STANDARD	1/4"	A-2678	4 EA.	4 EA. 1/2" DIA. HAS STANDARD	1/4"
1225	86	A-2678	4 EA.	4 EA. 1/2" DIA. HAS STANDARD	1/4"	A-2679	4 EA.	4 EA. 1/2" DIA. HAS STANDARD	1/4"
1500	86	A-2678	4 EA.	4 EA. 1/2" DIA. HAS STANDARD	1/4"	A-2678	4 EA.	4 EA. 1/2" DIA. HAS STANDARD	1/4"
1550	64	A-2678	4 EA.	4 EA. 1/2" DIA. HAS STANDARD	1/4"	A-2679	4 EA.	4 EA. 1/2" DIA. HAS STANDARD	1/4"
1650	86	A-2678	4 EA.	4 EA. 1/2" DIA. HAS STANDARD	1/4"	A-2678	4 EA.	4 EA. 1/2" DIA. HAS STANDARD	1/4"

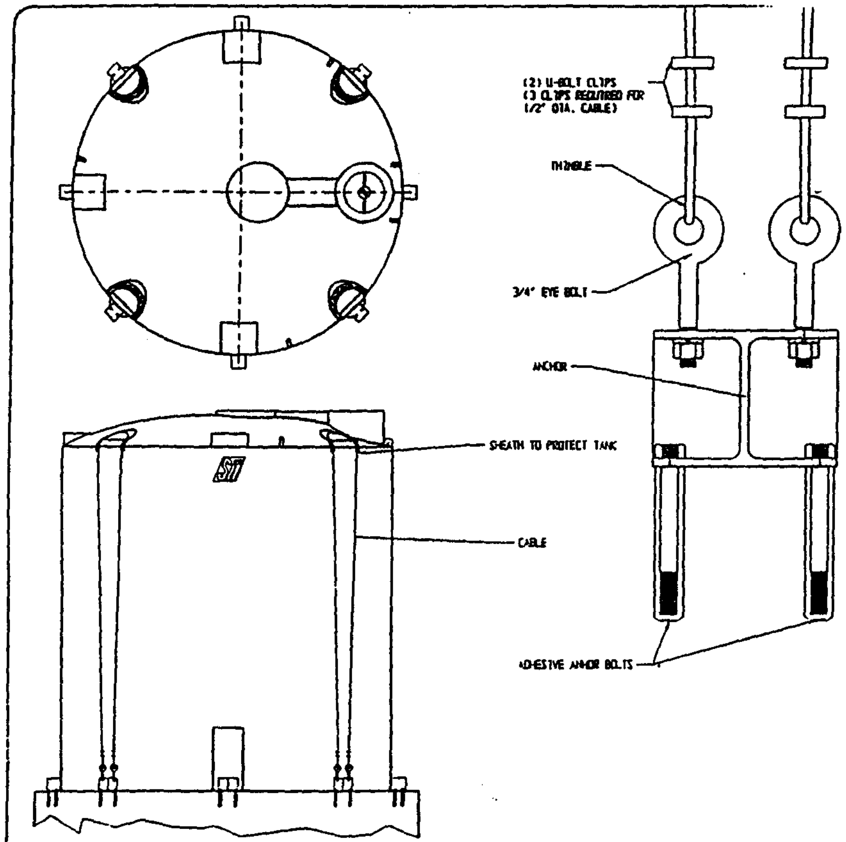
SNYDER INDUSTRIES INC.

LINCOLN, NE 68504

SCALE: NONE	APPROVED BY:	DRAWN BY D.A.D.
DATE: 8/18/92		REVISED BY: D.A.D.

S.I.I. TANK RESTRAINT APPLICATION RECOMMENDATIONS FOR S.I.I. 45" - 86" DIAMETER VERTICAL STORAGE TANKS

DRAWING NO. B-2686, PAGE 1 OF 1



TANK	TANK	1.5 SPECIFIC GRAVITY FLUID				1.9 SPECIFIC GRAVITY FLUID			
SIZE (GALLONS)	DIAMETER (INCHES)	ANCHOR REQUIRED	ANCHOR QUANTITY	ANCHOR BOLT MATERIAL	CABLE DIA. (INCHES)	ANCHOR REQUIRED	ANCHOR QUANTITY	ANCHOR BOLT MATERIAL	CABLE DIA. (INCHES)
5100	102	A-2679	4 EA.	4 EA. 3/4" DIA. HAS STANDARD	3/8"	A-2679	4 EA.	4 EA. 3/4" DIA. HAS SUPER	3/8"
6200	102	A-2679	4 EA.	4 EA. 3/4" DIA. HAS STANDARD	1/2"	-NA-	-NA-	-NA-	-NA-
5500	120	A-2679	4 EA.	4 EA. 3/4" DIA. HAS STANDARD	1/4"	A-2679	4 EA.	4 EA. 3/4" DIA. HAS SUPER	1/4"
6500	120	A-2679	4 EA.	4 EA. 3/4" DIA. HAS SUPER	1/4"	A-2679	4 EA.	4 EA. 3/4" DIA. HAS SUPER	3/8"
5600	142	A-2679	4 EA.	4 EA. 3/4" DIA. HAS STANDARD	1/4"	A-2679	4 EA.	4 EA. 3/4" DIA. HAS SUPER	1/4"
7000	142	A-2679	4 EA.	4 EA. 3/4" DIA. HAS SUPER	1/4"	A-2679	4 EA.	4 EA. 3/4" DIA. HAS SUPER	1/4"
8750	142	A-2679	4 EA.	4 EA. 3/4" DIA. HAS SUPER	1/4"	A-2679	8 EA.	4 EA. 3/4" DIA. HAS STANDARD	1/4"
10500	142	A-2679	4 EA.	4 EA. 3/4" DIA. HAS SUPER	3/8"	A-2679	8 EA.	4 EA. 3/4" DIA. HAS STANDARD	3/8"
12500	142	A-2679	8 EA.	4 EA. 3/4" DIA. HAS STANDARD	1/2"	-NA-	-NA-	-NA-	-NA-

WIND DESIGN:
1991 UBC SECTION 2316
110 MPH WIND
EXPOSURE Ce=1.22 (OPEN, FLAT, 0-20 FT.)
CYLINDRICAL SHAPE Cq=.8
DESIGN PRESSURE: 34 PSF

SEISMIC DESIGN:
1991 UBC SECTION 2336(b) ZONE 4, HAZARDOUS, ON GRADE
$F_p = ZI\,C_p\,W_p = (.4)(1.5)(2/3)(.75)W_p$
$F_p = .3\,W_p$

GENERAL:
1. ALL DESIGN WORK IS BASED ON THE 1991 EDITION OF THE UNIFORM BUILDING CODE.
2. ALL CONSTUCTION MUST MEET LOCAL BUILDING CODE REQUIREMENTS AND BE APPROVED BY THE CONSTRUCTION SITE ENGINEER.
3. THESE GUIDELINES HAVE BEEN PROVIDED TO SPECIFY THE RESTRAINT RECOMMENDATIONS FOR SNYDER INDUSTRY BULK STORAGE TANKS.

CONCRETE MATERIAL:
1. CONCRETE SHALL ATTAIN A MINIMUM ULTIMATE 28 DAY COMPRESSIVE STRENGTH OF Fc=3000 PSI.

CONCRETE REINFORCEMENT:
1. REINFORCING STEEL SHALL CONFORM TO THE REQUIREMENTS OF ASTM A615 GRADE 40 (Fy 40,000 PSI.) AND/OR WELDED WIRE FABRIC PER ASTM A185.
2. LAP ALL BARS A MINIMUM OF 40 BAR DIAMETERS. LAP WIRE FABRIC 6" MINIMUM.
3. MINIMUM COVER FOR REINFORCING BARS SHALL BE AS FOLLOWS:
   - 3" FOR CONCRETE DEPOSITED DIRECTLY AGAINST EARTH.
   - 2" FOR CONCRETE DEPOSITED IN FORMS.
4. CONCRETE PAD DESIGN SHOULD BE COMPLETED BY THE CONSTRUCTION SITE ENGINEER BASED ON SPECIFIC APPLICATION.

STUCTURAL STEEL:
1. ALL STUCTURAL STEEL COMPONENTS SHALL BE NEW AND OF BASIC OPEN HEARTH PROCESS STEEL CONFORMING TO ALL APPLICABLE REQUIREMENTS OF ASTM A36 (STUCTURAL STEEL FOR BRIDGES AND BUILDINGS - Fy = 36,000 PSI.).
2. ALL ARC WELDING ELECTRODES SHALL CONFORM TO ASTM A233 FOR STEEL ARC WELDING ELECTRODES. ELECTRODES SHALL BE AS RECOMENDED BY THE MANUFACTURES FOR THE POSITIONS AND OTHER CONDITIONS OF ACTUAL USE. WELDING SHALL CONFORM TO REQUIREMENTS OF AMERICAN WELDING SOCIETY AWS D121.
3. ALL SHARP EDGES AND CORNERS SHALL BE REMOVED ON ALL STRUCTURAL STEEL COMPONENTS.
4. CABLES TO BE 7X19 STRANDED CORE CONSTUCTION SIZED PER CHART. MATERIAL TO BE SPECIFIED BY CUSTOMER ORDER (MINIMUM BREAKING STRENGTH EQUAL TO OR GREATER THAN 304 SS RATING).
5. ANCHOR BOLTS TO BE HILTI ADHESIVE ANCHORS, MODEL HVA WITH SIZE AND MATERIAL AS SPECIFIED PER SPECIFICATION CHART. ALL 1/2" DIA. HVA ANCHORS TO HAVE 4-1/4" EMBEDMENT. ALL 3/4" DIA. HVA ANCHORS TO HAVE 6-5/8" EMBEDMENT. ALL OTHER FASTENER MATERIALS MUST CORRESPOND TO THE TYPE OF ANCHOR SELECTED.

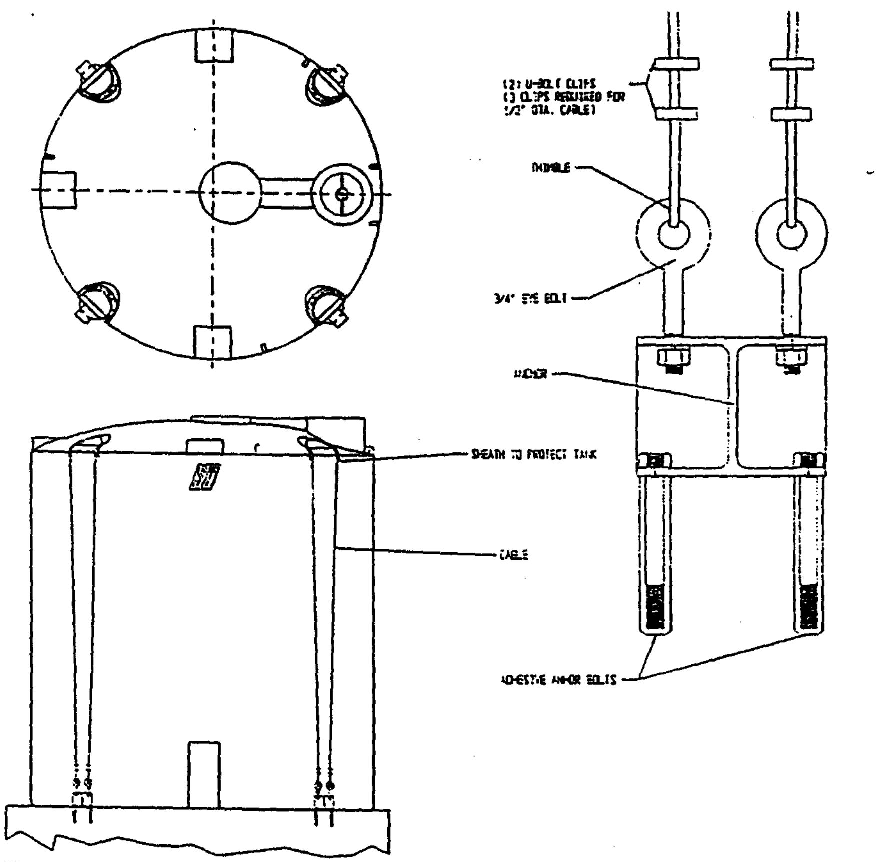
8/27/92
REGISTERED PROFESSIONAL ENGINEER
JAI IK CHOI
NO. 2049
Exp. 12/31/93
STRUCTURAL
STATE OF CALIFORNIA

SNYDER INDUSTRIES INC.
LINCOLN, NE 68504

SCALE: NONE	APPROVED BY:	DRAWN BY D.A.D.
DATE: 8/20/92		REVISED BY: D.A.D.

S.I.I. TANK RESTRAINT APPLICATION RECOMMENDATIONS
102" - 142" DIAMETER VST UP TO 12,500 1.5 SP. G.

DRAWING NO. B-2688, PAGE 1 OF 1



WIND DESIGN:
1991 UBC SECTION 2315
110 MPH WIND
EXPOSURE Ce=1.22 (OPEN, FLAT, 0-20 FT.)
CYLINDRICAL SHAPE Cq=.8
DESIGN PRESSURE: 34 PSF

SEISMIC DESIGN:
1991 UBC SECTION 2336(b) ZONE 4, HAZARDOUS, ON GRADE
Fp=ZI Cp Wp=(.4 X 1.5 X 2/3 X .75)Wp
Fp=.3 Wp

GENERAL:
1. ALL DESIGN WORK IS BASED ON THE 1991 EDITION OF THE UNIFORM BUILDING CODE.
2. ALL CONSTUCTION MUST MEET LOCAL BUILDING CODE REQUIREMENTS AND BE APPROVED BY THE CONSTRUCTION SITE ENGINEER.
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CONCRETE MATERIAL
1. CONCRETE SHALL ATTAIN A MINIMUM ULTIMATE 28 DAY COMPRESSIVE STRENGTH OF Fc=3000 PSI.

CONCRETE REINFORCEMENT:
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2. LAP ALL BARS A MINIMUM OF 40 BAR DIAMETERS. LAP WIRE FABRIC 8" MINIMUM.
3. MINIMUM COVER FOR REINFORCING BARS SHALL BE AS FOLLOWS:
   - 3" FOR CONCRETE DEPOSITED DIRECTLY AGAINST EARTH
   - 2" FOR CONCRETE DEPOSITED IN FORMS.
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2. ALL ARC WELDING ELECTRODES SHALL CONFORM TO ASTM A233 FOR STEEL ARC WELDING ELECTRODES. ELECTRODES SHALL BE AS RECOMENDED BY THE MANUFACTURES FOR THE POSITIONS AND OTHER CONDITIONS OF ACTUAL USE. WELDING SHALL CONFORM TO REQUIREMENTS OF AMERICAN WELDING SOCIETY AWS D1.1.
3. ALL SHARP EDGES AND CORNERS SHALL BE REMOVED ON ALL STRUCTURAL STEEL COMPONENTS.
4. CABLES TO BE 7X19 STRANDED CORE CONSTUCTION SIZED PER CHART. MATERIAL TO BE SPECIFIED BY CUSTOMER ORDER (MINIMUM BREAKING STRENGTH EQUAL TO OR GREATER THAN 304 SS RATING).
5. ANCHOR BOLTS TO BE HILTI ADHESIVE ANCHORS, MODEL HVA WITH SIZE AND MATERIAL AS SPECIFIED PER SPECIFICATION CHART. ALL 1/2" DIA. HVA ANCHORS TO HAVE 4-1/4" EMBEDMENT. ALL 3/4" DIA. HVA ANCHORS TO HAVE 6-5/8" EMBEDMENT. ALL OTHER FASTENER MATERIALS MUST CORRESPOND TO THE TYPE OF ANCHOR SELECTED.

8/27/92

REGISTERED PROFESSIONAL ENGINEER
JAI IK CHOI
NO. 2049
EXP. 12/31/93
STRUCTURAL
STATE OF CALIFORNIA

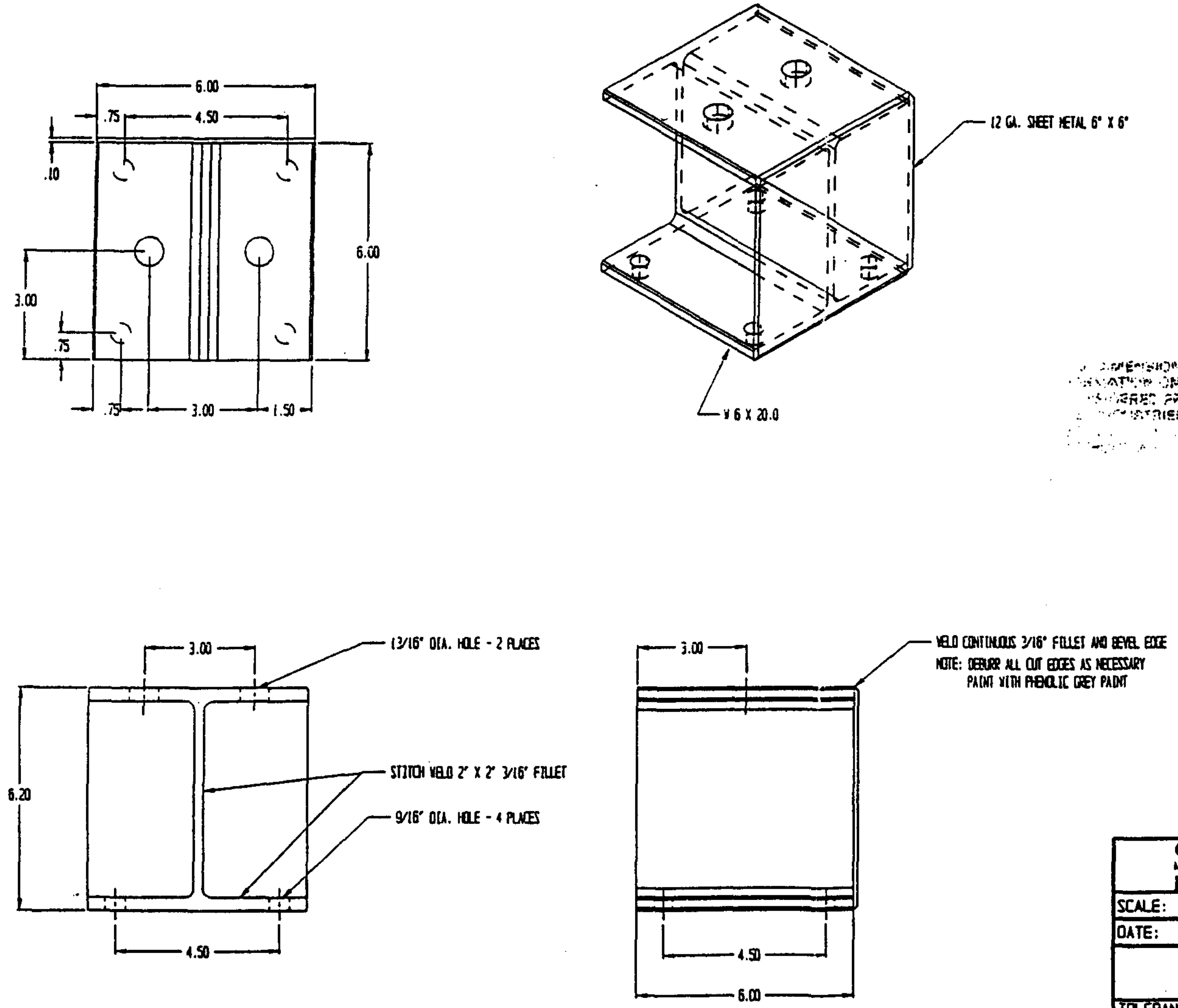
TANK SIZE (GALLONS)	TANK DIAMETER (INCHES)	1.5 SPECIFIC GRAVITY FLUID				1.9 SPECIFIC GRAVITY FLUID			
		ANCHOR REQUIRED	ANCHOR QUANTITY	ANCHOR BOLT MATERIAL	CABLE DIA. (INCHES)	ANCHOR REQUIRED	ANCHOR QUANTITY	ANCHOR BOLT MATERIAL	CABLE DIA. (INCHES)
2000	90	A-2678	4 EA.	4 EA. 1/2" DIA. HAS STANDARD	1/4"	A-2678	4 EA.	4 EA. 1/2" DIA. HAS STANDARD	1/4"
2500	90	A-2678	4 EA.	4 EA. 1/2" DIA. HAS STANDARD	1/4"	A-2678	4 EA.	4 EA. 1/2" DIA. HAS SUPER	1/4"
3000	90	A-2678	4 EA.	4 EA. 1/2" DIA. HAS SUPER	1/4"	A-2678	4 EA.	4 EA. 1/2" DIA. HAS SUPER	1/4"
3400	90	A-2678	4 EA.	4 EA. 1/2" DIA. HAS SUPER	1/4"	A-2678	4 EA.	4 EA. 1/2" DIA. HAS SUPER	3/8"
3900	90	A-2678	4 EA.	4 EA. 1/2" DIA. HAS SUPER	3/8"	A-2678	4 EA.	4 EA. 3/4" DIA. HAS STANDARD	3/8"
4400	90	A-2679	4 EA.	4 EA. 3/4" DIA. HAS STANDARD	1/2"	A-2678	4 EA.	4 EA. 3/4" DIA. HAS STANDARD	1/2"
4900	90	A-2679	4 EA.	4 EA. 3/4" DIA. HAS STANDARD	1/2"	-NA-	-NA-	-NA-	-NA-

SNYDER INDUSTRIES INC.
LINCOLN, NE 68504

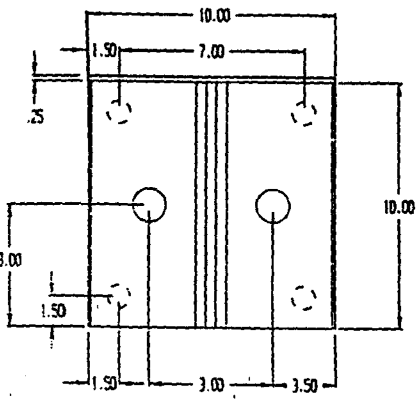
SCALE: NONE	APPROVED BY:	DRAWN BY D.A.O.
DATE: 8/18/92		REVISED BY: D.A.O.

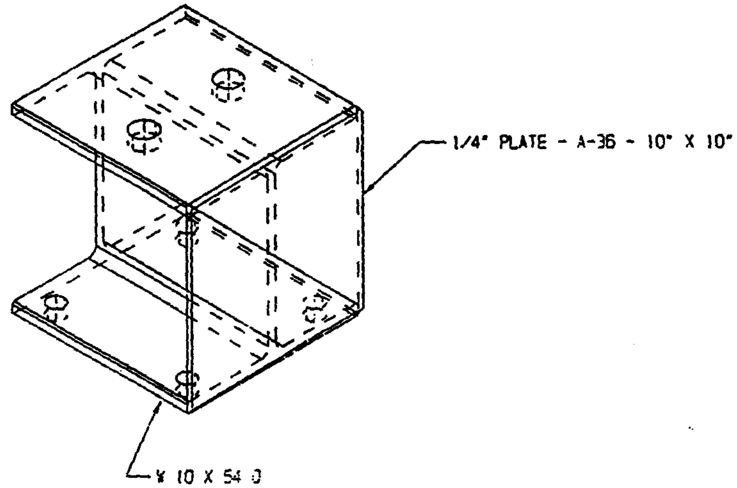
S.I.I. TANK RESTRAINT APPLICATION RECOMMENDATIONS 90" DIAMETER VERTICAL STORAGE TANKS UP TO 4900-1.5 SP. G.

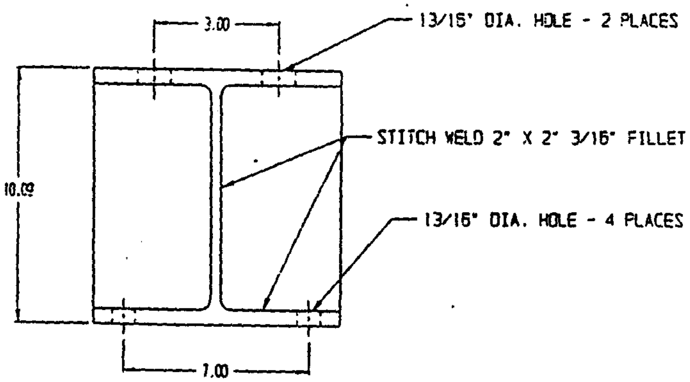
DRAWING NO. 8-2687, PAGE 1 OF 1

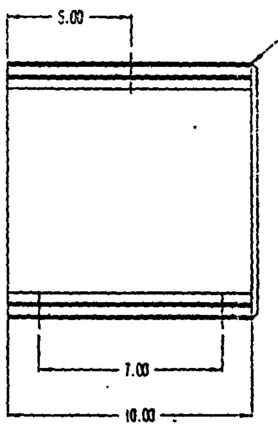


SNYDER INDUSTRIES INC. LINCOLN, NE 68504		
SCALE: 1:3	APPROVED BY:	DRAWN BY D. OLTMAN
DATE: 3/18/92		REVISED
TANK ANCHOR SYSTEM		
TOLERANCES UNLESS OTHERWISE SPECIFIED FRACTIONAL: +/- 1/32" ANGULAR: +/- 1 DEG. DECIMAL .X= .06 .XX= .06 .XXX= .06		DRAWING NUMBER 0002









WELD CONTINUOUS 3/16" FILLET AND BEVEL EDGE

NOTE: DEBURR ALL CUT EDGES AS NECESSARY
PAINT WITH BLACK CHLORINATED RUBBER
ENAMEL PAINT - FOUR SEASONS #3602

10/2/92

REGISTERED PROFESSIONAL ENGINEER
JAI IK CHOI
NO. 2049
Exp 12/31/93
STRUCTURAL
STATE OF CALIFORNIA

SNYDER INDUSTRIES INC.

LINCOLN, NE 68504

SCALE: NTS	APPROVED BY:	DRAWN BY D. OLTMAN
DATE: 8/10/92		REVISED D.D. 9/15/92

TANK ANCHOR BASE PLATE (LARGE) - SII #339236

TOLERANCES UNLESS OTHERWISE SPECIFIED FRACTIONAL: +/- 1/32" ANGULAR: +/- 1 DEG. DECIMAL .X= .06 .XX= .06 .XXX= .06	DRAWING NUMBER B-2679

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Air Stripper Blower

B-801A

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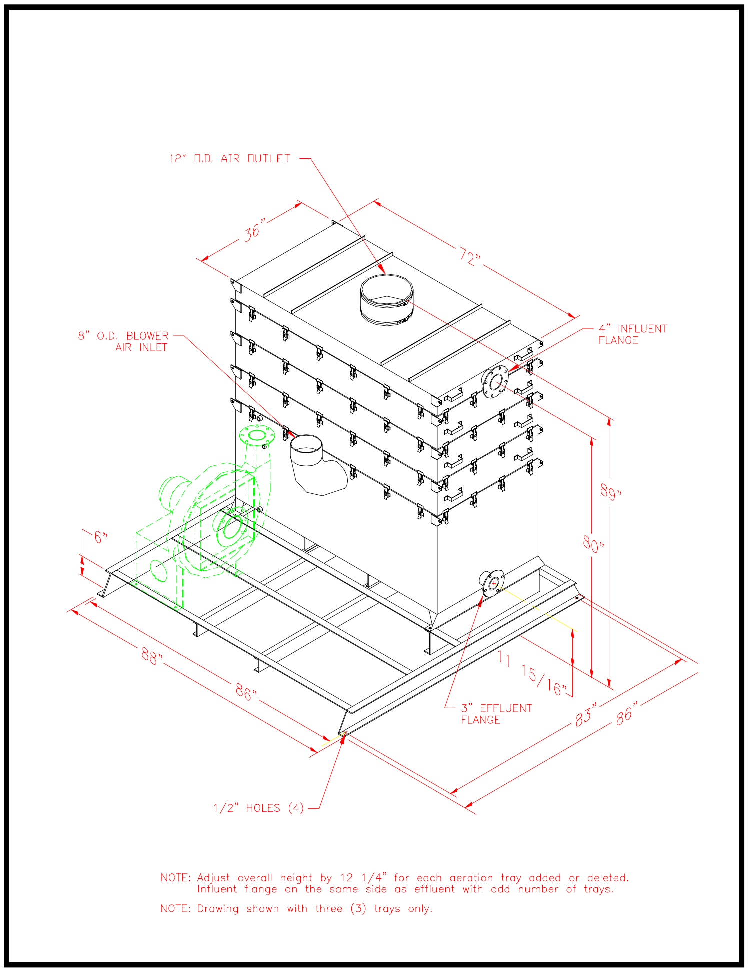
STAT SERIES LOW PROFILE AIR STRIPPERS

STAT 180



Specifications

- 6 tray
- XP pump out
- XP blower
- Air flow kit
- Control panel
- Skid mounted

Options

Flow meter
Air temperature kit
Sample tap kit
Water temperature kit
Muffler

Tray Dimensions (LxWxH; inches)	72x36x12
Sump holding capacity (gallons)	250
Maximum height (inches)*	120
Liquid flow (gpm)	10-200
Minimum air flow (cfm)	650
Maximum air flow	900

**Six-tray STAT without skid*

CARBONAIR®
ENVIRONMENTAL SYSTEMS

MINNESOTA: (corp hdqrtrs)
Carbonair
2731 Nevada Ave. N.
New Hope, MN 55427
PH:800-526-4999
763-544-2154
FAX:763-544-2151
Homepage: www.carbonair.com

FLORIDA:
Carbonair
2603 NW 74th Place
Gainesville, FL 32653
PH:800-241-7833
352-376-9528
FAX:352-373-4971

VIRGINIA:
Carbonair
761 Union Street
Salem, VA 24153
PH:800-204-0324
540-387-0540
FAX:540-389-6860

TEXAS:
Carbonair
4105 Hunter Rd. #10
San Marcos, TX 78666
PH:800-893-5937
512-392-0085
FAX:512-392-0066

STAT® Series
Low Profile Air Strippers

Carbonair's exclusive STAT series represents the best choice in low profile air strippers, combining high performance, flexibility and design simplicity. Carbonair's STAT units are available with a number of tray configurations, blowers and controls, and can achieve a removal efficiency of up to 99.99% for a long list of volatile organic compounds.

Construction Materials

Air Stripper
304 series stainless steel.

Gaskets
Gasoline-resistant neoprene.

Demister
Polypropylene material capable of removing 99.5% of the droplets 10 microns or larger; 95% of the droplets 5-10 microns in size.

Design

Flanged Inlet and Outlet
Flanged (150 pound) inlet and outlet configuration to maximize the integrity of piping connections.

Anti-bypass Valve*
Eliminates need for priming prior to system start-up.

Flapper Valve (Gravity units)*
Prevents air from bypassing the sieve trays through the effluent discharge during start-up.

Downcomer
Weir type square downcomer flow distribution system ensures uniform water distribution over the trays. Minimizes back pressure and head losses.

Sieve Trays
STAT 15, 30, 80: 10.25" high. Minimum water height of 4".
STAT 180, 400, 720: 12.25" high. Minimum water height of 4".

Tray Alignment Guides
Permanently installed for proper tray alignment.

Tray Fastening
Stainless steel over-center latching clips.

Collection Sump
Minimizes pump cycling and maintains sufficient turbulence.

Regenerative Blower
Direct coupled regenerative blower maintains high air pressure at low flow rates.

Accessories

Pump-out
Incorporates float switches in an externally-mounted clear PVC sight glass.

Pressure Gauge
Installed on sight glass.

Low Pressure Switch
Mounted in blower discharge piping.

Options

- Water temperature and flow monitoring.
- Air temperature and flow monitoring.
- Explosion-proof controls.
- Enclosures and trailers.
- Off-gas carbon filtration.
- Custom control panel.
- Humidity control.
- Discharge pump.
- Carbon polish.
- Well control.
- Pump-down.
- Sample taps.

*U.S. Patent Numbers 5,478,507 and 5,378,267.
STAT is a registered trademark of Carbonair Environmental Systems, Inc.

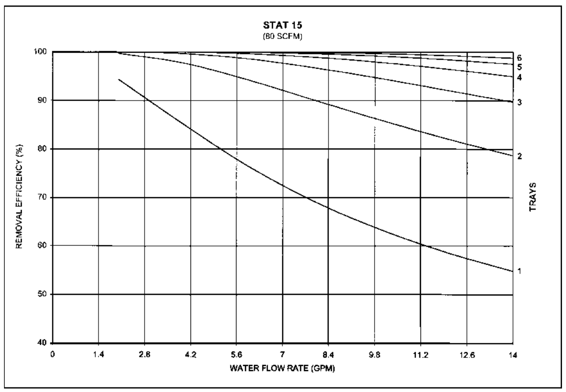
CARBONAIR®
ENVIRONMENTAL SYSTEMS
2731 Nevada Avenue North
New Hope, MN 55427-2806
800-526-4999 *Toll-free*
612-544-2154 *Voice*
612-544-2151 *Fax*
www.Carbonair.com

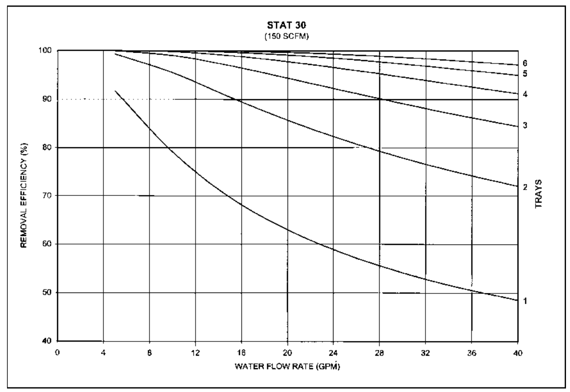
Specifications

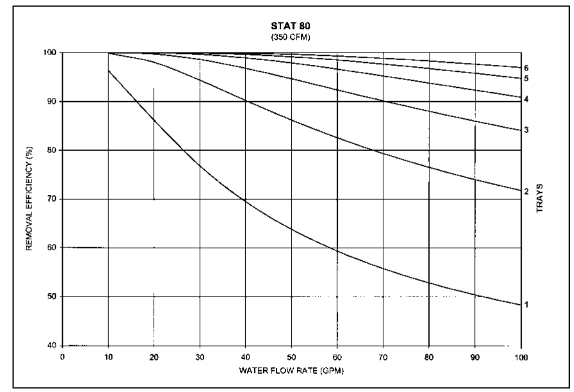
Model	STAT 15	STAT 30	STAT 80	STAT 180	STAT 400	STAT 720
Tray dimensions (LxWxH; inches)	24x9x10	36x12x10	48x24x10	72x36x12	120x48x12	144x72x12
Sump holding capacity (gallons)	13	30	70	250	560	1000
Maximum height (inches)*	93	96	97	120	122	130
Liquid flow (gpm)	0.5-12	1-35	5-80	10-200	20-400	40-1000
Minimum air flow (cfm)	60	100	300	650	1800	3000
Maximum air flow (cfm)	80	150	350	900	2100	4000

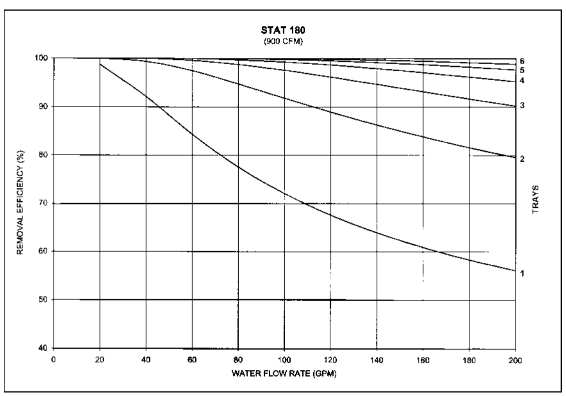
**Six-tray STAT without skid*

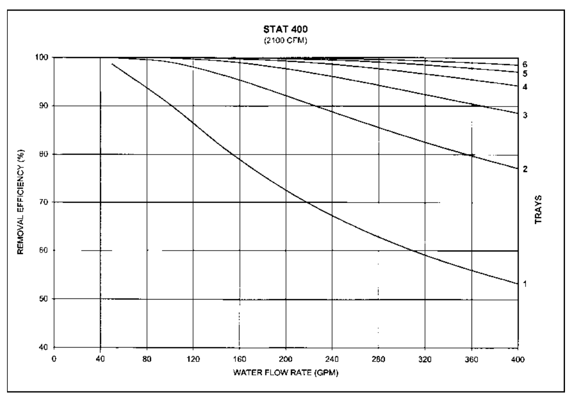
Benzene removal efficiency at 55° F predicted by computer modeling.

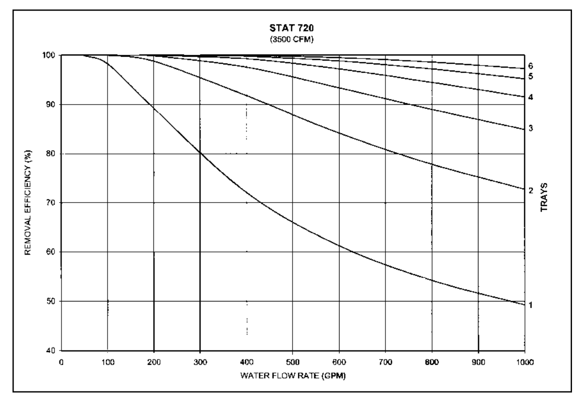












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Liquid Phase Carbon Unit

LC-801A, B

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OPERATING MANUAL

MODEL 7.5
GRANULAR CARBON ADSORPTION SYSTEM

CALGON

CALGON CARBON CORPORATION

OPERATING MANUAL

MODEL 7.5
GRANULAR CARBON ADSORPTION SYSTEM

TABLE OF CONTENTS

APPENDIX

1.0 INTRODUCTION

This manual covers a general description and operating procedures for a Model 7.5 granular carbon adsorption system. This system is designed to treat liquid streams containing organic compounds amenable to adsorption using Calgon Carbon Corporation's granular activated carbon products. If the guidelines in this manual are read and followed carefully, the system can be operated efficiently and safely with minimal operating expense.

The recommended operating practices set forth in this manual are patterned to suit normal operating conditions. Different conditions may require modifications of these operating practices. Since varying operating conditions or problems may arise over long term operation, the skill and judgement of the operating personnel should be exercised when needed.

This manual should be available to operating personnel and engineers so that the operating instructions are followed. Record all operating data and maintenance work (overhauls, repairs, etc.) in an operator's logbook. Only trained personnel should operate the system and perform maintenance. If further information beyond what is contained in this manual is required, please contact the nearest Calgon Carbon Corporation sales office for assistance.

Please note that this manual is a description for a standard Model 7.5 system. Some items specific to your installation may be custom designed. Specific information concerning any custom design details for your installation is described in Section 1.1 (Model 7.5 Specifications and Operating Conditions).

1.1 MODEL 7.5 SPECIFICATIONS & OPERATING CONDITIONS

1. Adsorber Vessel Specifications

Material of Construction: **Carbon Steel**

Tank Lining: **Plasite 4110**

Type of Heads:
Top: **F&D Per ASME Code**
Bottom: **F&D Per ASME Code**

Diameter: **7'-6"**

Straight Side Height: **7'-8"**

Design Temperature (°F):
Normal: **70** Max.: **150**

Design
Pressure: **75 psig @150°F**

Paint: Primer & Finish: **Sherwin-Williams Epoxy Mastic (self-priming)**

Vessel Capacities

Bed Volume: **2120 gal.**

Maximum Flow Rate:
Series: **350 gpm**
Parallel: **700 gpm**

Vessel Volume: **3,040 gal.**

System Pressure Drop* at 350 gpm:
Series: **23 psi**
Parallel: **7 psi**
*The pressure drop is for a fresh carbon bed (10,000 pounds).

Backwashing Information (if required):
Backwash Rate: **400 gpm***
Pressure Drop: **3.5 psi**

* Assumes 55°F backwash water source.

Empty Bed Contact Time at 350 gpm:
Backwashable System
Series: **4.3 min/bed**
Parallel: **8.7 min/bed**
Non-Backwashable System
Series: **6.7 min/bed**
Parallel: **13.4 min/bed**

Note that the Filtrasorb 400 pressure drop and bed expansion curves in the Appendix are calculated approximations for Reactivated carbon.

1.1 MODEL 7.5 SPECIFICATIONS & OPERATING CONDITIONS

2. System Weights & Dimensions (Approximate):

Total Shipping Weight (Includes two vessels filled w/carbon, piping, & skid):
Backwashable System: **31,000 lbs.**
Non-Backwashable System: **38,000 lbs.**

Operating Weight (Full w/Liquid + Carbon):
Backwashable and Non-Backwashable System: **84,000 lbs.**

Overall Length: **23'-3"** Overall Width: **8'-5¼"** Overall Height: **11'-6¾"**

3. Vessel Accessories/Piping

Piping:
Process Piping: **4" Sch. 40 Carbon Steel**
Carbon Transfer Piping: **2" Sch. 40 Carbon Steel (fill)**
2" PPL Lined Steel (discharge)
Backwash Piping: **6" Sch. 40 Carbon Steel**

Vessel Nozzles	*Number*	*Size*	*Flange Type*
Side Manway	1	20"	**75# F.F.**
Process In	1	6"	**150# F.F.**
Process Out	1	6"	**150# F.F.**
Carbon In	1	8"	**150# F.F./PAD**
Carbon Out	1	2"	**150# F.F./PAD**
Water In	1	1½"	**3000# FULL CPLG.**
BW In			**At Process Outlet**
BW Out			**At Process Inlet**
Air Inlet	1	1½"	**3000# HALF CPLG.**
Vent			**At Process Inlet**

1.1 MODEL 7.5 SPECIFICATIONS & OPERATING CONDITIONS

3. Vessel Accessories/Piping

Pressure Relief:
Pressure Relief Device: (**Rupture Disk**/Relief Valve)

Rupture Disk Material of Construction:	**Graphite**
Rupture Disk Stamped Burst Pressure:	**75 psig**
Rupture Disk Recommended Operating Ratio:	**0.75**
Maximum Inlet Pressure:	**56 psig**

4. Carbon

Carbon Type: **Reactivated**
Mesh Size: **8 x 40**

Initial Fill:	**18,000 lbs.**
Quantity per vessel:	**9,000 lbs.**

5. Other Options:

1.1 MODEL 7.5 SPECIFICATIONS & OPERATING CONDITIONS

6. Carbon Delivery

	Dump Truck * *(Atmospheric)*	*Standard Trailer (15 psig Hopper)*	*Lift Trailer (35 psig Hopper)*	*Triple Compartment Trailer*
Carbon (lbs):	20,000	10,000	10,000	10,000
Utility Requirements:				
Air (SCFM):	--	100	100	100
(PSIG):	--	100**	100***	100**
Water (GPM):	200-250	100	100	100
(PSIG):	80-120	--	--	--
Water Required to Fill Trailer (gallons):				Compartment End Center
Dry Carbon:	--	2,500	2,000	1,400 2,500
Pre-wetted Carbon:	--	2,000	1,500	1,200 2,000
Height Clearance (ft):	--	13	26	14
Empty Weight (lbs):	33,000	32,000	33,000	37,000
Filled Weight (lbs):				
Dry Carbon:	53,000	42,000	43,000	47,000
Wet Carbon (before drain):	--	63,000	64,000	68,000
(after drain):	--	52,000	53,000	57,000

*Unloading accomplished with eductor
**Regulated down to 15 psig max.
***Regulated down to 30 psig max.

1.2 GENERAL SYSTEM DESCRIPTION

The Model 7.5 adsorption system is a skid mounted unit consisting of two (2) vertical pressure vessels, each containing a fixed amount (10,000 pounds for non-backwashable adsorbers, 6500 pounds for backwashable adsorbers) of granular activated carbon. The vessels are complete with underdrain, face piping, carbon transfer piping and sample and instrument connections.

After connecting the influent and effluent piping to the system, the vessels may be operated in a series or parallel configuration.

Granular activated carbon delivery to the site will be in Calgon Carbon Corporation's bulk trailers for unloading directly as a water slurry into an empty adsorber.

The stream to be treated is pumped to the adsorption system at a flow rate compatible with the design capacity of the unit. The adsorption system is operated in a downflow mode with the granular carbon beds in a series or parallel configuration.

In a series system, flow is directed into the top of the first vessel (lead adsorber) and flows down through the carbon. From the bottom of the lead adsorber, the stream flows into the top of the second adsorber (polish adsorber). Effluent from the polish vessel flows into the effluent line for discharge to a point determined by the customer.

Initially, the impurities are adsorbed onto the carbon in the upper portion of the lead bed. As this top layer of carbon becomes saturated, adsorption takes place lower in the bed. Eventually all the carbon in the lead adsorber becomes saturated and the contaminant concentration of the effluent from the adsorber increases until it approaches or equals the influent concentration.

When the carbon in a vessel is exhausted, an empty trailer is sent to the site to remove the load of spent carbon. Pending completion of carbon acceptance by Calgon Carbon, the carbon will be returned to one of our plant sites for thermal reactivation.

In some cases, a transfer tank may be provided as part of the Model 7.5 installation. This tank is sized to hold 10,000 pounds of spent carbon, which is an amount equal to one charge of carbon from an adsorber. This tank is provided to facilitate carbon transfer operations and eliminates the need for, and costs associated with, an empty bulk trailer. Calgon Carbon's triple hopper trailer can also be used to accomplish the same effect (refer to Section 4.0 for details on the triple hopper trailer).

The spent carbon is transferred from the adsorber to the bulk trailer by first filling the adsorber with water. The adsorber is then pressurized using compressed air as the motive force to facilitate the carbon transfer to the trailer.

Once the spent carbon transfer operation is completed, a charge of fresh carbon can be transferred into the empty adsorber. This is accomplished by filling the bulk trailer with water and placing a water cushion in the adsorber. The bulk trailer is then pressurized with compressed air to facilitate the carbon transfer into the adsorber.

In series operation, when the lead bed is taken out of service, flow is directed to the polish adsorber for uninterrupted operation. After the first adsorber is emptied and then filled with fresh carbon, it can be placed on-stream in the polish position. At this point, the second adsorber becomes the lead bed. Series operation achieves the most efficient use of the carbon.

In parallel operation, the influent flow is directed to both vessels through a common inlet line. When contaminant breakthrough is detected from one or both vessels, the system is shut down for carbon replacement. If breakthrough occurs from only one bed, it is possible for the other adsorber to remain on-stream at its normal or a slightly higher flow rate. However, this is normally not done and both carbon beds are replaced. Parallel operation is used in situations where the carbon usage rate is low, the mass transfer zone is short, and/or the flow rate is high.

Pressure gauges are provided to measure the pressure drop across each bed. Pressure drop through an adsorber system is a function of many factors:

1. Pressure drop through the carbon bed(s).
2. Nozzle and piping pressure drop.
3. Mode of operation (series or parallel).
4. Flow rate, viscosity, and density of the liquid.
5. Solids build-up on top of the bed.
6. Bacteria growth or chemical precipitation in the bed.
7. Gas build-up in the bed.

Backwashing/backflushing is usually required when the pressure drop across an adsorber increases by 5 to 10 psi during the adsorption cycle.

To prevent damage to the system in the event that the pressure limitation of the vessels is exceeded, pressure relief devices are provided in the adsorber vent lines. Calgon

Carbon's standard pressure relief device is a graphite rupture disk with a 75% recommended operating ratio, which means that an operating pressure higher than 75% of the disk's burst pressure will begin to stress the disk. Certain operating conditions require metal rupture disks with a 90% operating ratio. Refer to the specifications table in Section 1.1 for details on the pressure relief device provided for your system.

After startup, records should be kept of pertinent data such as flow rate, pressure drop across each bed, total dissolved solids, temperature, pH, toxicity, BOD, COD, and organic contaminant levels.

2.0 INSTALLATION

In addition to the instructions below, refer to the Appendix of this manual for Calgon Carbon's Specification 7209A-VS13 on shipping and handling of liquid phase systems for more details.

2.1 UNLOADING/FOUNDATIONS

Before any assembly, inspect all of the equipment for any damage that may have occurred during shipment. Check the bill of materials against the items delivered to ensure that all of the equipment is at the site.

The equipment can be set on a permanent or temporary foundation. A gravel base with timbers or railroad ties is adequate for a temporary installation on suitable soil. Any foundation, either temporary or permanent, must be adequate to support the operating weight of the unit. See the Calgon Carbon Corporation general arrangement drawing for the dimensions of the skid.

Before installation of a permanent system, the adsorber tanks should be oriented on the foundation to ensure that the inlet and outlet opening and anchor lugs are positioned properly. The outline of the adsorbers, including lug positions, should be marked on the foundation. The equipment should be oriented for easy access to the carbon transfer connections from a bulk trailer.

2.2 EQUIPMENT INSTALLATION

The system will be shipped to the site as a complete, skid-mounted unit. A crane is required to off-load the vessels and the skid. Lifting lugs are provided. A properly trained and experienced rigging crew should be employed to set the equipment. The skid should be set on the foundation in a level position and be anchored as required by local codes and seismic regulations.

See the Specifications section (Section 1.1) for the shipping weights of the entire system and the individual pieces.

3.0 OPERATION

3.1 PRE-OPERATION CHECK-OUT

All equipment and systems affiliated with the granular carbon adsorption system such as pumps, filters, etc. should be checked out according to the manufacturer's instructions. Specific activities to complete before operating the adsorption equipment should include the following:

1. Check all piping connections for proper installation and tightness.
2. Ensure that all gauges and instruments are functional and installed correctly. Re-zero or re-calibrate if necessary.
3. Close all valves in the adsorber piping system.
4. Install the carbon acceptance canister (if provided) after checking to ensure it is filled with carbon.

For potable water treatment installations, the customer will be responsible for cleaning and disinfecting the vessels and piping prior to filling the system with carbon. The procedures to complete this step in the installation process are the responsibility of the customer.

3.2 FILLING AN ADSORBER WITH CARBON

Model 7.5 systems are normally shipped to the site with the initial load of carbon in the vessels. If the system is shipped without the carbon, carbon may be added after the system has been checked. The carbon is transferred to the adsorbers as a water slurry from Calgon Carbon trailers. The detailed procedures for making the transfer are given in Section 4.3.

The trailer driver connects the necessary hoses and operates all the valves on the trailer. A plant operator should be available to operate the valves on the adsorber skid.

After all the carbon is transferred from the trailer, the driver disconnects the hoses and closes the valves on the trailer. The plant operator closes the valves in the vent and carbon fill lines on the adsorber. The adsorber is now ready to be backwashed or backflushed.

3.3 WETTING (DEAERATING THE CARBON)

In a typical bed of virgin carbon, the pore volume is approximately 40% of the bed volume. Carbon which is shipped dry will contain air in these pores. Therefore, the carbon must be properly wetted prior to being placed on stream. If this is not done, the air within these pores will displace into the void spaces between the carbon particles during operation and cause high pressure drop and channelling in the adsorbers. These problems can cause premature breakthrough of contaminants. Air will not migrate out of the bed during normal downflow operation.

The time required for wetting is a function of liquid temperature and viscosity. Generally, a minimum wetting period of 24 hours is required using water at ambient temperatures, although a period of up to 72 hours is preferred for complete wetting. After wetting, backwashable adsorbers should be backwashed to remove air and segregate the carbon by size.

As an alternative, the Calgon Carbon Service trailer containing fresh carbon may be filled with water and allowed to stand for several hours. When the fresh carbon is transferred to the adsorber, the adsorber should be backwashed to eliminate any remaining air.

In a non-backwashable system, after the carbon has been wetted, the adsorber should be drained and then backfilled until water flows out the vent line. The adsorber should be filled upflow at 4 gpm/ft^2, maximum. For a Model 7.5 system this is 175 gpm, maximum.

If the unit must be placed on-stream before the carbon has been wetted, the adsorbers should be drained and backfilled when the pressure drop becomes prohibitive or after two days of operation, whichever occurs first.

For process applications, the same procedure is required. If the process liquid cannot be diluted with water and the carbon must be wetted with the process liquid there will be a significant heat of adsorption. In this case, Calgon Carbon should be contacted for specific instructions on the method to be used for wetting.

3.4 BACKWASHING AND BACKFLUSHING

3.4.1 BACKWASH/BACKFLUSH - GENERAL

Backwashing and backflushing are procedures involving running clean, contaminant-free water upflow through the adsorber. Backwashing or backflushing of a carbon bed can be done after fresh carbon has been transferred into an adsorber and wetted, or during operation to remove sediment from the top of the bed.

If the adsorbers are to be backwashed during operation, they should be backwashed prior to startup. The reasons for backwashing before placing fresh carbon on-line are to: (1) size segregate the carbon so subsequent backwashing will return the carbon to the same relative position in the bed, (2) remove any remaining air from the bed, and (3) remove carbon fines which can, in some cases, lead to excessive pressure drop and flow restriction.

Backwashing is done during operation to remove: (1) sediment from the top of the bed, (2) carbon fines that may be plugging the underdrain nozzles, and (3) air that is binding the bed. The need to backwash is indicated by an increased bed pressure drop.

Backwashing an adsorber results in expanding the carbon bed, removing air, suspended solids and carbon fines and classifying the carbon particles. The backwash flow rate depends upon the carbon particle mesh size and the water temperature (refer to the bed expansion curve in the Appendix). Generally, rates in the range of 10 to 15 gpm/ft^2 (450-650 gpm) are sufficient to remove solids, remove air, and expand the bed. However, backwashable Model 7.5 units are designed with significant straight side height to permit 35% bed expansion, and the selected backwash rate should limit the bed expansion to a maximum of 35%. For your system, refer to Section 1.1 for the design backwash water flow rate. Note that this rate assumes a 55°F backwash water source. Use the bed expansion curve in the Appendix to determine a backwash rate if the water source is at a different temperature.

In a system that is not designed for backwashing, an operation termed backflushing can be used to remove fines from the upper portion of the bed. This operation will not remove fines from the lower portion of the bed because it does not expand the bed. Expansion of the bed allows the fines at the bottom of the bed to move to the top. However, fines do not always cause high pressure drop, and their removal is not always necessary.

The backflushing rate is 2 to 3 gpm/ft^2 and this is not significant enough to expand the carbon bed. For the Model 7.5 adsorber this is a flow rate from 90 gpm to 130 gpm. Flow rates of less than 175 gpm will not expand the bed; therefore, size segregation of the bed will not occur. The time required for backflushing is 30 to 45 minutes.

Normally when backwashing or backflushing, a clean external water source is used. The stream should be compatible with the system and free of suspended solids and organic contaminants which might affect adsorption. If necessary, effluent from the adsorber system may be used as the water source. In this case a tank with storage capacity for 15 minutes of backwash water (10,000 gallons) will be necessary.

When normal downflow operation is started after backwashing, the initial 5 to 15 minutes of effluent flow will be dark due to a small quantity of fines. Under normal operating conditions, this condition will clear up.

3.4.2 BACKWASHING AN ADSORBER (FIGURES 6 AND 7 IN APPENDIX)

In this mode, a clean external source is used as the source for the backwash water. Note that the lead adsorber is taken out of service while the backwashing procedure takes place. The sequence refers to isolating and backwashing adsorber PV1 (starting valve positions are as shown in Figure 1 in the Appendix). Valve numbers applying to adsorber PV2 (using a starting valve position as shown in Figure 3 in the Appendix) are in parentheses. This sequence applies to a series operated system, with the lag adsorber remaining on-line during the backwash. For a system operating in parallel, both beds should be taken off-line when backwashing is required.

1. Isolate the adsorber to be backwashed. If adsorber PV1 is to be backwashed, refer to Section 3.6.4 for valve sequencing. If adsorber PV2 is to be backwashed, refer to Section 3.6.6. for sequencing.
2. Open vent valve V9. (V10)
3. Open backwash water valve V7 (V8) and start the backwash pump.

The backwash water enters the vessel through the effluent line and flows up through the underdrain and the carbon bed. The backwash water discharge from the vent line should be observed for clarity to determine the duration of backwashing. Backwashing for high pressure drop should take approximately 10 minutes. If excessive sediment and turbidity exists in the untreated water, the backwashing times may have to be increased to 15 minutes. A fresh carbon fill should be backwashed to classify the carbon. The time required for this step is approximately 30 minutes or until the backwash discharge is free of fines.

Note that the above procedure can also be applied for backflushing when the adsorbers are non-backwashable. The only difference for backflushing is that the flow rate is lower and the time required to backflush is longer.

3.4.3 RESTARTING SYSTEM AFTER BACKWASHING

The valve sequence given below describes the steps taken to bring a system on-line after backwashing. The valve numbers refer to bringing adsorber PV1 back on-line in the lead position. Valve numbers applying to placing adsorber PV2 back in the lead position are in parentheses.

1. Close backwash water valve V7. (V8)
2. Close vent valve V9. (V10)
3. Open cross-over valve V6. (V5)
4. Open the influent valve V1. (V2)
5. Close the influent valve V2. (V1)

3.5 STARTUP

3.5.1 SERIES FLOW

The adsorber system is normally operated in a series mode. Valves in the influent and effluent lines are opened or closed, as required, to set the operation of the carbon vessels in the desired configuration. The first bed in the system is called the lead bed. The second bed is referred to as the polish or lag bed.

The following sequence of steps should be followed to bring an adsorption system on-line in the series mode:

1. Check that all the valves in the adsorption system are closed.

2. Place the feed pump (s) in service to supply the adsorption module at the required flow and pressure.

3. Open the valve in the effluent line from the polish adsorber (either V3 or V4).

4. Open the valve in the cross-over influent line to the polish adsorber (either V5 or V6).

5. Start the feed pump and open the valve in the pump discharge line.

6. Slowly open the valve in the influent line to the lead adsorber (either V1 or V2) and allow the pressure to increase to the operating level.

At this point, flow should be established downflow through both vessels and they will be on-line in series.

Set the flow rate to the system at the desired value after flow is established to the unit. The flow control meters and control instrumentation will be provided by the customer as required for the system.

In order to obtain full utilization of the carbon and prevent air entrapment and channeling in the bed, the water level must remain above the carbon bed. To prevent the bed from draining due to gravity or loss of influent supply, a vacuum break (anti-syphon) loop or backpressure should be included by the customer in the effluent piping. This start-up sequence assumes that an anti-syphon loop is present in the effluent piping. If no anti-syphon loop or backpressure is present, start the system by starting the pump and opening the valves in the opposite order of the sequence given previously (i.e. open the influent valve first, followed by the cross-over valve and effluent valve).

3.5.2 PARALLEL FLOW

The following sequence of steps should be followed to bring an adsorption system on-line in the parallel mode:

1. Check that all the valves in the adsorption system are closed.

2. Place the feed pump (s) in service to supply the adsorption module at the required flow and pressure.

3. Open the valves in the effluent lines from the adsorbers (V3 and V4).

4. Start the feed pump and open the valve in the pump discharge line.

5. Slowly open the valve in the influent line to one adsorber (either V1 or V2) and allow the pressure to increase to the operating level.

6. Slowly open the valve in the influent line to the other adsorber (either V1 or V2) and allow the pressure to increase to the operating level.

At this point, flow should be established downflow through both vessels and they will be on-line in parallel.

Set the flow rate to the system at the desired value after flow is established to the unit. The flow control meters and control instrumentation will be provided by the customer as required for the system.

In order to obtain full utilization of the carbon and prevent air entrapment and channeling in the bed, the water level must remain above the carbon bed. To prevent the bed from draining due to gravity or loss of influent supply, a vacuum break (anti-syphon) loop or backpressure should be included by the customer in the effluent piping. This start-up sequence assumes that an anti-syphon loop is present in the effluent piping. If no anti-syphon loop or backpressure is present, start the system by starting the pump and opening the valves in the opposite order of the sequence given previously (i.e. open the influent valves first, followed by the effluent valves).

For parallel operation, flow is established to each vessel by opening the valves as indicated previously. Changing the flow to one vessel may result in a flow change to the other vessel on the skid. This occurs because the vessels share a common influent and effluent line. Flow meters can be installed in the individual influent lines to each vessel to balance the flow to each unit if required.

3.6 STEADY STATE OPERATION

Once flow is established to both vessels and the flow rate is set, no further adjustments are made during normal operation. The operator should establish a routine to check the adsorbers and to collect operating data. This data can be used to establish a maintenance schedule, to determine when backwashing/backflushing is necessary, or to determine when fresh carbon is needed.

3.6.1 MONITORING

Sample connections are provided on the influent and effluent lines from each vessel to take periodic samples for analysis.

Pressure gauges are provided to determine the pressure drop across each carbon bed. Taking periodic pressure readings will provide the operator with historic data for troubleshooting purposes. In the event that operating conditions change, the operator has the capability of taking corrective action.

3.6.2 VALVE OPERATION

All valves should be operated in a slow and even motion. Abrupt opening and closing of the valves can shock the system. Since complete shut-off of flow while a pump is operating could cause damage to the pump, the valves should be operated in the proper sequence in order to always maintain flow through the system. If the vessels are identified as PV1 and PV2 then the corresponding valve positions during adsorption are given as follows:

Process Valve Number	***Series PV1 to PV2 (Figure 1)***	***PV2 Single Operation (Figure 2)***	***Series PV2 to PV1 (Figure 3)***	***PV1 Single Operation (Figure 4)***	***Parallel Operation (Figure 5)***
V-1	Open	Closed	Closed	Open	Open
V-2	Closed	Open	Open	Closed	Open
V-3	Closed	Closed	Open	Open	Open
V-4	Open	Open	Closed	Closed	Open
V-5	Closed	Closed	Open	Closed	Closed
V-6	Open	Closed	Closed	Closed	Closed
V-7	Closed	Closed	Closed	Closed	Closed
V-8	Closed	Closed	Closed	Closed	Closed
V-9	Closed	Closed	Closed	Closed	Closed
V-10	Closed	Closed	Closed	Closed	Closed

Single stage operation occurs for short time periods, such as during carbon transfer or backwashing of the lead bed, or during other routine maintenance on one of the adsorber vessels. **NOTE: FLOW SEQUENCE CHANGES (AS DESCRIBED IN THE FOLLOWING SECTIONS) SHOULD BE PERFORMED ONLY WHEN CARBON CHANGEOUTS, BACKWASHING, OR OTHER VESSEL MAINTENANCE IS REQUIRED.**

3.6.3 ADSORBER SEQUENCING: PV1 LEAD, PV2 LAG

This sequence should be used to start up the system in series mode from PV1 to PV2. Refer to Section 3.5.1 for additional details.

Starting valve position: All valves closed.

- Open valve V4
- Open valve V6
- Open valve V1

At this point, flow should be established from PV1 to PV2.

3.6.4 ADSORBER SEQUENCING: TAKING ADSORBER PV1 OFF-LINE

When adsorber PV1 is taken off-line for carbon transfer or backwashing, all of the process flow should be sent through adsorber PV2.

Starting valve position: Series flow from PV1 to PV2.

- Open valve V2
- Close valve V6
- Close valve V1

Flow should now be established through adsorber PV2 with adsorber PV1 off-line for carbon transfer or backwashing.

3.6.5 ADSORBER SEQUENCING: PV1 BACK ON-LINE AS LAG VESSEL

After adsorber PV1 is filled with fresh carbon, it should be placed on-line in the polish position, with adsorber PV2 moved to the lead position.

Starting valve position: Single stage flow to PV2.

- Open valve V5
- Open valve V3
- Close valve V4

Flow should now be established from adsorber PV2 into adsorber PV1.

3.6.6 ADSORBER SEQUENCING:TAKING ADSORBER PV2 OFF-LINE

When adsorber PV2 is taken off-line for carbon transfer or backwashing, all of the process flow should be sent through adsorber PV1.

Starting valve position: Series flow from PV2 to PV1.

- Open valve V1
- Close valve V5
- Close valve V2

Flow should now be established through adsorber PV1 with adsorber PV2 off-line for carbon transfer or backwashing.

3.6.7 ADSORBER SEQUENCING: PV2 BACK ON-LINE AS LAG VESSEL

After adsorber PV2 is filled with fresh carbon, it should be placed on-line in the polish position, with adsorber PV1 moved to the lead position.

Starting valve position: Single stage flow to PV1.

- Open valve V6
- Open valve V4
- Close valve V3

Flow should now be established from adsorber PV1 into adsorber PV2.

3.6.8 ADSORBER SEQUENCING: PARALLEL OPERATION

The following sequence should be used to start up the system in parallel mode. Refer to Section 3.5.2 for details.

Starting valve position: All valves closed.

- Open valves V3 & V4
- Open valves V1 & V2

Flow should now be established through the system in parallel. When carbon transfer or backwashing is required, the system should be shut down until the operation is complete.

3.7 SHUTDOWN

3.7.1 SHORT TERM SHUTDOWN

For short duration shutdowns lasting less than one or two weeks, little needs to be done. Close all valves in the adsorber piping system, and open the vent line valves on each vessel. The feed pumps should be shut down and the valves closed in the lines to and from the pumps. Any drain valves in the pump casing should be opened for the duration of the shutdown. Freeze protection measures such as draining lines at the low points should be taken when there is a chance of freezing. Freeze protection measures are usually the responsibility of the client.

3.7.2 EXTENDED SHUTDOWNS

For extended shutdowns, in addition to the steps in Section 3.7.1, the adsorbers should be drained of all water and filled with clean plant water.

When the adsorbers are started up again, the carbon beds may require disinfection. If disinfection is required, the procedures to disinfect a carbon bed can be found in the Appendix of this manual. Once the disinfection is complete, backwashable adsorbers should be backwashed prior to startup.

After disinfection, bring the adsorber back on-line in the downflow mode, monitor the effluent for coliform count and monitor the pressure drop.

3.8 TROUBLESHOOTING GUIDE

PROBLEM		*PROBABLE CAUSE*		*REMEDY*
High pressure drop across adsorber.	1.	Bed not flooded. Bed is air bound.	1.	Open vent valve or carbon inlet valve to release pressure. Add water upflow to fill vessel. Establish constant forward flow, then close valve.
	2.	High feed pump pressure.	2.	Throttle feed pump.
	3.	High suspended solids loading or carbon fines around the nozzles.	3.	Test feed for suspended solids. Install influent filter. Backwash/backflush the adsorber.
	4.	Improper valve settings.	4.	Check valve sequence.
	5.	Carbon in effluent retainer.	5.	Shut down system. Clean out retainer and effluent line. Remove carbon from adsorber. Inspect vessel using side manway and repair damaged underdrain in adsorber.
Carbon in the effluent.	1.	Internal mechanical (i.e. underdrain) failure.	1.	Determine which adsorber is causing the problem, then remove carbon and make repairs. In addition, inspect carbon retainer in effluent line and replace if necessary.
Leaking flange.	1.	Loose bolts.	1.	Tighten bolts.

3.8 TROUBLESHOOTING GUIDE

PROBLEM		***PROBABLE CAUSE***		***REMEDY***
Excessive flow out vent line.	1.	Broken rupture disk.	1.	Check the following conditions before replacing disk: 1) Check downstream valving to make sure that the system is not plugged off. 2) Check feed pump pressure to make sure it is not too high. 3) Check process valve sequence. 4) Check that excessive pressure build-up did not occur in closed vessels during extended shutdowns. Once the potential source of overpressurization is removed, replace rupture disk.
Sudden high contaminant concentration in effluent.	1.	Carbon heel from improper transfer.	1.	Wait until contaminant flushes out. Review transfer procedures.
	2.	Leaking valve.	2.	Repair/replace valve.
	3.	Mass transfer zone has extended into effluent.	3.	Replace carbon.

3.8 TROUBLESHOOTING GUIDE

PROBLEM		***PROBABLE CAUSE***		***REMEDY***
Premature breakthrough of organics in the effluent.	1.	Influent concentration change.	1.	Confirm by analyzing effluent sample(s) before changing carbon.
	2.	Air in the influent stream.	2.	Open vent valve and fill bed upflow with water as required.
	3.	Background TOC or colloids present.	3.	Change carbon.
	4.	Leaking valves.	4.	Check operation of valves in influent and effluent lines.
	5.	Incorrect valve sequence.	5.	Sequence the flow through the system properly.
Carbon heel in empty vessel.	1.	Insufficient rinse water.	1.	Provide additional rinse water flow.
	2.	Mechanical failure.	2.	Check vessel internal parts and make repairs.
	3.	Foreign material on the carbon.	3.	Rinse vessel to remove carbon.

4.0 CARBON TRANSFER PROCEDURE - STANDARD TRAILER

The procedures that are detailed in this section of the manual are for Calgon Carbon's standard carbon trailer. Carbon may be delivered in any of three types of trailers; the standard trailer, the lift (dump) trailer, or the triple compartment trailer. The procedures for loading or unloading carbon are similar for all three units, but there are some slight differences.

The lift trailer (Figure 9) is a high pressure unit and can be operated at pressures as great as 35 psig. This unit is used when the adsorbers are elevated or when they have long straight sides. For these cases, higher pressure is required to deliver carbon to the top of the vessels. This trailer requires an overhead clearance of 26' because the tank portion is elevated before the start of carbon transfer.

The procedural difference between the standard trailer and the lift trailer is that the lift trailer is pressurized to 30 psig when fresh carbon is transferred from the trailer to the adsorber.

The triple compartment trailer (Figure 10) is built to hold 10,000 pounds of carbon in each end section and 20,000 pounds in its center section. The triple compartment trailer arrives at the site with fresh carbon in the end sections. First, spent carbon is transferred to the center section of the trailer, then the fresh carbon is transferred from an end compartment to the adsorber.

In cold weather conditions, steam may be used to thaw the trailer and transfer lines if necessary. Contact Calgon Carbon for trailer steaming procedures if required.

4.1 SITE REQUIREMENTS

A flat paved area is needed to support the Calgon Carbon service trailer which may weigh up to 100,000 pounds. The overhead clearance required for the adsorption system is 13 feet. A diagram of the trailer and its on-board piping is shown in Figure 8.

The utility and piping requirements to connect to the adsorber and trailer are as follows:

<u>Adsorber</u>	
Plant air line	1½" 150 lb. flanged connection 100 scfm at 30 to 80 psig (Attaches to 1½" compressed air connection on adsorber) -OR- 3/4" female Kamlock connection 100 scfm at 30 to 80 psig (Attaches to 3/4" flush connection on carbon fill line above carbon inlet valve)
Plant water line	1½" 150 lb. flanged connection 100 gpm (max) at 30 to 65 psig
<u>Trailer (See Figure 8)</u>	
Plant air line	3/4" female Kamlock connection (for both industrial & food grade trailer) 100 scfm regulated to 15 psig max.
Plant water line	4" Kamlock connection (female for industrial trailer, male for food grade trailer) 100 gpm regulated to 15 psig max. (Connect to Trailer Carbon Discharge & Drain Line)

4.2 SPENT CARBON TRANSFER TO TRAILER

Spent carbon transfer from the adsorber to the trailer is accomplished by pressurizing the adsorber with plant air. When the transfer is complete, the spent carbon in the trailer is drained of water. Prior to disconnecting any lines, the air supply must be shut off, and the adsorber and all transfer lines must be vented.

4.2.1 SPENT CARBON TRANSFER

A. Prepare for Spent Carbon Transfer:

1. Isolate the adsorber to be changed out. Refer to Section 3.6.2 for valve positioning.

2. Connect the adsorber carbon outlet line to the trailer fill line #1 using 4" flexible hose.

3. Open the center manway of the trailer or trailer vent valve T1 for venting.

4. Open valve T2 in the trailer fill line.

5. Check that the adsorber is full of water.

6. To aid the initial phase of transferring spent carbon, fill the transfer line with water. To do this, use a 3/4" water hose to fill the transfer line with water at the adsorber carbon outlet valve's flush-out connection.

B. Transfer Spent Carbon

1. Open the adsorber compressed air line valve (V11 or V12) slowly and pressurize the adsorber to 25 to 30 psig.

2. Open the adsorber carbon outlet valve (V15 or V16) and transfer the spent carbon to the trailer.

3. As the trailer starts to fill with carbon slurry, open the trailer septa valves T8, T9, and T10 to drain off excess motive water.

The transfer should take 20 to 30 minutes. The transfer will end with a loss of pressure in the adsorber and the sound of air in the transfer line.

C. Heel Removal

It will be necessary to add a small amount of water to the adsorber to ensure that all of the spent carbon has been removed from the adsorber. During the last five minutes of the transfer, open the plant water valve (V17 or V18). This flow of water will flush the carbon heel off the sides of the adsorber and into the bottom of the vessel.

D. End Transfer

1. Close the adsorber plant air line valve (V11 or V12).

2. Vent the tank and lines through the trailer vent valve T1.

3. Open the adsorber vent valve (V9 or V10) to further aid the venting.

4. Close the adsorber carbon outlet valve (V15 or V16).

5. Using a 3/4" water hose at the adsorber carbon discharge line flush-out connection, flush out the transfer line for a few minutes to remove all traces of carbon. Bleed the water hose and remove it.

4.2.2 DRAIN WATER FROM TRAILER

A. Prepare for Draining Water

1. Close all valves on the trailer. Close the trailer manway.

2. Connect the plant air line to the 3/4" connection on trailer fill line #1 using the air line hose.

3. Connect line #2 on the trailer to the drain line in the trench by means of a 4" flexible hose.

B. Draining Trailer

1. Pressurize the trailer to 15 psig by slowly opening plant air line valve T4 on the trailer.

2. Open 2" trailer septa valves T8, T9, and T10.

By pressurizing the trailer, water will be drained in less time than if drained by gravity.

C. End Draining

1. When the carbon is completely drained, close the air line valve T4 on the trailer.

2. Vent trailer slowly through trailer vent valve T1.

3. When venting is complete, close all valves on the trailer and disconnect all hoses.

The trailer is now full of drained spent carbon and is ready for return to Calgon Carbon for reactivation.

4.3 FRESH CARBON TRANSFER FROM TRAILER

Fresh carbon is transferred in a slurry using plant air pressure. The trailer is first filled with water to create the slurry. The carbon slurry hose on the trailer is connected to the adsorber fill line and the trailer carbon outlet line. After putting a water cushion in the adsorber, the trailer is pressurized and the carbon slurry is transferred to the empty adsorber. Prior to disconnecting any lines, the air supply must be shut off, and the trailer and all transfer lines must be vented.

Under no circumstances should the standard and triple compartment trailers be connected to a pressure source exceeding 15 psig.

4.3.1 FILL THE TRAILER WITH WATER

If the carbon is wetted prior to delivery, about 2000 gallons of water will be required. If the carbon is dry, about 2500 gallons of water will be required. The trailer may be filled either upflow or downflow.

A. Filling Operation

1. Connect water line to the trailer (carbon fill line if filling downflow, carbon discharge line if filling upflow) using a 4" flexible hose.
2. Open one top manway to vent trailer during filling.
3. Open trailer vent line valve T1.
4. Open trailer water line valve (T2 if filling downflow, T8, T9, and/or T10 if filling upflow).
5. Open the plant water line valve slowly and fill the trailer.

The trailer will be filled with approximately 2000 to 2500 gallons of water. The trailer filling shall be visually determined by observing the water level through the manway or by metering the desired amount.

B. End Filling Operation

1. Close plant water line valve.

2. Close trailer fill line valve (T2 for downflow, T8, T9, and T10 for upflow), manways, and trailer vent valve T1.

3. Disconnect hose.

4.3.2 TRANSFER CARBON TO ADSORBER

A. Prepare for Transfer

Place about 1000 gallons of water in the adsorber. This water cushion helps to protect the underdrain system and vessel lining.

1. Connect the adsorber fill line to the trailer carbon outlet line #2 using 4" flexible hose.

2. Connect the 3/4" plant air line to the trailer fill line #1 using the air line hose.

3. Close all valves on the adsorber.

4. Open the adsorber vent line (V9 or V10).

5. To aid the initial phase of transferring fresh carbon, fill the transfer line with water. To do this, use a 3/4" water hose to fill the transfer line with water, at the carbon inlet valve's flush-out connection.

B. Transfer Fresh Carbon

1. Pressurize the trailer to 15 psig by slowly opening the plant air line valve and then slowly opening valve #4 in the trailer fill line.

2. Open the adsorber fill line valve (V13 or V14).

3. The Calgon Carbon trailer driver will open the trailer carbon outlet valves T5, T6, and T7 to empty the respective hoppers.

4. If a water cushion is utilized, open an adsorber drain valve shortly after starting the transfer. This is done to reduce the amount of water that

overflows at the end of the transfer. The disposal of excess motive water is provided by the customer.

C. End Transfer

1. Close the plant air valve and vent the trailer through the adsorber vent valve (V9 or V10).

2. Close the adsorber drain valve if it was utilized during the transfer.

3. Slowly open trailer vent valve T1 for additional venting.

4. When completely vented, close the adsorber fill line valve (V13 or V14), disconnect the hoses, and close the trailer valves.

5. Refer to Sections 3.3 and 3.4.2 for instructions on wetting and backwashing/backflushing the adsorber.

6. After the adsorber has been backwashed/backflushed, shut off the plant water and close the vent valve on the adsorber.

5.0 GENERAL INFORMATION

5.1 MAINTENANCE

As preventative maintenance, periodic inspection of the vessel internal parts should be made to ensure that the underdrain, vessel lining, and nozzles are in good condition. As a minimum, each adsorber should be inspected once per year, or during carbon transfers if the on-line period exceeds one year. Any nozzles showing signs of fatigue or surface area restriction due to pluggage of the nozzle slots should be replaced. Nozzles should be physically checked to ensure that they are tightly secured.

Systems with high backwash frequencies and rigorous backwash requirements should be inspected more frequently . The vessels must be fully emptied to allow inspection of the interior of the vessel. Follow the safety guidelines listed in the following sections when entering enclosed vessels. Calgon Carbon Operations personnel should be present during internal vessel inspections.

Pressure gauges have been installed to determine the pressure drop across each carbon bed. Taking periodic pressure readings will give the operator the capability of monitoring the pressure drop across the carbon vessels over time. If a pressure increase is observed, then corrective action can be taken before the pressure drop becomes a problem.

In order to protect the vessel from high pressure, a safety device is provided. Usually, this device is a rupture disk or pressure relief valve. The rupture disk is designed to rupture within ±5% of the disk's stamped burst pressure. However, repeated pressure swings above the operating ratio pressure (75% of the burst pressure for Calgon Carbon's standard graphite rupture disk) can cause premature bursting of the disk.

In order to prevent carbon from entering the effluent stream, a carbon retainer screen is installed in the system effluent line. In the event of an underdrain nozzle failure, the strainer will fill with carbon and the pressure drop will increase to a point where the system flow is reduced. If this should occur, the system should be shut down until the damaged underdrain is repaired.

5.2 SAFETY CONSIDERATIONS

5.2.1 OXYGEN DEMAND DUE TO ACTIVATED CARBON

Studies have shown that low oxygen content exists in vessels containing wet drained granular activated carbon. The laboratory experiments conducted since that time also have revealed that commercial activated carbons in a wet or moist condition will lower the oxygen content of an isolated space.

Preliminary indications of this research are:

1) The phenomenon occurs with all types of wet activated carbon.

2) The rate of oxygen uptake naturally varies with the degree of exposure of the wet carbon to the air. Thus, it is relatively rapid in a drained bed.

3) There is some indication of a limit to the carbon's capacity for oxygen, but until more is known, it would be prudent to assume that all carbons (fresh, used, reactivated) will also exhibit this characteristic. Similarly, although these tests were run with water, it should be assumed that the phenomenon will occur in other liquid and vapor systems.

Based on the properties of wet activated carbon, a confined space entry procedure should be established for any facility using carbon in confined vessels.

All confined spaces, including those containing activated carbon, should be presumed to be hazardous. Appropriate safety measures should always be taken before entering, as well as when workers are in a confined space. OSHA regulations applicable to respiratory protection in oxygen deficient atmospheres should be strictly adhered to.

5.2.2 EMERGENCY PROCEDURES

In the event a malfunction which causes a shutdown of an adsorber should occur, the flow can either be switched to the second adsorber in the system or the flow can be stopped.

If a major leak or similar problem develops, flow to the adsorber should be stopped immediately and steps taken to correct the problem. Proper safety procedures should be observed at all times to prevent damage to the equipment or injury to personnel.

5.2.3 PRESSURE RELIEF WARNING

TO AVOID VESSEL DAMAGE AND ENDANGERMENT OF OPERATING PERSONNEL, DO NOT BLOCK THE PRESSURE RELIEF DEVICE FROM VENTING TO ATMOSPHERE.

5.3 RECORD KEEPING

Normally, operating data is taken for: 1) flow rates, 2) which beds are in service, 3) pressure drop across each unit, and 4) necessary analytical work for influent and effluent to each adsorber. This may include: pH, TOC level, BOD, COD, toxicity, organic contaminant levels, and inorganic levels.

6.0 ACTIVATED CARBON/ADSORPTION INFORMATION

6.1 GLOSSARY

The following terms are commonly used to describe adsorption theory, activated carbon, and adsorption systems.

Abrasion Number - A test performed on a particulate material to define the resistance of the particles to degrade on handling. It is calculated by contacting a sample with steel balls in a Ro-Tap machine and determining the ratio of the final to the original mean particle diameter.

Activated Carbon - A carbonaceous material that is a crude form of graphite with a random and amorphous structure. The structure is highly porous, over a broad range of pore sizes, from visible to molecular cracks and crevices.

Acid Washed Activated Carbon - Activated carbon which has been washed with an acid solution for the purpose of dissolving the iron from the carbon. Acid washed carbons are usually used in systems/processes operating at low pH.

Adsorbate - Any substance that is or can be adsorbed on the adsorbent.

Adsorbent - Any solid having the ability to concentrate significant quantities of other substances on its surface. Activated carbon is an adsorbent.

Adsorber - A vessel designed to hold granular activated carbon.

Adsorption - A phenomenon where an adsorbate is physically attracted to the surface of the adsorbent.

Adsorption Isotherm - A graphic depiction of the capacity of an adsorbent to adsorb a specific adsorbate. The measurements of capacity are performed at constant temperature using either varying amounts of the adsorbate or adsorbent.

Adsorption Pores - The finest pores in the carbon structure. Pores which have adsorption capacity.

Air Scouring - A process that uses pressurized air to break-up any agglomerations in a carbon bed. Air is blown into the bottom of the bed before the bed is backwashed. Air scouring capability must be incorporated into the system design during the design phase.

Apparent Density - A physical property that is defined as the mass per unit volume of a granular material under specified conditions. The apparent density includes the carbon skeleton volume plus the pore and void volumes.

Ash - The noncombustible mineral matter that is contained in activated carbon and is the residue that remains after the combustion of a carbonaceous material. The measurement of ash is performed under specified conditions and is normally defined on a weight percent basis.

Backwash - An operating method used to remove suspended solids from a carbon bed. Water is pumped into the bottom of the adsorber, flows upward through the carbon bed, and exits through the backwash outlet. The upward flow expands the bed and removes carbon fines, entrained air and suspended solids. The percent bed expansion (up to 50%) and time required for backwashing are a function of the backwash rate and water temperature.

Backflush - A process similar to backwashing, but the flow rate is not high enough to expand the bed more than five percent.

Carbon Heel - Any quantity of spent carbon not removed from an adsorber before recharging the vessel with fresh carbon.

Carbon Tetrachloride Activity - A measurement of the increase in weight of a sample of activated carbon after air saturated with carbon tetrachloride is passed through the sample. The test is performed at a given temperature and the results are reported as weight percent.

Carbon Trailer - A bulk trailer used to transport 20,000 pound (or less) loads of granular carbon to/from the customer's plant site.

Chemisorption - A chemical process that binds an adsorbate to the surface of an adsorbent by forces whose energy levels approximate those of a chemical bond.

Color Bodies - Complex molecules which impart color (usually undesirable) to a solution. Carbon adsorption is often used for color removal applications.

Counter-current Operation - A mode of operation where the flow of liquid is opposite the movement of the adsorbent. This method of operation produces the lowest carbon usage rate or highest efficiency.

Critical Bed Depth - The distance between the fresh carbon and the spent carbon for a bed of activated carbon. In other words, it is the portion of the bed which is partially spent and the zone where adsorption takes place. The critical bed depth is measured in feet. For a single column system, this is the amount of carbon that is not completely utilized when the effluent objective is reached and the carbon is taken off-stream.

Deaeration (Wetting) - The process of removing air (gases) from a carbon bed and the carbon pores. The volume of air in activated carbon is in the void space and pore volume, which typically accounts for 80% of the total volume in a carbon bed (the carbon skeleton accounts for the other 20%).

Desorption - The opposite of adsorption. A phenomenon where an adsorbed substance leaves the surface of the adsorbent.

Eductor - A device to motivate a slurry of activated carbon and water slurry through hoses and pipes. An eductor has no moving parts and utilizes pressurized water as the motive force.

Fresh Carbon - New carbon that is placed into an adsorber. Fresh carbon can be either virgin carbon or newly reactivated carbon.

Hardness Number - A measurement of the resistance of a granular carbon to the degradation action of steel balls in a Ro-Tap machine. This number is calculated by using the weight of granular carbon retained on a particular sieve after the carbon has been in vigorous contact with the steel balls.

Heat of Adsorption - The heat given off when molecules are adsorbed.

Iodine Number - The measurement of the amount of iodine adsorbed by one gram of carbon. The concentration of iodine is 0.02N. The iodine number is reported as milligrams of iodine.

Lag Adsorber - The second bed of carbon through which the liquid passes in a series operated adsorption system. The lag vessel contains carbon that is partially spent when the carbon in the lead adsorber is completely spent.

Lead Adsorber - The first bed of carbon through which the liquid passes in a series operated adsorption system. The lead vessel contains carbon that is the first to become spent.

Mass Transfer Zone - The adsorption gradient that exists in the carbon bed. It corresponds to the gradual transition of the carbon from spent to fresh.

Mesh Size - The measurement of the particle size of granular activated carbons determined by the U.S. Sieve Series. Particle size distribution within a mesh series is typically given in the specification of the particular Calgon Carbon carbon.

Molasses Number - A ratio of the optical densities of a molasses solution treated with a standard activated carbon compared to a molasses solution treated with the activated carbon in question.

Moisture - The measurement of the amount of water adsorbed on activated carbon. Moisture is reported as percent. For Calgon Carbon's coal based products the moisture specification is less than 2% as packed.

Parallel Flow - The mode of operation when two or more adsorbers are operated so that the influent flow is distributed equally to each adsorber.

Particle Density - A measurement of the weight per unit volume of granular activated carbon as determined by the displacement of mercury. Particle density is typically reported as g/cc. The particle density includes the carbon skeleton volume plus the pore volume.

Polish Adsorber - See Lag Adsorber.

Pore Volume - A measurement of the volume of pores in a unit weight of carbon. The pore volume is determined by obtaining the difference in the volumetric displacement of carbon in mercury and helium at standard conditions.

Pressure Relief Device - A device such as a rupture disk or a pressure relief valve which prevents a vessel from exceeding its design pressure.

Real Density - A measurement of the weight per unit volume of the skeleton only of a carbon granule. This measurement excludes the pore volume and the inter- particle void space. This property is determined by helium displacement and is approximately 2.1 g/cc for coal based carbons.

Reactivated Carbon (React carbon) - Granular carbon that has been thermally reactivated for re-use as fresh carbon in adsorption systems.

Reactivation - A process to remove adsorbates from spent granular activated carbons using vaporization and oxidation at temperatures greater than 1000°F. Reactivated carbon can be reused. Depending on the application the performance of the reactivated carbon can be less than, equal to, or better than virgin carbon. This is a type of carbon regeneration.

Series Flow (Lead-Lag Operation) - A mode of operation where two or more adsorbers are operated so that each adsorber treats the entire influent flow, one after the other. When the carbon in the lead bed is spent, the carbon is replaced with fresh carbon and this adsorber is placed in the lag (polish) position.

Specific Heat - A physical property that is defined as the ratio of the quantity of heat required to raise the temperature of a compound through a particular temperature interval compared to the corresponding heat quantity for water. For Calgon Carbon carbons this value is approximately 0.20 cal/g/°C at temperatures less than 200°C.

Spent Carbon - Carbon that has adsorbed organic contaminants and must be removed from the system so that the effluent quality specifications are not exceeded.

Surface Area - A measurement of the total surface area available for adsorption inside the pores of activated carbon. Surface area is determined by the Brunauer, Emmett, and Teller method (BET Method), which uses the adsorption of nitrogen at liquid nitrogen temperature. Surface area is usually expressed in square meters per gram of carbon. The surface area of Calgon Carbon carbons ranges from 700 to 1200 square meters per gram.

Transfer Tank - A storage tank designed to hold a charge of spent carbon. The purpose of the tank is to save on freight as only one truck is needed to deliver fresh carbon and return the spent carbon for reactivation.

Transport Pores - Pores larger than the largest adsorption pores. These pores function as a diffusion path to transport adsorbates. Adsorption does not occur in these pores even at saturated conditions.

Underdrain - A device located inside the adsorber to collect the fluid being treated . The underdrain permits the fluid to flow into the piping network while retaining the granular carbon in the vessel.

Vent - A pipe line from an adsorber or transfer tank to an unrestricted sewer or the atmosphere.

Virgin Carbon - Fresh granular activated carbon that has not been used.

Voids - The space (volume) between the carbon granules. For Calgon Carbon carbons the typical range is 37% to 43% by volume.

Water Cushion - The water added to an adsorber or transfer tank before charging the vessel with carbon. This is done to protect the underdrain, nozzles and lining.

Wave Front - See Mass Transfer Zone

6.2 ADSORPTION

There are two types of adsorption: chemical and physical.

Chemical adsorption is a chemical reaction between a molecule in a solution or vapor with the surface of an adsorbent such as activated carbon. The chemical reaction is usually irreversible. An example of chemical adsorption is chlorine removal from water. The chemical reaction of chlorine with carbon and water forms Cl^- and $CO_3^=$ ions.

Physical adsorption is usually explained in terms of surface structure (or energy per unit volume) of the solid. While molecules in the interior of any solid material are subject to equal forces in all directions, the molecules on the material's surface are subjected to unbalanced forces. This results in an imbalance with inward forces toward the solids. Molecules that are either gaseous or liquid then become attracted (adsorbed) to the solid's surface.

The attractive forces, known as London Dispersion Forces, are the same forces responsible for surface tension and condensation of vapors to liquid. These forces are a type of Van der Waals force and range from very weak to moderately strong. Physical adsorption is reversible and changing the process variables in a system can cause molecules to be desorbed.

An important aspect to any adsorbent is the amount of pore volume it contains per unit volume or per net weight. Examples of adsorbents are activated carbon, silica gel, activated gel, alumina, and zeolite.

6.3 ACTIVATED CARBON AND HOW IT WORKS

Any organic material with a high carbon content (coal, wood, peat, coconut shells, etc.) can be used as the raw material for making activated carbons of various activities and properties. When making high quality granular activated carbon from coal, the raw material is ground and a binder is added to give the end product suitable hardness. The mixture is then re-compacted and crushed to give it the desired particle size. The carbon is then activated by thermally decomposing and removing carbon from the structure in a reducing atmosphere at about 1800 F. Furnace temperature and the furnace atmosphere are controlled to produce the desired adsorption properties in the product.

The resultant product has an incredibly large internal pore volume per unit particle volume and a network of submicroscopic pores where the adsorption takes place. About

40% of the particle volume is used to contain adsorbates. One pound of activated carbon contains an effective total area of over 100 acres.

Activated carbon normally removes adsorbates (contaminants or desired products) from a solution (solute) through physical adsorption. The adsorbate would have to differ from the solute. For example, in aqueous solutions the solute should be more neutral or non-polar and have a higher molecular weight.

Many factors affect carbon adsorption in liquids, such as pH, flow rate, temperature, solubility, concentration of adsorbate, type and number of different adsorbates, viscosity, and the level of adsorbate removal required.

In any stream, there are four steps that occur in order for adsorption to take place. First, the adsorbate molecule must migrate through the bulk of solution toward the carbon particle. This is known as bulk diffusion. Second, the adsorbate penetrates the surface film to reach the exterior surface of the carbon. This is known as film diffusion. Third, the adsorbate diffuses through the transport or large pores. This is known as pore diffusion. Fourth, the adsorbate is adsorbed deep into the micropore structure of the activated carbon. In most water applications, the rate limiting step is the pore diffusion step.

In a typical fixed bed carbon system, the liquid flows down through an adsorber. Initially, the adsorbate is adsorbed onto the top most portion of the carbon. The rate of adsorption will determine the depth of carbon (mass transfer zone) that is utilized to remove the adsorbates. The varying concentration in the mass transfer zone is known as the wavefront.

Eventually, the wavefront moves through the bed and contamination breaks through into the effluent from the bed. This is known as the breakpoint. In a single or parallel adsorber system, the contaminants are usually monitored until the effluent approaches the allowable limit. The adsorber is then taken off-line and the spent carbon is removed. The adsorber is then refilled with fresh carbon and brought back on-line.

In a series mode, the mass transfer zone in the first or lead bed is allowed to pass through the adsorber into the second bed. Usually, when adsorbing multiple components, the first two or three compounds that are being monitored in the effluent from the lead bed are allowed to approach their influent levels, at which point the adsorber is taken off-line.

6.4 FACTORS AFFECTING ADSORPTION

Concentration: With each adsorbate, a high concentration will result in a higher adsorption capacity for that adsorbate on the carbon. For example, if an adsorbate has a one percent loading at 1 mg/l, it might have a three percent loading at 10 mg/l. However, the volume of carbon required to treat a fixed volume of solution will go up if the concentration goes up.

When the concentration of the feedstream changes dramatically, such as when a spill occurs upstream of a potable water plant intake, undesirable effects may occur. Concentrations at the intake of the plant may go up 100 to 1000 times the normal influent concentration. The activated carbon would adsorb the contamination with a higher capacity, if adsorptive capacity was available.

However, upon passage of the spill past the intake, the activated carbon may desorb some of the high level contamination to fresh carbon downstream of the mass transfer zone or into the effluent. When upsets occur, a conservative approximation is to assume that additional carbon is exhausted by the excess contaminant at the original loading rate for the normal influent level.

Another example is when the contaminant concentration in the influent decreases for a period of time. In this instance the adsorbate will start to desorb. The rate of desorption is slower than the rate of adsorption. Therefore, a conservative estimate of the overall effect is that a fixed volume at the reduced influent level will exhaust as much carbon as if the influent concentration was consistently high.

A steady feed concentration will help minimize the amount of carbon that is used in an application. A steady feed would usually be considered to be +/-25% of the average concentration. However, the carbon bed will act to average out upsets and variations, except when the bed is nearly exhausted.

Flow Rate: In many applications, the flow rate to the adsorber is varied because the flow demand changes. As the flow changes, so does the mass transfer zone (MTZ). These changes are approximated by a directly proportional relationship between MTZ length and flow rate. For example, if the MTZ is 1 foot at 250 gpm, it would be 2 feet at 500 gpm. If the flow rate is increased dramatically, the MTZ is further lengthened because some desorption may take place, resulting in less efficient operation. For the optimum carbon usage, the flow rate should be steady (if possible).

In a series configuration, increasing the flow rate usually has a minimal impact. In a parallel mode, this impact is more substantial since the carbon is usually taken off line on the basis of the effluent quality. since the MTZ is lengthened the on-stream time will be shortened.

Viscosity: As viscosity increases in a system, the time to adsorb lengthens, and thus the MTZ lengthens. In a process application the temperature of the feedstream may be raised to offset increases in viscosity, but if the temperature is raised too high degradation of product may occur or the adsorption capacity of the carbon may be reduced. In water applications, viscosity has minimal impact because it is relatively low.

Temperature: In liquid phase systems, the adsorptive capacity is usually lowered at higher temperatures because the solubility is increased.

Feedstream pH: The pH of the feedstream can impact adsorption efficiency. This impact may be substantial since the pH affects the ionization of the adsorbate. Usually, the more ionic adsorbates have less adsorption capacity. Therefore, organic acids adsorb better at lower pH levels, while organic bases adsorb better at higher pH levels.

Water Characteristics: On each start-up of fresh carbon, the pH of the effluent stream may rise. This occurs because species like sulfates, nitrates and chlorine adsorb and displace alkaline species. The pH will return to normal, depending on water characteristics, after 250 to 350 bed volumes have been treated. If this is a problem, then either acid should be added to the effluent, or the carbon should be allowed to stand in a sodium sulfate solution for 10 to 12 hours.

The carbon has a capacity for sodium sulfate of 1% by weight. Therefore, the water in contact with the carbon should contain a quantity of sodium sulfate at least equal to 2% by weight of the carbon. In a 20,000 pound adsorber this would be 400 pounds of Na_2SO_4 in 5,000 gallons of water.

Solubility: The water solubility of a particular compound is a very good indicator of its adsorptivity. Generally, the more soluble a compound is, the more difficult it is to be adsorbed. Also, a more water soluble compound has a longer MTZ.

Suspended Solids: Suspended solids should usually be taken out of the feedstream before the carbon adsorbers. Suspended solids (>10 microns) will usually be filtered out within the first 6" of carbon and the pressure drop across the carbon will increase. If the pressure drop increases too much, the unit should be backwashed or backflushed.

Normally, feed streams containing suspended solids of more than 50 ppm are pre-filtered.

If the suspended solids are finer than 10 microns, the solids will usually not be filtered out by the carbon. The solids would then pass through the carbon into the effluent. This condition is very undesirable because the solids often contain dissolved or attached adsorbate and premature breakthrough can appear to occur. For materials to adsorb they must be in solution, so they can diffuse into the pore structure.

<u>Immiscible Oils and Greases</u>: Immiscible oils and greases have to be separated from the feedstream before the carbon adsorbers. If they are not removed, they may coat the carbon particles with a fine film. The adsorbates will not be able to pass through this film, and the carbon will not be effectively utilized. Oils and grease can also behave as a suspended, immiscible solid.

<u>Heat of Adsorption</u>: Heat is often given off when molecules are adsorbed. The amount of heat is conservatively estimated at two (2) times the heat of vaporization. In a process stream where the solvent is an organic liquid, a heat-up potential exists if the carbon has not been previously wetted and deaerated properly. Refer to Section 3.3 of this manual for wetting procedures.

Water has too low a heat of adsorption to cause a problem for aqueous solutions.

<u>Competitive Adsorption</u>: In most carbon applications (process, wastewater, groundwater, and potable water), more than one adsorbing compound is in the feedstream. Some of these compounds must be adsorbed while others may be permitted to pass through the carbon bed.

Unfortunately, the activated carbon cannot tell which of the molecules must be adsorbed. All of the components in the feedstream will compete for adsorption space, making the removal of target components less efficient. Therefore, competitive adsorption can cause premature breakthrough of the target component.

6.5 ADDITIONAL ADSORPTION THEORY

Desorption/Displacement: Desorption is the opposite of adsorption and may occur for many reasons. Changes in the feedstream components, temperature, pH, and feedstream concentration may promote desorption. In order to minimize desorption and optimize carbon usage, the feedstream should be stable (if possible). The rate at which desorption takes place is usually much slower than the adsorption rate.

If a more strongly adsorbed organic enters the feed it will desorb the target adsorbate. This forces the target adsorbate to re-adsorb deeper in the carbon bed, and eventually breakthrough will occur.

Roll-over in Competitive Adsorption: When an adsorber system runs beyond breakthrough, the more weakly adsorbed components originally in the feedstream can be desorbed into the effluent. The resulting concentrations may exceed the inlet concentrations. This phenomenon is known as roll-over. In a properly operated column system, roll-over of key components will not be observed in the effluent.

Effect of Bacteria: Higher pressure drops can be a result of bacteria growth in some wastewater applications. This is due to bacteria slime and exhaust gasses from the bacteria. If backwashing does not get rid of the pressure drop problem, then either NaOH washing or higher temperatures will control bacteria growth. Usually, sodium hydroxide washing is used in lined vessels. Do not use biocides, chlorine, or other additives, since they will adsorb and reduce carbon life without affecting the bacteria.

Refer to Section 3.7.2 for sodium hydroxide washing procedures.

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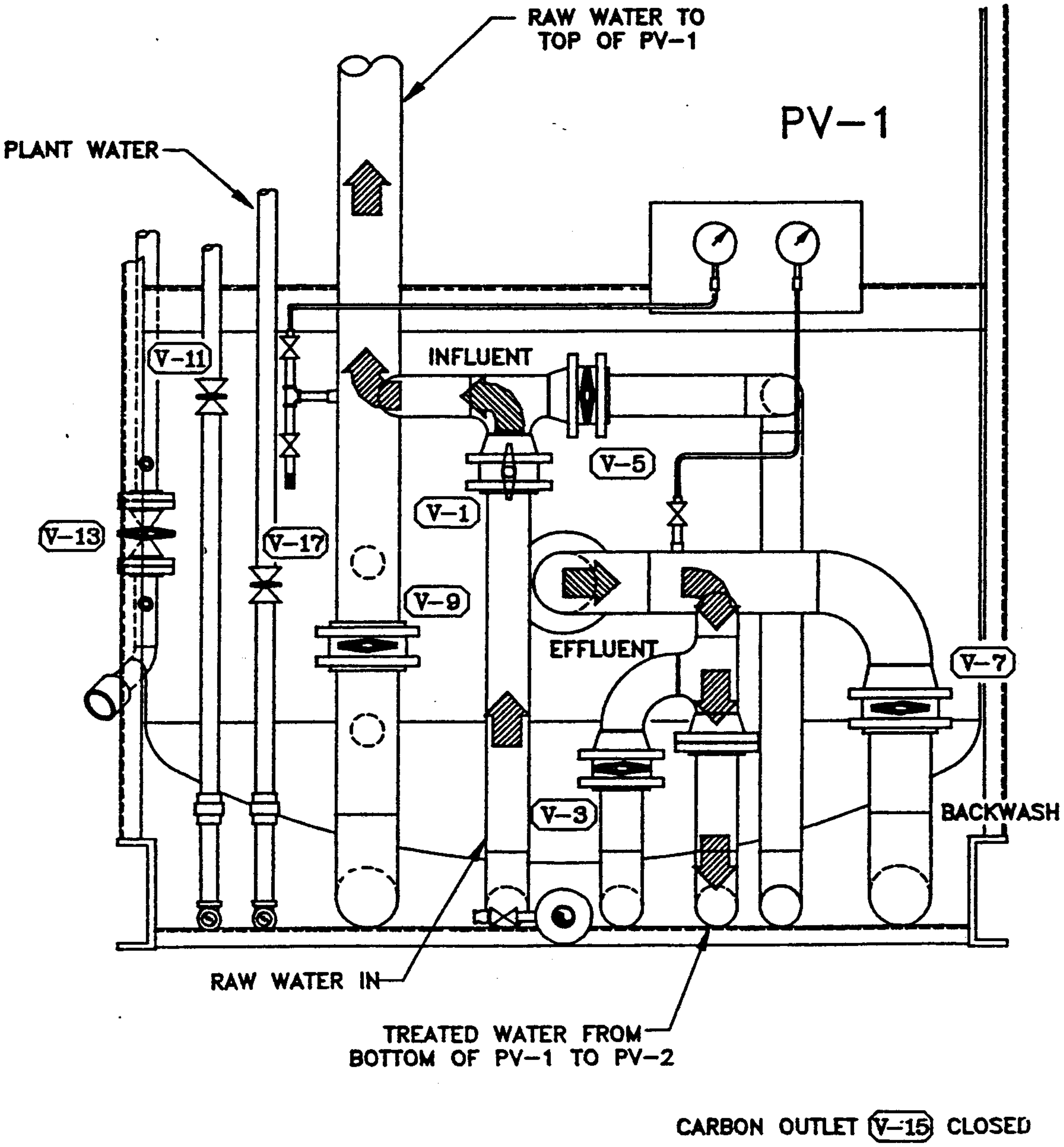
SYSTEM OPERATION

VALVE DIAGRAM

FIGURE 1

SERIES FLOW
VESSEL PV-1 TO PV-2



VALVE CONFIGURATION ON PV-1

SYSTEM OPERATION

VALVE DIAGRAM

SERIES FLOW
VESSEL PV-1 TO PV-2

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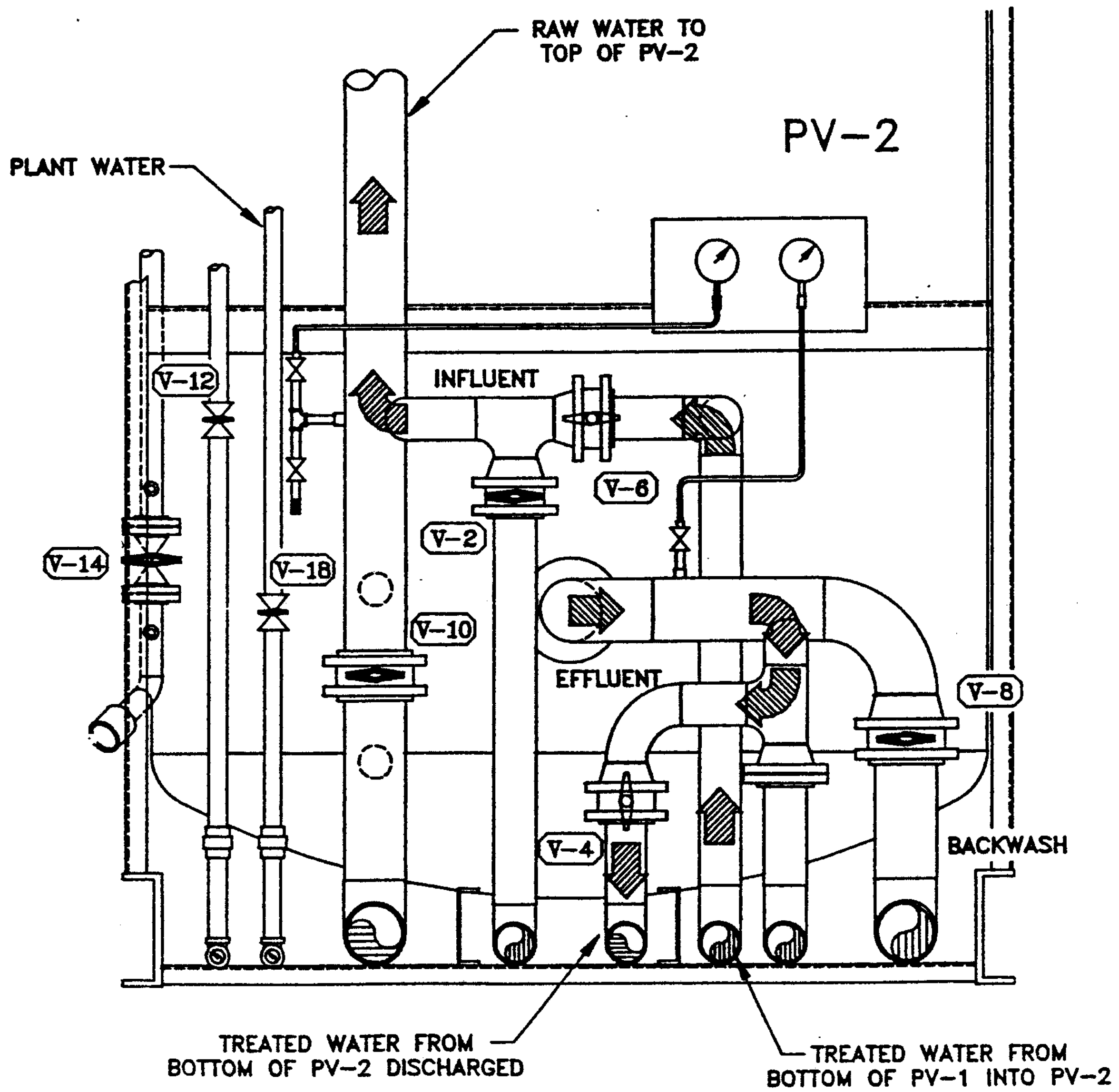
FIGURE 1



CARBON OUTLET V-16 CLOSED

VALVE CONFIGURATION ON PV-2

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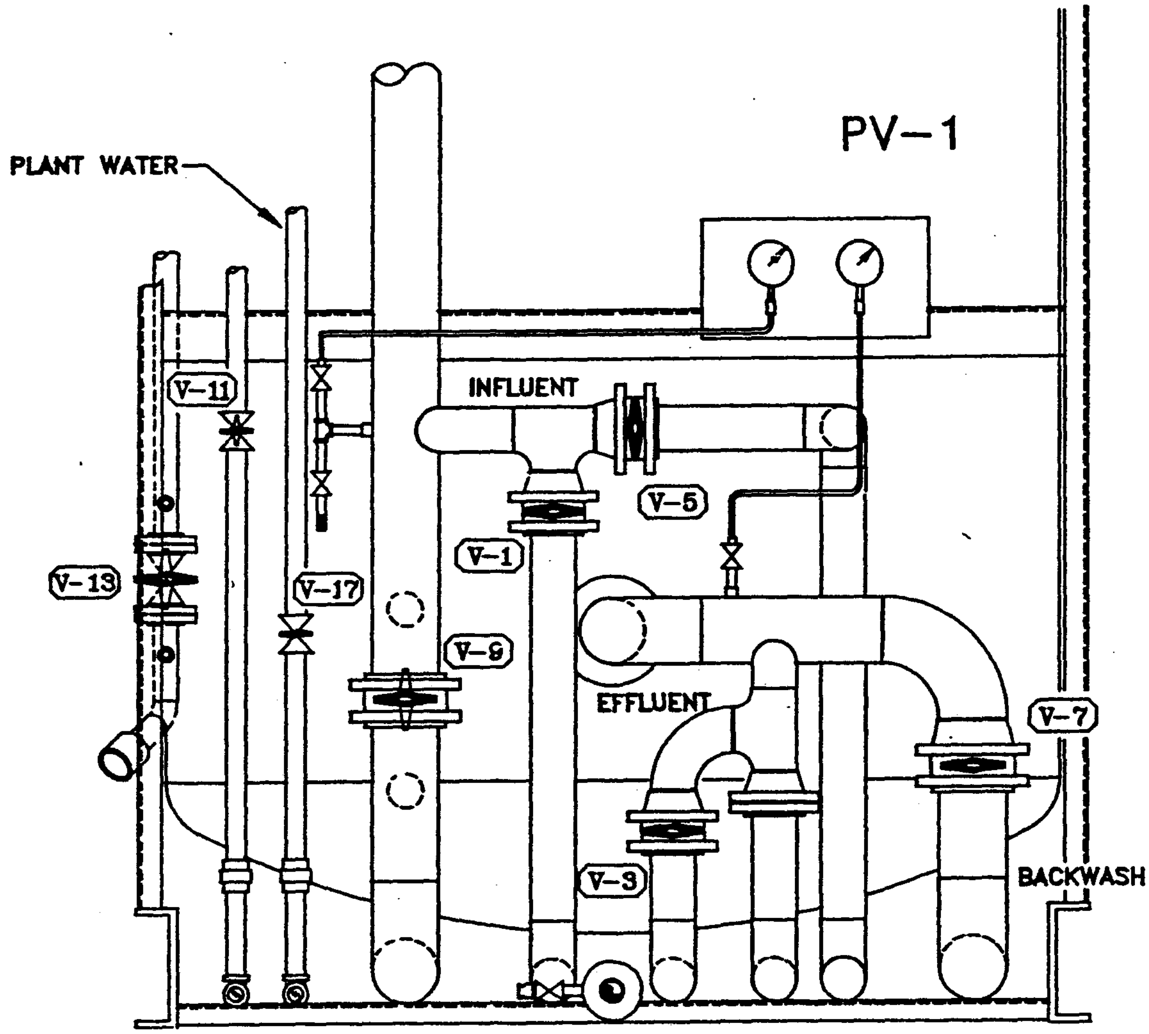
SYSTEM OPERATION

VALVE DIAGRAM

FIGURE 2

PV-1 CARBON TRANSFER
PV-2 ONLINE



CARBON DISCHARGE			CARBON FILL		
VENT/DRAIN	V-9	CLOSED	VENT/DRAIN	V-9	OPEN
COMP. AIR	V-11	OPEN	COMP. AIR	V-11	CLOSED
CARBON INLET	V-13	CLOSED	CARBON INLET	V-13	OPEN
CARBON OUTLET	V-15	OPEN	CARBON OUTLET	V-15	CLOSED

VALVE CONFIGURATION ON PV-1

SYSTEM OPERATION

VALVE DIAGRAM

PV–1 CARBON TRANSFER
PV–2 ONLINE

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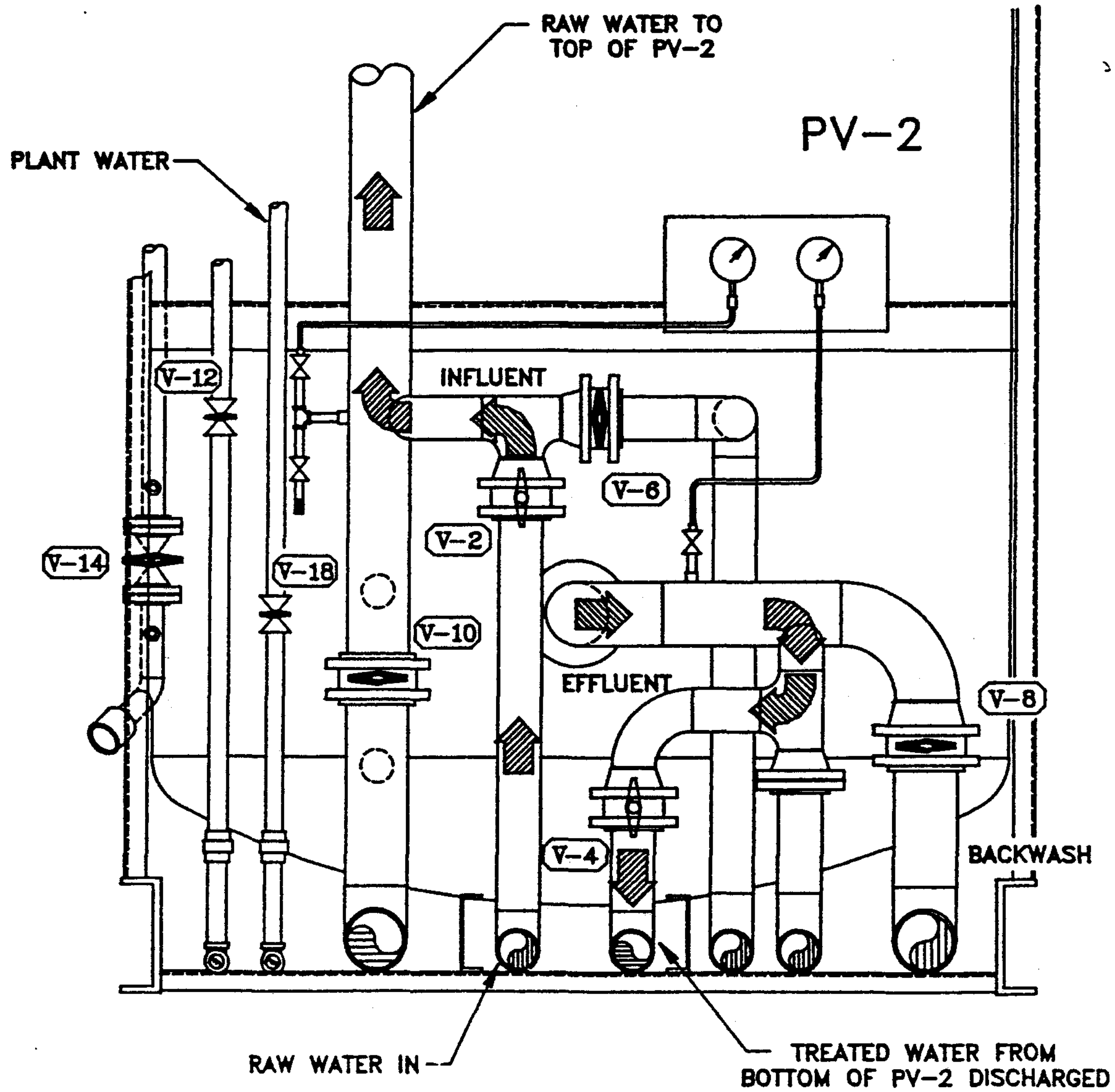
FIGURE 2



CARBON OUTLET V–16 CLOSED

VALVE CONFIGURATION ON PV–2

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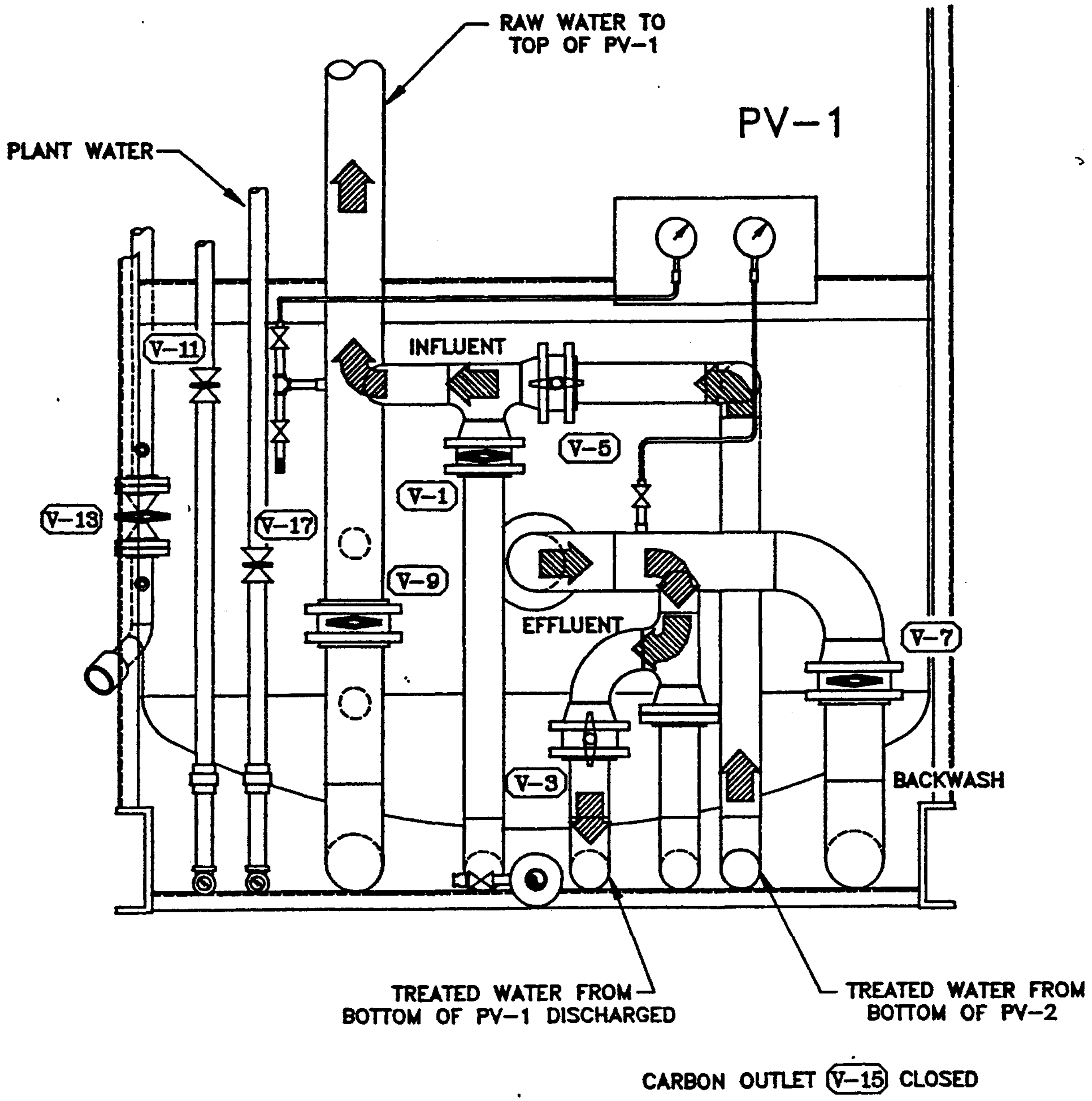
SYSTEM OPERATION

VALVE DIAGRAM

FIGURE 3

SERIES FLOW
VESSEL PV-2 TO PV-1



VALVE CONFIGURATION ON PV-1

SYSTEM OPERATION

VALVE DIAGRAM

SERIES FLOW
VESSEL PV-2 TO PV-1

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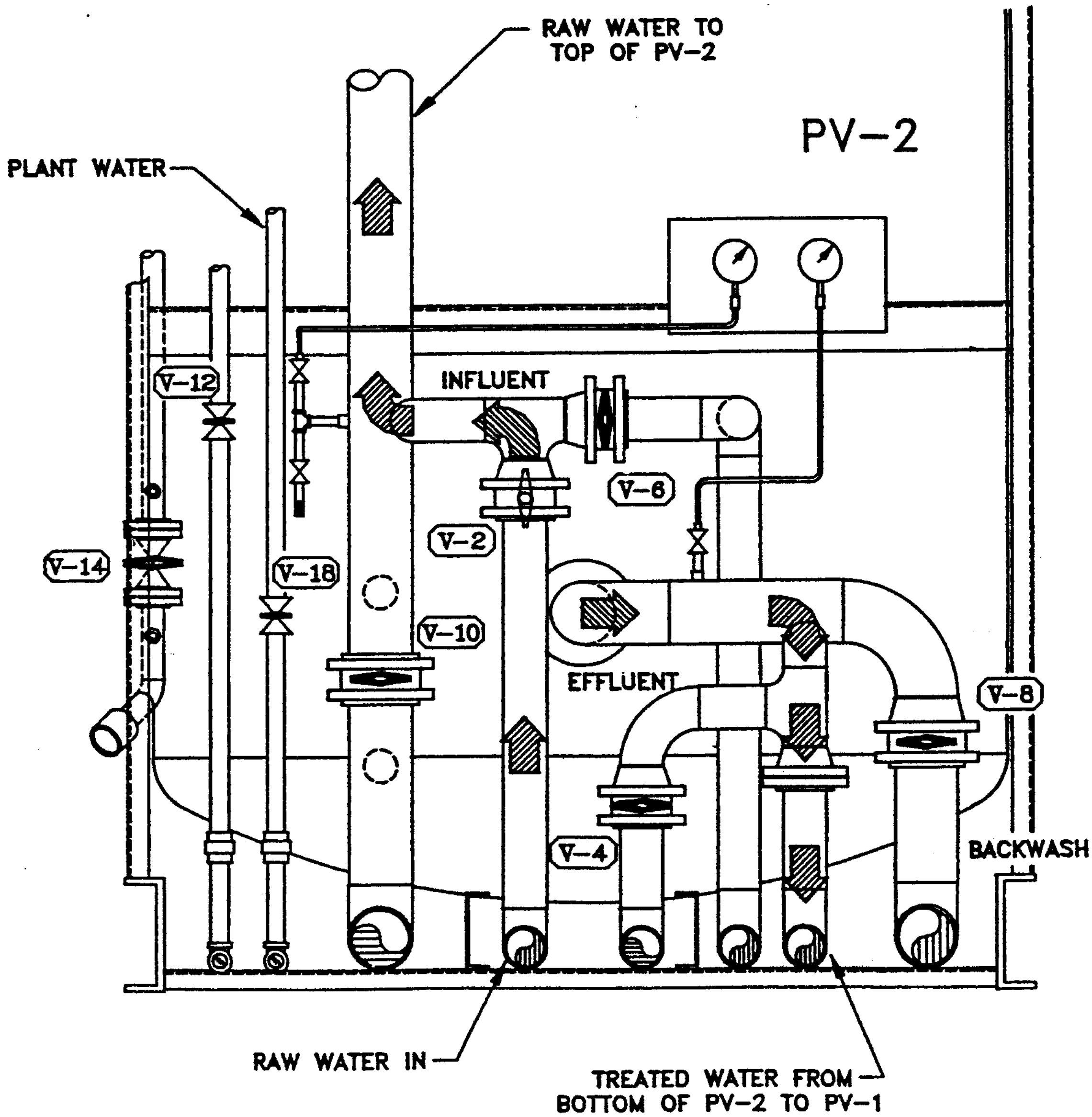
FIGURE 3



CARBON OUTLET V-16 CLOSED

VALVE CONFIGURATION ON PV-2

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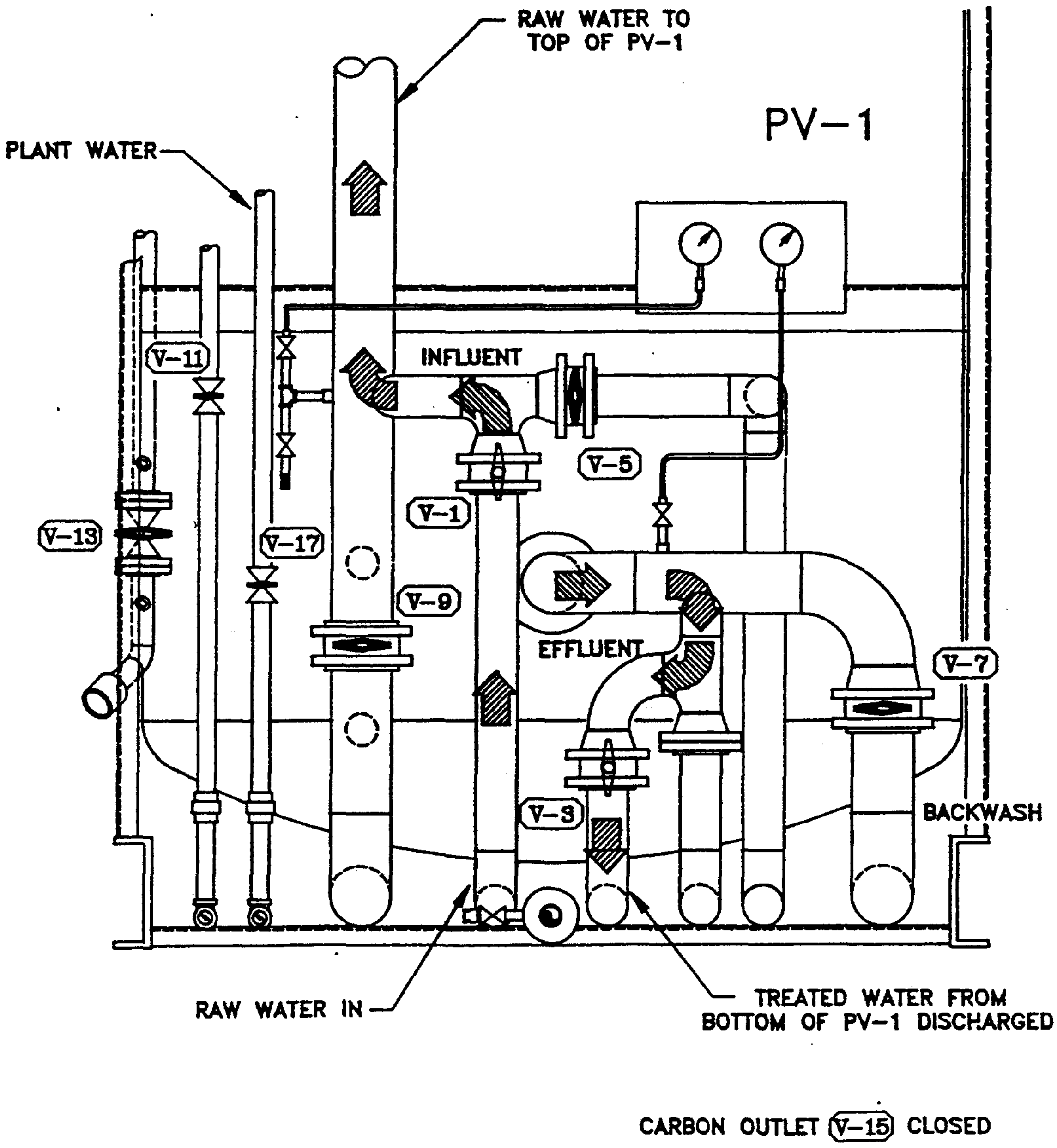
SYSTEM OPERATION

VALVE DIAGRAM

FIGURE 4

PV-1 ONLINE
PV-2 CARBON TRANSFER



VALVE CONFIGURATION ON PV-1

SYSTEM OPERATION

VALVE DIAGRAM

PV-1 ONLINE
PV-2 CARBON TRANSFER

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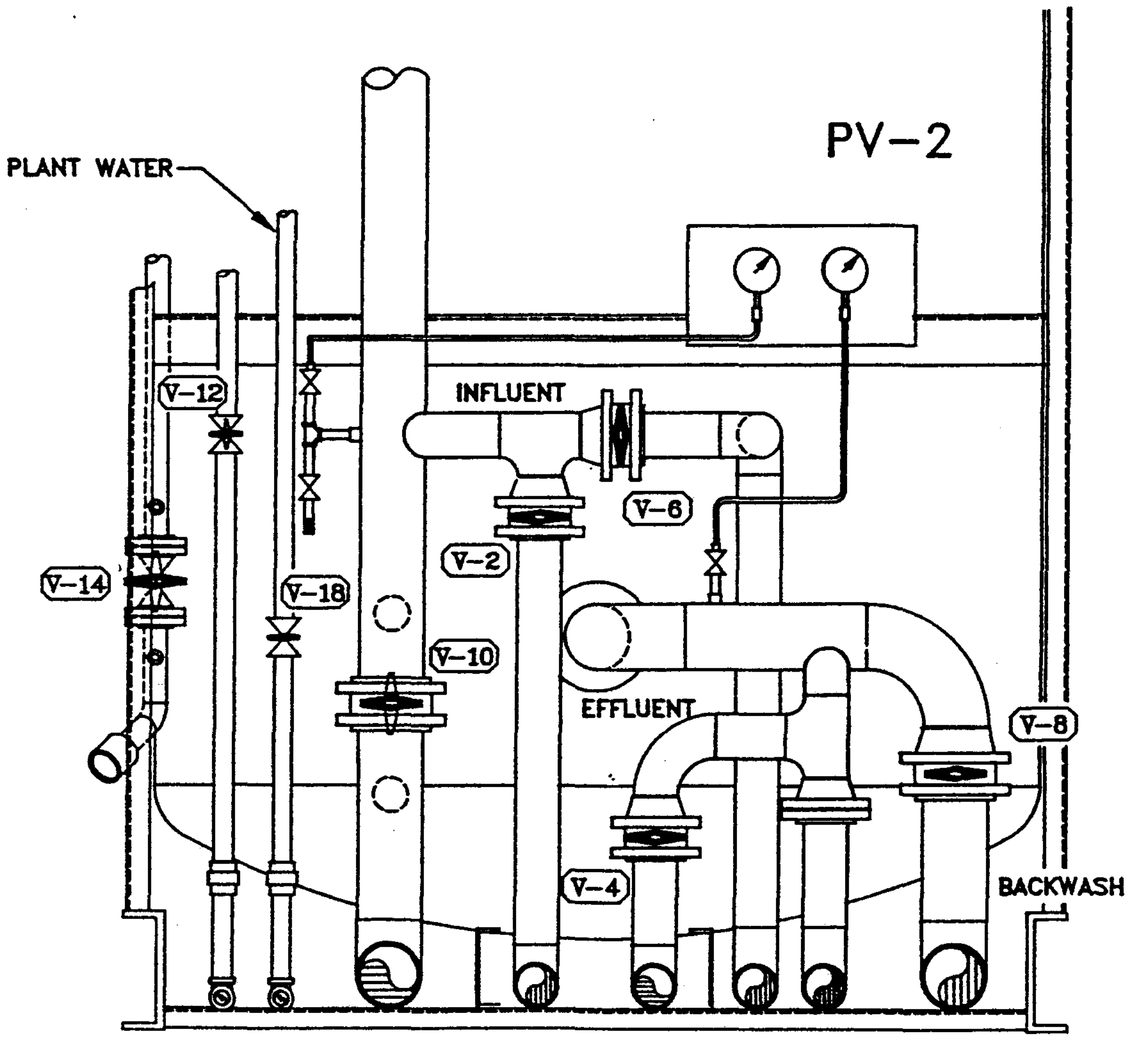
FIGURE 4



CARBON DISCHARGE			CARBON FILL		
VENT/DRAIN	V-10	CLOSED	VENT/DRAIN	V-10	OPEN
COMP. AIR	V-12	OPEN	COMP. AIR	V-12	CLOSED
CARBON INLET	V-14	CLOSED	CARBON INLET	V-14	OPEN
CARBON OUTLET	V-16	OPEN	CARBON OUTLET	V-16	CLOSED

VALVE CONFIGURATION ON PV-2

CALGON

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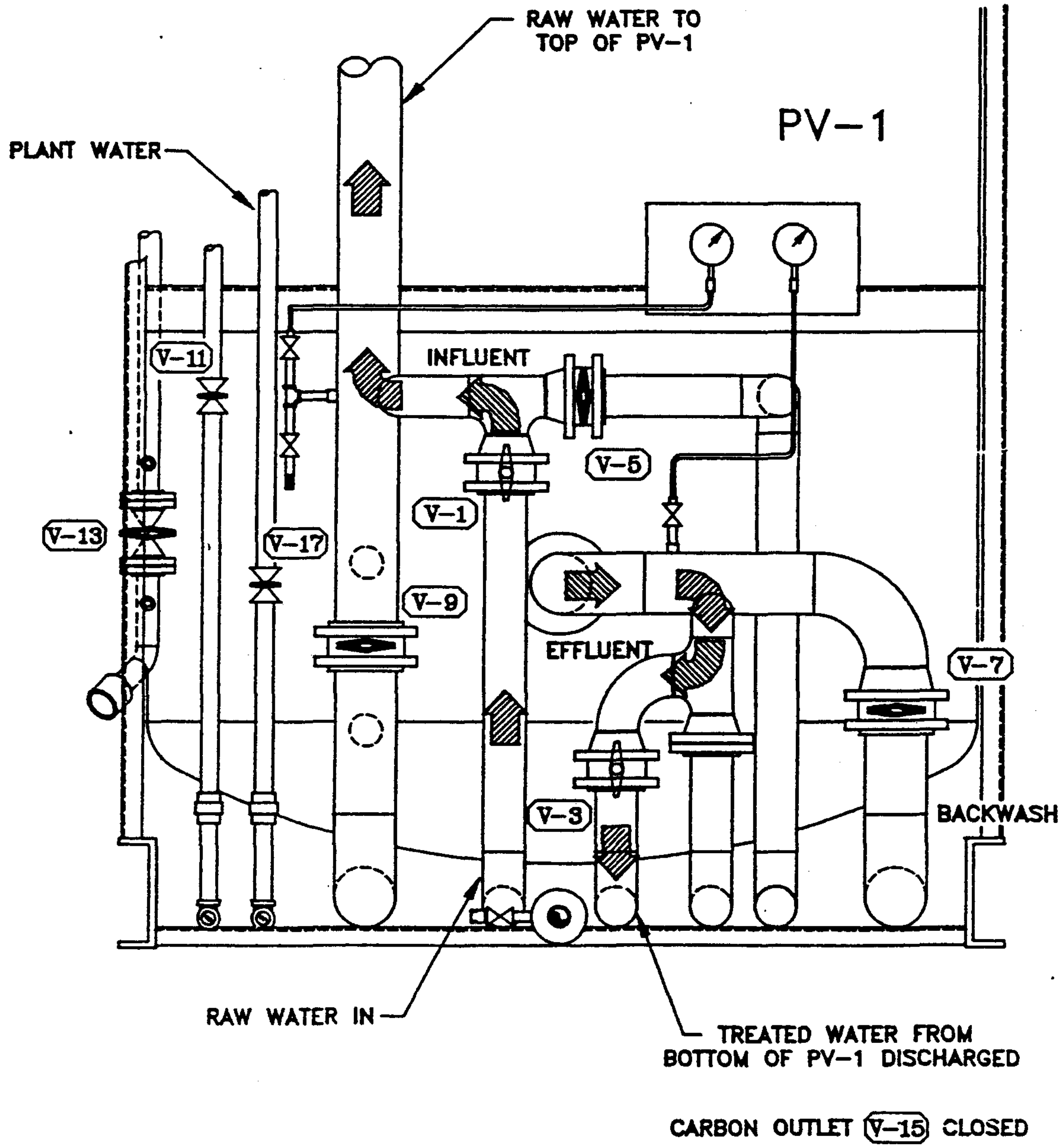
SYSTEM OPERATION

VALVE DIAGRAM

FIGURE 5

PARALLEL FLOW
VESSELS PV-1 AND PV-2



VALVE CONFIGURATION ON PV-1

SYSTEM OPERATION

VALVE DIAGRAM

PARALLEL FLOW
VESSELS PV-1 AND PV-2

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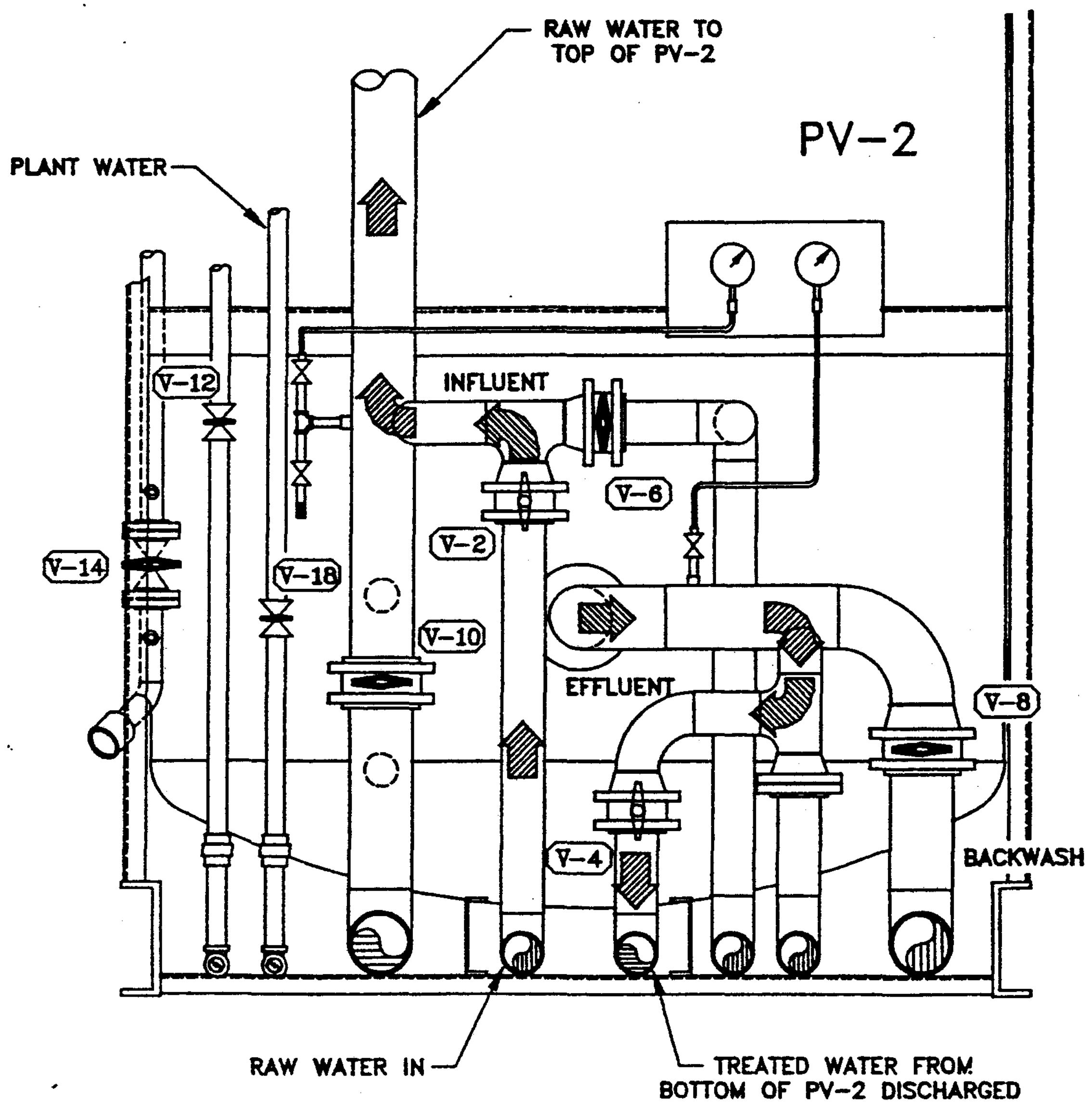
FIGURE 5



CARBON OUTLET V-16 CLOSED

VALVE CONFIGURATION ON PV-2

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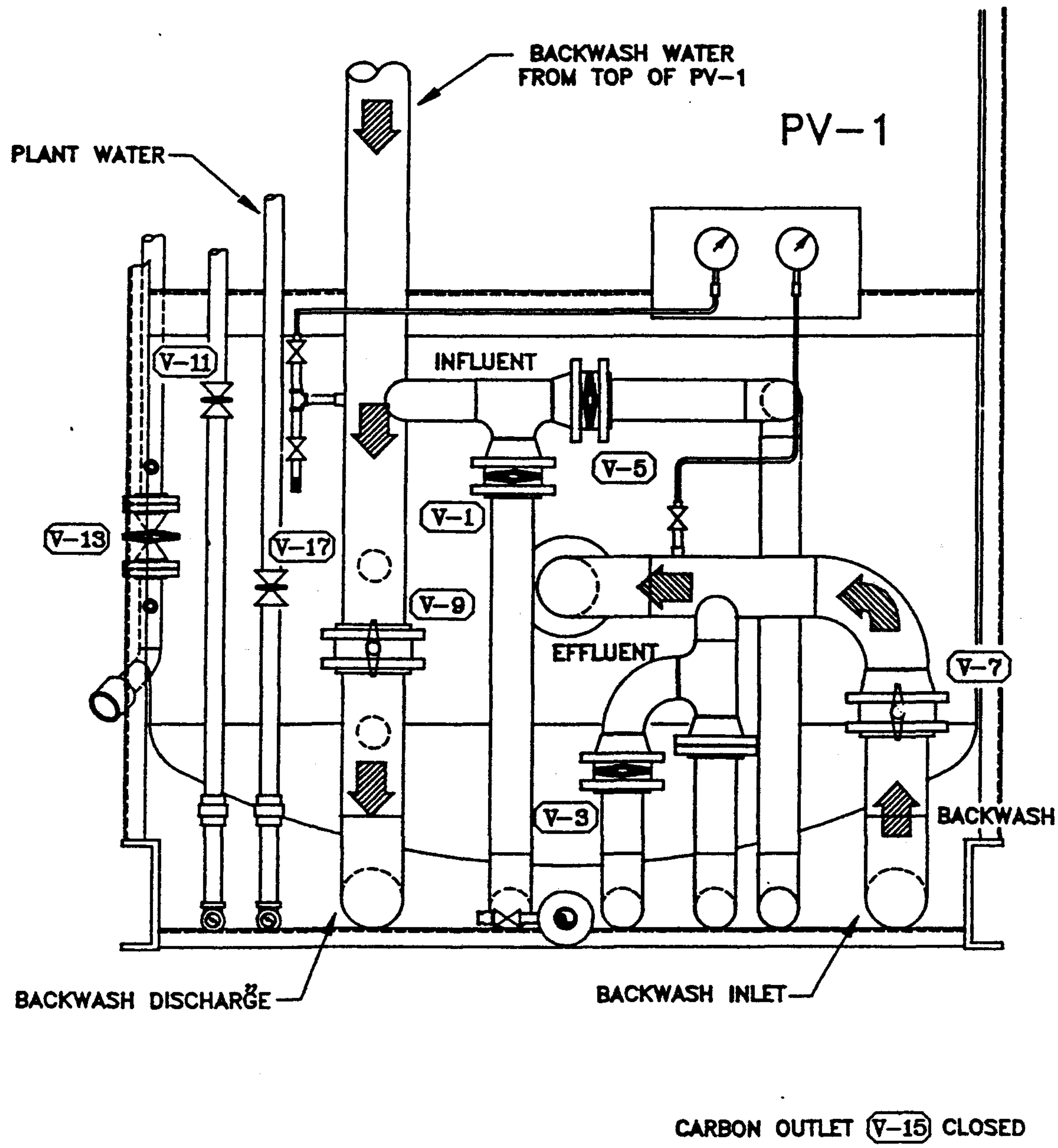
FIGURE 6

SYSTEM OPERATION

VALVE DIAGRAM

PV-1 BACKWASHING
PV-2 ONLINE



VALVE CONFIGURATION ON PV-1

SYSTEM OPERATION

VALVE DIAGRAM

PV–1 BACKWASHING
PV–2 ONLINE

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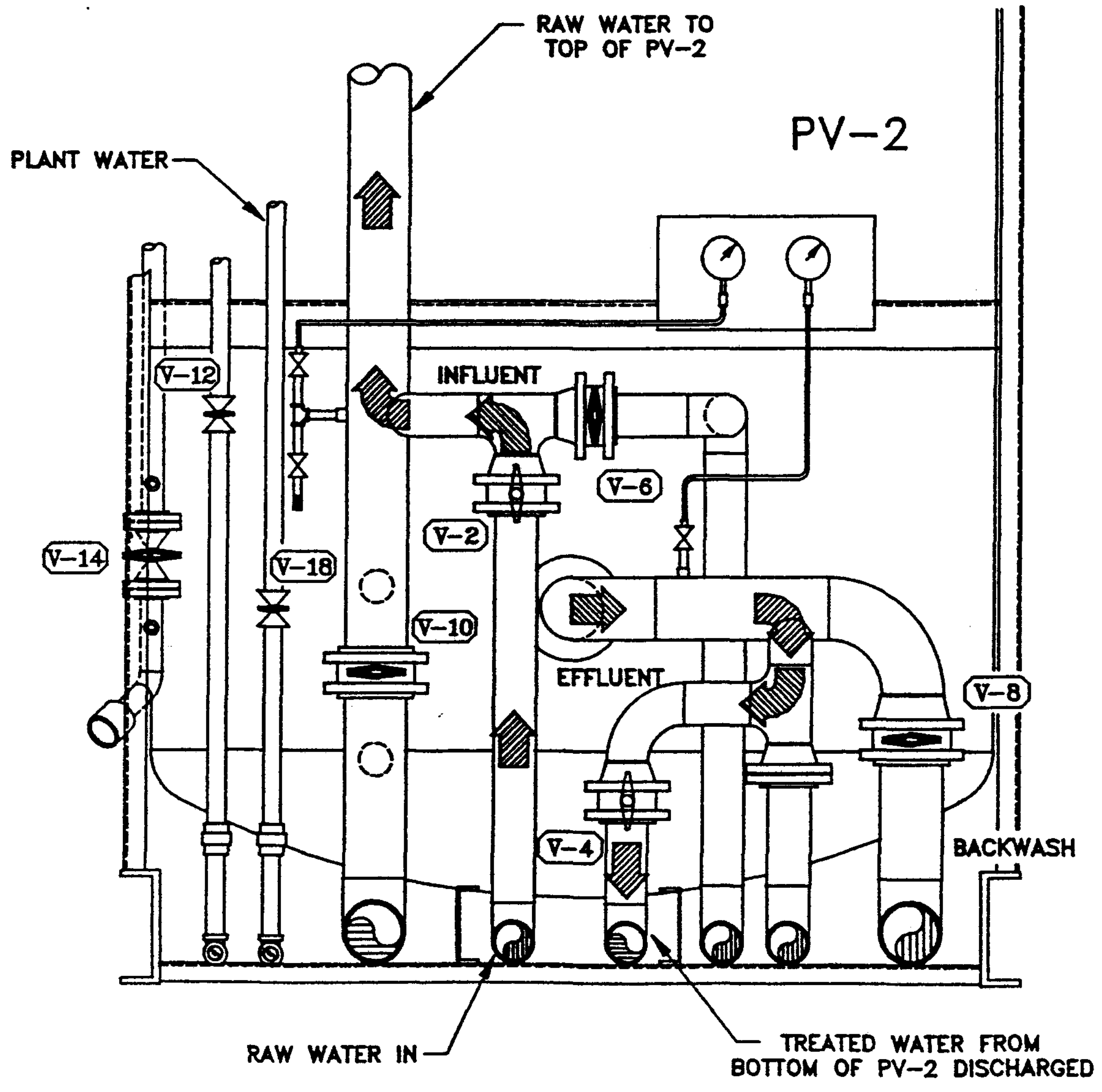
FIGURE 6



CARBON OUTLET V–16 CLOSED

VALVE CONFIGURATION ON PV–2

CALGON

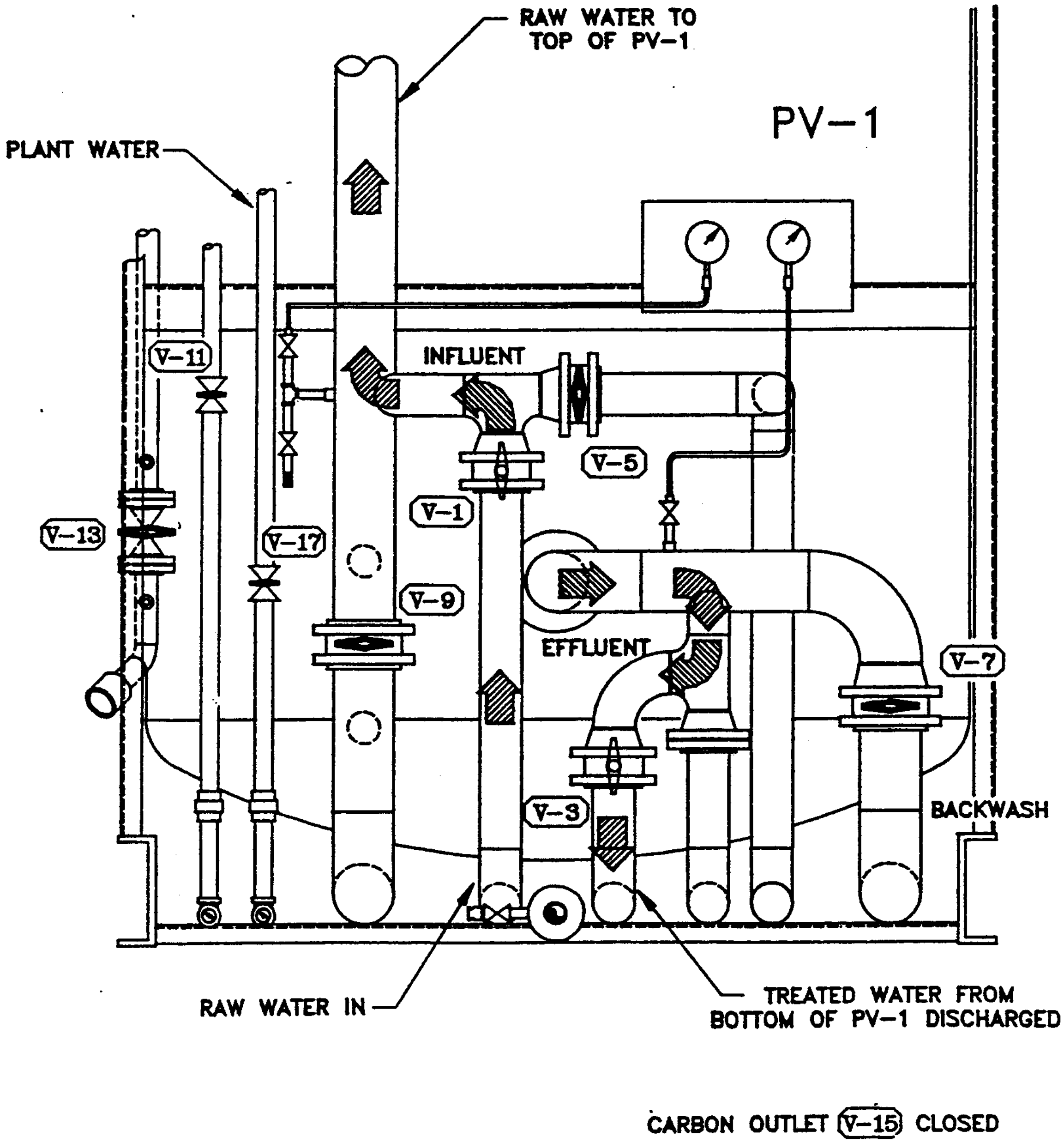
CALGON CARBON CORPORATION

SYSTEM OPERATION

VALVE DIAGRAM

FIGURE 7

PV−1 ONLINE
PV−2 BACKWASHING



VALVE CONFIGURATION ON PV−1

SYSTEM OPERATION

VALVE DIAGRAM

PV-1 ONLINE
PV-2 BACKWASHING

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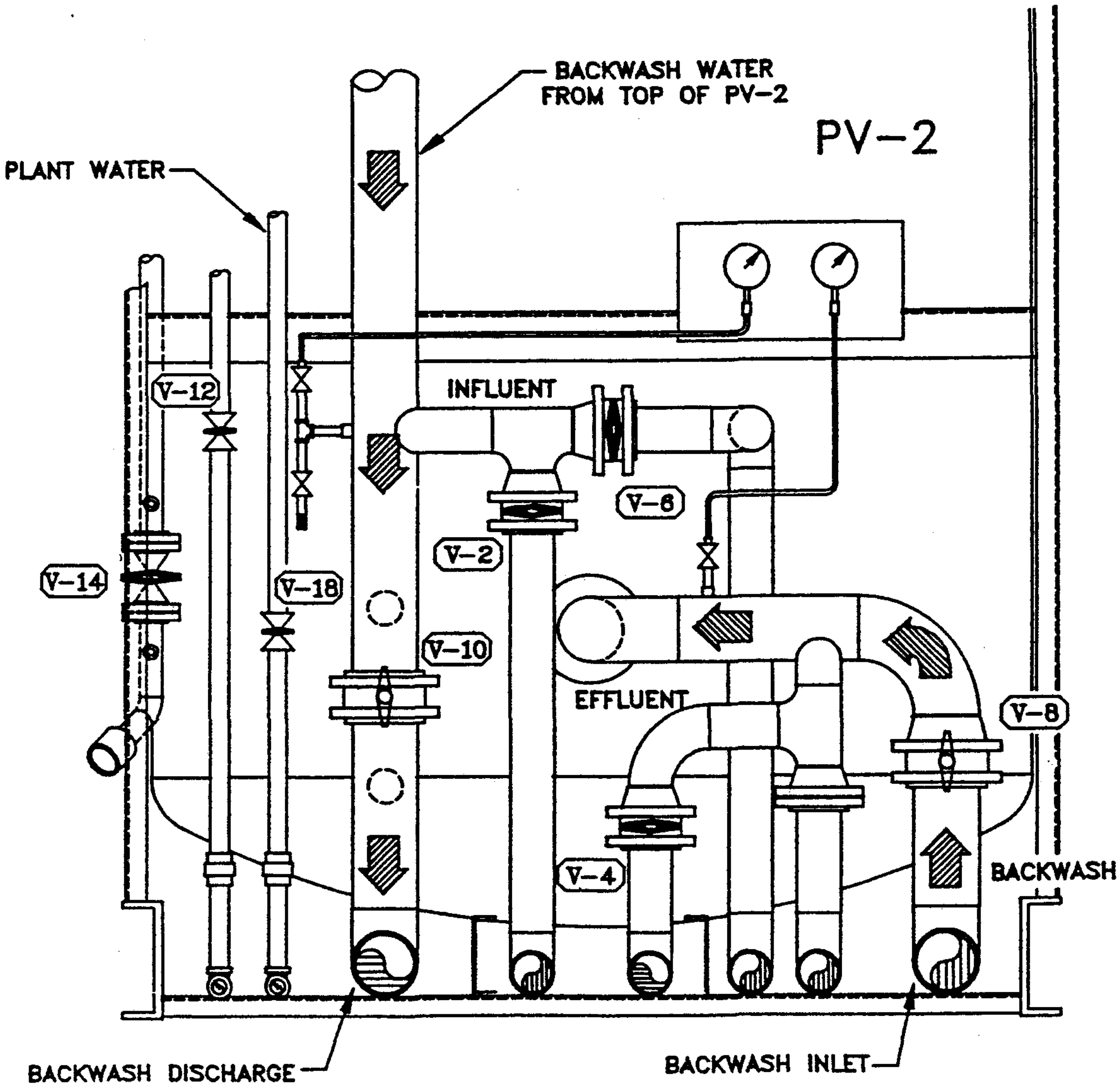
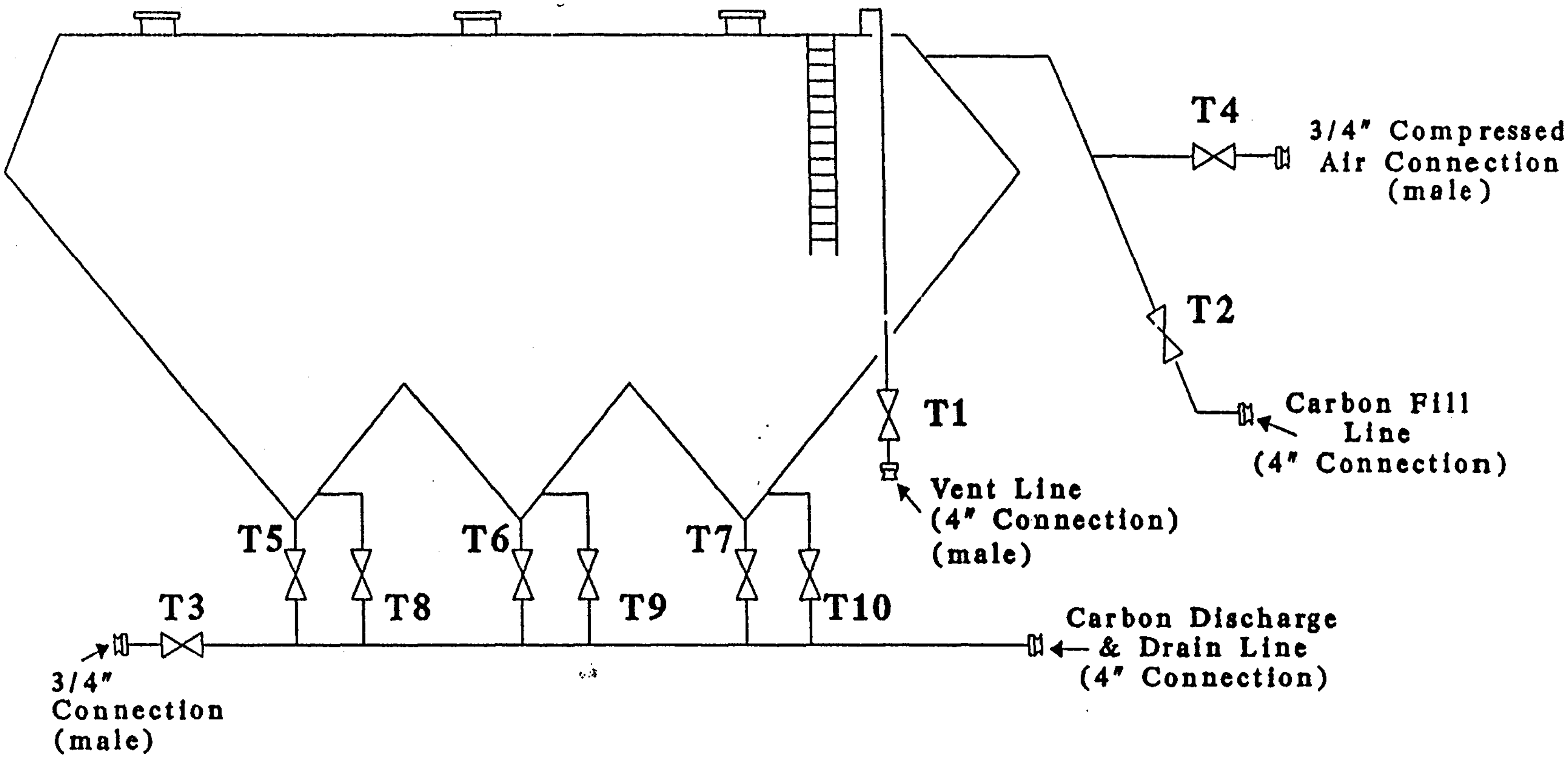
FIGURE 7



CARBON OUTLET V-16 CLOSED

VALVE CONFIGURATION ON PV-2

Figure 8: Calgon Carbon Standard Trailer



Note: 1) For Industrial Trailers, the Carbon Fill & Discharge connections are Kamlock style (male)

2) For Food Grade Trailers, the Carbon Fill & Discharge connections are Kamlock style (female)

3) All other connections are male Kamlock for ALL trailers

4) Maximum Operating Pressure = 15 psig

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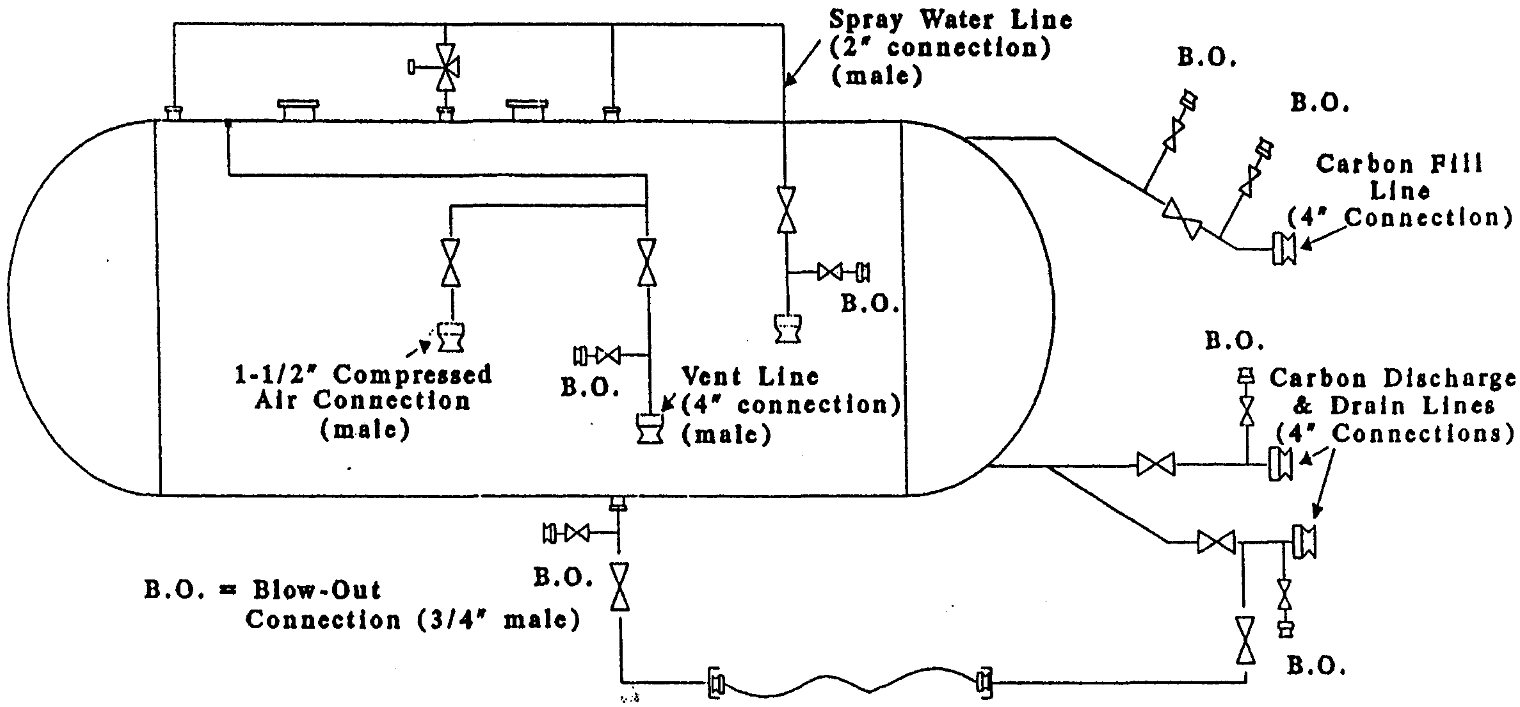
Figure 9: Calgon Carbon Lift Trailer



Note:
1) For Industrial Trailers, the Carbon Fill & Discharge connections are Kamlock style (male)
2) For Food Grade Trailers, the Carbon Fill & Discharge connections are Kamlock style (female)
3) All other connections are male Kamlock for ALL trailers
4) Maximum Operating Pressure = 30 psig

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5/14/92

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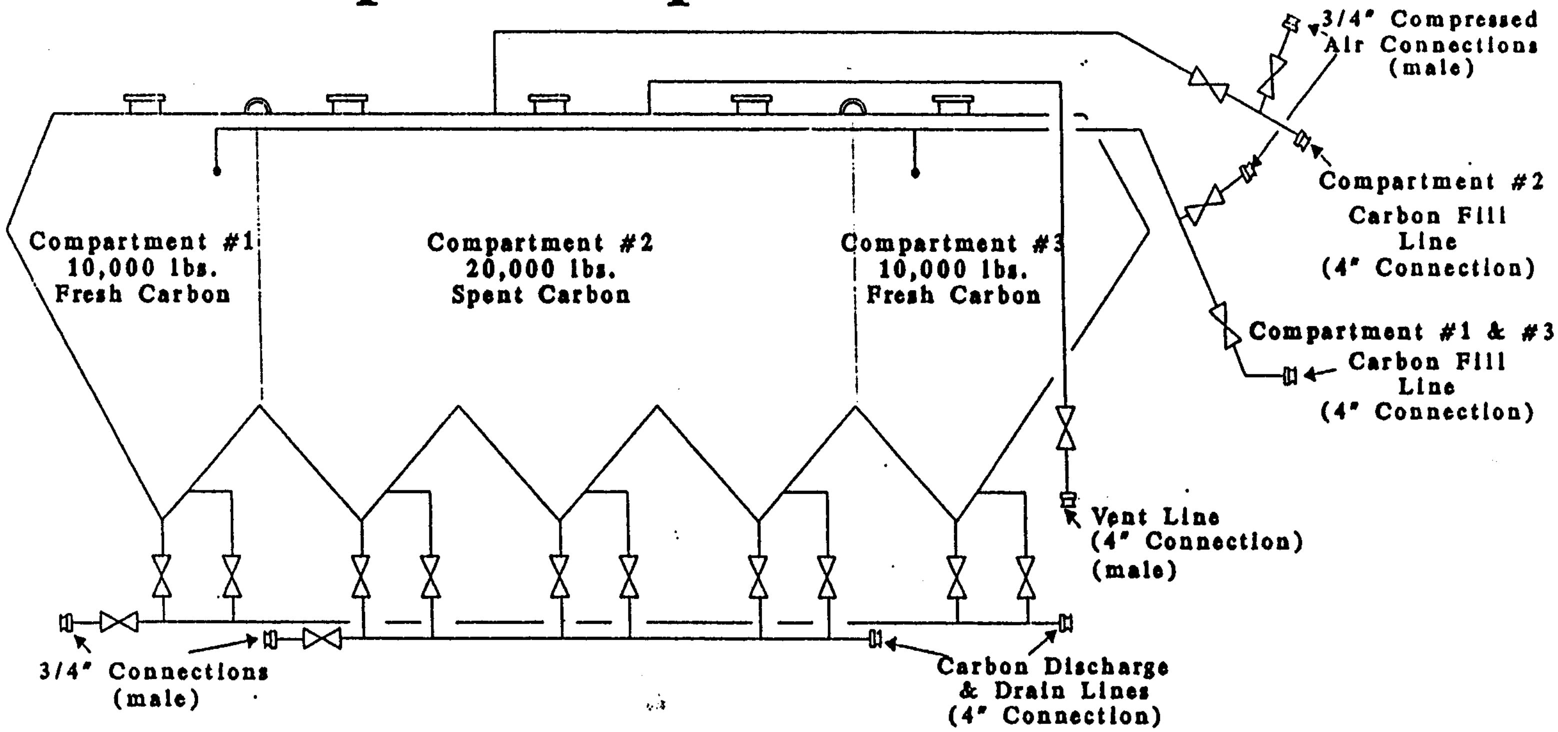
Figure 10: Calgon Carbon Triple Compartment Trailer



Note:

1) For Industrial Trailers, the Carbon Fill & Discharge connections are Kamlock style (male)
2) For Food Grade Trailers, the Carbon Fill & Discharge connections are Kamlock style (female)
3) All other connections are male Kamlock for ALL trailers
4) Maximum Operating Pressure = 15 psig

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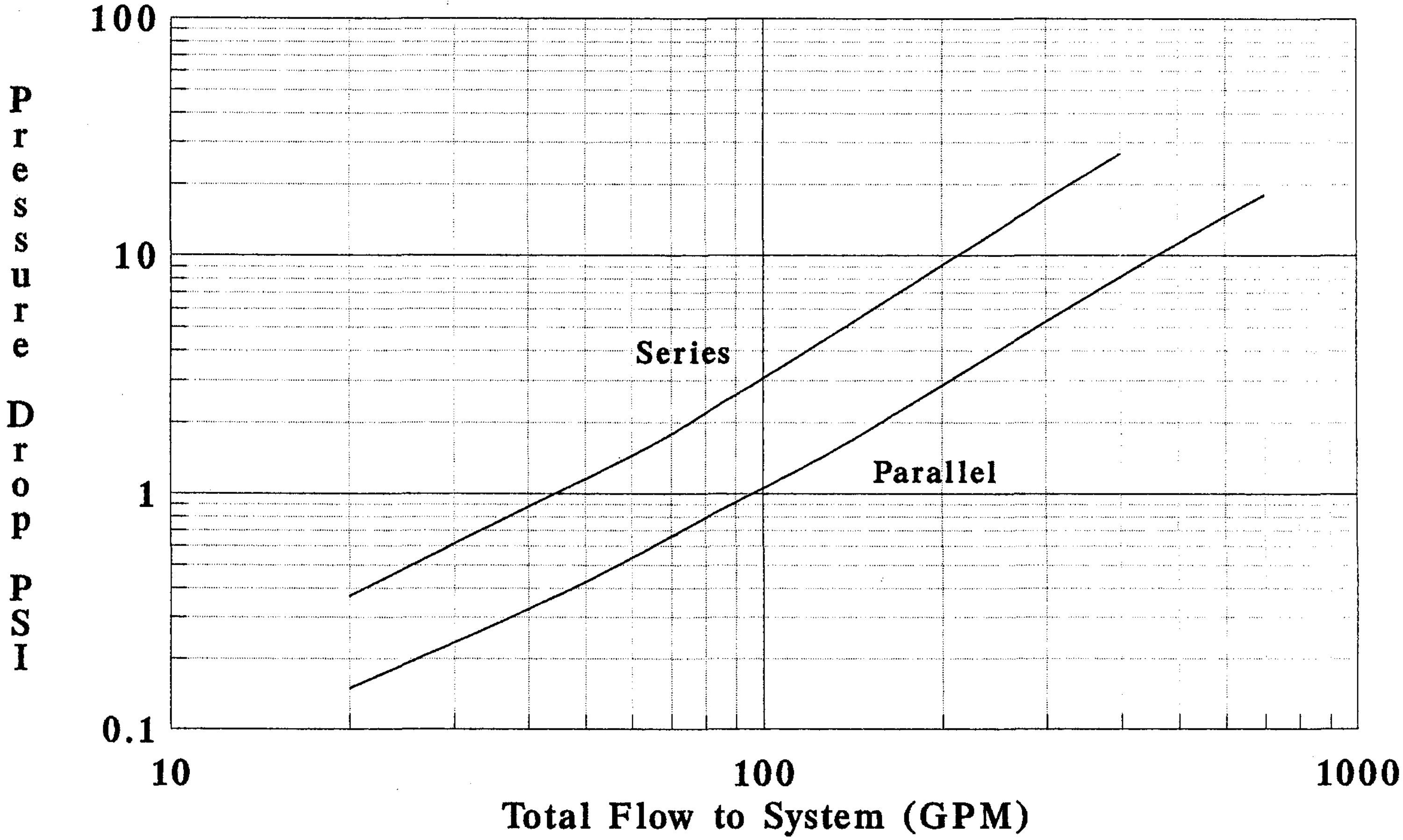
Model 7.5 Pressure Drop
Filtrasorb 200 Carbon (55 F)
Sch.40 Carbon Steel Pipe



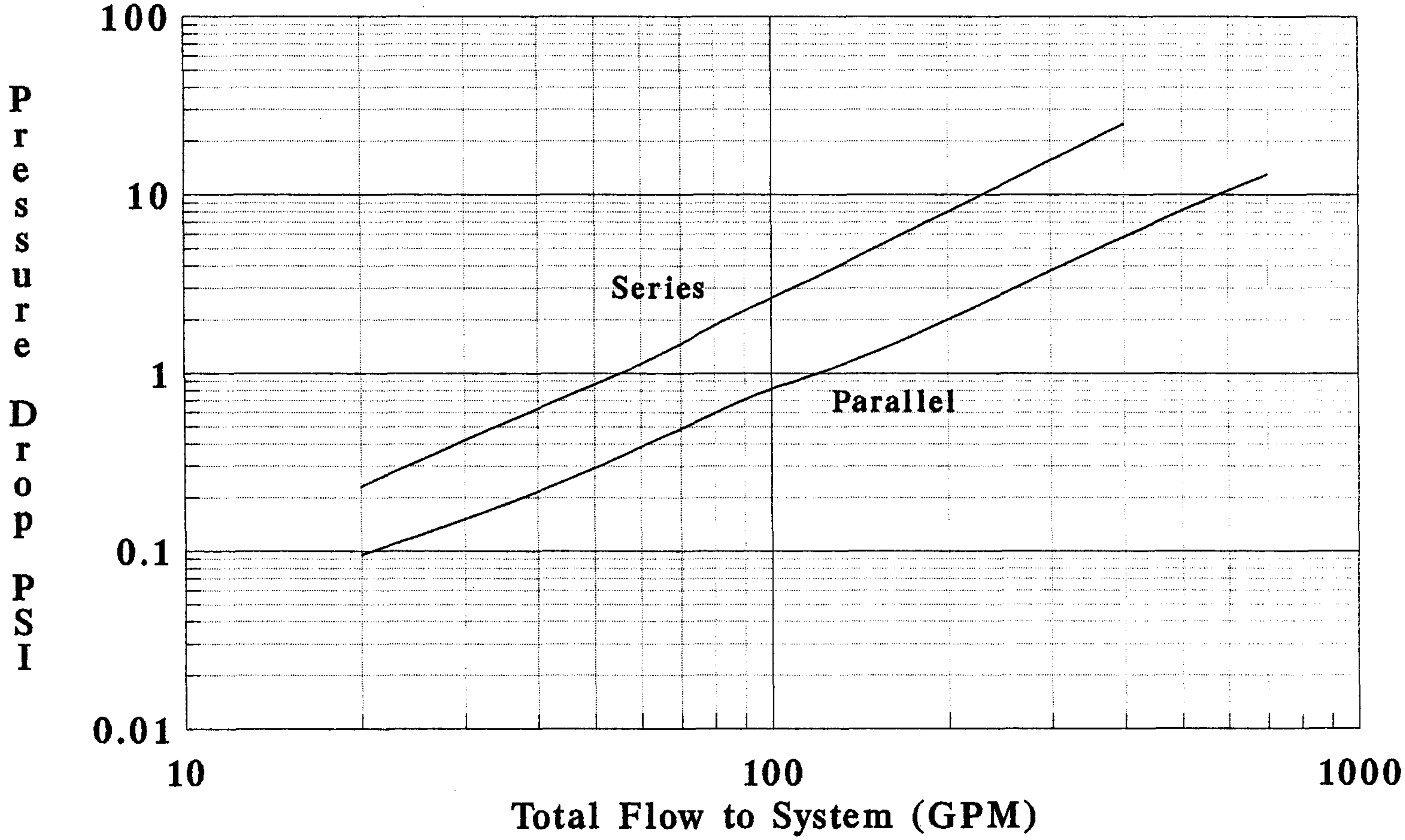
For Lined Pipe: Multiply by 1.4
For PVC Sch. 80 Pipe: Multiply by 1.1
5/21/93

CALGON
CALGON CARBON CORPORATION

Model 7.5 Pressure Drop

Filtrasorb 300 Carbon (55 F)

Sch.40 Carbon Steel Pipe

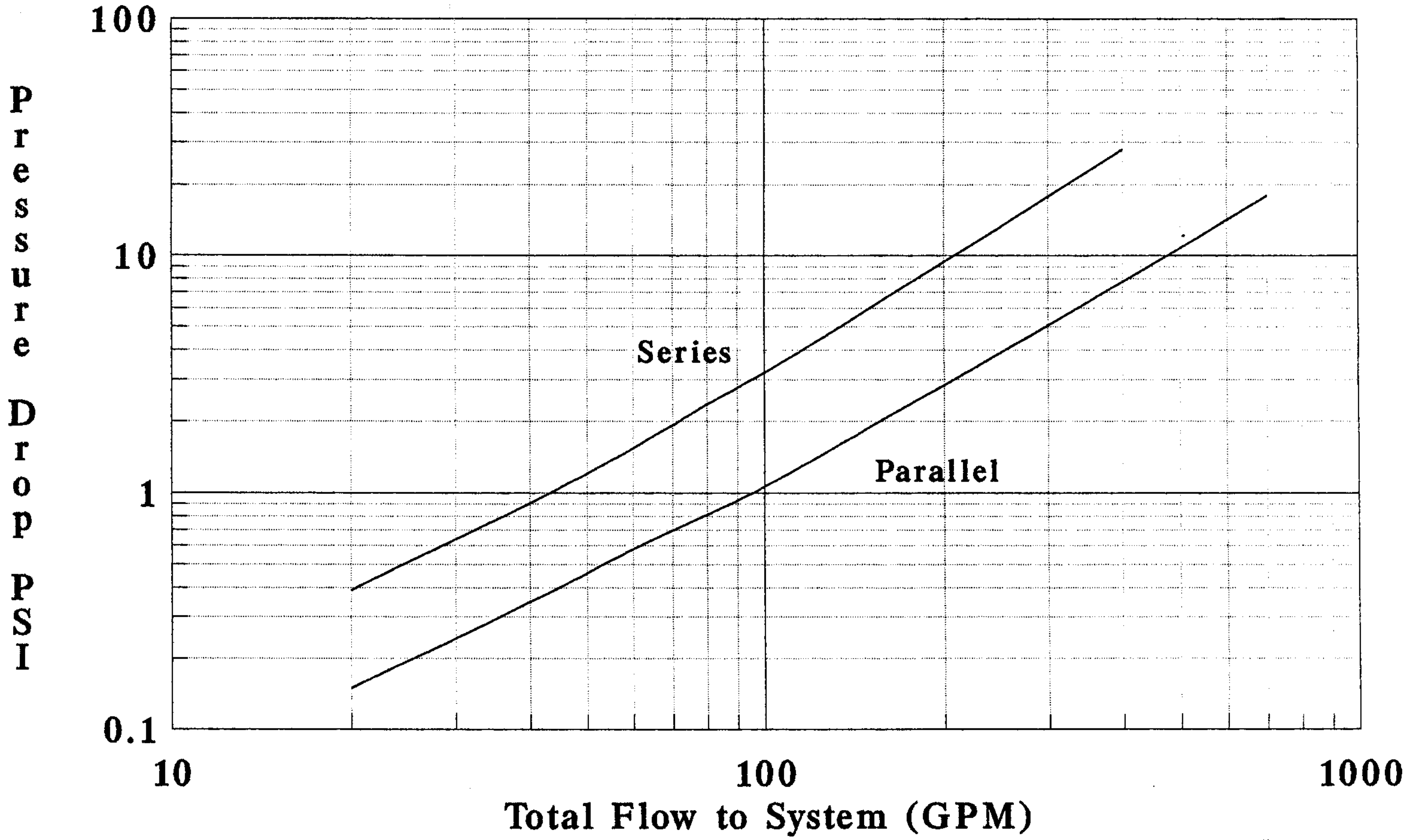


For Lined Pipe: Multiply by 1.4
For PVC Sch. 80 Pipe: Multiply by 1.1
5/21/93

CALGON

CALGON CARBON CORPORATION

Model 7.5 Pressure Drop
Filtrasorb 400 Carbon (55 F)
Sch.40 Carbon Steel Pipe



For Lined Pipe: Multiply by 1.4
For PVC Sch. 80 Pipe: Multiply by 1.1
5/21/93

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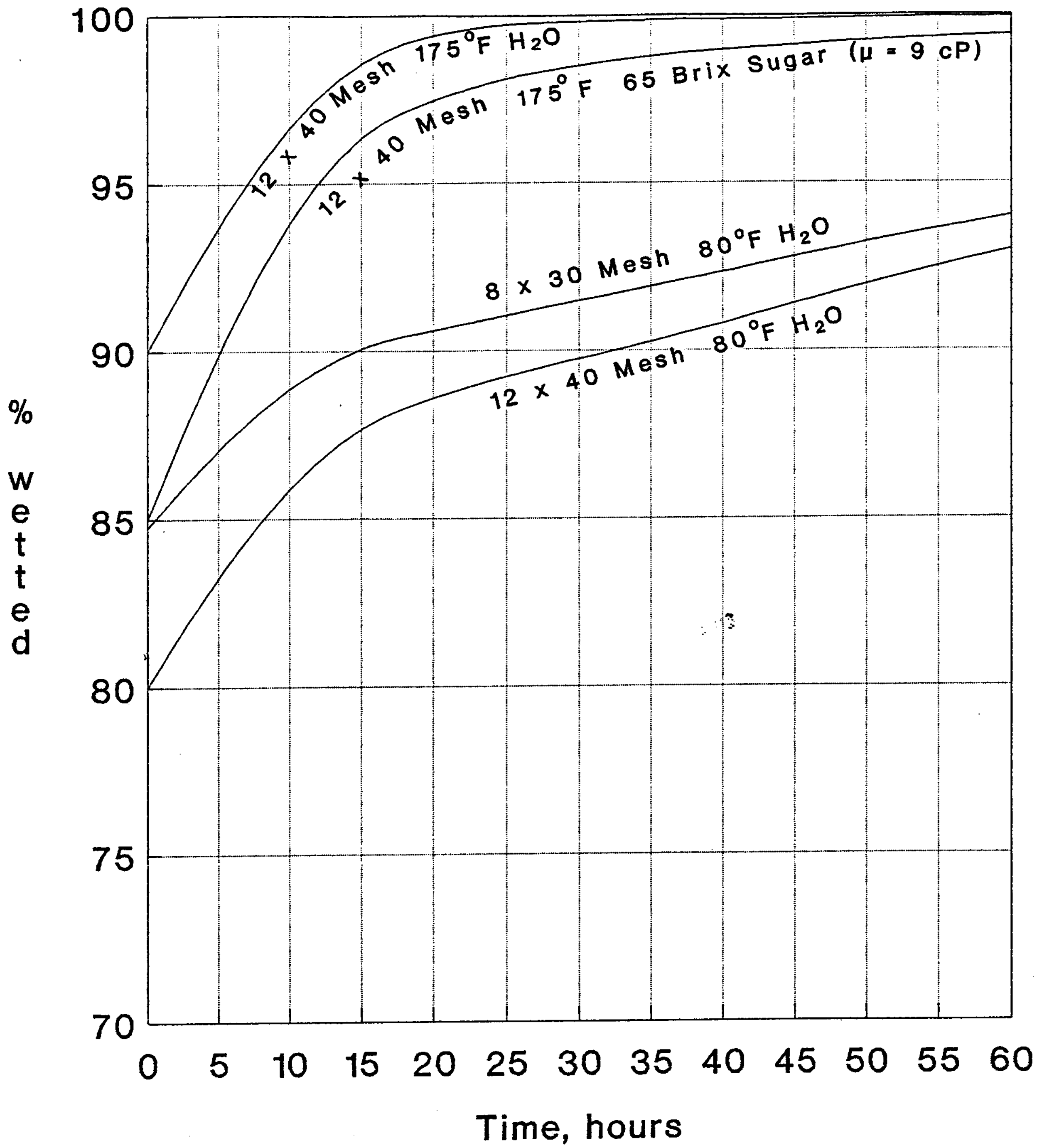
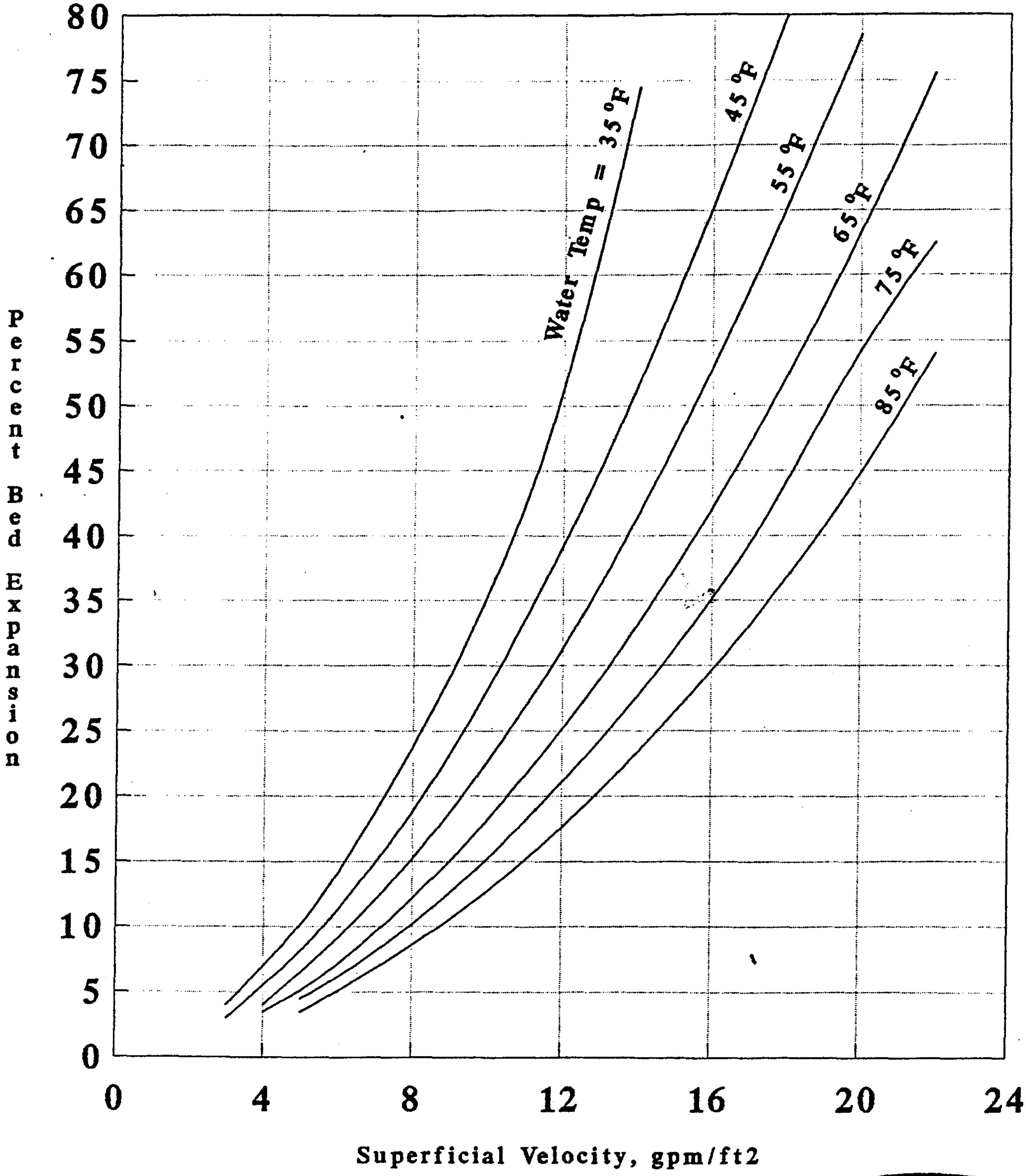
CALGON CARBON CORPORATION

Rate of Wetting Versus Time for Granular Activated Carbon



CALGON CARBON CORPORATION

Percent Bed Expansion for Filtrasorb 200
Backwashed-Segregated Bed



CALGON
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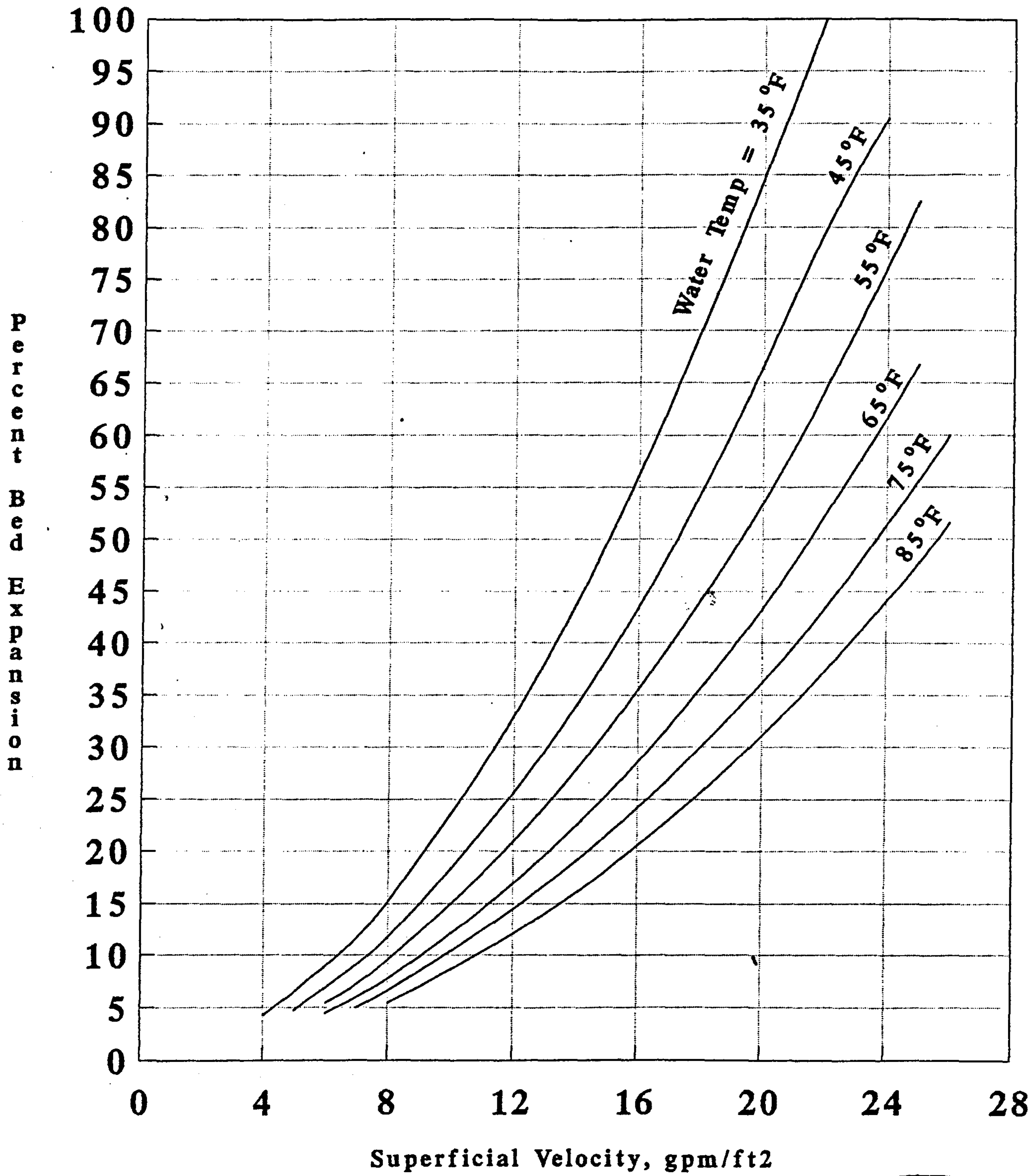
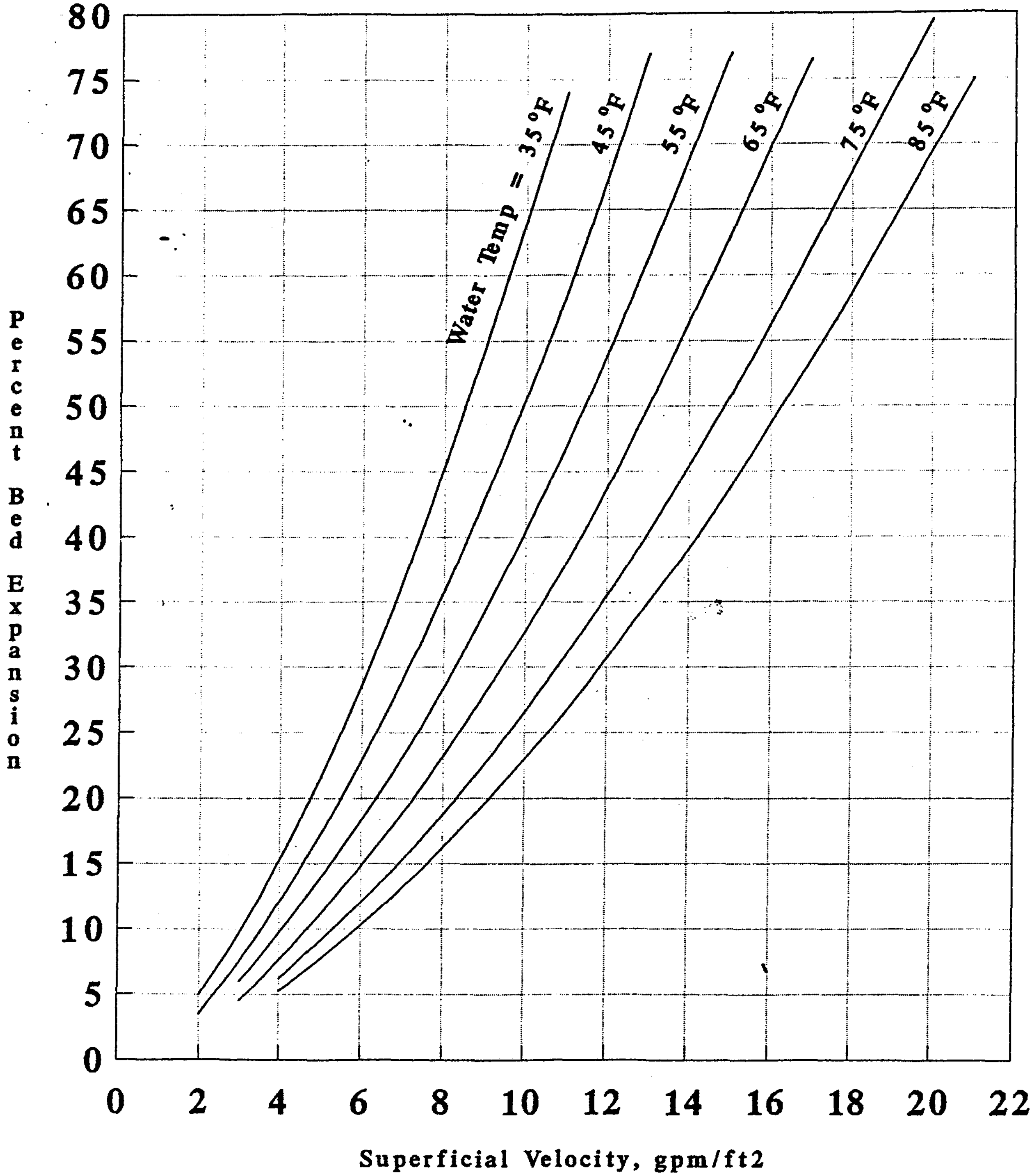
Percent Bed Expansion for Filtrasorb 300

Backwashed-Segregated Bed



CALGON
CALGON CARBON CORPORATIO

Percent Bed Expansion for Filtrasorb 400
Backwashed-Segregated Bed



CALGON

CALGON CARBON CORPORATIO

INSTRUCTIONS FOR CARBON ACCEPTANCE CANISTER (CAC)

1. Connect the carbon acceptance canister (CAC) as shown on the attached Drawing No. 90-90-1786. Start the adsorption system according to the operating manual. All valves in the influent and effluent lines to the CAC should be closed.

2. Open the top 2-inch plug on the CAC. Slowly fill the CAC with clean tap water (preferably hot tap water) thru the top plug nozzle. This will require about one gallon of water.

3. Allow the water filled CAC to stand for 24 hours to wet the carbon, replace 2-inch top plug.

4. Open both valves in the CAC effluent line. (One valve is located near the adsorption system's main effluent header and the other valve near the CAC as shown on the drawing and identified as the "D" valve in the effluent line).

5. Disconnect the tubing on the CAC influent line located near the adsorption system's main influent header.

6. Slowly open the valve in the CAC influent line to allow clean effluent water to purge thru both CAC lines and backflush the CAC. Allow about five gallons of clean water to flow out of the influent tubing.

7. Close the valve in the CAC influent line to stop water flow. Reconnect the water filled tubing on the CAC influent line at the adsorption system's main influent header.

8. Slowly open both valves in the CAC influent line to allow untreated water to flow through the CAC.

9. If the carbon adsorber is to be backwashed or shut down, close the influent and effluent valves to CAC and open the top 2-inch plug to vent the CAC. Once the adsorption system is restarted, replace the top 2-inch plug and put the CAC back on-line.

10. A rough guideline for how long the CAC should be left in:

    a. If the adsorption system is in a parallel mode, then the unit should be on-line about 1/10 of the anticipated bed life.

    b. If the adsorption system is in a series mode, then the unit should be on-line about 1/5 of the anticipated bed life.

11. The CAC is taken out of service by closing all valves in the influent and effluent lines. Then disconnect the effluent line tubing connector at the CAC. Open the top 2-inch plug to vent the CAC. Slowly open the valve identified as the "D" valve in the effluent line and drain the liquid from the CAC to a suitable container (all necessary safety precautions should be taken depending on the hazardous nature of the process liquid). Open the valve identified as the "D" valve in the influent line and carefully disconnect the influent line tubing connector at the CAC. Allow the liquid in the lines to drain thru the CAC into the collection container.

12. Close the valves labeled "D" in both the influent and effluent lines at the CAC. Replace the top 2-inch plug. Detach the CAC from the adsorber system and ship with valves attached (valves must be closed) to Calgon Carbon Corporation.

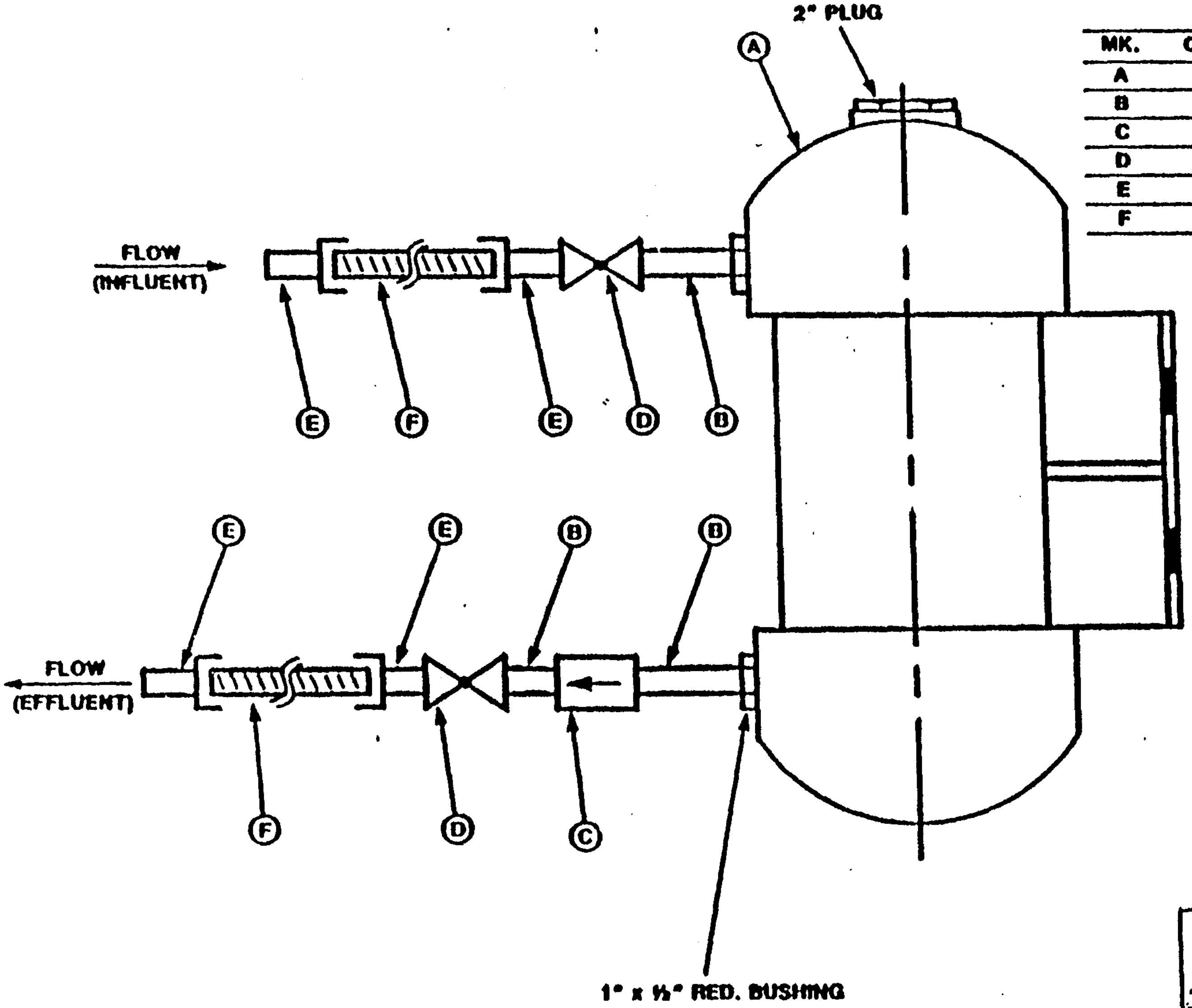
13. Safety considerations for units are as follows:

    a. The unit is rated for 150 psig.

    b. The materials of construction of the unit and piping are as follows:

Septa and Body	-	PVC
Valves	-	Polypropylene
Tubing	-	Polypropylene
Flow Control Valve	-	Dole, Nickle Plated Brass

14. Contact the local sales office if you have any questions.



BILL OF MATERIAL

MK.	QTY.	INVENTORY NO.	DESCRIPTION
A	1	B3024	CANISTER
B	3	PINIP04XA	½" NIPP. X 1½" LG. (TBE)
C	1	JDOLEV10G	1 GPM DOLE VALVE
D	2	P145004	½" VALVE
E	4	PMCO4TO4P	½" MNPT x ½" TUBE CONN.
F		JTUBINGO4	½" TUBING

NOTES:

1. ALL MATERIAL TO BE PVC EXCEPT FLOW CONTROL VALVE.
2. THIS SKETCH TO BE USED AS A REFERENCE FOR ASSEMBLY OF NEW PVC CARBON ACCEPTANCE CANISTER.
3. CUSTOMER TO CHECK MATERIAL OF CONSTRUCTION COMPATIBILITY.

PLOTTED 8 - 26 - 91

CALGON

E & A

CARBON ACCEPTANCE CANISTER

DETAILS — (PVC)

WE

90 - 96 - 1796

NTS

CALGON CARBON CORPORATION
SPARE PARTS PROGRAM

INTRODUCTION: Calgon Carbon Corporation has developed a standard product line of engineered treatment systems for air and water applications. Much of the fabrication and assembly of these systems is done at Calgon Carbon's own facility; therefore, most of the system parts and components are maintained in inventory. As a service to customers to provide a source of specified parts in a timely manner, these parts and components are available for purchase. Prices are valid for one year from date on list, after which time they are subject to revision.

ORDER ENTRY: The purchase order for spare parts should be entered using the spare parts order form provided. This form should be sent to:

Order Service Department
Calgon Carbon Corporation
P.O. Box 717
Pittsburgh, PA 15230-0717

The form can also be sent via fax to 412-787-6713.
The order can also be verbally provided to Order Service at 412-787-6700.

SHIPPING OPTIONS: Order shipping options are either rush (next-day delivery by UPS) or normal (one week after order, delivery by UPS). Other shipping directions should be provided at time of order. Shipping charges will be added to the sum of the prices for the parts.

SALES TAX: Sales tax will be added to the invoice unless sales tax exemption information is provided with the order.

PAYMENT: An invoice will be sent to the billing address upon shipment of the complete order. Payment terms are net 30 days upon shipment.

WARRANTY: Calgon Carbon Corporation warrants that the equipment sold hereunder shall be free from defects in materials and workmanship for a period of one (1) year from the date of shipment. This warranty does not apply to problems associated with normal wear and tear, improper maintenance, negligence, misuse, abuse, or the failure to operate the equipment in strict accordance with the operating and maintenance plan provided. For those items provided by, but not directly manufactured by Calgon Carbon, the manufacturer's warranty shall apply provided warranty coverage exceeds that which is provided by Calgon Carbon. All other warranties, either express or implied, are hereby disclaimed including, but not limited to, the warranty of merchantability and fitness for a particular purpose.

LIMITATION OF LIABILITY: The purchaser's exclusive remedy for any cause of action arising out of this transaction, including but not limited to breach of warranty, negligence and/or indemnification, is expressly limited to a maximum of the purchase price of the equipment sold hereunder. All claims of whatsoever nature shall be deemed waived unless made in writing within forty-five (45) days of the occurrence giving rise to the claim. In no event shall Calgon Carbon for any reason or pursuant to any provision of the Warranty be liable for incidental or consequential damages, or damages in excess of the purchase price of the equipment supplied, loss of profits, or fines imposed by Governmental agencies.

STANDARD MODEL 7.5 SPARE PARTS LIST PART IDENTIFICATION	PART NUMBER	UNIT PRICE	SHIP WEIGHT	REC QTY	QUANTITY ORDER	PRICE (UNITxQTY)
GASKETS						
8" full face, 1/8" red rubber	NR80FFRR	$ 6	0.25	0		
6" ring, 1/8" red rubber	NR60RGRR	2	0.25	2		
4" ring, 1/8" red rubber	NR40RGRR	2	0.25	2		
3" ring, 1/8" red rubber	NR30RGRR	2	0.25	2		
2" ring, 1/8" red rubber	NR20RGRR	2	0.25	2		
20" manway, full face EPR	NMW200BL	35	1	1		
VALVES						
6" wafer butterfly	A3116	360	30	1		
4" wafer butterfly	A3114	222	20	1		
2" stainless ball valve	A40820	364	22	0		
1¼" ductile iron ball valve	A405A	63	3	1		
3/4" ductile iron ball valve	A40506	28	1	1		
1/2" ductile iron ball valve	A40504	22	1	1		
INSTRUMENTS						
0-100 psig pressure gauge	FPI216	118	3	1		
ACCESSORIES						
3/4" nylon hose connect	B324506	6	0.25	1		
2" nylon hose connect (male thread/male fitting)	B32452N	9	0.5	2		
3" 75-lb graphite rupture disk	FPSE252	88	1	4		
PPL underdrain nozzle	VLNOZ06	7	0.25	46		
PPL vessel spray nozzle	V2522A	72	0.5	0		
6" pipe stainless carbon trap	B225360	450	4	1		

REFERENCE PURCHASE ORDER NO. ________________ TOTAL PRICE ________________

SHIP TO: ________________

SHIPPING: Normal ________ ________
Rush ________ ________
Other ________ ________

TOTAL ORDER (Minimum Order $200) ________________

BILL TO: ________________

AUTHORIZED BY ________________

DATE ________________

TAXES Sales tax will be added to invoice unless tax exemption noted ________________

FOR USE BY CALGON CARBON ORDER SERVICES

PRODUCT CODE EXXSPO
PROJECT SHORT NAME ________________

5/93

Calgon Carbon Corporation
Materials of Construction
System: Model 7.5

CALGON CARBON CORPORATION

WETTED CONTINUOUSLY		
Item	**CCC Spec. #**	**Material of Construction**
Proces, Carbon Fill , and Instrument Piping	C2 G2	Sch. 40 Carbon Steel Pipe Cast Iron Fittings Red Rubber Gaskets
Process Valves	3.11	Cast Iron Body Buna-N Seat Bronze Disk 18-8 Stainless Steel Shaft TFE Seals
Carbon Discharge Piping	L1	PPL Lined Steel PPL Lined Cast Iron Fittings
Carbon Exchange Valves	4.08	316SS Body, Ball, & Stem TFE Seats & Seals
Utility Piping	C13 G2	Sch. 40 Galvanized Carbon Steel Galvanized Iron Fittings Red Rubber Gaskets
Utility & Instrument Valves	4.03	Bronze/Brass Body, Ball, & Stem TFE Seats, Graphite Seals
Compressed Air Check Valve	8.21	Bronze Body, Cap, Trim, & Disk
Flush Connection Piping	S7 G10	304SS Pipe & Fittings TFE Gaskets
Flush Connection Valves	4.57	316SS Body, Ball, & Stem TFE Seats & Seals
Piping Spacers	35.43	PPL
Pressure Gauges	PI-216	316SS Bourdon Tube 316SS Connection
Rupture Disks	PSE-157	Graphite
Spray Nozzle	25.27	PPL
Carbon Retainer Basket	22.53	316SS
Vessel Lining	--	Plasite 4110, vinyl ester
Vessel Manway Gaskets	--	Neoprene
Underdrain Materials	--	Sch. 80 PVC Piping PPL Nozzles & U-bolts Tefzel Bolts FRP Supports
WETTED INTERMITTENTLY OR FOR SHORT TIME PERIODS		
Quick Connect Couplings	32.44, 32.45	Nylon

12/15/93 Rev. 1

CALGON
CALGON CARBON CORPORATION

APPLICATION BULLETIN

DISINFECTION OF GRANULAR ACTIVATED CARBON

SUMMARY

There are situations where it becomes necessary to disinfect granular activated carbon (GAC) beds due to the presence of bacteria. The bacteria are usually present because of (1) oxygen depletion in wastewater and potable water applications, and (2) low (<140°F) temperatures in food-related (sugars, etc.) applications.

The procedure described below is intended for in situ disinfection of carbon in an adsorber containing 20,000 pounds of GAC. By adjusting the amount of sodium hydroxide, larger or smaller carbon beds can be disinfected with this procedure.

CAUTION: Due to the hazardous nature of sodium hydroxide (NaOH) and hydrochloric acid (HCl), appropriate protective clothing such as a face shield, goggles, gloves and impervious clothing must be worn when handling these chemicals. For specific instructions, refer to your plant procedures and/or material safety data sheets for these chemicals.

Materials of construction must be compatible with NaOH and HCl.

DISINFECTION

1. Take the adsorber off line. Make sure that a line on top of the adsorber is open to serve as a vent.

2. Drain the water from the adsorber through the adsorber effluent line.

3. Pump 5 wt–% sodium hydroxide into the adsorber through the effluent line. For Calgon Carbon Corporation's backwashable Model 10 and Model 12 adsorbers, the required volumes are 7,000 and 6,000 gal., respectively. See step 9a for an alternate procedure.

4. Stop pumping when the NaOH solution overflows through the vent line.

5. Allow the carbon to soak in the sodium hydroxide for at least four hours.

6. Repeat step 2 above.

NEUTRALIZATION

7. Wash the carbon by adding contaminant-free or clean water through the effluent line for 7–10 hours at a flow of 1.3–3 gpm/ft^2 in order to wash out the residual sodium hydroxide and neutralize the carbon. The disinfection is then complete.

8a. An alternate, faster procedure for neutralizing the carbon includes acid treatment. After the sodium hydroxide solution is drained from the adsorber, pump 5 gallons of reagent grade hydrochloric acid (37% HCl) into the adsorber through the effluent line.

8b. Fill the adsorber with clean water by backfilling through the effluent line at 3–5 gpm/ft^2 so as to thoroughly mix the contents of the adsorber. Shut off the backfill water when it begins to overflow through the vent line.

8c. Allow the carbon to soak for 60 minutes, then drain the adsorber. Check the pH of the water, which should be in the range of 8 to 10.

8d. Wash the carbon by adding clean water through the effluent line at a rate of 1.3–3 gpm/ft^2 until the pH of the effluent water is the same as the influent water or within the desired pH range. The disinfection is then complete.

ALTERNATE DISINFECTION PROCEDURE

9a. After step 2, add ~1,000 gallons of clear water through the effluent line.

9b. After completing step 9a, pump the contents of two 55-gallon drums of 50% sodium hydroxide into the adsorber through the effluent line.

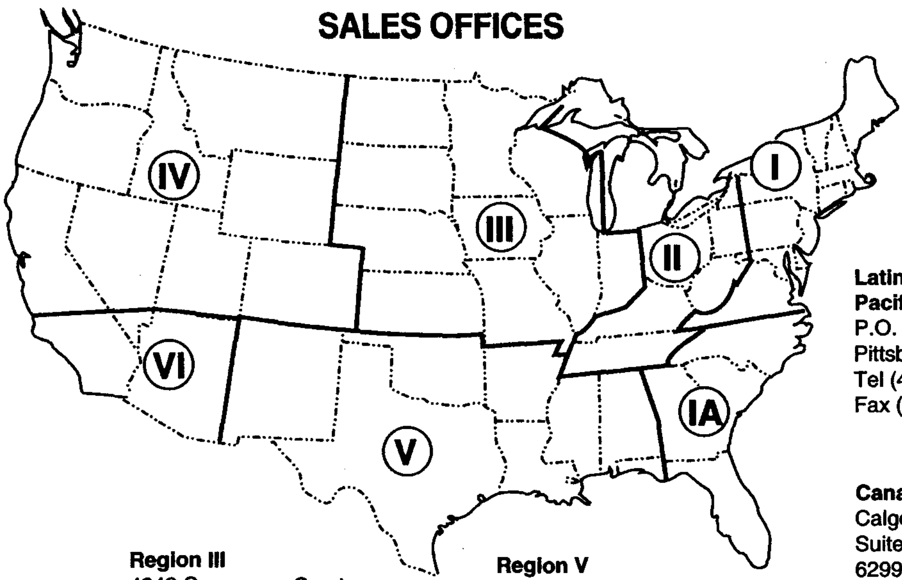
9c. Fill the adsorber with clean water by backfilling through the effluent line at 3–5 gpm/ft^2 so as to thoroughly mix the contents of the adsorber.

9d. Shut off the backfill water when it begins to overflow through the vent line. Check the pH of the water exiting the vent line. It should be 13 or higher.

10. Go to step 5.

CALGON CARBON CORPORATION • P.O. BOX 717 • PITTSBURGH, PA 15230-0717 • PHONE 1-800-4CARBON

SALES OFFICES



Region I
PO Box 6768
1120 Route 22 East
Bridgewater, NJ 08807
Tel (908) 526-4646
Fax (908) 526-2467

Region IA
5600 77 Center Drive
Suite 200
Charlotte, NC 28217
Tel (704) 527-7580
Fax (704) 523-3550

Region II
P.O. Box 717
Pittsburgh, PA 15230-0717
Tel (412) 787-6700
800/4-CARBON
Fax (412) 787-6676

Region III
4343 Commerce Court
Suite 400
Lisle, IL 60532
Tel (708) 505-1919
Fax (708) 505-1936

Region IV
2121 South El Camino Real
San Mateo, CA 94403
Tel (415) 572-9111
Fax (415) 574-4466

Region V
Unisys Tower
13430 Northwest Freeway
Suite 804
Houston, TX 77040-6071
Tel (713) 690-2000
Fax (713) 690-7909

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1901 Camino Vida Roble
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Carlsbad, CA 92008
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CALGON REACTIVATED CARBON

TYPICAL PROPERTIES

TEST	PROPERTY*
Iodine Number	750**
Ash, Wt. %	9
A.D., g/cc	.60
Mesh Size Nomenclature	8x40
Particle Size	
Thru U.S. #40 Mesh, %	5

*Properties represent typical results based on (pre-quenched) dry furnace discharge.

**To perform the Iodine Number Test on representative wet carbon samples, the samples must be dried under a nitrogen purge, vacuum or other conditions which eliminate oxygen. In addition, the representative samples must be pulverized to 95% <325 mesh to achieve the required kinetics of the analytical test.

27-205

TECHNICAL INFORMATION

ISSUED 12-1-89; REV. 5-6-92

PIPING MATERIAL SPECIFICATION C2

MATERIAL	Carbon steel pipe with steel fittings
RATING	125 PSIG @ 350 DEG. F 200 PSIG @ 150 DEG. F Includes corrosion allowance of 0.050" min.
CONSTRUCTION	Screwed for 1 1/2" and smaller. Welded and/or flanged for 2" and larger
PIPE	Carbon steel, ASTM A53, Grade B: Threaded, schedule 80, seamless, 1 1/2" and smaller. Plain end, schedule 40, seamless, 2" to 10" Plain end, 3/8" wall, seamless, 12" and above
FITTINGS	3000lb., ANSI B16.11, forged steel, threaded ends, 1 1/2" and smaller. Schedule 40, ANSI B16.9, ASTM A234, Grade WPB, carbon steel, butt welding ends, 2"-12". 3/8" wall, ANSI B16.9, ASTM A234, Grade WPB, carbon steel, butt welding ends, 14" to 24", or 125# flanged cast iron elbows and tees, ASTM A126, Class B with 125# ANSI B16.1 drilling with dimensions per ANSI A21.10 (AWWA C110). Location of tapped holes for drains shall be in accordance with ANSI B16.1. Use thread-o-lets on branch connections 1-1/2" and smaller, use stub-in or reducing tee connections for 2" and above.
UNIONS	3000LB., forged steel, ASTM A105, Grade 2, integral steel seat, ground joint, threaded ends.
FLANGES	150LB., ANSI B16.5, ASTM A105 forged carbon steel, slip-on or weld neck type 2" and larger, threaded 1 1/2" and smaller. Where bolting to flat face cast iron flanges, flanges shall be furnished with a flat face. Others shall be raised face.
ORIFICE FLANGES	Instrument item.
BOLTING	See attached Fastener Specification F3.
GASKETS	See attached Gasket Specification G2.

ISSUED 12-1-89; REV. 4-10-92

PIPING MATERIAL SPECIFICATION C13

MATERIAL	Galvanized carbon steel pipe with galvanized iron or steel fittings.
RATING	300 PSIG @ -20 to 150 DEG. F 150 PSIG @ 350 DEG. F Includes corrosion allowance of 0.050" minimum.
CONSTRUCTION	Screwed 3" and smaller No bending permitted
PIPE	Galvanized carbon steel, ASTM A120: Threaded, schedule 40, butt welded seam 2" and smaller. Threaded schedule 40, butt welded seam or seamless, 2 1/2" and 3".
FITTINGS	150 lb., ANSI B16.3, ASTM A197, galvanized malleable iron, banded, threaded ends.
UNIONS	150 LB., ASTM A197, galvanized malleable iron, integral iron seat, ground joint, threaded ends.
FLANGES	150 lb., ANSI B16.5, ASTM A105, Grade 1, galvanized forged carbon steel, threaded. Where bolting to flat face cast iron flanges, steel flanges shall be furnished with a flat face. Others shall be raised face.
ORIFICE FLANGES	Instrument item.
BOLTING	See attached Fastener Specification F3.
GASKETS	See attached Gasket Specification G2.

ISSUED 12-1-89

FASTENER SPECIFICATION F1

FAA Hex Bolt, low or medium carbon steel.
SAE-J429, Grade 1.
1/4" thru 1 1/2" Proof load 33,000 psi.
1/4" thru 1 1/2" Tensile strength min. 60,000 psi.
Zinc or Cadmium plated.
Threads to be UNC unless specified UNF bolts to include (1) heavy hex nut, ASTM A307, and (2) Flat Washers.

FASTENER SPECIFICATION F2

FAB Hex Bolt, low or medium carbon steel.
ASTM-A307.
1/4" thru 4" No proof load.
1/4" thru 4" Tensile strength min. 60,000 psi.
Zinc or Cadmium plated.
Threads to be UNC unless specified UNF bolts to include (1) heavy hex nut, ASTM A307, and (2) Flat Washers.

FASTENER SPECIFICATION F3

FAC Hex Bolt, low or medium carbon steel.
SAE-J429, Grade 2.
1/4" thru 3/4" Proof load 55,000 psi.
1/4" thru 3/4" Tensile strength min. 74,000 psi.
Over 3/4" thru 1 1/2" Proof load 33,000 psi.
Over 3/4" thru 1 1/2" Tensile strength min. 60,000 psi.
Zinc or Cadmium plated.
Threads to be UNC unless specified UNF bolts to include (1) heavy hex nut, ASTM A307, and (2) Flat Washers.

FASTENER SPECIFICATION F4

FAD Hex Bolt, medium carbon steel quenched and tempered.
SAE-J429, Grade 5.
1/4" thru 1" Proof load 85,000 psi.
1/4" thru 1" Tensile strength min. 120,000 psi.
Over 1" thru 1 1/2" Proof load 74,000 psi.
Over 1" thru 1 1/2" Tensile strength min. 105,000 psi.
Zinc or Cadmium plated.
Threads to be UNC unless specified UNF bolts to include (1) heavy hex nut, ASTM A307, and (2) Flat Washers.

ISSUED 12-1-89

GASKET SPECIFICATION G1

GAC Red Rubber sheet material, 1/16" thick.
Durometer hardness 75-85.
Temperature to 180 DEG. F.
Pipe gasket flange dimensions per ANSI B16.21.
Johns-Manville No. 107 or equal.

GASKET SPECIFICATION G2

GAA Red Rubber sheet material, 1/8" thick.
Durometer hardness 75-85.
Temperature to 180 DEG. F.
Pipe gasket flange dimensions per ANSI B16.21.
Johns-Manville No. 107 or equal.

GASKET SPECIFICATION G3

GAB Neoprene Rubber sheet material, 1/16" thick.
Durometer hardness 55-65.
Temperature to 250 DEG. F.
Pipe gasket flange dimensions per ANSI B16.21.
John-Manville No. 104 or equal.

GASKET SPECIFICATION G4

GAD Neoprene Rubber sheet material, 1/8" thick.
Durometer hardness 55-65.
Temperature to 250 DEG. F.
Pipe gasket flange dimensions per ANSI B16.21.
Johns-Manville No. 104 or equal.

GASKET SPECIFICATION G5

GAE Neoprene Rubber sheet material, 1/8" thick.
Durometer hardness 45-55.
Temperature to 250 DEG. F.
Pipe gasket dimensions per ANSI B16.21.
Johns-Manville No. 111 or equal.

GASKET SPECIFICATION G6

GAG Natural Rubber sheet material, 1/8" thick.
Durometer hardness 35-45.
Temperature to 200 DEG. F.
Pipe gasket flange dimensions per ANSI B16.21.
Johns-Manville No. 113 or equal.

ISSUED 12-1-89

PIPING MATERIAL SPECIFICATION L1

MATERIAL	Plastic lined steel pipe with plastic lined flanged fittings.
RATING	150 PSIG @ minus 20 DEG. to plus 225 DEG. F.
CONSTRUCTION	Flanged 1" to 8", Dow Chemical Company's MORAF PPL brand piping system using polypropylene resin lined steel pipe and lined cast iron flanged fittings. Each spool piece and fitting to be furnished with ends of plastic liner formed over flanged ends to form a molded raised face.
PIPE	Schedule 40, ANSI B36.10, ASTM A53, steel pipe with lining.
FITTINGS	125 lb., ANSI B16.1, ASTM A126, Class A, cast iron flanged with lining.
LINING	Thermally stabilized polypropylene resin.
FLANGES	125 lb., ANSI B16.1, ASTM A126, Class A, cast iron, threaded, flat face with smooth finish, drilled and chamfered.
BOLTING	See attached Fastener Specification. F3
GASKETS	See attached Gasket Specification. (NONE)
FIELD FABRICATION	For piping not shop fabricated Contractor must have special tools and equipment to cut the lined pipe and form the molded raised face on the job. See DOW's Form 178-103 "Field Installation of Dow Plastic Lined Piping Products" for necessary equipment and instructions.

BUTTERFLY VALVES CONTINUED

3.09 Ductile iron, two-piece lug-type body, TFE lined butterfly valve, TFE encapsulated iron disc, stainless steel shaft, TFE coated bearings, TFE shaft seal and seat, metal notched throttling handle for 2" thru 4" sizes, and handwheel operator for 6" and larger. Lug holes to conform to 150 lb. ANSI flange drilling.
Garlock Gar-Seal 100 Series, or equal.
RATING: 150 PSIG @ -40 DEG. F. to 400 DEG. F.

SIZES: 2" thru 24"

3.10 Cast iron, two-piece wafer type body, TFE lined butterfly valve, TFE encapsulated 316 stainless steel disc and stem resilient TFE lined seat, Acetal stem bushing, Buna-N stem, 316 stainless steel body screws, metal notched throttling handle for 2" thru 4" sizes, and handwheel operator for 6" and larger. All sizes to be suitable for mounting between 125 lb. or 150 lb. ANSI flanges.

KEYSTONE Figure 999, or equal

RATING: 150 PSIG @ 0 DEG. F. for 2" to 12" sizes
75 PSIG @ 0 DEG. F. to 250 F. for 14" and 16" sizes

SIZES: 2" thru 16"

3.11 Cast iron, one piece wafer type body, Buna-N seat and flange gasket, bronze disc, 18-8 stainless steel one piece thru shaft, self-locking Type 316 stainless steel disc screws, Buna-N shaft seal and reinforced Teflon upper and lower inboard bushings. Wafer body to mate with 125 lb. or 150 lb. ANSI FLANGES. Notched plate handle for throttling valve in 10 position increments to be furnished for valve sizes 2" thru 6". Weatherproof worm gear wheel operator for sizes 8" thru 20". Valves shall comply with all of the design strength, testing and performance requirements of AWWA Specification C-504-70 (except for laying length).

Crane Monarch Cat.No.21 BRB, or equal.

RATING: 200 PSIG in closed position @ 180 DEG. F.

VALVE SIZE	LAYING LENGTH (inches)
2	1.88
3	1.94
4	2.19
6	2.32
8	2.51
10	2.82
12	3.19
14	3.19
16	3.25
18	4.00
20	5.09

PIPING SPECIALTIES SPECIFICATION

BALL VALVES

4.01 Malleable iron or carbon steel body full bore ball valve, chromium plated steel ball, steel stem, TFE seats and seals wrench operated, threaded ends.

RATING: 400 PSIG @ 300 DEG. F.

SIZES: 1/4" thru 1 1/2", W-K-M Type B138, or equal

4.02 Cast iron body full bore ball valve, chromium plated steel ball, steel stem, TFE seats and seals, wrench operated, 150 lb. ANSI B16.5 flanged ends, flat face. Face-to-face dimensions to conform to ANSI B16.10 for steel gate valves.

Rating: 200 PSIG @ 300 DEG. F.

Sizes: 2" and 3", W-K-M Type B111, or equal
4" and 6", W-K-M Type B112, or equal

4.03 Bronze or forged brass or barstock brass body regular port ball valve, blow-out proof stem, ball and seat retainer design to permit valve to be dead ended in either flow direction, bronze or brass ball and stem, TFE seats and seals (furnish glass fiber reinforced TFE seats and graphited stem seal if required to meet pressure and temperature rating), wrench handle operated, threaded ends.

Rating: 500 PSIG @ 100 DEG. F.
150 PSIG @ 366 DEG. F.

Sizes: 1/4" thru 2"

Models: Powell "CRESCENT" figure 4210R, or equal

Worcester "WOVCO" 600, Figure No. 5811R, or equal

Clayton Mark-Pacific Valve Figure No. BR-880-I-T, or equal

Jamesbury "CLINCHER" Code No. 2111, or equal

Consolidated Valve Industries "APOLLO" 70 Series, or equal.

Rockwood Figure 105S, or equal

BALL VALVES CONTINUED

4.08 Stainless steel and entry full bore ball valve thru 4" size (Reduced Port for 6" & 8" Acceptable) with blow-out proof stem and seat retainer design to permit valve to be dead ended in either flow direction. Type 316 stainless steel body, ball and stem, TFE seats and seals, wrench operated, 150 lb. ANSI B16.5 flanged ends, raised face, thur 4" size Face-to-face dimensions to conform to ANSI B16.10 for steel gate valves. <u>Screwed body inserts not acceptable.</u> Gear Operator for 6" and 8" size valves. No asbestos allowed.

Rating: 275 PSIG @ 100 DEG. F. or 110 PSIG @ 353 DEG. F.

4.09 Malleable iron body angle port 3-way ball valve, 90 DEG. turn, chormium plated steel ball, stainless steel stem, TFE seats and seals, wrench operated, threaded ends.

Rating: 200 PSIG @ 350 DEG. F.

Sizes: 1/2" thru 3"
Pittsburgh Brass Mfg. Co., Series MPD, or equal.

4.10 Malleable iron body angle port 3-way ball valve, 90 DEG. turn, chromium plated steel ball, stainless steel stem, TFE seals, wrench operated, 150 lb. ANSI flanged ends, flat face

Rating: 200 PSIG @ 350 DEG. F.

Sizes: 1-1/2" thru 4"
Pittsburgh Brass Mfg. Co., Series MPD, or equal.

4.11 Bronze body reduced port ball valve, ASTM B-62, chrome finished ball and stem, Buna-N seat and O-rings, threaded ends.

Rating: 150 PSIG WOG @ 180 DEG. F. max.

Sizes: 1/4" thru 2"
Crane Figure 2180, or equal.

BALL VALVES CONTINUED

4.55 Polypropylene regular port ball valve, Polypropylene body, and stem, Teflon seats, Viton seals, snap-on-T-type directional handle, threaded union ends.

Nibco Chemtrol "True Union Ball Valve", or equal.

Rating: 150 PSIG water @ 75 DEG., non-shock

Sizes: 1/2" thru 2"

4.56 PVC, regular port ball valve, PVC, body, ball and stem, Teflon seats, Viton seals, threaded ends, snap-on T-Type directional handle.

Plastic Piping Systems Catalog No. 80026 for 1/4" size, Catalog No. 80028 fpr 3/8" size, or equal.

Rating: 100 PSIG @ 100 DEG. F.

Sizes: 1/4" and 3/8"

4.57 Stainless steel end entry regular port ball valve with blow-out proof stem and seat retainer design to permit valve to be dead ended in either flow direction. ASTM A-296, Grade CF8M Type 316 stainless steel body, ball and stem, TFE seats and seals, wrench operated, threded ends. Screwed body inserts or tail pieces not acceptable.

Jamesbury Buletin 210
Trueline - N600LL or equal

Rating: 80 PSIG @ 400 DEG. F. or 1500 PSIG @ 150 DEG. F.

Sizes: 1/4" thru 2"

4.58 Teflon lined regular bore ball valve. Carbon steel body and ball core with stainless steel stem core all lined with Teflon, seat ring and packing shall be Teflon, wrench operated with 150 lb. ANSI B16.5 raised face, Teflon lined flanged ends.

W-K-M Dynaseal 350 ball valve, or equal.

Rating: 275 PSIG @ 100 DEG. F.
150 PSIG @ 300 DEG. F.

Sizes: 1 1/2" x 1" 4" x 3"
2" x 1 1/2" 6" x 4"
3" x 2" 8" x 6"

ISSUED 2-25-93

CHECK VALVES

8.01 Check valve, horizontal or vertical swing type. ASTM A-126, Class B cast iron body, all iron mounted, regrinding steel disc, screw-in cap, threaded ends.
Jenkins Fig. 72, or equal.

Rating: 250 PSIG WOG @ 100 DEG. F.

Sizes: 1/2" thru 2"

8.02 Check valve, horizontal or vertical swing type. ASTM A-126, Class B cast iron body, bronze mounted, regrindable - renewable disc and seat ring, bolted cover, 125 lb. ANSI B16.1 flanged ends.
Jenkins Fig. 624 or equal.

Rating: 125 PSIG saturated steam
200 PSIG WOG @ 100 DEG. F.

Sizes: 2" thru 12"

8.03 Check valve, horizontal or vertical swing type. ASTM A-126, Class B cast iron body, all iron mounted, regrindable-renewable disc and seat ring, bolted cover, 125 lb. ANSI B16.1 flanged ends.
Jenkins Fig. 85, or equal.

Rating: 200 PSIG WOG @ 100 DEG. F.

Sizes: 2" thru 12".

8.04 Check valve, horizontal or vertical swing type, cast steel body, ASTM A-216, Grade WCB, trim A-182, Grade F6 (type 410 chromium steel), flanged ends.
Crane figure 159X, or equal.

Rating: 300 PSIG per ANSI B16.5

Sizes: 2" thru 10".

8.21 Check Valve, horizontal or vertical swing type. ASTM B-62 cast bronze body and cap, bronze trim, regrinding bronze disc, screw-in cap, threaded ends.
Jenkins Fig. 92-A or equal.

Rating: 125 PSIG saturated steam
250 PSIG WOG @ 100 DEG. F.

Sizes: 1/2" thru 4".

STRAINERS CONTINUED

22.51 "Y" type pipeline strainer, 316 stainless steel, 150# ANSI B16.5 flanged ends, bolted blow-off cover with threaded blow-off connection, stainless steel screen of 40 mesh (1/64" opening).
Mueller 761-SS, or equal.

Rating: 150 PSIG steam @ 500 DEG. F.
275 PSIG WOG @ 100 DEG. F.

Sizes: 1/2" to 12"

22.52 Disposable fabric basket filter with 316. S. S. metal basket, 304 S.S. body, floor mounted, stainless steel victaulic receiver connection on inlet and threaded stainless steel nipple outlet connection.
Ronningen-Petter Model SS-324 or equal with 10 disposable fabric filter baskets, polypropylene fabric,
60 mesh equivalent

22.53 Perforated basket strainer (Carbon Retainer) for 150 lb. Raised Face Flanges, type 316 stainless steel construction. Basket is to be Fabricated from 14 Gage 316 stainless steel with 1/8" holes drilled on 3/16" centers and covered with 40 mesh 316 stainless steel screen, this will then be covered by a 4 mesh 316 stainless steel support screen (0.063" wire diameter). Support Screen is to be designed for 125 PSIG if plugged in forward or reverse flow.

Mack Iron Works Company Series PB-R/FF, Style PBL or equall.

Sizes: 2" thru 12"

22.54 "Y" type pipeline strainer, ASTM A-351, Grade CF8M cast stainless steel, threaded ends and blow-off outlet, stainless steel screen with standard perforations for medium straining duty on water service.
Armstrong fig. 12-1, or equal.

Rating: 600 PSIG steam @ 750 DEG. F.
800 PSIG WOG @ 100 DEG. F.

Sizes: 1/2" thru 3

22.55 Tubular filter, 316 stainless steel construction, 250 micron retention stainless steel screen, lever operated 3-way valve for shock backwash operation, 150 lb. flanged connections.
Duriron company Model TE-1, or equal.

Rating: 200 PSIG @ 300 DEG. F.

Size: Body - 4"
Filter Element - 3 1/4" x 36"
Pipe inlet & outlet - 2"

ISSUED 12-1-89; REV.4-29-92

STRAINERS CONTINUED

22.91 Filter nozzle, 316L stainless steel, Johnson division U.O.P. with 3/4" MNPT pipe nipple, 0.012 opening for insertion in absorber sample nozzle, with stainless steel coupling, bushing, pipe and flange. Materials and construction per Detail Item 22.91 Dwg. No.90-86-0236.

22.92 Filter nozzle, polypropylene construction. Orthos Type DA, 0.3 MM Slot Opening, 3/4" MNPT Thread.

22.93 Filter nozzle, 316L stainless steel Johnson division U.O.P. with 1" MNPT pipe nipple, screen 2" O.D. x 2" screen length, 3 1/8" O.A.L. with 0.012" slot openings.

22.94 Filter nozzle, polyproplyene construction. Orthos Type TA, 0.3 MM Slot Opening, 3/4" MNPT Thread.

22.95 Filter nozzle, 316L stainless steel Johnson division, U.O.P. with 3/4" MNPT pipe nipple, screen 2" O.D. x 2" screen length, 3 1/8" O.A.L. with 0.012" slot openings.

22.96 Filter nozzle, Orthos type C2, 0.012" slot, 1" WW thread x 45mm long stem complete with MUZ slots. Furnish a type MUZS nut, 1" WW thread with special bossed washer to match a 1-1/8" diameter hole in a 3/8" thick plate. Furnish a 3"O.D. x 1-1/8" I.D. x 1/8" thick white Buna N (FDA approved) gasket. All plastic parts shall be manufactured from virgin polypropylene.

22.97 Filter Nozzle, Orthos type C2, 0.012" Slot, 1" WW thread x 45 MM long with 3/4" six point nut, polypropylene construction. Expanding ring, 32 MM diameter 1" WW thread for 12-17 MM plate thickness, polypropylene construction. Pipe saddle, FDA approved Rubber to suit a schedule 80 PVC pipe, the pipe size shall be specified by Calgon Carbon Corporation.

22.98 Filter Nozzle, Orthos type C2, 0.012" Slot, 1" WW thread x 2" long. Expanding Ring, 28 MM diameter, 1" WW thread for 3/8" plate and 1 3/16" dia. hole. Viton Gasket and all parts shall be manufactured from Kynar.

22.99 Filter Nozzle, Orthos Type SE11, 316 stainless steel construction with 0.012" slot openings.
1" WW thread x 2" long nipple. Polypropylene expanding ring, 28 mm dia., 1" WW thread for 3/8" plate and 1 3/16" hole. White (FDA approved) Buna-N gasket.

SPRAY NOZZLE CONTINUED

25.24 Spray Nozzle, Teflon construction, study type, full cone narrow angle (60 DEG.) spray pattern, male pipe thread connection.

Bete Fog Nozzle, Inc. NCS Series, or equal.

Rating: 150 psig at 100 DEG. F.

		GALLONS PER MINUTE AT PSI					
PIPING SIZE	NOZZLE NO.	10	20	40	60	80	100
1"	NCS1007N	8.4	12	17	20	24	26
1 1/2"	NCS1516N	19	27	38	47	54	60
2"	NCS2035N	42	59	78	103	118	132
2 1/2"	NCS2550N	60	84	120	146	170	190
3"	NCS3085N	102	143	203	239	287	321
4"	NCS4120N	143	203	286	352	406	454

25.25 Spray Nozzle, Polypropylene construction, 30 degree hollow cone type spray pattern, female pipe thread connection.

Bete Fog Nozzle, Inc. NCF Series, or equal.

Rating: 150 psig at 100 DEG. F.

		GALLONS PER MINUTE AT PSI						
PIPING SIZE	NOZZLE NO.	10	20	30	40	60	80	100
3/4"	NCF 0706J-30	7.5	11	13	15	18	21	24
1"	NCF 1012J-30	14	20	23	28	34	40	44
1 1/4"	NCF 1218J-30	22	30	37	43	53	61	68
1 1/2"	NCF 1526J-30	31	45	55	63	77	89	100
2"	NCF 2048J-30	57	81	100	115	141	162	182
2 1/2"	NCF 2572J-30	87	124	152	175	214	247	277
3"	NCF 30105J-30	125	176	216	250	306	353	395
4"	NCF 40190J-30	225	318	390	450	550	636	712

25.26 Spray Nozzle, Type 316 stainless steel construction, 30 degree hollow cone type spray pattern, female pipe threaded connection.

Bette Fog Nozzle, Inc. NCF Series, or equal.

Rating: 150 psig at 100 DEG. F.

See Item 25.25 table for nozzle numbers and capacities.

25.27 Spray Nozzle, Polypropylene, 90 degree full cone spray pattern, female pipe connection, 1 1/2"

Bete Fog Nozzle Inc. NCF 1516M-Polypropylene.

HOSE FITTINGS CONTINUED

32.44 Quick Disconnect Adaptor, nylon, female NPT on one end with other end for connecting to quick disconnect coupler. NY-Last Style A, or equal.

Rating: 70 psig to 175 psig @ 0 DEG.F. to 150 DEG. F. depending on size.

Sizes: 1/2" thru 4"

32.45 Quick Disconnect Adaptor, nylon, male NPT on one end with other end for connecting to quick disconnect coupler. NY-Last Style F, or equal.

Rating: 70 psig to 175 psig @ 0 DEG. F. to 150 DEG. F. depending on size.

Sizes: 1/2" thru 4"

32.46 Quick Disconnect Coupler, nylon, Buna-N gaskets, male NPT on one end with other end for connecting to quick disconnect adaptor.
NY-Last Style B, or equal.
Rating: 70 psig to 175 psig @ 0 DEG. F. to 150 DEG. F. depending on size.
Sizes: 1/2" thru 4"

32.47 Quick Disconnect Coupler, nylon, Buna-N gaskets, female NPT on one end, other end for connecting to quick disconnect adaptor.
NY-Last Style D, or equal.

Rating: 70 psig to 174 psig @ 0 DEG. F. to 150 DEG. F. depending on size.

Sizes: 1/2" thru 4"

32.48 Dust Plug for couplers, Nylon, complete with 15" length of brass or stainless steel chain.
NY-Last Style DP, or equal.

Rating: 70 psig or 175 psig @ 0 DEG. F. to 150 DEG. F. depending on size.

Sizes: 3/4" thru 4"

32.49 Quick Disconnect Coupler, nylon, hose shank on one end with other end for connecting to quick disconnect adaptor.
NY-Last Style C, or equal.

Rating: 70 psig to 175 psig @ 0 DEG. F. to 150 DEG. F. depending on size.

Sizes: 1/2" thru 4"

ISSUED 1-1-89

PLASTIC SPACERS FOR POLYPROPYLENE LINED PIPE

The spacers listed below for plastic lined pipe shall be fabricated from thermally stabilized polypropylene resin suitable for minus 20 DEG. to plus 225 DEG. F. service. Spacers shall be molded or machined in accordance with Calgon Drawing No. 7209A-561

Sizes: 1" through 8", unless otherwise stated

35.01	Standard ring spacer
35.07	Standard ring blind spacer
35.13	Standard full face spacer
35.19	Standard full face blind spacer 1/2" thick
35.25	Special tapered bore ring spacer
35.31	Single taper ring spacer with 4 DEG. - 9′ taper - for 4" line only.
35.37	
35.43	Orifice spacer, ring type/one 3/4" FNPT tap
35.49	Orifice spacer, ring type/one 1/2" FNPT tap
35.55	Orifice spacer, ring type/two 3/4" FNPT taps @ 180 DEG.
35.61	Orifice spacer, ring type/two 3/4" FNPT taps @ 90 DEG.
35.67	Orifice spacer, ring type/one 1/2" and one 3/4" FNPT tap @ 180 DEG.
35.73	Orifice spacer, ring type/one 1/2" and one 3/4" FNPT tap @ 90 DEG.
35.79	Orifice spacer, ring type/one 1 1/2" FNPT tap
35.85	Orifice spacer, ring type/one 3/4" and one 1 1/2" FNPT tap @ 180 DEG.
35.90	Orifice spacer, 2" thick PPL, ring type, with one 1" FNPT tap. 6 7/8" O.D. x 3 5/8" I.D. W/ 1 5/32" drill for 1" FNPT. For mounting between two 4" lined pipe flanges.
35.91	Orifice spacer, Ring-type/one 1" FNPT tap.

PRESSURE INDICATING GAGES

MODEL:	Weksler AA44P-Liquid Fill
GAGE	
Case:	4 1/2" size stainless steel, steel, brass, aluminum and phenol
Socket:	1/2" NPT male bottom connection, stainless steel
Dial:	White litho with black figure
Pointer:	Balanced micrometer
Bourdon Tube:	Stainless steel
Movement:	Stainless steel and Delrin
Accuracy:	1% of full range
Range:	Listed below
Liquid Fill:	Glycerin (Temp. range of -36 DEG.F. to + 140 DEG. F.)
TAGGING:	Tag each assembly with Item No. and Service.

ITEM NO.	SERVICE	ITEM NO.	SERVICE
PI-213	0-15 PSIG	PI-448	0-300 PSIG
PI-214	0-30 PSIG	PI-557	0-300 PSIG *
PI-215	0-60 PSIG	PI-449	0-400 PSIG
PI-216	0-100 PSIG	PI-556	0-400 PSIG *
PI-217	0-160 PSIG	PI-450	0-800 PSIG
PI-218	0-200 PSIG	PI-558	0-800 PSIG *
		PI-559	0-1500 PSIG
		PI-560	0-1500 PSIG *

NOTE: Replaces Items

PI-101 Spec. 7209A-CS161
PI-102 Spec. 7209A-CS161
PI-103 Spec. 7209A-CS161
PI-104 Spec. 7209A-CS161
PI-105 Spec. 7209A-CS161
PI-106 Spec. 7209A-CS161

PI-107 Spec. 7209A-CS162
PI-108 Spec. 7209A-CS162
PI-109 Spec. 7209A-CS162
PI-110 Spec. 7209A-CS162
PI-111 Spec. 7209A-CS162
PI-112 Spec. 7209A-CS162

ALTERNATE SOURCES:

MANUFACTURER	MODEL NO.
Ashcroft	
Ametek-U.S. Gauge	
Marshalltown	

3-D

* W/STEAM COIL SIPHON

RUPTURE DISKS

MANUFACTURER: Process Equip. Div.
Carborundum Co.

RUPTURE DISK:
- Type: Standard
- Size: (See below)
- Material: Impervious graphite
- Vacuum Support: Furnish for disks w/bursting pressure of 15 psig or less.

DISK HOLDER: Rupture disk to fit between 150# ANSI RF or FF companion flanges furnished by others.

SERVICE CONDITIONS:
- Fluid Under Disks: Wastewater
- Pressure Fluctuation: Steady during normal operation
- Temperature: 40 degrees - 150 degrees F.
- Operating Pressure: 65 psig max.
- Back Pressure: Atmospheric
- Vessel Design Pressure: 75 psig @ 100 degrees F.

PERFORMANCE EQUIPMENTS:
- Bursting Pressure: 75 psig ± 5%
- Coincident Temp.: 40 degrees to 150 degrees F.
- Relieving Capacity Req'd.: Nil - for thermal expansion

TAGGING: Tag w/Item No. and Service

ITEM NO.	SIZE	BURSTING PRESSURE
PSE-155	1"	75 PSIG ± 5%
PSE-156	1 1/2"	75 PSIG ± 5%
PSE-157	2"	75 PSIG ± 5%
PSE-252	3"	75 PSIG ± 5%
PSE-301	3"	35 PSIG ± 5%
PSE-302	3"	50 PSIG ± 5%
PSE-303	3"	65 PSIG ± 5%
PSE-304	3"	87 PSIG ± 5%
PSE-305	3"	150 PSIG ± 5%
PSE-306	3"	75 PSIG ± 5%

A.S.M.E. Nameplate: Furnish in accordance w/code requirements.

ALTERNATE SOURCES:

MANUFACTURER	MODEL#
Zook	
Carbone	
Frangible Disks	

PSE 157 PSE 577
PSE 252 PSE 604
PSE 301 PSE 605

ZOOK

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Chagrin Falls Ohio
44022-0419 USA

Phone 216-543-1010
Fax 216-543-4930

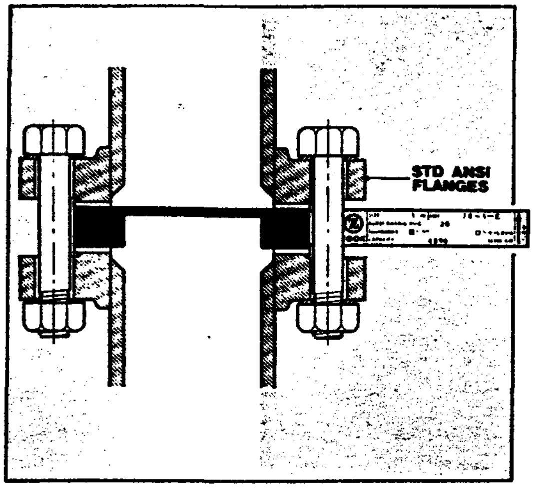
Bulletin 6000-2

REF 1581.51368 PRINTED USA

installation of ZOOK graphite rupture disks

PSE 157 PSE 577
PSE 252 PSE 604
PSE 301 PSE 605

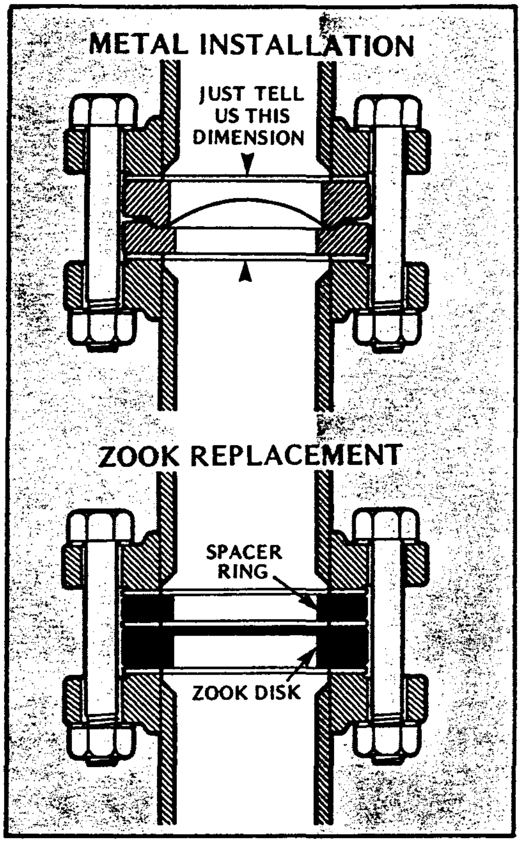
Zook graphite rupture disks fit directly between standard ANSI flanges without requiring additional holders.



Proper orientation is shown with a flow arrow on each disk nameplate which must be followed. Detailed instructions are supplied with each disk. Gaskets should be ring type, non-metallic, relatively soft, and must be sized as shown in the gasket dimension chart on page 16, except for TWOWAY disks.

Steel armor is recommended for all Zook disks and is supplied as standard on selected disks shown under the heading "Armor" on page 17. Armor enhances performance by blocking extraneous structural stresses as well as unequal flange bolting stresses from reaching the pressure sensitive membrane of the disk. Also, armor increases overall safety, particularly during catastrophic blowdowns in toxic and flammable service. Standard armor is carbon steel. Also available from stock is Stainless 304 and 316.

Normal good practice should be used for making flange connections, particularly concentric alignment of the disk, and uniform cross tightening of flange bolts to prevent unequal stresses. Also, it is necessary that vent piping be adequately supported to withstand thrust during blowdown, and that personnel and equipment are protected against high velocity open discharge of process material and rupture disk fragments.



To replace a metal disk with a Zook graphite style, a graphite armored spacer ring will be provided on request to fill the vertical space left by the thick metal holders. Thereby, repiping is not necessary.

A detailed Installation Guide is supplied with each disk. A separate copy is available on request.

ZOOK phone 216-543-1010 fax 216-543-4930

SE 157 PSE 577
PSE 252 PSE 604
PSE 301 PSE 605

corrosion guide

This simplifed guide gives yes/no answers to use of Zook disks with common corrosives. Those not named typically can be accommodated by unlined Zook graphite disks. Where there is doubt about compatibility, use DUPLEX design, or test a disk material sample available on request.

INSULATED disks utilize fibrous silica and alumina which is not usable with liquids, and is attacked by hydrofluoric and phosphoric acids and concentrated alkalis.

Reagent	Mono Inverted & Unlined Disks	Duplex & Lined Disks
Aluminum Hydroxide	No	Yes
Ammonium Hydroxide	No	Yes
Bromine (free)*	No	Yes
Calcium Chlorate	No	Yes
Calcium Hydroxide	No	Yes
Calcium Hypochlorite	No	Yes
Chloral	No	Yes
Chlorine (free)	No	Yes
Chromic Acid (plating)	No	Yes
Fluorine (free)	No	No
Hydrofluoric Acid	to 50% conc.	Yes
Iodine (free)	No	Yes
Molten Metal Alkalis	Yes	Yes
Nitric Acid	to 10% to 85°C. to 20% to 60°C.	Yes
Oleum	No	Yes
Ozone	No	Yes
Potassium Chlorate	No	Yes
Potassium Hydroxide	No	Yes
Potassium Hypochlorite	No	Yes
Sodium Chlorate	No	Yes
Sodium Hydroxide	No	Yes
Sodium Hypochlorite	No	Yes
Sulfur Trioxide	No	Yes
Sulfuric Acid	to 85% conc.	Yes
Sulfuric with *any* Nitric	No	Yes

*On request we will furnish liners in Kynar or FEP Teflon. (Kynar and Teflon are registered trademarks belonging to Pennwalt and duPont, respectively.)

gaskets

We stock all sizes of gaskets for our disks in the materials shown. We can supply gaskets loose or attached to your disks, thereby giving your installer the right gasket at the right place at the right time.

If you cut your own gaskets, follow dimensions in the chart, especially the inside diameter which provides interference clearance to permit proper burst. Gaskets for INSULATED Disks are a high temperature material and are always furnished.

Gasket Material	Thickness	TempF
Neoprene	1/8	250
Non-asbestos	1/8	700
PTFE Teflon (solid)	1/8	500
Envelope (Teflon)		
Non-asbestos filler	3/16	500
Neoprene filler	3/16	250

Gasket Dimensions

Nozzle Size	Flanges Class 150 I.D.	Class 150 O.D.	Class 300 I.D.	Class 300 O.D.
1/2	3/4	1-3/4	3/4	2
3/4	1	2-1/8	1	2-1/2
1	1-5/16	2-1/2	1-5/16	2-3/4
1-1/2	1-29/32	3-1/4	1-29/32	3-5/8
2	2-1/2	4	2-1/2	4-1/4
3	3-3/4	5-1/4	3-3/4	5-3/4
4	5	6-3/4	4-3/4	7
6	7-1/8	8-5/8	7-1/8	9-3/4
8	8-7/8	10-7/8	9	12
10	11-5/8	13-1/4		
12	13-3/4	16		
14	14-1/2	17-5/8		
16	17	20-1/8		
18	19-1/2	21-1/2		
20	21-3/4	23-3/4		
24	25	28-1/8		

ZOOK phone 216-543-1010 fax 216-543-4930

Ordering Information

PSE 157 PSE 577
PSE 252 PSE 604
PSE 301 PSE 605

ZOOK phone 216-543-1010 fax 216-543-4930

Quantity

Disk Style
Choose from
a. MONO
b. INVERTED
c. DUPLEX
d. TWOWAY

Disk Diameter
Specify nominal nozzle size

Flange Rating
Choose from
a. Class 150
b. Class 300
c. Other

Burst Rating
Specify any burst rating within allowable limits shown on pages 9, 11, 13, and 14.

Coincident Temperature
Specify temperature at disk location at expected time of disk rupture. Coincident temperature is **not** necessarily operating temperature. Specify one of the following temperature options unless ASME testing is desired.

A. ROOM TEMPERATURE: (40F to 100F)
Disks ordered at coincident temperatures ranging from 40F to 100F will be burst tested and stamped at 72F.

B. OVEN TESTED: (added cost)
Disks ordered at coincident temperatures above 100F to 338F will be tested at actual coincident temperatures specified.

Coincident temperatures above 338F will be oven tested at the cold face temperature of required insulation (See Insulated Disk, page 7).

C. CHART COMPENSATED:
Disks ordered at coincident temperatures above 100F to 338F will be chart compensated from a test curve to establish burst rating at coincident temperature specified.

Coincident temperatures above 338F will be chart compensated at the cold face temperature of the required insulation. (See Insulated Disk, page 7.)

In all of the above temperature options, nameplate burst rating will be the ordered rating based on 2 or more verification burst tests from a given lot of disks designed to burst within ±5% of ordered rating.

ASME Testing
Specify Conform to Section VIII.

Nameplate burst rating will be the average of 2 or more test bursts falling within a Manufacturing Design Range of ±5% of ordered rating.

To 338F, ordered, test, and nameplate coincident temperatures will be equal.

Above 338F to 700F, insulation is required beneath the rupture disk. Therefore, testing must be done at the cold face temperature of the insulation; but nameplate coincident temperature rating must be the same as that ordered. As a result, Insulated Disks are furnished with insulation and disk as an attached unit. (See Insulated Disk, page 7.)

Vacuum Support
Required only on disks rated below 25 psig in installations where vacuum is expected, and available only on MONO disks.

Armor
Choose from
a. Carbon steel
b. Stainless steel (added cost)

Gaskets
If you want gaskets furnished with your order, specify material and how you want them supplied as described on page 16.

Example: 6 Zook rupture disks, MONO Style, 4" diameter, to fit Class 150 flange, 50 psig burst rating at 150F coincident temperature, Chart Compensated, carbon steel armor, PTFE gaskets attached.

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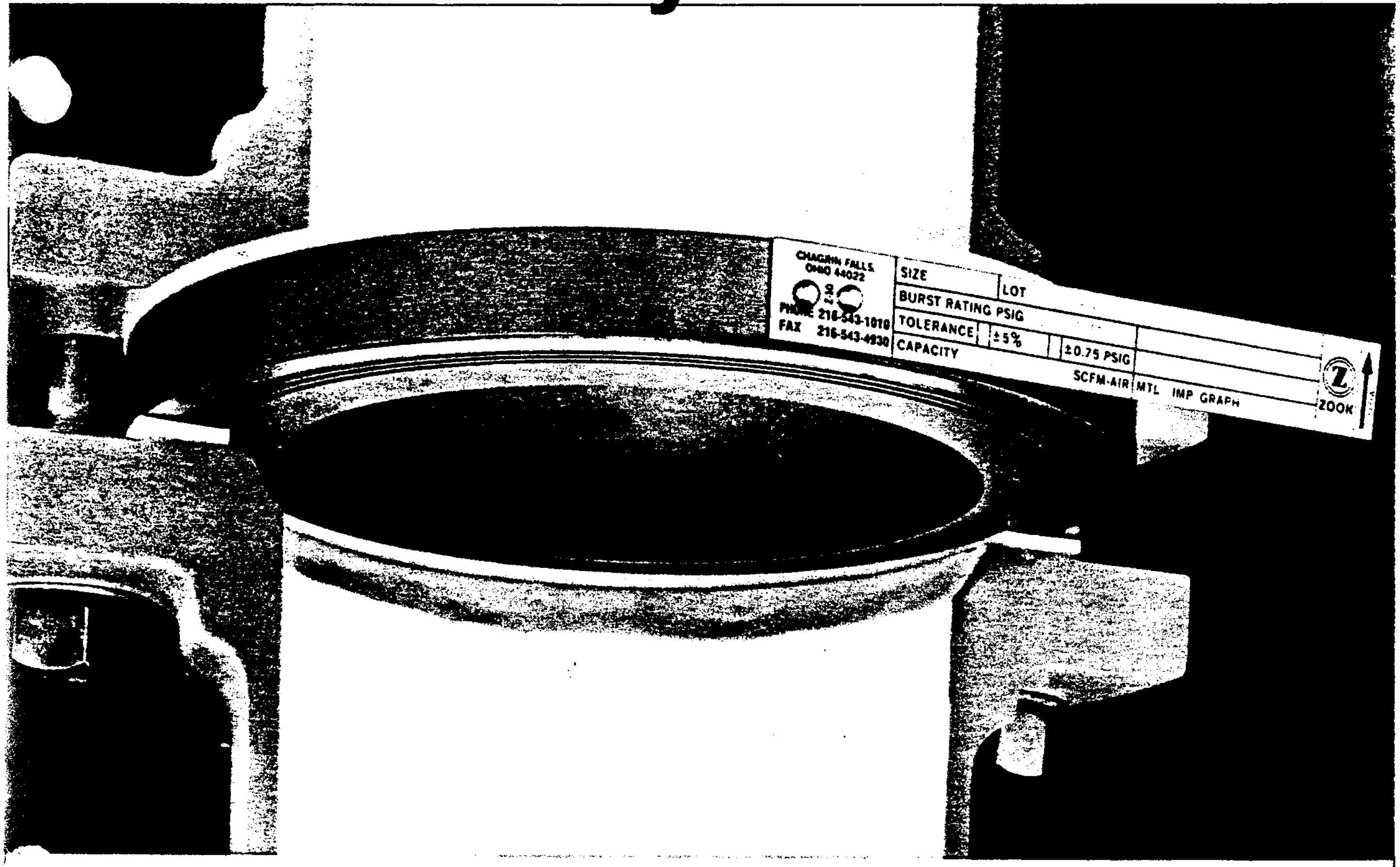
Mono style



	Column 1	2	3	4	5	6	7
	Nozzle Size	Diameter		Thickness*		Burst Ratings	
		I. D.	O.D.	Disk	Insulated Disk	Min.	Max.
	FITS CLASS 150 ANSI FLANGES						
	STOCKED RATINGS 10, 15, 20, 25, 30, 40, 50, 75, 100, 125, 150 PSIG at 70F.						
	1/2	1/2	1-3/4	5/8	1-3/4	25	150
	3/4	3/4	2-1/8	5/8	1-3/4	25	150
IN STOCK FOR FAST SHIPMENT	1	1	2-1/2	7/8	2-1/4	10	150
IN STOCK FOR FAST SHIPMENT	1-1/2	1-1/2	3-1/4	7/8	2-1/4	7	150
IN STOCK FOR FAST SHIPMENT	2	2	4	7/8	2-1/4	3	150
IN STOCK FOR FAST SHIPMENT	3	3	5-1/4	7/8	2-1/4	2	150
IN STOCK FOR FAST SHIPMENT	4	4	6-3/4	7/8	2-1/4	1-1/2	150
IN STOCK FOR FAST SHIPMENT	6	6	8-5/8	7/8	2-1/4	1	150
IN STOCK FOR FAST SHIPMENT	8	8	10-7/8	1-1/8	2-3/4	1/2	150
	10	10	13-1/4	1-1/2	3-3/8	1/4	125
	12	12	16	2	4-3/8	1/4	125
	14	13-1/4	17-5/8	2-1/4	4-7/8	1/4	100
	16	15-1/4	20-1/8	2-1/2	5-3/8	1/4	100
	18	17-1/4	21-1/2	2-3/4	5-7/8	1/4	< 100
	20	19-1/4	23-3/4	3	6-3/8	1/4	< 50
	24	23-1/4	28-1/8	3	6-3/8	1/4	< 50

*Insulated disk thickness (column 5) includes all gaskets. Disk is furnished complete, ready for immediate installation. Disk thickness (column 4) does not include gaskets.

Stocked MONO Disks noted in the chart at left will be shipped on an emergency basis within 24 hours upon request in reasonable quantities. Higher ratings to fit Class 300 flanges are furnished in INVERTED style. See page 10. Red Dot Service is available for faster emergency shipment of any style, size, or rating.

Vacuum supports are unnecessary except where Mono disks are rated below 25 psig. Disks which must be steel armored include all INSULATED disks plus those shown in bold type in the capacity chart at right. Also, see ARMOR on page 17. Mono disk temperature limits are 338F without insulation and 700F with insulation. Armored disks will typically accept blowdown temperatures equal to pipe limits. Gaskets must be cut to dimensions shown on page 16. If ordered, gaskets can be attached to disk at time of shipment.

Details on tolerance, ASME and Zook testing, elevated temperatures, and service life appear on page 5; corrosion, gaskets, and armor on pages 16 and 17; and ordering information on page 18.

WARNING

Use of rupture disks described in this bulletin are intended for use only by persons possessing requisite technical skill, and at their own discretion and risk.

Venting capacities

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MONO disk venting capacities are shown below in standard cubic feet per minute of air x 1000 at standard conditions of 60F, 14.7 psia, and air weight of 0.0766 lbs./cu. ft. Calculations use a coefficient of discharge (K) of .888 based on sonic tests per ASME Code Sec. VIII, UG 131. Adjustment factors are shown at bottom for vacuum supports and insulated disks. Type of vacuum support used by diameter and rating is shown in boxed areas in the chart. **Example**: A 4" MONO disk rated 20 psig, and expected to see vacuum in service, will use a bar type vacuum support, which reduces original capacity of **7.49** by a factor of **.77**, resulting in adjusted capacity of 5.77 x 1000 scfm air. If this same disk also will be insulated for use above 338F, then the adjusted capacity of 5.77 must be reduced further by the factor of **.71** noted in the 4" diameter column for INSULATED disks. The plate type vacuum support cannot be used with an INSULATED disk. Those disks armored as standard are shown in bolder type. For higher burst ratings or capacities, see INVERTED style, pages 10 and 11.

Disk Diameter - Inches

Burst Rating Psig	1/2	3/4	1	1-1/2	2	3	4	6	8	10	12	14	16	18	20	24
1/4	—	—	—	—	—	—	—	—	—	19.1	27.5	33.5	44.4	56.8	70.8	103
1/2	—	—	—	—	—	—	—	—	12.4	19.4	28.0	34.1	45.2	57.9	72.1	105
1	—	—	—	—	—	—	—	7.25	12.9	20.1	29.0	35.4	46.8	60.0	74.7	109
1-1/2	—	—	—	—	—	—	3.34	7.50	13.3	20.8	30.0	36.6	48.4	62.0	77.2	113
2	—	—	—	—	—	1.94	3.45	7.76	13.8	21.5	31.0	37.8	50.1	64.1	79.8	116
3	—	—	—	—	.918	2.07	3.67	8.26	14.7	23.0	33.0	40.3	53.4	68.3	85.0	124
4	—	—	—	—	.974	2.19	3.90	8.77	15.6	24.4	35.1	42.8	56.6	72.5	90.2	132
5	—	—	—	—	1.03	2.32	4.12	9.27	16.5	25.8	37.1	45.2	59.9	76.6	95.4	139
6	—	—	—	—	1.09	2.44	4.35	9.78	17.4	27.2	39.1	47.7	63.2	80.8	101	147
7	—	—	—	.643	1.14	2.57	4.57	10.3	18.3	28.6	41.1	50.1	66.4	85.0	106	154
8	—	—	—	.674	1.20	2.70	4.80	10.8	19.2	30.0	43.1	52.6	69.7	89.2	111	162
9	—	—	—	.706	1.25	2.82	5.02	11.3	20.1	31.4	45.2	55.1	72.9	93.3	116	170
10	—	—	.328	.738	1.31	2.95	5.24	11.8	21.0	32.8	47.2	57.5	76.2	97.5	121	177
15	—	—	.398	.897	1.59	3.58	6.37	14.3	25.5	39.8	57.3	69.8	92.5	118	147	215
20	—	—	.468	1.05	1.87	4.21	**7.49**	16.8	30.0	46.8	67.4	82.1	109	139	173	253
25	.134	.303	.538	1.21	2.15	4.84	8.61	19.4	34.4	53.8	77.5	94.5	125	160	199	291
30	.152	.342	.608	1.37	2.43	5.47	9.73	21.9	38.9	60.8	87.6	107	141	181	225	329
40	.187	.421	.748	1.69	2.99	6.74	12.0	26.9	47.9	74.8	108	131	174	223	277	405
50	.222	.500	.888	2.00	3.55	8.00	14.2	32.0	56.9	88.9	128	156	207	264	329	480
75	.310	.697	1.24	2.79	4.95	11.2	19.8	44.6	79.3	124	**178**	**218**	**288**	**369**	—	—
100	.397	.894	1.59	3.58	6.36	14.3	25.4	**57.2**	**102**	**159**	**229**	**279**	**370**	**473**	—	—
125	.485	1.09	1.94	4.37	7.76	17.5	**31.1**	**69.8**	**124**	**194**	**279**	—	—	—	—	—
150	.583	1.31	2.33	5.26	9.33	21.0	**37.3**	**84.0**	**149**	—	—	—	—	—	—	—

RING / BAR / CROSS / PLATE

CONSULT FACTORY FOR VACUUM SUPPORT

Guide to capacity adjustments for Mono style disks only

Vacuum Supports	1	1-1/2	2	3	4	6	8	10	12	14	16	18	20	24
RING	.47	—	—	—	—	—	—	—	—	—	—	—	—	—
CROSS	—	—	.39	.56	.62	.56	.58	.60	.56	.55	——CONTACT FACTORY——			
PLATE	—	—	.36	.37	.38	.36	.35	.35	.35	.37	——CONTACT FACTORY——			
BAR	—	.63	.63	.74	**.77**	.68	.75	.76	.75	.73	——CONTACT FACTORY——			
Insulated Disks	**1.0**	**.80**	**.79**	**.63**	**.71**	**.68**	**.71**	**.76**	**.76**	**.75**	——CONTACT FACTORY——			

ZOOK phone 216-543-1010 fax 216-543-4930

CALGON CARBON CORPORATION
PITTSBURGH, PA

SPECIFICATION NO. 7209A-VS7
FOR
VINYL ESTER VESSEL LINING
(4110)

FEBRUARY 4, 1985

* * * *

REVISIONS

This specification has been revised as indicated below. The new pages added and/or the existing pages revised are attached as replacements for those previously issued.

Revision	Date	By	Page	Remarks
A	1/04/85	DJH	All	Issued for Purchase
B	8/01/90	FRF	All	Issued for Purchase

1.0 SCOPE OF WORK

1.1 This specification covers materials, surface preparation, application and testing of protective coatings for internal lining of carbon steel vessels.

1.2 The scope of work includes all labor, materials, equipment and services required for lining and testing the vessels indicated on the drawings and/or other applicable documents.

1.3 The entire internal surface of the designated vessels including all nozzles and manways shall be lined.

1.4 The lining must satisfactorily protect the internal metal surfaces from corrosion and erosion by the contained carbon slurry.

1.5 The Contractor shall guarantee that all materials and workmanship shall be free of defects and that they will conform to standards set forth for first-class workmanship and quality. In the event of failure of the lining to withstand the service conditions set forth in Article 3.0, the Contractor shall, at his expense, replace the defective materials and workmanship to the Buyer's satisfaction.

2.0 REFERENCE DOCUMENTS

2.1 Steel Structures Painting Council Surface Preparation Specification No. 1, "Solvent Cleaning" (SSPC-SP1-85).

2.2 Steel Structures Painting Council Surface Preparation Specification No. 2, "Hand Tool Cleaning" (SSPC-SP2-85).

2.3 Steel Structures Painting Council Surface Preparation Specification No. 3, "Power Tool Cleaning" (SSPC-SP3-85).

2.4 Steel Structures Painting Council Surface Preparation Specification No. 5, "White Metal Blast Cleaning" (SSPC-SP5-85).

2.5 Steel Structures Painting Council Paint Application Specification No. 1, "Shop, Field and Maintenance Painting" (SSPC-PA1-82).

2.0 REFERENCE DOCUMENTS (continued)

2.6 Steel Structures Painting Council, "Method for Measurement of Dry Film Paint Thickness with Magnetic Gages" (SSPC-PA2-82).

2.7 Plasite 4110 Technical Bulletin.

3.0 SERVICE CONDITIONS

3.1 The lining will be exposed to static and moving water slurries of granular activated carbon.

3.2 The characteristics of the slurries will be as follows:

3.2.1 Carbon Slurry in Wastewater
3.2.2 Temperature - 35-100°F
3.2.3 pH - 5.0 to 9.0
3.2.4 Density - 26 lbs./cu.ft., Dry
3.2.5 Abrasive - Yes

4.0 MATERIALS

4.1 The lining shall be a heavy-duty, thick film, high-resistant vinyl ester resin material with special abrasion resistant qualities. The lining material shall be suitable for spray application to a nominal 35 to 45 mil dry film thickness on a steel surface.

4.2 The lining shall be Plasite No. 4110 coating material as supplied by Wisconsin Protective Coating Corporation, Green Bay, Wisconsin. Products from other suppliers or manufacturers are not approved.

5.0 DELIVERY, STORAGE AND HANDLING

5.1 Product Delivery: Materials shall be delivered to the site in sealed, original, labeled containers with the Plasite name, product number, batch number, color designation, and instructions for mixing and thinning.

5.2 Storage: Contractor shall be responsible for the proper storage of all coating materials. Damaged, leaking, or unlabeled containers shall be disposed of daily.

5.0 DELIVERY, STORAGE AND HANDLING (continued)

5.3 Storage Location: Materials shall be stored in a place specifically assigned for that purpose which is dry and out of direct sunlight. Materials shall be stored in a manner so as not to exceed the manufacturer's temperature limitations. In all cases, the storage and handling of materials shall conform to the requirements of the manufacturer and the applicable safety regulatory agencies.

5.4 Fire Prevention: All precautions to prevent fire shall be taken. Containers of flammable materials shall be opened only when needed. Rubbing cloths and oil rags shall be kept in tightly-closed containers and removed from the site daily. Fire or other damage due to spontaneous combustion or other means shall be the Contractor's responsibility.

6.0 APPLICATION

6.1 Surface Preparation

6.1.1 The Contractor shall install and maintain protective coverings on any surface not to be painted to protect the surface during surface preparation and paint application.

6.1.2 Grease, Oil & Interference Material: Surface contamination on bare steel such as grease, oil, tape tags, markings, etc. shall be removed by the contractor by solvent cleaning per SSPC-SP1 prior to blast cleaning.

6.1.3 Surface Irregularities: Prior to blast cleaning, all surfaces shall be inspected for weld spatter, weld flux, or any other surface irregularities. When discovered, they will be removed by the Contractor.

6.1.4 Edges: All sharp edges will be ground to a smooth radius.

6.1.5 Ambient Conditions: Final blast cleaning shall not be performed when the surface temperature is less than 5°F greater than the dewpoint temperature of the surrounding air, nor when the relative humidity is greater than 90%.

6.0 APPLICATION (continued)

6.1 Surface Preparation (continued)

6.1.6 Compressed Air Cleanliness: The air supply used for blast cleaning shall be free from moisture and oil contamination. The air cleanliness shall be verified at least once per shift for each compressor used. The test involves directing the air stream onto a piece of white paper held not more than 18-inches away from the air outlet. The test shall be run downstream of moisture and oil separators for a period of not less than two-minutes. Sufficient freedom from oil and water is confirmed if no soiling or discoloration is visible on the paper. If air contamination is evidenced, the filters shall be changed or cleaned, traps emptied, after-coolers, moisture separators or filters added, the equipment maintained, or such adjustments made as may be otherwise required to achieve clean, dry air for all blast cleaning, coating application, blow-down, or any other quality operations involving compressed air.

6.1.7 Abrasive/Profile: The abrasive selected shall be identified by the Contractor prior to use. The abrasive shall have a sharp, hard cutting surface and shall be dry and free of oil or soluble salt contaminants. Copper slag shall not be used. The abrasive shall provide an anchor pattern of at least 4.0 mils in depth. The surface profile shall be measured using the WPCC 4000 Series Anchor Profile Comparator.

6.1.8 Abrasive Blasting of Carbon Steel: The preparation of all carbon steel shall be by abrasive blast cleaning to remove all mill scale, rust and coatings.

6.1.9 Dry abrasive blast clean all interior steel surfaces in accordance with SSPC-SP5, "White Metal Blast Cleaning."

6.0 APPLICATION (continued)

6.2 Coating Application

6.2.1 Surface Cleanliness: The surface of the prepared steel shall be blown down (clean, dry, compressed air), brushed and/or vacuumed prior to coating application to remove spent abrasive, dust and other interference material. If grease or oil have become deposited on the surface, they shall be removed by solvent cleaning (SSPC-SP1) prior to coating application. Any rust which has formed shall be removed to the specified degree of cleanliness prior to painting.

6.2.2 Ambient Conditions: Coatings shall be applied only when the interior surface and air temperatures are between 60°F and 100°F, the relative humidity in the tank is less than 90%, and the temperature of the surface to be painted is at least 5°F above the dewpoint temperature of the air in the tank.

6.2.3 Mixing: Paint to be mixed shall have been delivered to the jobsite and stored in accordance with Section 5 and shall not have exceeded its shelf life. Mixing shall conform to the requirements of the coating manufacturer.

6.2.4 Mix Part II into Part I using a high-speed mechanical agitator with mixing blades fitting close to sides of container, making sure all of Part II is completely mixed with Part I. Mix well until obtaining a smooth liquid free of any unmixed particles of pigment. Add Part III and mix well. Part I is the liquid resin, Part II is the pigment, and Part III is the small portion of catalyst. Splitting of kits is not recommended. If necessary, mix Part I and Part II thoroughly and proportion mixture accurately with Part III. Continuous mixing during use is required. Operator should wear a face mask during high-speed mixing of the coating components. Avoid breathing dust.

6.0 APPLICATION (continued)

6.2 Coating Application (continued)

6.2.5 Only complete kits shall be mixed. Paint which has skinned, gelled, separated, or otherwise deteriorated during storage to the extent that it cannot be remixed to a homogeneous film of the intended viscosity, uniformity and consistency shall not be used. Mixed coatings shall not be used beyond their pot life.

6.2.6 Thinning: Only Plasite 20 Thinner shall be used for thinning. The amount of thinning will be limited 10% (except for stripe coat).

6.2.7 Methods: Coatings shall be applied by conventional spray. Coating applications shall be in accordance with the requirements of SSPC-PA1 and the Plasite 4110 Technical Bulletin. In the event of a conflict, the requirements of this specification, manufacturer's instructions and PA1 shall prevail in that order.

6.2.8 Stripe Coat: A stripe coat of Plasite 4110 thinned 50% with Plasite Thinner 20 shall be applied to all edges, corners, welds, crevices and irregularities prior to each full coat application. Such striping shall extend a minimum of 3-inches beyond the edge or irregularity.

6.2.9 Brush Application: Brush application is not allowed except for touch-up repairs, inaccessible areas and stripe coating. Those areas for which the contractor desires to use brush application shall be carefully defined prior to the start of all work.

6.2.10 Agitation: Paint must be kept agitated in spray pots or containers during paint application.

6.2.11 Coating Thickness: The coating shall be applied in a minimum of two coats. Each coat shall have a dry film thickness of between 17 and 23 mils, with a total system thickness of between 35 and 45 mils.

6.0 APPLICATION (continued)

6.2 Coating Application (continued)

6.2.12 Coating Continuity: All coats shall have smooth, streamline surfaces relatively free of dryspray, overspray, orange peel, fish eyes, craters, bubbles and other significant defects. Shadow-through, skips and misses are not acceptable. Runs or sags can be brushed out while the material remains wet. Areas where blast products or other debris have become embedded in the paint film shall be prepared by removing these products and touching up the area. In addition, the final coat shall be tested for discontinuities by performing high-voltage holiday testing at 3,500 volts to obtain a pinhole-free film. Holiday testing shall be performed only after a minimum cure time of 48-hours at 70°F with ventilation has elapsed after application of the final coat.

6.2.13 Re-coat Time and Cleanliness: Subsequent coats shall be applied only after the previously-applied coat has been allowed to dry as required by the Plasite 4110 Technical Bulletin, but as soon as possible in order to minimize exposure to intercoat contamination. Any such surface contamination which is present shall be removed prior to the application of subsequent coats.

6.3 Safety

6.3.1 The coating system may be handled safely by trained personnel following normal laboratory and plant standards for good housekeeping and personal hygiene. In the event of skin contact complications, the affected areas should be washed with soap and water. Eye protection is recommended. Work shall be performed in well-ventilated areas away from an open flame. When in enclosed areas, although ventilated, fresh air masks should be provided.

6.0 APPLICATION (continued)

6.3 Safety (continued)

6.3.2 The catalyst or curing agent is relatively stable at room temperature but must be protected from contamination, heat and fire and is classified by the Interstate Commerce Commission as an "oxidizing material" and subsequently all shipping containers bear a yellow caution label. The catalyst is highly irritating if it gets into the eyes. Immediately rinse eyes thoroughly with water and get medical attention. The catalyst also can be a skin irritant and this should be removed with large quantities of soap and water. Since this is an oxidizing material, it should not be allowed to accumulate or remain in soaked rags or clothing.

7.0 INSPECTION AND TESTING

7.1 Inspection

7.1.1 Contractor Inspection: The Contractor shall be responsible for inspecting all phases of the surface preparation and paint application in accordance with the Inspection Procedure.

7.1.2 Owner Inspection: Calgon Carbon reserves the right to inspect all phases of the coating operation to assure compliance with specification requirements. The Contractor shall repair/correct any and all deficiencies at his own expense. The Contractor shall provide accessibility and lighting for any inspections. It is not intended, however, that the presence or activity of such inspection shall in any way whatsoever relieve the Contractor of his obligation to provide inspection of his own to assure compliance with this specification. In all cases, Calgon Carbon or its approved agent will perform final inspection before acceptance.

7.1.3 Work Stoppage: Calgon Carbon reserves the right to stop any and all work at any time for non-compliance with the requirements of this specification.

7.0 INSPECTION AND TESTING (continued)

7.2 Testing

7.2.1 Check dry film thickness of coating by means of a General Electric Model Type B, or equal, dry film gage. Make at least one measurement for each 50 sq.ft. of surface. All areas with less than 30 mil DFT must have additional lining sprayed on before spark test. Run thickness test prior to spark test.

7.2.2 Spark test for pinholes with a 4500 VDC detector on all coated surfaces. A Tinker and Rasor Model AP-W, or equivalent device, is required for this operation; 3500-volt maximum, minimum 48-hours at 70°F cure before spark test is run.

8.0 INSPECTION PROCEDURE

8.1 Surface Preparation

8.1.1 Verify prior to blast cleaning that sharp edges, weld spatter, slivers, laminations, scabs or any other surface irregularities have been adequately removed to provide a surface suitable for coating application.

8.1.2 Verify prior to blast cleaning that heavy deposits of oil and/or grease have been adequately removed in accordance with "Solvent Cleaning" (SSPC-SP1).

8.1.3 Prior to blast cleaning operations, perform compressed air cleanliness test at least once per eight-hour shift. Insert a clean, white blotter or clean, white paper into the air stream no more than 18-inches from air source downstream of moisture and oil separators for approximately two minutes. Examine the blotter or paper for signs of moisture and/or oil contamination. Blast cleaning should not begin unless air is free of detrimental amounts of oil and/or water.

8.0 INSPECTION PROCEDURE (continued)

8.1 Surface Preparation (continued)

8.1.4 Verify that only clean and dry abrasives will be used. If bulk abrasive is to be used, verify that the abrasive is properly protected from rain, moisture and oil.

8.1.5 If abrasives are recycled, test for the presence of abrasive contamination. Add approximately one ounce of recycled abrasive to several ounces of clean water. Shake contents vigorously and visually examine the water level for signs of oil contamination.

8.1.6 Angular abrasive that will provide an anchor profile depth minimum equal to the SPCC 4000 Series Blast Comparator will be used.

8.1.7 Verify that required protective coverings are intact to assure that previously-coated surfaces will not be damaged during blast cleaning operations.

8.1.8 Monitor and record ambient conditions and surface temperatures during blast cleaning operations using a psychrometer, surface temperature thermometer and U.S. Weather Bureau Tables.

8.1.9 "Final blast cleaning" shall not be performed unless the surface temperature is at least 5°F higher than the dew point. "Rough blasting" may be performed regardless of ambient conditions, but must be "final blast cleaned" when conditions become favorable.

8.1.10 Verify that blast cleaned surfaces have been prepared in accordance with SSPC-SP5, "White Metal Blast Cleaning". SSPC-VIS-1 may be used as a visual reference. Mark all non-conforming areas with chalk or spray paint for rework.

8.0 INSPECTION PROCEDURE (continued)

8.1 Surface Preparation (continued)

8.1.11 Verify the profile (4 mils minimum) has been achieved using the WPCC 4000 Series Blast Comparator.

8.1.12 Using a dry film thickness gage, determine the magnetic base reading and record.

8.2 Coating Preparation

8.2.1 Verify that all containers are sealed, intact and properly labeled.

8.2.2 Verify that all coating material temperatures are at least 60°F before mixing by the use of a stem thermometer.

8.2.3 Verify type of coating mixed, batch numbers of all components, type of thinner and batch number, thinning ratios, time of mix, maximum pot life, etc.

8.2.4 Verify that all three components are combined and thoroughly mixed in the proper proportions to obtain a uniform color, free of lumps.

8.2.5 Verify that only the recommended thinner is used.

8.2.6 Verify that the pot life is observed.

8.3 Application of All Coatings

8.3.1 Monitor and record ambient conditions and surface temperatures every three to four hours during coating application using a psychrometer, surface temperature thermometer and U.S. Weather Bureau Tables. Coating application shall not be permitted when the surface temperature is less than 5°F above the dew point.

8.0 INSPECTION PROCEDURE (continued)

8.3 Application of All Coatings (continued)

8.3.1 (continued)

No coatings shall be applied when the surface and/or material temperatures are less than 70°F. No coating shall be applied when the surface temperature is expected to drop below 60°F before it has dried. Coating application shall not be permitted when the relative humidity is greater than 90%.

8.3.2 Verify compressed air cleanliness and test for conventional spray application and blowdown operations (see Section 8.1.3). Plasite 4110 must be applied using an agitated conventional pressure pot using continuous agitation during application.

8.3.3 Verify that protective coverings previously established are intact.

8.3.4 Verify that surrounding air is free of airborne contaminants prior to the application of coatings.

8.3.5 Verify intercoat cleanliness and that blast-cleaned surfaces have been cleaned to assure that coatings will not be applied over oil, grease, dirt, dust, spent abrasive, etc.

8.4 Application of First Coat

8.4.1 Verify that Plasite 4110 has been applied to all surfaces prepared that day before visual oxidation takes place. Any surfaces not primed the same day shall be reblasted prior to primer application.

8.4.2 Verify that weld seams have been brush-coated at least 3-inches on each side of seam prior to spray application.

8.0 INSPECTION PROCEDURE (continued)

8.4 Application of First Coat (continued)

8.4.3 Verify that the first coat has been applied to a dry film thickness of 17-23 mils. Perform dry film thickness tests in accordance with SSPC-PA2. (Deduct magnetic base reading.)

8.5 Application of Final Coat

8.5.1 Verify that previously-coated surfaces have dried at least eight hours at 70°F with ventilation prior to application of second coat.

8.5.2 Verify that the final coat has been applied to a dry film thickness of 17-23 mils. Perform dry film thickness test in accordance with SSPC-PA2. (Deduct primer thickness.)

8.6 Final Inspection of Coated Surfaces

8.6.1 Verify that all surfaces have a smooth and uniform appearance free of any irregularities.

8.6.2 Verify that the total dry film thickness (minimum two coats) is 35-45 mils. Perform dry film thickness test in accordance with SSPC-PA2.

8.6.3 Allow 48-hours cure at 70°F before holiday testing. Verify that a void-free, continuous film has been achieved by performing high-voltage holiday detection on 100% of the coated surfaces. The voltage shall be set at 3,500-volts. Mark all discovered holidays and re-test all repairs.

8.6.4 All repairs shall be made in strict accordance with this specification.

CCS TREATMENT PLANTS

SPECIFICATION NO. 7209A-RS17
FOR
EPOXY PAINTING

SEPTEMBER 8, 1989

REVISIONS

This specification has been revised as indicated below and the new pages added and/or the existing pages revised are attached as replacement for those previously issued.

REV.	DATE	BY	PAGE	REMARKS
0	9/7/89	FRF	All	Issued for Construction

1.0 Scope

1.1 This specification covers the procedures required for the surface preparation and coating of equipment that has been previously painted.

1.2 This specification also covers the procedures required for the surface preparation and painting of unpainted equipment. The work to be performed under this specification consists of painting all unpainted metal materials including vessels, supports, base plates, skids, pipelines, conduit runs, pipe and conduit supports, brackets, hanger rods, pipe clamps, "U" bolts and all other metal surfaces that are part of the system.

1.3 The Calgon Carbon Corporation equipment shall be painted with Sherwin Williams B58 Series (two part) Epoxy Mastic Coating System.

1.4 Unless otherwise specified, the contractor shall furnish all paints and solvents, necessary tools, scaffolds, ladders, compressed air, etc.

1.5 The contractor will familiarize himself with rules and regulations as set forth by the Safety Department.

2.0 Surface Preparation of Painted Surfaces

2.1 Previously coated surfaces that are in good condition.

Description - maintenance painting will frequently not permit or require complete removal of all old coatings prior to re-painting. However, all surface contamination such as oil, grease, loose paint, mill scale, dirt, foreign matter, rust, mold mildew, mortar, efflorsecence and sealers must be removed to assure sound bonding to the tightly adhering old paint. In addition, glossy surfaces of old paint films must be clean and dull before repainting. Thorough washing with an abrasive kitchen cleanser will clean and dull in one operation, or wash thoroughly and dull by sanding. Remove all sanding dust. It is recommended that water blasting be used (NACE standard RP-01-72) which removes foreign matter by water (with cleanser) at pressures of 2,000-5,000 psi at a flow of 4-14 gallons per minute. The contractor shall recognize that any surface preparation short of total removal of the old coatings may compromise the service length of the new coating system. The contractor shall always check for the compatibility of the previously painted surface with the new coating by applying a test patch of 2-3 square feet. Allow to dry thoroughly then check adhesion.

2.2 Previously coated surfaces that are not in good condition.

Description - The contractor will hand tool clean the surfaces to remove loose rust, loose mill scale and loose paint to the degree specified by SSPC-SP2-63. The contractor shall accomplish this by hand chipping, scrapping, sanding and wire brushing. Then the contractor shall further prepare the hand tool cleaned surface per paragraph 2.1 above.

3.0 Surface Preparation of Unpainted Surfaces

3.1 The metal surface shall be free of dirt, rust, rustproofing, drawing oils and compounds, finger prints, mill scale and other foreign substances both visible and invisible; thereby improving adhesion and reducing the tendency to blister and corrode on exposure.

3.2 The contractor shall use power tool cleaning to remove all loose rust and mill scale to the degree specified by SSPC-SP3-63 by power tool chipping, descaling, sanding, wire brushing and grinding.

4.0 Paint Application

4.1 The coating shall be applied by a method described in the attached Sherwin Williams specification for B58 series (two part W&X) epoxy mastic coating system. The system shall consist of at least one (1) coat of epoxy mastic, B58 series/B58V1 to a total DFT of 6 mils.

4.2 All paint shall be furnished in unopened containers.

4.3 Thinners shall be used only with the permission of Calgon Carbon Corporation.

4.4 Painting will not be allowed when the relative humidity is above 85% or the temperature is below 55°F without special permission from Calgon Carbon Corporation.

5.0 Areas not to be Painted

5.1 Galvanized steel and PVC pipe are not to be painted.

5.2 Inside of pipes shall not be painted.

5.3 Gage faces, name plates, fittings, etc. shall be taped to protect against overspray and tape shall be removed prior to shipping.

5.4 Insides of vessel shall be lined by others.

6.0 Material Specification

6.1 The paint used shall be Sherwin Williams B58 series (two part W&X) epoxy mastic coating system. The specifications are attached and shall be followed along with any recommendations and precautions stated on the paint can label.

6.2 The color shall be Sherwin Williams MC-71 slate gray.

EPOXY MASTIC COATING

B58 Series (Part W)
B58 Series (Part X)

PRODUCT DESCRIPTION:
Epoxy Mastic Coating is a high solids, polyamine/bisphenol A epoxy coating formulated to provide a high performance system over marginally prepared surfaces.

USES:
- As a primer under high-performance finishes for rusted/pitted steel when sandblasting is not possible.
- As a self-priming finish coat for marginally prepared substrates.
- Where chemical and moisture-resistance is required.

Performance Information:
- Chemical/moisture-resistant
- Compatible with old, intact paint films
- Outstanding adhesion over dry, marginally prepared surfaces

Physical Properties:
- Abrasion Resistance .... 67 mg
  (ASTM D4060 CS-17 wheel, 1,000 cycles, 1 kg Taber/Abraser)
- Direct Impact Resistance .... 64 in. lbs
  (ASTM G14)
- Dry Heat Resistance .... 200°F (Discolors)
  (ASTM D2485)
- Elcometer Adhesion .... 750 psi
  (ASTM D4541)
- Exterior Durability .... Excellent
  (with non-progressive chalk face developing in 3-6 months)
- Flexibility .... Passes
  (ASTM D1737, 180° bend 1" mandrel)
- Moisture Condensation Resistance .... Excellent
  (ASTM D2247, 100°F, 2500 hours)
- Pencil Hardness 7H
  (ASTM D3363)
- Salt Fog Resistance .... Excellent
  (ASTM B117, 2500 hours)
- Thermal Shock .... Passes
  (ASTM D1211, 100 cycles)
- Wet Heat Resistance .... 120°F (not immersion)

Resistance Guide: (Per ASTM D3912)
- Acid and Alkaline salt solutions: SEVERE
- Aliphatic hydrocarbon solvents: SEVERE
- Alkalies: SEVERE
- Aromatic hydrocarbon solvents: MODERATE
- Chlorinated solvents: MODERATE
- Fresh water & salt water: SEVERE
- Glycol ethers; alcohols, formaldehyde: SEVERE
- Inorganic acids: MODERATE
- Oils (cutting, vegetable, lubricating): SEVERE
- Organic acids: MODERATE
- Oxygenated solvents: MODERATE

CHARACTERISTICS:
- **Color/Finish:** Wide range of color possible/70 ± 10 units @ 60°F. Available in Pure White and Ultradeep Bases
- **Drying Schedule:** (temperature & humidity dependent) @ 77°F and 50% RH @ 7 mils wet:
  To Touch: 8 hours
  Tack Free: Overnight
  To Recoat: Minimum 16 hours, maximum 7 days (with vinyls and chlorinated rubber — 72 hours max.). If maximum recoat time is exceeded, brush blast before recoating.
  To Cure: 10 days
- **Flash Point (catalyzed):** 95°F (Pensky-Martens Closed Cup)
- **Pot Life:** 8 Hours @ 55°F
  2½ hours @ 77°F
  1 hour @ 95°F

product description CONTINUED

- **Recommended Spreading Rate:** 227 sq. ft./gal. @ 7 mils wet, 6.0 mils dry (theoretical, no loss)
- **Spreading Rate Coverage:** 1,363 sq. ft./gal. @ 1.0 mil dry (theoretical, no loss)
- **"Sweat-in" Time:** 15 minutes
- **Volume Solids (catalyzed):** 85% ± 2%
- **Limitations:** Do not apply to large expanses of sheet metal. Do not apply to any surface containing moisture. Moisture condensation on Epoxy Mastic Coating which is not thoroughly dry will adversely affect its cure.

PRECAUTIONS: See notes 2 and 3, page 70.

SURFACE PREPARATION: See pages 4 and 5

- Aluminum .... S-W 1
- Concrete Block .... S-W 3
- Galvanized Metal S-W10
- Masonry .... S-W 6D or A
- Steel .... S-W 14 (SSPC-SP2)
- Previously Painted Surfaces .... S-W 12

Recommended Systems:

- **Steel: Light/Moderate Service**
  1 coat Epoxy Mastic, B58 Series/B58 V 1 @ 6 mils DFT
  Total DFT, mils: 6
- **Steel: Severe Service**
  2 coats Epoxy Mastic, B58 Series/B58 V 1 @ 6 mils DFT/Coat
  Total DFT, mils: 12
- **Steel: Epoxy Topcoat**
  1 coat Epoxy Mastic, B58 Series/B58 V 1 @ 6 mils, DFT
  1 coat Heavy-Duty Epoxy, B67 Series/B60 V3 @ 6 mils DFT
  Total DFT, mils: 12
- **Steel: Epoxy Topcoat**
  1 coat Epoxy Mastic, B58 Series/B58 V 1 @ 6 mils DFT
  1 coat Tile Clad II Epoxy, B62 Series/B60 V 70 @ 4 mils DFT
  Total DFT, mils: 10
- **Steel: Vinyl Topcoat**
  1 coat Epoxy Mastic, B58 Series/B58 V 1 @ 6 mils DFT (max. recoat 72 hours)
  1 coat Hi-Bild Vinyl Finish, B64 W 101, @ 2 mils DFT
  Total DFT, mils: 8
- **Steel: Chlorinated Rubber Topcoat**
  1 coat Epoxy Mastic, B58 Series/B58 V 1 @ 6 mils DFT (max. recoat 72 hours)
  1 coat Hi-Bild Chlorinated Rubber, B63 Series, @ 3 mils DFT
  Total DFT, mils: 9
- **Steel: Polyurethane Topcoat**
  1 coat Epoxy Mastic, B58 Series/B58 V 1, @ 6 mils DFT
  1 coat Hi-Bild Aliphatic Polyurethane, B65 Series/B60 V 2, @ 3 mils DFT
  Total DFT, mils: 9
- **Aluminum/Galvanized Metal: Moderate Service**
  1 coat Epoxy Mastic, B58 Series/B58 V 1, @ 6 mils DFT
  Total DFT, mils: 6
- **Concrete Block**
  1 coat Heavy-Duty Block Filler, B42 W 46, @ 10 mils, DFT or
  1 coat Kem Cati Coat Epoxy Filler/Sealer, @ 10 mils DFT
  1 coat Epoxy Mastic, B58 Series/B58 V 1 @ 6 mils DFT
  Total DFT, mils: 16
- **Masonry**
  1 or 2 coats Epoxy Mastic, B58 Series/B58 V 1 @ 6 mils DFT/coat
  Total DFT, mils: 6-12

product description CONTINUED

APPLICATION:
To eliminate possible blocking of equipment during spraying, clean the equipment before use and before extended periods of down time with Methyl Ethyl Ketone following supplier's safety cautions. In the early stages of drying Epoxy Mastic is sensitive to rain, dew, high humidity, cool evening temperatures, and moisture condensation. Painting schedules should be planned to avoid these influences during the initial 16 hour drying period.

- **Application Conditions:**
- **Temperature** .... (air, surface, material) 55°F - 120°F (at least 5°F above the dew point)
- **Relative Humidity** .... 85% max
- **Methods** .... Brush, roll, conventional and airless spray

- **Airless Spray:**
  Unit .... 2,500 psi pressure
  Hose .... 3/8" I.D.
  Tip .... .021" minimum
  Filter .... 30 mesh
- **Brush/Roller** .... Use nylon, polyester or natural bristle brush, 1/2" lambswool or synthetic roller cover.
- **Conventional Spray:** Binks 62 SS Gun, 68 Fluid Nozzle, 68 PB Air Nozzle, 40 psi atomization pressure, 30 psi fluid pressure, or equivalent equipment.
  Note: Flush equipment with MEK every 3-4 hours to prevent material from "settling" in lines.
- **Mixing Instructions:** Thoroughly mix each separate component (W & X). Then combine equal parts (by volume) of Part W and Hardener Part X, thoroughly agitate. Allow mixture to "sweat-in" for 15 minutes. Complete mixing and proper induction time is essential for Epoxy Mastic Coating to dry.
- **Tinting:** Tint with Nuodex Chroma Chem 844 PM Colorants into Part W only, 150% tint strength. Fifteen-minutes mixing on a mechanical shaker is required for complete mixing of color.
- **Tint Levels:** Pure White, 0-6 oz.; UltraDeep Base, 12-18 oz. For Midtone Base colors, first intermix (by volume) three parts Pure White with one part UltraDeep Base (tint 6-12 oz.). For Deeptone Base colors, first intermix (by volume) equal parts Pure White and UltraDeep Base (tint 12-18 oz.).
- **Reducer:**
  Below 65°F .... Xylene (R2K4)
  Above 65°F R7K58
- **Reduction:***
  Airless Spray .... None
  Brush Roller: Up to 10% per gallon catalyzed material after induction.
  Conventional Spray: Up to 15% per gallon catalyzed material after induction.
- **Reduction Recommendations:** See Note 4, page 70.
  *NOTE: Excess reduction will affect film build, appearance, and may cause lifting of old paint films.
- **Clean-up** ...... Use Methyl Ethyl Ketone following supplier's safety cautions.

UIA NOT AVAILABLE PRESENTLY, IT WILL BE FORWARD LATER.

CALGON CARBON CORPORATION
PITTSBURGH, PA

SPECIFICATION NO. 7209A-VS13

FOR

SHIPPING OF STANDARD LIQUID-PHASE SYSTEMS

ISSUED
JANUARY 15, 1993

* * REVISIONS * *

This specification has been revised as indicated below. The new pages added and/or the existing pages revised are attached as replacements for those previously issued.

Revision	Date	By	Page	Remarks
A	1/15/93	JMcM	All	Issued for Comment
B	5/19/93	JPM	All	Issued for Comment
C	9/01/93	JPM	2-3	Issued for Comment
D	10/12/93	JPM	3	Issued for Comment

1.0 INTRODUCTION

1.1 The following Calgon Carbon Corporation shipping, handling, and installation specification is designed to protect the surface finish of the adsorber vessels, pipe racks, and piping comprising a complete adsorption system. Proper handling and installation procedures are required to ensure against damage to the surface finish of new equipment.

1.2 The shipping, handling, and installation instructions and procedures outlined in this specification are only recommendations and do not relieve any party from full responsibility for proper inspection, handling, shipping preparation, shipping, or installation of the equipment. Also, the purchaser should be aware that failure to take the precautions outlined in this specification may invalidate the equipment warranty.

2.0 GENERAL HANDLING INSTRUCTIONS

2.1 Calgon Carbon Corporation liquid-phase equipment is designed with specific locations for lifting and will withstand normal handling procedures. The proper lifting locations, shown on the equipment drawings, are generally located on the vessel head. Review of these drawings is required before handling the equipment.

2.2 Normal precautions to follow to prevent equipment damage are as follows:

2.2.1 Operators of hoist equipment must follow proper rigging procedures at all times.

2.2.2 Always lift - **NEVER** roll or slide equipment.

2.2.3 When moving equipment, do not drop or allow hard impact. Do not allow cables, hooks, or spanner bars to swing against the vessel.

2.2.4 Never allow tools to strike or drop on equipment (especially inside or outside of vessels).

2.0 GENERAL HANDLING INSTRUCTIONS (continued)

2.2.5 All ladders used inside vessels should have ends protected. They should be wood construction; if not, ladders must have rubber protectors to prevent damaging the lining.

2.2.6 Workmen entering a lined vessel must wear soft-soled shoes, free of grit.

2.2.7 Always make lifting attachments to the lifting lugs when using chains or cables. Never lift from the nozzles.

2.2.8 Never lift a vessel or pipe rack by using any fitting or appurtenance other than the lift lugs. When lift lugs are not provided as part of the equipment, nylon web rigging slings must be used by attachment directly to the corners of the structural frame. It is recommended that the nylon web be protected with rubber pads or sheets to prevent cutting or tearing across the corners.

3.0 PREPARATION FOR SHIPMENT

3.1 Calgon Carbon Corporation and their representatives are to take every precaution possible when preparing equipment for shipment. Normally, a flat-bed truck will be used to transport the vessels, pipe rack and piping to the customer. Any hold-down location where a chain or strap contacts a painted surface must be protected with rubber sheeting, carpeting or other similar material.

3.2 Vessel loading will be the responsibility of the shop or customer. Fastening to the truck will be the responsibility of the truck driver. Painted surfaces must be protected from damage.

3.3 The pipe rack loading is the responsibility of the shop or customer. The truck driver is to secure the rack to the truck bed. Points of contact are to be padded to protect the equipment.

3.0 PREPARATION FOR SHIPMENT (continued)

3.4 All loose piping is to be loaded in such a manner as to avoid damage to painted surfaces. No chains are to be in direct contact with piping. Padding is to be used. Loading of loose piping will be the responsibility of the shop or customer. The truck driver is to secure the piping to the truck bed.

4.0 SHIPPING REQUIREMENTS

4.1 Vessels shall be shipped one (1) per truck unless otherwise specified by Calgon Carbon Corporation.

4.2 Once the vessels, pipe racks or loose piping are loaded onto a truck, they shall not be unloaded again until they reach their final destination.

4.3 No vessels, pipe racks or loose piping shall be shipped without a complete bill of lading which itemizes items. Also, no shipment shall be made without the completed packing list for crated parts which has been initialed by the person who packed and the person doing the checking.

5.0 INSPECTION UPON RECEIPT

5.1 The purchaser should arrange for an inspector or a responsible person at the jobsite to inspect and also supervise the off-loading of the vessel.

5.2 If damage has occurred during transit, it must be noted on the delivery receipt prior to signing acceptance. If damage has occurred, a claim should be filed promptly with the delivery carrier. Do not unpackage equipment until a freight claims examiner has made an inspection.

5.3 If no claim is filed, the purchaser accepts all further responsibility for damaged equipment.

5.4 If damage has occurred and is not first repaired by Calgon Carbon Corporation prior to the equipment being put into service, the purchaser accepts all future responsibility for the effects of equipment failure resulting from such damage.

6.0 RECOMMENDED INSPECTION PROCEDURES

6.1 The following should be used as a guideline in making an inspection of the equipment prior to unloading.

6.2 The adsorber vessel exterior should be visually examined for damage. Any sign of impacting may result in cracked or flaking of the vessel interior lining. If this damage has occurred, it is required that the manway be opened and the interior lining be visually inspected.

6.3 Check the equipment for any signs of breakage, abrasion, shifting or rotation that may have resulted in damage to the paint on vessels, pipe rack, or loose piping.

7.0 UNLOADING

7.1 Calgon Carbon Corporation specifically does not assume responsibility for the unloading of vessels, pipe racks or piping from commercial trucks. Shipment will be considered complete when the equipment arrives at the jobsite and prior to removal of the equipment from the truck by the purchaser. The presence of Calgon Carbon Corporation representative(s) at the delivery or installation site does not relieve the purchaser of any of his responsibility for proper handling procedures.

7.2 All instructions shown in Section 2.1 (Unloading/ Foundations) in the Calgon Carbon Corporation Operation and Maintenance Manual shall be followed.

8.0 RECOMMENDED UNLOADING PROCEDURES

8.1 Vessel and pipe rack unloading shall be accomplished in such a manner as to avoid damage to finished surfaces. Adequate padding may be necessary around the lifting point.

8.2 The use of chains, slings, or a spreader bar are required for hoisting vessels and the pipe rack. The angle between the lifting point and the top of the equipment must always be 60° or greater. Workmen should keep control over the vessel with guidelines.

9.0 INSTALLATION

9.1 All instructions shown in Section 2.2 (Installation) in the Calgon Carbon Corporation Operation and Maintenance Manual shall be followed.

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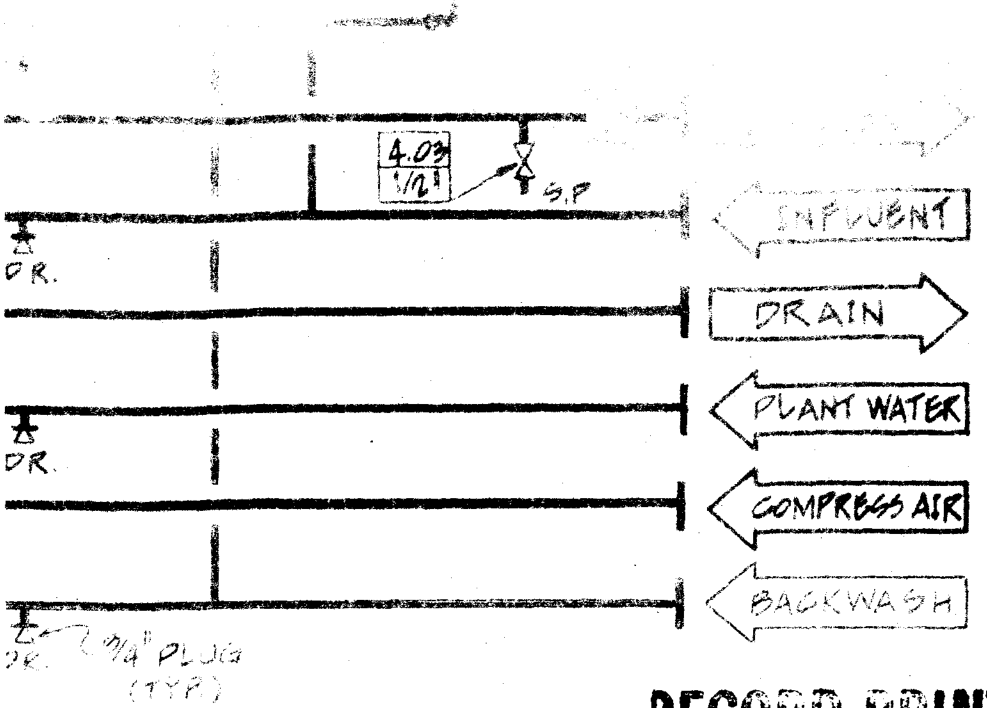

RECORD PRINT

ISSUED
FEB 14 1994
CALGON CARBON CORPORATION

NO.	REVISION	BY	DATE	FILM

McLAREN HART
SANBORN, N.Y.

PLANT

TITLE
MODEL 7.5
BACKWASHABLE
75 P.S.I.G.

ON
ORPORATION
SBURGH, PA. 15230-0717

DRAWN	CHECKED	APPROVED	SCALE
E.J. McMANUS			~
PROJEC MCLH 2LS	DRAWING NO. 91-94-2780		REV. 0

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Air Compressor

E-601

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Price $ 5.00

GARDNER DENVER®

1-1-541
5th Edition
January, 1994

AIR COOLED
RECIPROCATING AIR COMPRESSORS
BARE & PACKAGED

MODELS

APJ_ _E, APK_ _E

ASJ_ _E, ASK_ _E

4.75 & 2.5 x 4

PARTS LIST
OPERATING AND
SERVICE MANUAL

Gardner Denver

Gardner Denver

WARRANTY
RECIPROCATING COMPRESSORS
GARDNER DENVER® • JOY®

GENERAL PROVISIONS AND LIMITATIONS

Gardner Denver Machinery Inc. (the "Company") warrants to each original retail purchaser ("Purchaser") of its new products from the Company or its authorized distributor that such products are, at the time of delivery to the Purchaser, made with good material and workmanship. No warranty is made with respect to:

1. Any product which has been repaired or altered in such a way, in the Company's judgment, as to affect the product adversely.
2. Any product which has, in the Company's judgment, been subject to negligence, accident, improper storage, or improper installation or application.
3. Any product which has not been operated or maintained in accordance with the recommendations of the Company.
4. Components or accessories manufactured, warranted and serviced by others.
5. Any reconditioned or prior owned product.

Claims for items described in (4) above should be submitted directly to the manufacturer.

WARRANTY PERIOD

The Company's obligation under this warranty is limited to repairing or, at its option, replacing, during normal business hours at an authorized service facility of the Company, any part which in its judgment proved not to be as warranted within the applicable Warranty Period as follows.

1. The power end is warranted for 24 months from date of start up, or 27 months from date of shipment to the Purchaser, whichever occurs first.
2. Expendable parts such as, but not limited to: rings, valves, packing and filters for air application only are warranted for 12 months from date of start up or 15 months from date of shipment to the Purchaser, whichever occurs first.
3. All other components are warranted for 12 months from date of start up or 15 months from date of shipment to the Purchaser, whichever occurs first.

Note: Deterioration or wear occasioned by chemical and/or abrasive action or excessive heat shall not constitute manufacturing defects.

LABOR TRANSPORTATION AND INSPECTION

The Company will provide labor, by Company representative or authorized service personnel, for repair or replacement of any product or part thereof which in the Company's judgment is proved not to be as warranted. Labor shall be limited to the amount specified in the Company's labor rate schedule.

Labor costs in excess of the Company rate schedules caused by, but not limited to, location or inaccessibility of the equipment, or labor provided by unauthorized service personnel is not provided by this warranty.

All costs of transportation of product or parts claimed not to be as warranted and, of repaired or replacement parts to or from such service facility shall be borne by the Purchaser. The Company may require the return of any part claimed not to be as warranted to one of its facilities as designated by Company, transportation prepaid by Purchaser, to establish a claim under this warranty.

Replacement parts provided under the terms of this warranty are warranted for the remainder of the Warranty Period of the product upon which installed to the same extent as if such parts were original components.

WARRANTY REGISTRATION VALIDATION

A warranty registration form is provided with each machine. The form must be completed by the Purchaser and mailed within ten days after machine start-up to validate the warranty.

DISCLAIMER

THE FOREGOING WARRANTY IS EXCLUSIVE AND IT IS EXPRESSLY AGREED THAT, EXCEPT AS TO TITLE, THE COMPANY MAKES NO OTHER WARRANTIES, EXPRESSED, IMPLIED OR STATUTORY, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY.

THE REMEDY PROVIDED UNDER THIS WARRANTY SHALL BE THE SOLE, EXCLUSIVE AND ONLY REMEDY AVAILABLE TO THE PURCHASER AND IN NO CASE SHALL THE COMPANY BE SUBJECT TO ANY OTHER OBLIGATIONS OR LIABILITIES. UNDER NO CIRCUMSTANCES SHALL THE COMPANY BE LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES, EXPENSES, LOSSES OR DELAYS HOWSOEVER CAUSED.

No statement, representation, agreement or understanding, oral or written, made by any agent, distributor, representative, or employee of the Company which is not contained in this Warranty will be binding upon the Company unless made in writing and executed by an officer of the Company.

This warranty shall not be effective as to any claim which is not presented within 30 days after the date upon which the product is claimed not to have been as warranted. Any action for breach of this warranty must be commenced within one year after the date upon which the cause of action occurred.

Any adjustment made pursuant to this warranty shall not be construed as an admission by the Company that any product was not as warranted.

MAINTAIN COMPRESSOR RELIABILITY AND PERFORMANCE WITH GENUINE GARDNER DENVER AND JOY COMPRESSOR PARTS AND SUPPORT SERVICES

Gardner Denver and Joy Compressor genuine parts, engineered to original tolerances, are designed for optimum dependability — specifically for Gardner Denver and Joy compressor systems. Design and material innovations are the result of years of experience with hundreds of different compressor applications. Reliability in materials and quality assurance are incorporated in our genuine replacement parts.

Your authorized Gardner Denver and Joy Compressor distributor offers all the backup you'll need. A worldwide network of authorized distributors provides the finest product support in the air compressor industry.

Your local authorized distributor maintains a large inventory of genuine parts and he is backed up for emergency parts by direct access to the Gardner Denver Machinery Inc. Master Distribution Center (MDC) in Memphis, Tennessee.

Your authorized distributor can support your Gardner Denver or Joy air compressor with these services:

1. Trained parts specialists to assist you in selecting the correct replacement parts.
2. A full line of factory tested AEON™ compressor lubricants specifically formulated for use in Gardner Denver and Joy compressors.
3. Repair and maintenance kits designed with the necessary parts to simplify servicing your compressor.

Authorized distributor service technicians are factory-trained and skilled in compressor maintenance and repair. They are ready to respond and assist you by providing fast, expert maintenance and repair services.

For the location of your local authorized Gardner Denver and Joy Air Compressor distributor refer to the yellow pages of your phone directory or contact:

Distribution Center:
Gardner Denver Machinery Inc.
Master Distribution Center
5585 East Shelby Drive
Memphis, TN 38141
Phone: (901) 363-6100
Fax: (901) 363-1095

Factory:
Gardner Denver Machinery Inc.
1800 Gardner Expressway
Quincy, IL 62301
Phone: (217) 222-5400
Fax: (217) 223-5897

INSTRUCTIONS FOR ORDERING REPAIR PARTS

When ordering parts, specify Compressor **MODEL**, Method of Cooling, **HORSEPOWER** and **SERIAL NUMBER** (see nameplate on unit). Serial Number is also stamped on top of the cylinder flange to the right of the inlet housing.

All orders for Parts should be placed with the nearest authorized distributor.

Where NOT specified, quantity of parts required per compressor or unit is one (1); where more than one is required per unit, quantity is indicated in parenthesis. **SPECIFY EXACTLY THE NUMBER OF PARTS REQUIRED.**

DO NOT ORDER BY SETS OR GROUPS.

To determine the Right Hand and Left Hand side of a compressor, stand at the motor end and look toward the compressor. Right Hand and Left Hand are indicated in parenthesis following part name, i.e. (RH) & (LH).

MODELS APJ, APK, ASJ & ASK
7.5 & 10 HP VERTICAL AIR-COOLED COMPRESSORS
MATRIX/MENU

NOTICE TO CUSTOMER - To find the construction options for your compressor unit, FILL IN THE BALANCE OF LETTERS OR NUMBERS FROM YOUR COMPRESSOR NAMEPLATE

	A					E						
COLUMN NUMBER:	1	2	3	4	5	6	7	8	9	10	11	12

Follow the line down and over from each space thus filled in to find the appropriate construction option with which your machine is equipped. The number "9" in any column space indicates "NOT APPLICABLE". The number "8" in any column space indicates SPECIAL DESIGN - REFER TO FACTORY ORDER TICKET.

COLUMN 1 - COMPRESSOR MODEL
- A. AIR COOLED

COLUMN 2 - LUBRICATION & CRANKCASE
- S. SPLASH LUBE - CAST IRON CRANKCASE
- P. PRESSURE LUBE - CAST IRON CRANKCASE

COLUMN 3 - HORSEPOWER
- J. 7 1/2 HP PACKAGE ONLY
- K. 10 HP BARE OR PACKAGE

COLUMN 4 - CONSTRUCTION
- A. BARE TWO STAGE COMPR W/SUV
- D. BARE SINGLE STAGE COMPR W/SUV
- Q. PACKAGE-BASE MTD
- R. PACKAGE-TANK MTD

COLUMN 5 - **BARE UNITS** - SHEAVE
- A. COUNTER/CLOCKWISE ROTATION (18.1 P.D - 2 GROOVE, "A" SECTION)

COLUMN 5 - **PACKAGE UNITS** - PRESSURE
- K. 125 PSIG
- M. 175 PSIG
- P. 250 PSIG

COLUMN 6 - DESIGN VERSION
- E. FIFTH

COLUMN 7 - PACKAGE DRIVER
- A. MOTOR - ODP, STD DUTY, STD EFF., 1.15 S.F.
- B. MOTOR - ODP, STD DUTY, HIGH EFF., 1.15 S.F.
- C. MOTOR - TEFC, STD DUTY, STD EFF., 1.15 S.F.
- D. MOTOR - TEFC, STD DUTY, HIGH EFF., 1.15 S.F.

COLUMN 8 - PACKAGE DRIVER VOLTAGE & STARTER VOLTAGE
- B. 3 PHASE, 60 HZ, 200 VOLT
- C. 3 PHASE, 60 HZ, 230 VOLT
- D. 3 PHASE, 60 HZ, 460 VOLT
- E. 3 PHASE, 60 HZ, 575 VOLT
- F. 3 PHASE, 60 HZ, 230/460 VOLT MOTOR, 120 VOLT CONTROL, NO STARTER
- G. 3 PHASE, 50 HZ, 380 VOLT

COLUMN 9 - PACKAGE CONTROL
- E. DUAL TYPE - MOTOR VOLTAGE - NEMA 1
- F. DUAL TYPE - LOW OIL LEVEL SWITCH - MOTOR VOLTAGE - (460V MAX) - NEMA 1
- G. DUAL TYPE - STARTER - MOTOR VOLTAGE - NEMA 1
- H. DUAL TYPE - LOW OIL LEVEL SWITCH - STARTER - MOTOR VOLTAGE (460V MAX) - NEMA 1
- J. DUAL TYPE - 120 VOLT - NEMA 1
- K. DUAL TYPE - LOW OIL LEVEL SWITCH - 120 V - NEMA 1
- P. DUAL TYPE - MOTOR VOLTAGE - NEMA 4
- Q. DUAL TYPE - LOW OIL LEVEL SWITCH - MOTOR VOLTAGE - (460V MAX) - NEMA 4
- R. DUAL TYPE - STARTER - MOTOR VOLTAGE - NEMA 4
- S. DUAL TYPE - LOW OIL LEVEL SWITCH - STARTER - MOTOR VOLTAGE (460V MAX) - NEMA 4
- T. DUAL TYPE - 120 VOLT - NEMA 4
- U. DUAL TYPE - LOW OIL LEVEL SWITCH - 120 V - NEMA 4
- V. DUAL TYPE - STARTER W/120 VOLT TRANSFORMER - NEMA 4
- W. DUAL TYPE - LOW OIL LEVEL SWITCH - STARTER W/120 VOLT TRANSFORMER - NEMA 4

COLUMN 10 - PACKAGE AFTERCOOLER
- A. STANDARD DISCHARGE PIPING ONLY.
- B. AIR COOLED AFTERCOOLER & REC. CON. DRAIN VALVE (175 PSIG MAX.)
- C. AIR COOLED AFTERCOOLER ONLY (175 PSIG MAX.)
- D. REC. CON. DRAIN VALVE ONLY & STANDARD DISCHARGE PIPING

COLUMN 11 - PACKAGE RECEIVER SIZE
- G. 80 GALLON HORIZONTAL RECEIVER
- H. 80 GALLON VERTICAL RECEIVER (175 PSIG MAX.)
- J. 120 GALLON HORIZONTAL RECEIVER (175 PSIG MAX.)
- 9. SKIPPED - USE THIS FOR BASE MOUNTED UNITS

COLUMN 12 - PACKAGE SUCTION AIR FILTER
- A. DRY TYPE - HOODED FILTER SILENCER

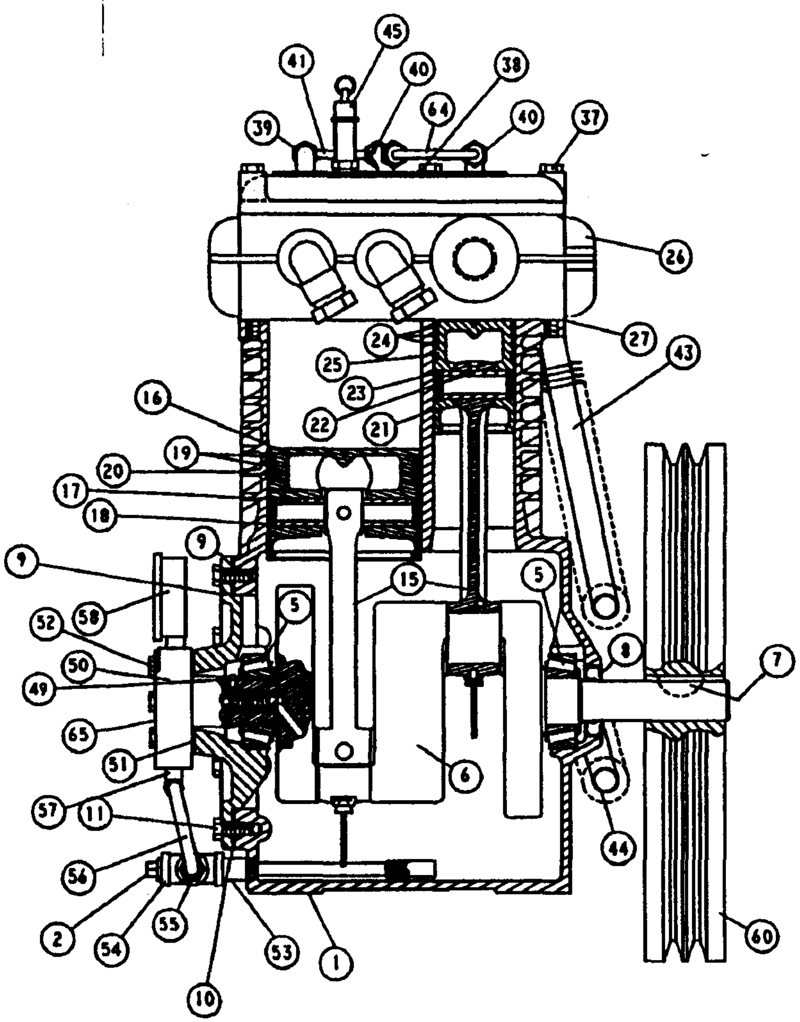
INDEX

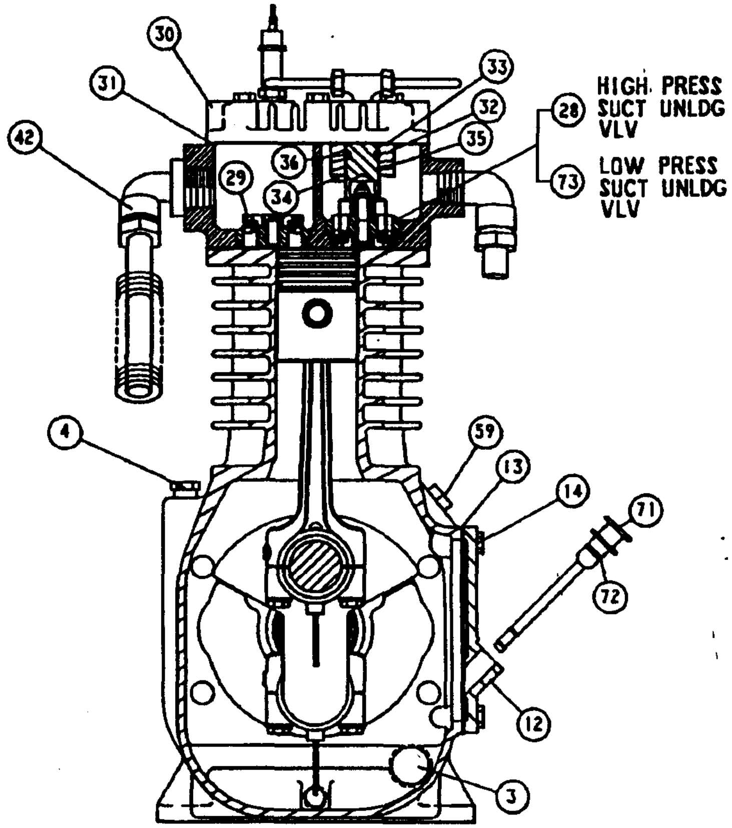
Order by Part Number and Description. Reference Numbers for your convenience only.

Ref. No.	Name of Part	Qty.	Model APKA/APKD
	COMPRESSOR		Part No.
1	CRANKCASE/CYLINDER	1	205ATS013
2	PLUG-SQHD	1	64AA4
3	PLUG	1	64B4
4	ASM PLUG-BTHR	1	200ASL034
5	BEARING-ROLLER	2	12C5
6	CRANKSHAFT	1	200ATP004
7	KEY-WOODRUFF	1	35D21
8	SEAL-OIL	1	60G47
9	HOUSING-BEARING	1	200ATP006
10	SHIM SET-CUP	1	77B18
11	SCREW-HEX CAP	6	75A130
12	PLATE-INSPECTION	1	201ASL052
13	GASKET-INSP PLATE	1	204ATS715
14	SCREW-HEX CAP	4	75A33
15	ROD-CONNECTING	2	200ATP003
+	SHIM	4	77A289
+	WASHER-PLAIN	4	95U3
+	SCREW, Connecting Rod	4	655ED070
16	PISTON-AIR, LP	1	200ATS015
17	PIN-PISTON, LP	1	200ATS505
18	RING-RETAINING	2	74D45
19	RING-PISTON	2	65V13
20	ASM PISTON RING	1	65AM352
21	PISTON-AIR, HP	1	201ATS015
22	PIN-PISTON, HP	1	201ATS505
23	RING-RETAINING	2	74D45
24	RING-PISTON	3	65V12
25	ASM PISTON RING	1	65AM351
26	HEAD-CYLINDER (APKA)	1	202ATS007
26	HEAD-CYLINDER (APKD)	1	203ATS007
27	GASKET	1	202ASK715
28	ASM SUCT UNLDG VLV (HP)	1	202ASK2029
29	ASM DISCHARGE VALVE	3	201ASK2031
30	COVER-CYLINDER HEAD ...	1	200ATS225
31	GASKET-COVER/HEAD	1	203ASK715

Ref. No.	Name of Part	Qty.	Model APKA/APKD
	COMPRESSOR		Part No.
32	COVER-SUV	3	200ATS185
33	GASKET-SUV CYLINDER	3	204ASK715
34	SCREW-HEX CAP	6	75A98
35	PLUNGER-UNLOADER	3	201ATS184
36	O-RING	3	25BC100
37	SCREW-HEX CAP	8	655ED220
38	SCREW-HEX CAP	2	655ED070
39	ELBOW-TUBE	1	86A40
40	TEE-TUBE	2	86A41
41	TUBE-UNLOADER	1	204ATS857
* 42	ELBOW-TUBE	4	86E73
* 43	TUBE-INTERCOOLER FIN ...	1	200ATS242
* 44	TUBE-INTERCOOLER FIN ...	1	201ATS242
** 45	VALVE-RELIEF	1	90AR731
49	PIN-SPRING ROLL	1	62R3
50	PUMP-OIL, Nonreversing	1	201AVS188
+	COVER	1	2116421
+	PUMP	1	2010242
+	PLUNGER	1	2010244
+	SPRING	1	2010245
51	SHIM SET	1	208ASL732
52	SCREW-HEX CAP	6	655EC060
53	SCREEN-OIL	1	200ADD019
54	TEE-PIPE	1	64G5
55	CONNECTOR-TUBE	1	86M7
56	TUBE	1	2012913
57	ELBOW-TUBE	1	86A53
58	GAUGE-PRESSURE	1	27P227
59	PLUG-SQHD PIPE	1	64AA7
60	SHEAVE	1	2013696
+ 63	TAG-INSTRUCTION	1	200ATS304
64	TUBE-UNLOADER	1	205ATS857
65	DECAL (Oil Pump Rotation).	1	200AVS077
71	ROD-OIL LEVEL	1	201ASK491
72	O-RING	1	25AM18
73	ASM SUCT UNLDG VLV (LP)	2	201ASK2029

+ Not shown on illustration.
* Not used on APKD Single Stage Compressor
** APKD uses (1) 64AA5 PLUG-SQHD PIPE





221ASK810
(Ref. Drawing)

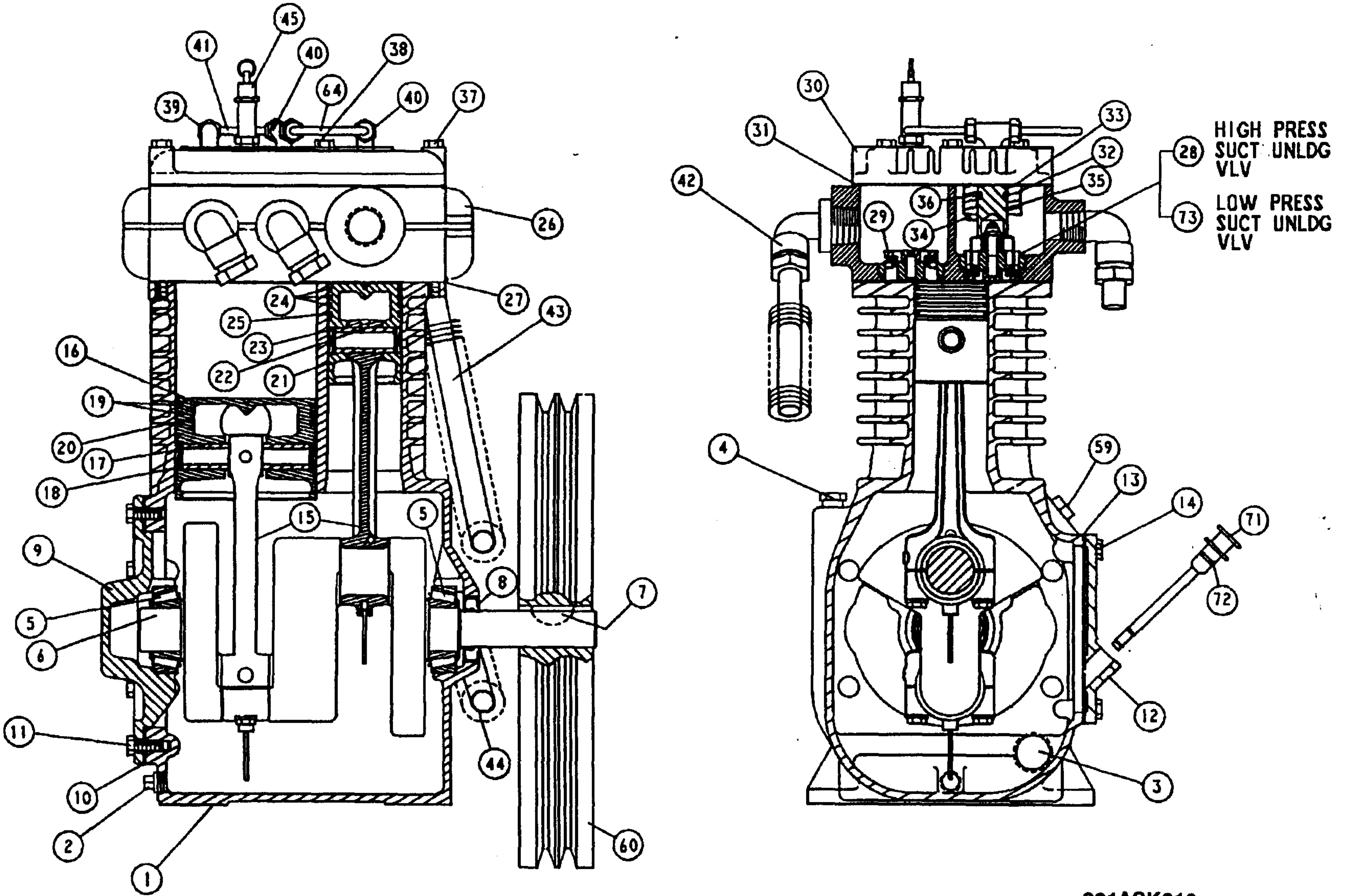
FOR LIST OF PARTS SEE PAGE 5.

Order by Part Number and Description. Reference Numbers for your convenience only.

Ref. No.	Name of Part	Qty.	Model ASKA/ASKD
	COMPRESSOR		**Part No.**
1	CRANKCASE/CYLINDER	1	205ATS013
2	PLUG-SQHD	1	64AA4
3	PLUG	1	64B4
4	ASM PLUG-BTHR	1	200ASL034
5	BEARING-ROLLER	2	12C5
6	CRANKSHAFT	1	200ATS004
7	KEY-WOODRUFF	1	35D21
8	SEAL-OIL	1	60G47
9	HOUSING-BEARING	1	200ATS006
10	SHIM SET-CUP	1	77B18
11	SCREW-HEX CAP	6	75A130
12	PLATE-INSPECTION	1	201ASL052
13	GASKET-INSP PLATE	1	204ATS715
14	SCREW-HEX CAP	4	75A33
15	ROD-CONNECTING	2	200ATS003
+	SHIM	4	77A289
+	WASHER-PLAIN	4	95U3
+	SCREW, Connecting Rod	4	655ED070
+	PIN-SPLASH	2	AUX150
16	PISTON-AIR, LP	1	200ATS015
17	PIN-PISTON, LP	1	200ATS505
18	RING-RETAINING	2	74D45
19	RING-PISTON	2	65V13
20	ASM PISTON RING	1	65AM352
21	PISTON-AIR, HP	1	201ATS015
22	PIN-PISTON, HP	1	201ATS505
23	RING-RETAINING	2	74D45
24	RING-PISTON	3	65V12
25	ASM PISTON RING	1	65AM351

Ref. No.	Name of Part	Qty.	Model ASKA/ASKD
	COMPRESSOR		**Part No.**
26	HEAD-CYLINDER (ASKA)	1	202ATS007
26	HEAD-CYLINDER (ASKD)	1	203ATS007
27	GASKET	1	202ASK715
28	ASM SUCT UNLDG VLV (HP)	1	202ASK2029
29	ASM DISCHARGE VALVE	3	201ASK2031
30	COVER-CYLINDER HEAD	1	200ATS225
31	GASKET-COVER/HEAD	1	203ASK715
32	COVER-SUV	3	200ATS185
33	GASKET-SUV CYLINDER	3	204ASK715
34	SCREW-HEX CAP	6	75A98
35	PLUNGER-UNLOADER	3	201ATS184
36	O-RING	3	25BC100
37	SCREW-HEX CAP	8	655ED220
38	SCREW-HEX CAP	2	655ED070
39	ELBOW-TUBE	1	86A40
40	TEE-TUBE	2	86A41
41	TUBE-UNLOADER	1	204ATS857
* 42	ELBOW-TUBE	4	86E73
* 43	TUBE-INTERCOOLER FIN	1	200ATS242
* 44	TUBE-INTERCOOLER FIN	1	201ATS242
** 45	VALVE-RELIEF	1	90AR731
59	PLUG-SQHD PIPE	1	64AA7
60	SHEAVE	1	2013696
+ 63	TAG-INSTRUCTION	1	200ATS304
64	TUBE-UNLOADER	1	205ATS857
71	ROD-OIL LEVEL	1	201ASK491
72	O-RING	1	25AM18
73	ASM SUCT UNLDG VLV (LP)	2	201ASK2029

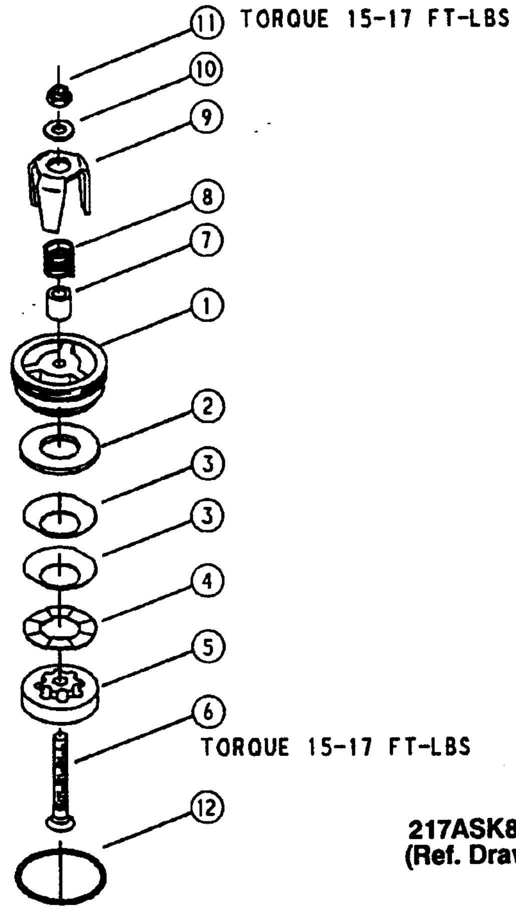
+ Not shown on illustration.
* Not used on ASKD Single Stage Compressor
** ASKD uses (1) 64AA5 PLUG-SQHD PIPE



221ASK810
(Ref. Drawing)

FOR LIST OF PARTS SEE PAGE 7.

Order by Part Number and Description. Reference Numbers for your convenience only.



217ASK810-A
(Ref. Drawing)

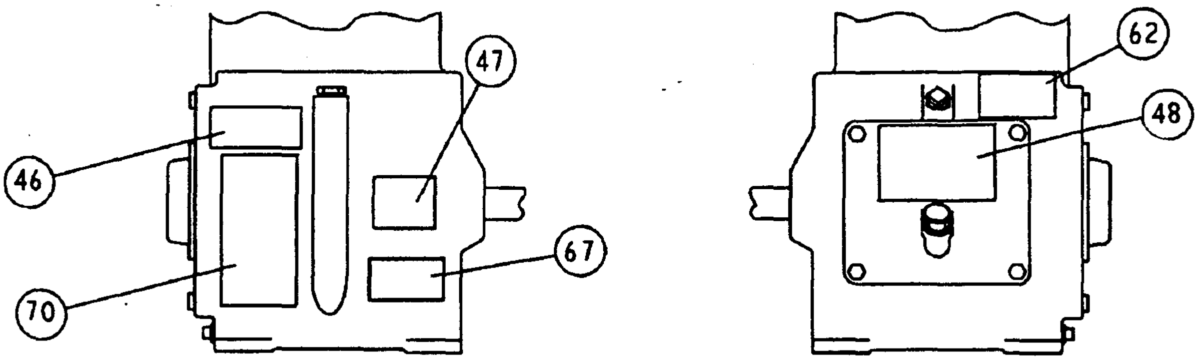
SUCTION UNLOADING VALVE ASSEMBLY (Low Pressure)

Ref. No.	Name of Part	Qty. Req. Per Unit	Part No.
*	SUCTION UNLOADING VALVE ASSEMBLY (LP)	2	201ASK2029
1	SEAT-SUCT/VALVE	2	201ATS202
2	DISC-VALVE	2	90V52
3	SPRING	4	200ASK518
4	PLATE-REACTION	2	200ASK952
5	BUMPER-VALVE	2	201ASK128
6	SCREW-FLAT SOC HD	2	75LM198
7	SPACER	2	201ASK144
8	SPRING	2	78W46
9	FINGER-UNLOADER	2	200ASK183
10	WASHER-PLAIN	2	95F2
11	LOCKNUT LIGHT HEX	2	50AH2
12	GASKET-RING	2	25L22

* Includes Ref. Numbers 1 Thru 12.

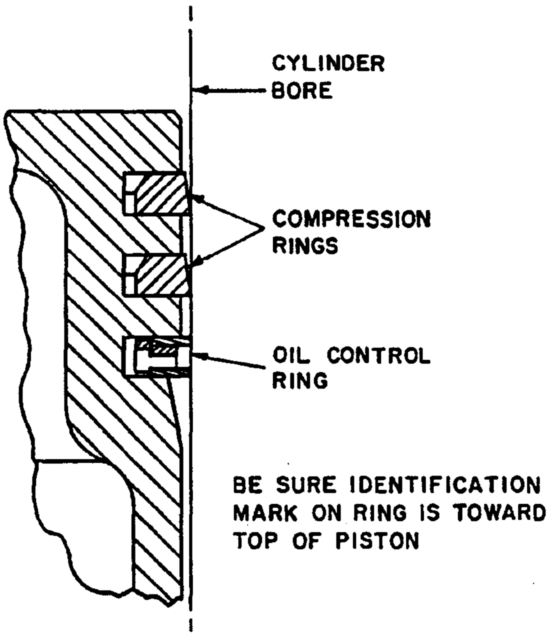
NOTE: Assemble Spring Ref. # 3 with O.D. Flats Contacting Disk Ref. # 2.

DECAL LOCATIONS

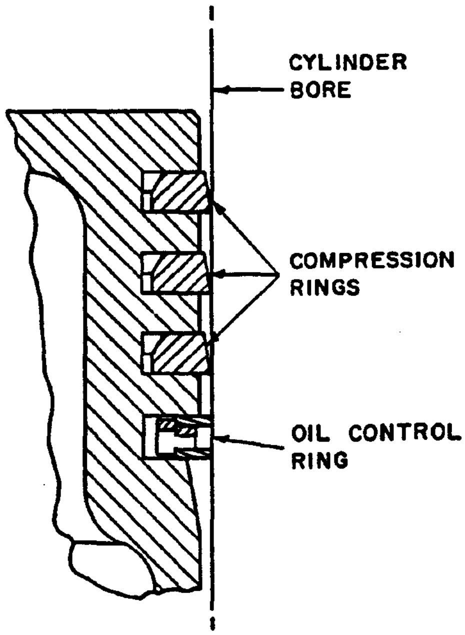


221ASK810
(Ref. Drawing)

Ref. No.	Name of Part	Qty. Req. Per Unit	All Models
46	DECAL (DO NOT BREATHE AIR)	1	211SPH077
47	DECAL (VALVE INSTALLATION)	1	200ASA077
48	PLATE-NAME	1	201ASL496
62	DECAL (LUBRICATION)	1	200MBV077
67	NAMEPLATE (QUALITY WITHOUT QUESTION)	1	242EAQ077
70	DECAL (WARNING-ROTATING EQUIPMENT)	1	200ASL077

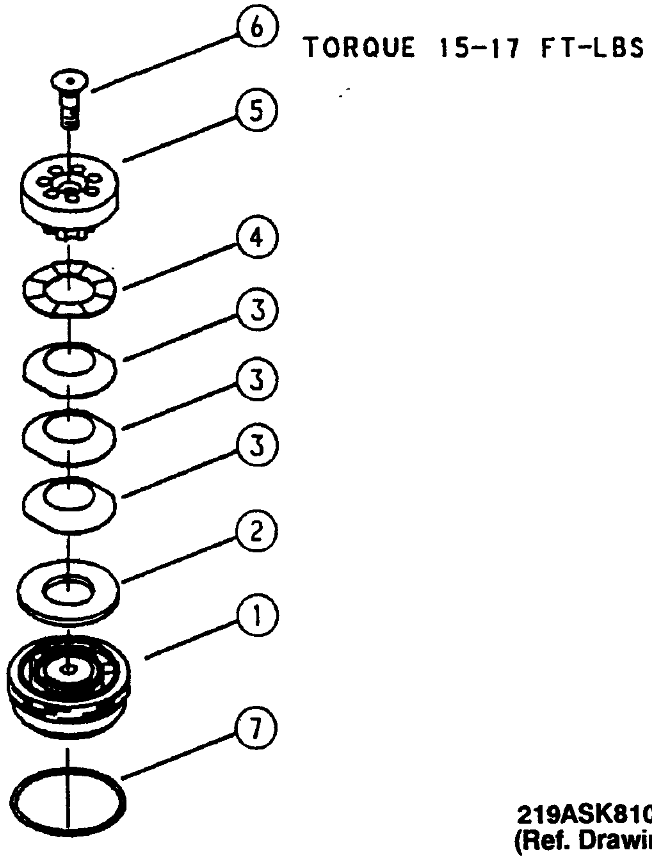


LP PISTON RINGS



HP PISTON RINGS

Order by Part Number and Description. Reference Numbers for your convenience only.



219ASK810-A
(Ref. Drawing)

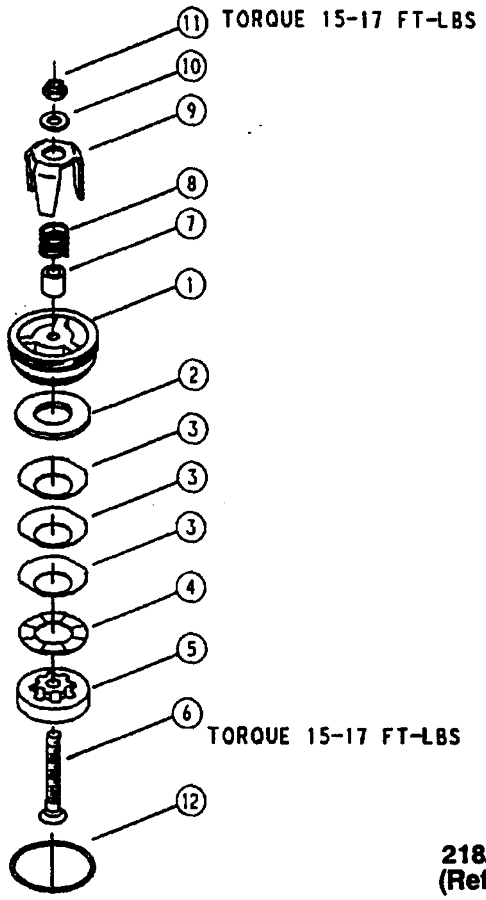
DISCHARGE VALVE ASSEMBLY

Ref. No.	Name of Part	Qty. Req. Per Unit	Part No.
*	DISCHARGE VALVE ASSEMBLY	3	201ASK2031
1	SEAT-DISCH/VALVE	3	201ATS203
2	DISC-VALVE	3	90V52
3	SPRING	9	200ASK518
4	PLATE-REACTION	3	200ASK952
5	BUMPER-VALVE	3	201ASK128
6	SCREW-FLAT SOC HD	3	75LM197
7	GASKET RING	3	25L22

* Includes Reference Numbers 1 Thru 7.

NOTE: Assemble Spring Ref. # 3 with O.D. Flats Contacting Disk Ref. # 2.

Order by Part Number and Description. Reference Numbers for your convenience only.



218ASK810-A
(Ref. Drawing)

SUCTION UNLOADING VALVE ASSEMBLY (High Pressure)

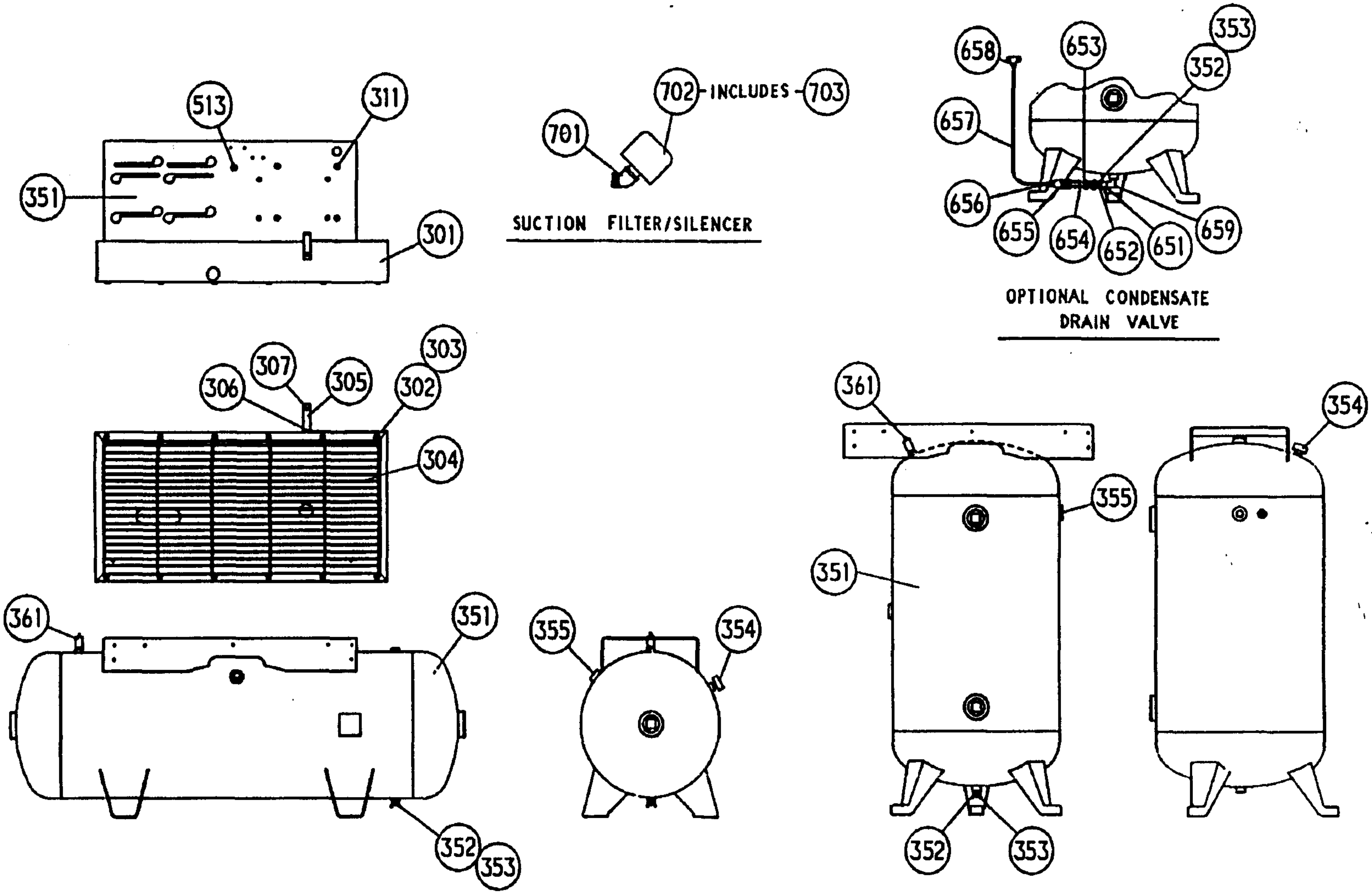
Ref. No.	Name of Part	Qty.Req. Per Unit	Part No.
*	SUCTION UNLOADING VALVE ASSEMBLY (HP)	1	202ASK2029
1	SEAT-SUCT/VALVE	1	201ATS202
2	DISC-VALVE	1	90V52
3	SPRING	3	200ASK518
4	PLATE-REACTION	1	200ASK952
5	BUMPER-VALVE	1	201ASK128
6	SCREW-FLAT SOC HD	1	75LM198
7	SPACER	1	201ASK144
8	SPRING	1	78W46
9	FINGER-UNLOADER	1	200ASK183
10	WASHER-PLAIN	1	95F2
11	LOCKNUT LIGHT HEX	1	50AH2
12	GASKET-RING	1	25L22

* Includes Ref. Numbers 1 Thru 12.

NOTE: Assemble Spring Ref. # 3 with O.D. Flats Contacting Disk Ref. # 2.

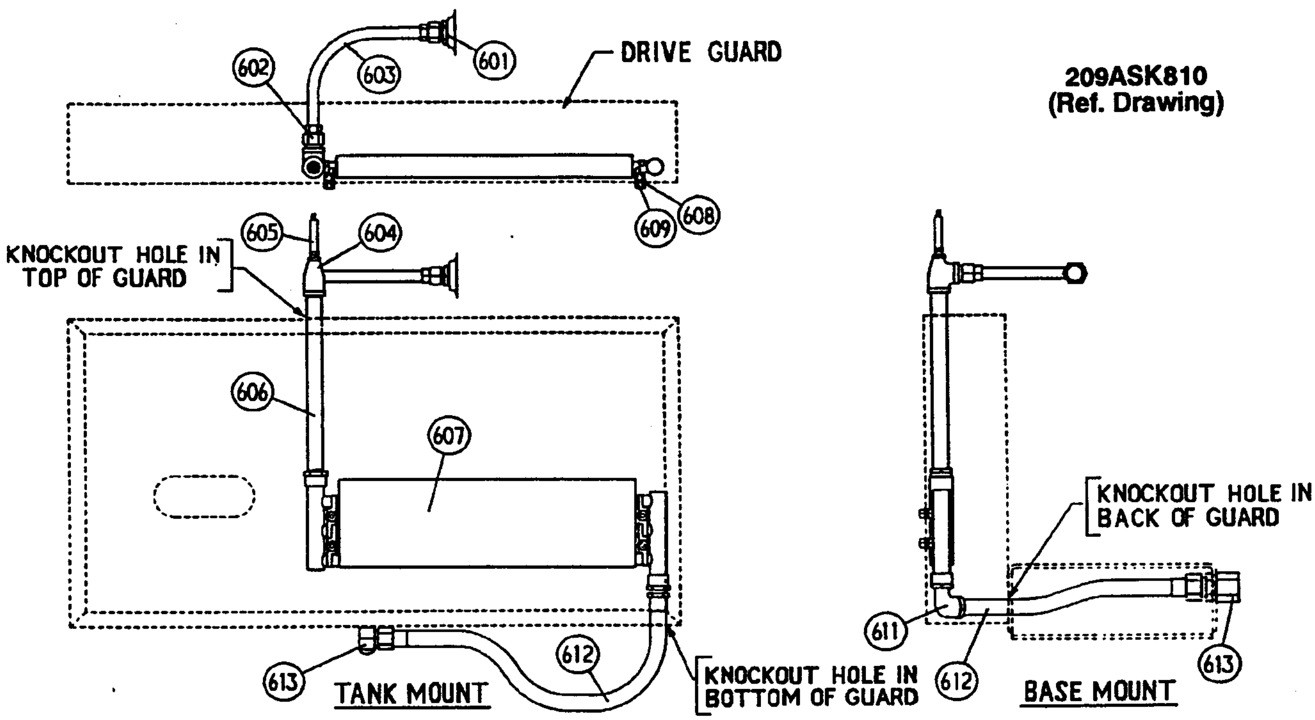
Order by Part Number and Description. Refe ⌄ Numbers for your convenience only.

Ref. No.	Name of Part or Group	Qty.	Part No.
	DRIVE GUARD GROUP (Incl. Ref. 301-311)		
301	DRIVE GUARD	1	200ASK120
302	SCREW-SELF TAPPING	17	75LM72
303	CLIP-U/NUT	12	31D57
304	GRILL-DRIVE GUARD	1	200ASK736
305	BRACKET	1	201ASK142
306	NUT	1	50AW4
307	SCREW-FLANGED HEAD	1	75K54
311	SCREW-HEX HEAD	4	655EE06Z
	BASE GROUP (Incl. Ref. 351 & 513) (Base Mounted Units Only)	1	
351	BASE (Base Mounted Units Only)		200ASK285
513	PIPE COUPLING		64EB368
	AIR FILTER GROUP (Incl. Ref. 701-703)		
701	ELBOW	1	64X8
702	FILTER SILENCER (Incl. Ref. 703)	1	5L176
703	REPLACEMENT FILTER ELEMENT	1	2109946
	AIR RECEIVER GROUPS (Incl. Ref. 351-361)		
351	RECEIVER-AIR	1	
	80 GALLON VERTICAL 200 PSIG MAX.		200ASK645
	80 GALLON HORIZONTAL 200 PSIG MAX.		201ASK645
	120 GALLON HORIZONTAL 200 PSIG MAX.		202ASK645
	80 GALLON HORIZONTAL 300 PSIG MAX.		203ASK645
352	BUSHING-PIPE	1	64E2
353	COCK-DRAIN	1	
	80 or 120 GALLON RECEIVER 200 PSIG MAX.		90C12
	80 GALLON RECEIVER 300 PSIG MAX.		90AR89
354	GAUGE		27P201
355	PLUG-PIPE	1	64B3
361	PRESSURE RELIEF VALVE	1	
	125 PSIG UNIT PRESSURE		90AR734
	175 PSIG UNIT PRESSURE		90AR734
	250 PSIG UNIT PRESSURE		90G229
	OPTIONAL CONDENSATE DRAIN VALVE PIPING		
651	NIPPLE-PIPE	1	63F21G
652	TEE-PIPE	1	64G6G
653	BUSHING-PIPE	1	2009296
654	NIPPLE-PIPE	1	63E4G
655	VALVE-DUMP	1	90AR921
656	TUBE CONNECTOR	1	86E4
657	TUBE	4 Ft.	85D4A
658	TEE	1	86E155
659	ELBOW	1	64D57



207ASK810
(Ref. Drawing)

Order by Part Number and Description. Reference Numbers for your convenience only.



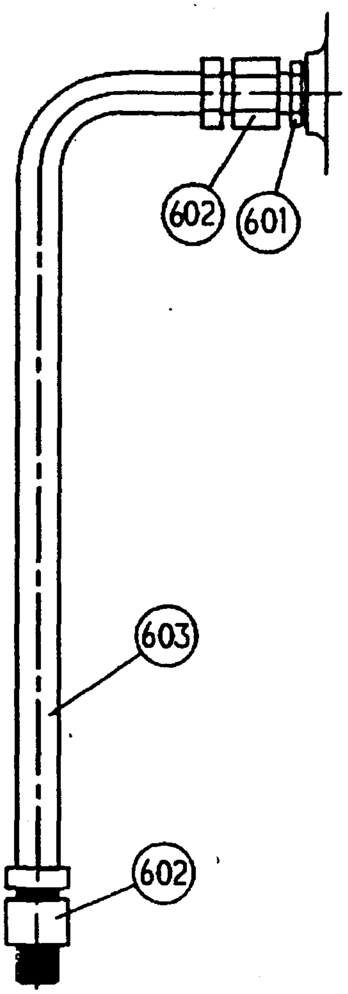
209ASK810
(Ref. Drawing)

AIR COOLED AFTER COOLER

Ref. No.	Name of Part	Qty.	Part No.
601	BUSHING-PIPE	1	64E16
602	CONNECTOR-TUBE	2	86E22
603	TUBE-FORMED DISCH	1	202ASK857
604	TEE-PIPE	1	64P14
605	VALVE-PRESS RELIEF	1	90AR735
606	NIPPLE	1	63N12X130
607	AFTERCOOLER	1	200ASK292
608	WASHER	8	95F2C
609	NUT-FLANGED	4	50AW4
* 611	ELBOW-PIPE ST	1	64D6G
* 612	ASM-HOSE	1	29Z332
* 613	ADAPTOR-HOSE	1	29Z331
+ 612	ASM-HOSE	1	29Z333
+ 613	ADAPTOR-HOSE	1	29Z241

* Required on Base Mounted Unit Only

+ Required on Tank Mounted Unit Only



208ASK810
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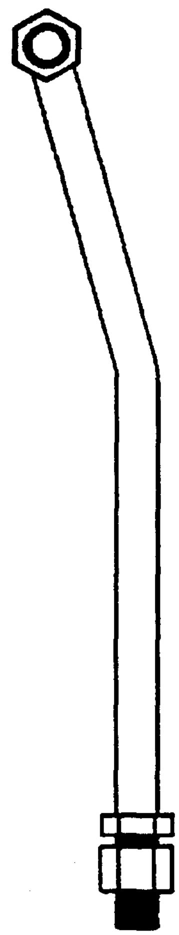


STANDARD DISCHARGE PIPING

Ref. No.	Name of Part	Qty.	Part No.
601	BUSHING-PIPE	1	64E16
602	CONNECTOR-TUBE	2	86E22
603	TUBE-FORMED	1	201ASK857

OPEN DRIP-PROOF (ODP)

STANDARD DUTY (60 HZ)

	200V	230V	460V	575V	(50 HZ) 380V
COLUMN 3-7-8 CODE	J-A-B	J-A-C	J-A-D	J-A-E	J-A-G
MOTOR 7-1/2 HP	24AW6	24AW22	24AW22	24AW41	24CA3960
COLUMN 3-7-8 CODE	K-A-B	K-A-C	K-A-D	K-A-E	K-A-G
MOTOR 10 HP	24AW7	24AW23	24AW23	24AW42	24CA3961

HIGH EFFICIENCY (ODP)

COLUMN 3-7-8 CODE	J-B-B	J-B-C	J-B-D	J-B-E	------
MOTOR 7-1/2 HP	24CA1487	24CA1507	24CA1507	24CA1534	------
COLUMN 3-7-8 CODE	K-B-B	K-B-C	K-B-D	K-B-E	------
MOTOR 10 HP	24CA1488	24CA1508	24CA1508	24CA1535	------

TOTALLY ENCLOSED FAN-COOLED (TEFC)

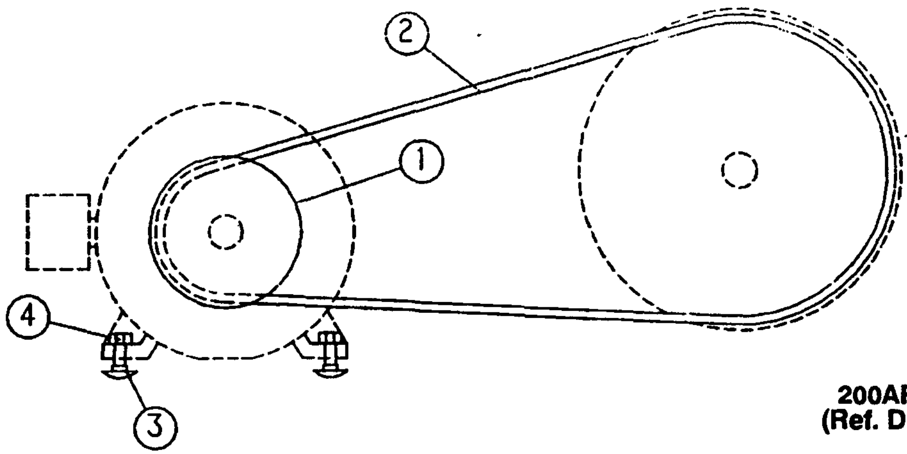
STANDARD DUTY (60 HZ)

	200V	230V	460V	575V	(50 HZ) 380V
COLUMN 3-7-8 CODE	J-C-B	J-C-C	J-C-D	J-C-E	J-C-G
MOTOR 7-1/2 HP	24CA2379	24CA2380	24CA2380	24CA2381	24CA3693
OLUMN 3-7-8 CODE	K-C-B	K-C-C	K-C-D	K-C-E	K-C-G
MOTOR 10 HP	24CA2382	24CA2383	24CA2383	24CA2384	24CA3426

HIGH EFFICIENCY (TEFC)

COLUMN 3-7-8 CODE	J-D-B	J-D-C	J-D-D	J-D-E	------
MOTOR 7-1/2 HP	----	----	----	----	------
COLUMN 3-7-8 CODE	K-D-B	K-D-C	K-D-D	K-D-E	------
MOTOR 10 HP	24CA2901	24CA2902	24CA2902	24CA2903	------

Order by Part Number and Description. Reference Numbers for your convenience only.

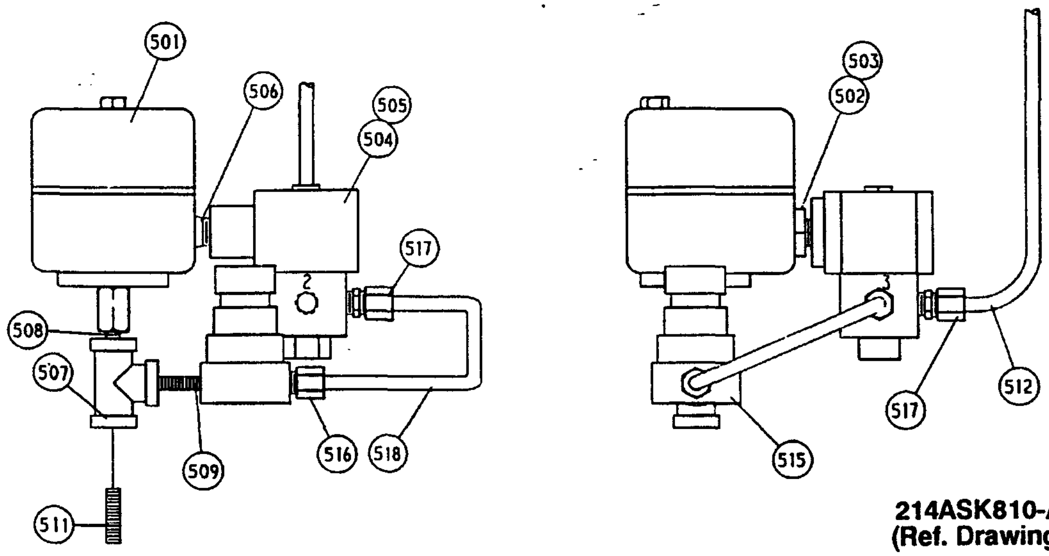


200ARD810
(Ref. Drawing)

DRIVE/MOTOR MOUNTING GROUP

Ref. No.	Name of Part	Qty.	Part No.
1	SHEAVE	1	
	1200 RPM (50 HZ MOTORS)		73S116
	1065 RPM (50 HZ MOTORS)		73S102
	1165 RPM		73S2
	1065 RPM		2009884
	970 RPM		73A607
	875 RPM		73A506
	835 RPM		73A530
	735 RPM		2009842
2	BELT SET	1	
	1065 THRU 1200 RPM (50 HZ MOTORS)		13D13
	970 THRU 1165 RPM		13D12
	735 thru 875 RPM		13D11
3	BOLT-CARRIAGE	4	15AA7
4	NUT-FLANGED	4	50AW5

Order by Part Number and Description. Reference Numbers for your convenience only.

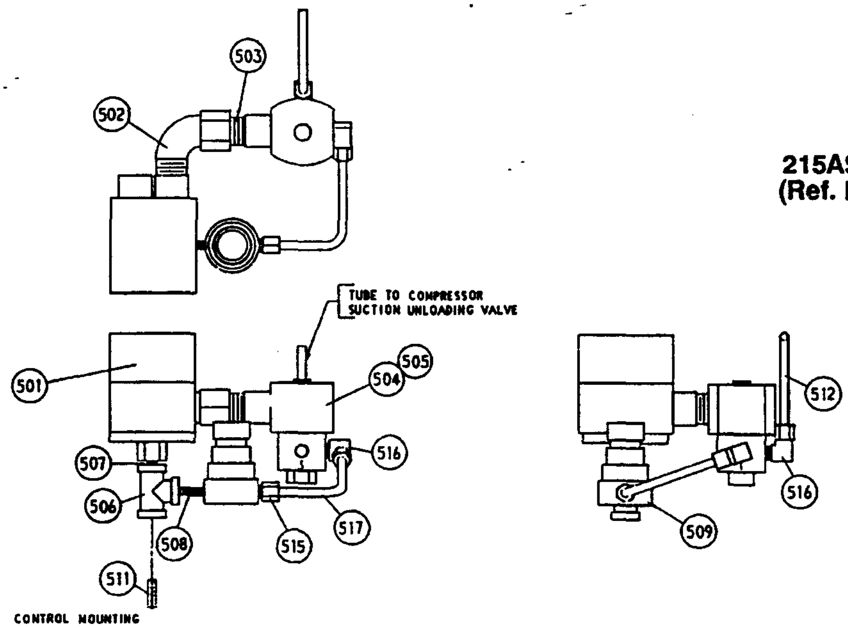


214ASK810-A
(Ref. Drawing)

ELECT/PNEUMATIC NEMA 4 CONTROL

Ref. No.	Name of Part	Qty.	Part No.
501	SWITCH-PRESSURE 250 PSI	1	88H182
502	NIPPLE-CHASE	1	24A37
503	O-RING	1	24A383
504	VALVE-SOLENOID	1	
	120V		91B78
	200V		91B89
	230V		91B90
	460V		91B91
	575V		91B92
	380V		91B93
505	COIL-CLASS F	1	
	120V		2116453
	200V		2116709
	230V		2116710
	460V		2116711
	575V		2116712
	380V		2116720
506	ELBOW	1	24CA4
507	TEE-PIPE	1	64G19G
508	NIPPLE-PIPE	1	63U4X07G
509	NIPPLE-PIPE	1	63U4X14G
511	NIPPLE-PIPE	1	63U4X07G
512	TUBE	2	85E4A
515	REGULATOR-PRESSURE	1	88H207
516	CONNECTOR-TUBE	1	86E4
517	CONNECTOR-TUBE	1	86E3
518	TUBE	1	85D4A

Order by Part Number and Description. Reference Numbers for your convenience only.

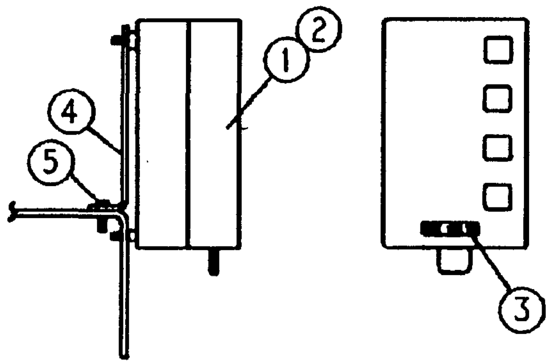


**215ASK810-A
(Ref. Drawing)**

ELECT/PNEUMATIC NEMA 4 CONTROL

Ref. No.	Name of Part	Qty.	125 PSI Part No.	175 PSI Part No.	250 PSI Part No.
501	SWITCH-PRESSURE	1	88H163	88H162	88H183
502	ELBOW	1	24CA4	24CA4	24CA4
503	NIPPLE-CONDUIT	1	24A503	24A503	24A503
504	VALVE-SOLENOID	1			
	120V		91B78	91B78	91B78
	200V		91B89	91B89	91B89
	230V		91B90	91B90	91B90
	460V		91B91	91B91	91B91
	575V		91B92	91B92	91B92
	380V		91B93	91B93	91B93
505	COIL-CLASS F	1			
	120V		2116453	2116453	2116453
	200V		2116709	2116709	2116709
	230V		2116710	2116710	2116710
	460V		2116711	2116711	2116711
	575V		2116712	2116712	2116712
	380V		2116720	2116720	2116720
506	TEE-PIPE	1	64T38G	64T38G	64G19G
507	NIPPLE-PIPE	1	-----	-----	63U4X07G
508	NIPPLE-PIPE	1	63U4X14G	63U4X14G	63U4X14G
509	REGULATOR-PRESSURE	1	88H207	88H207	88H207
511	NIPPLE-PIPE	1	63U4X07G	63U4X07G	63U4X07G
512	TUBE	2	85E4A	85E4A	85E4A
515	CONNECTOR-TUBE	1	86E4	86E4	86E4
516	ELBOW-TUBE	2	86E59	86E59	86E59
517	TUBE	1	85D4A	85D4A	85D4A

STARTER MOUNTING GROUPS - NEMA 1

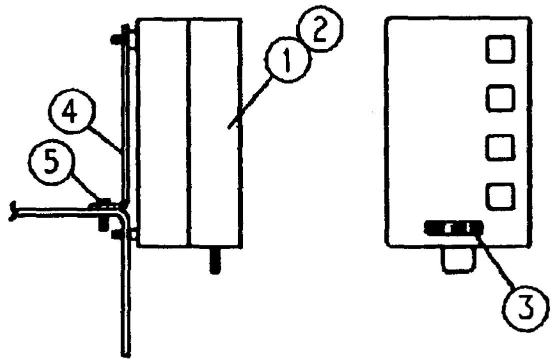


202ASK546-A
(Ref. Drawing)

GROUP PART NO.	H.P.	VOLTAGE	REF. NO. 1 STARTER (1)	REF. NO. 2 O/L HEATER (3)	REF. NO. 3 VOLTAGE DECAL (1)	REF. NO. 4 BRACKET (1)	REF. NO. 5 SCREW (5)
200ASK4016	7-1/2	200	200ARD661	24CA2604	69F50	200ARD142	75LM76
201ASK4016	7-1/2	230	201ARD661	24CA2604	69F51	200ARD142	75LM76
202ASK4016	7-1/2	460	202ARD661	24CA2488	69F52	200ARD142	75LM76
203ASK4016	7-1/2	575	203ARD661	24CA2487	69F60	200ARD142	75LM76
208ASK4016	7-1/2	380	209ARD661	24CA2488	69F55	200ARD142	75LM76
204ASK4016	10	200	204ARD661	24CA2605	69F50	200ASK142	75LM76
205ASK4016	10	230	205ARD661	24CA2604	69F51	200ASK142	75LM76
206ASK4016	10	460	206ARD661	24CA2488	69F52	200ASK142	75LM76
207ASK4016	10	575	207ARD661	24CA2487	69F60	200ASK142	75LM76
209ASK4016	10	380	209ARD661	24CA2604	69F55	200ARD142	75LM76

See Page 37 for Wiring Diagram.

STARTER MOUNTING GROUPS - NEMA 4

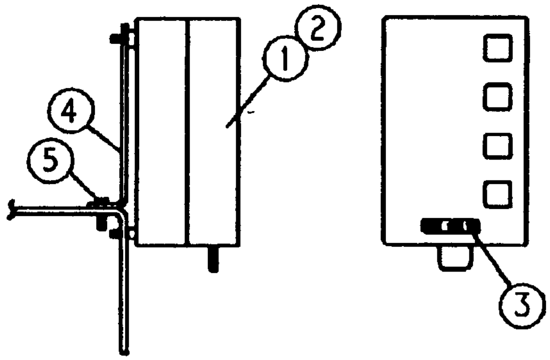


202ASK546-A
(Ref. Drawing)

GROUP PART NO.	H.P.	VOLTAGE	REF. NO. 1 STARTER (1)	REF. NO. 2 O/L HEATER (3)	REF. NO. 3 VOLTAGE DECAL (1)	REF. NO. 4 BRACKET (1)	REF. NO. 5 SCREW (6)
210ASK4016	7-1/2	200	200ASK661	24CA2604	69F50	202ASK142	75LM72
211ASK4016	7-1/2	230	201ASK661	24CA2604	69F51	202ASK142	75LM72
212ASK4016	7-1/2	460	203ASK661	24CA2488	69F52	202ASK142	75LM72
213ASK4016	7-1/2	575	204ASK661	24CA2487	69F60	202ASK142	75LM72
203ASD4016	7-1/2	380	202ASK661	24CA2488	69F55	202ASK142	75LM72
214ASK4016	10	200	205ASK661	24CA2605	69F50	202ASK142	75LM72
215ASK4016	10	230	206ASK661	24CA2604	69F51	202ASK142	75LM72
217ASK4016	10	460	208ASK661	24CA2488	69F52	202ASK142	75LM72
226ASK4016	10	575	204ASK661	24CA2488	69F60	202ASK142	75LM72
216ASK4016	10	380	202ASK661	24CA2604	69F55	202ASK142	75LM72

See Page 37 for Wiring Diagram.

STARTER MOUNTING GROUPS - NEMA 4 with 120 V TRANSFORMER

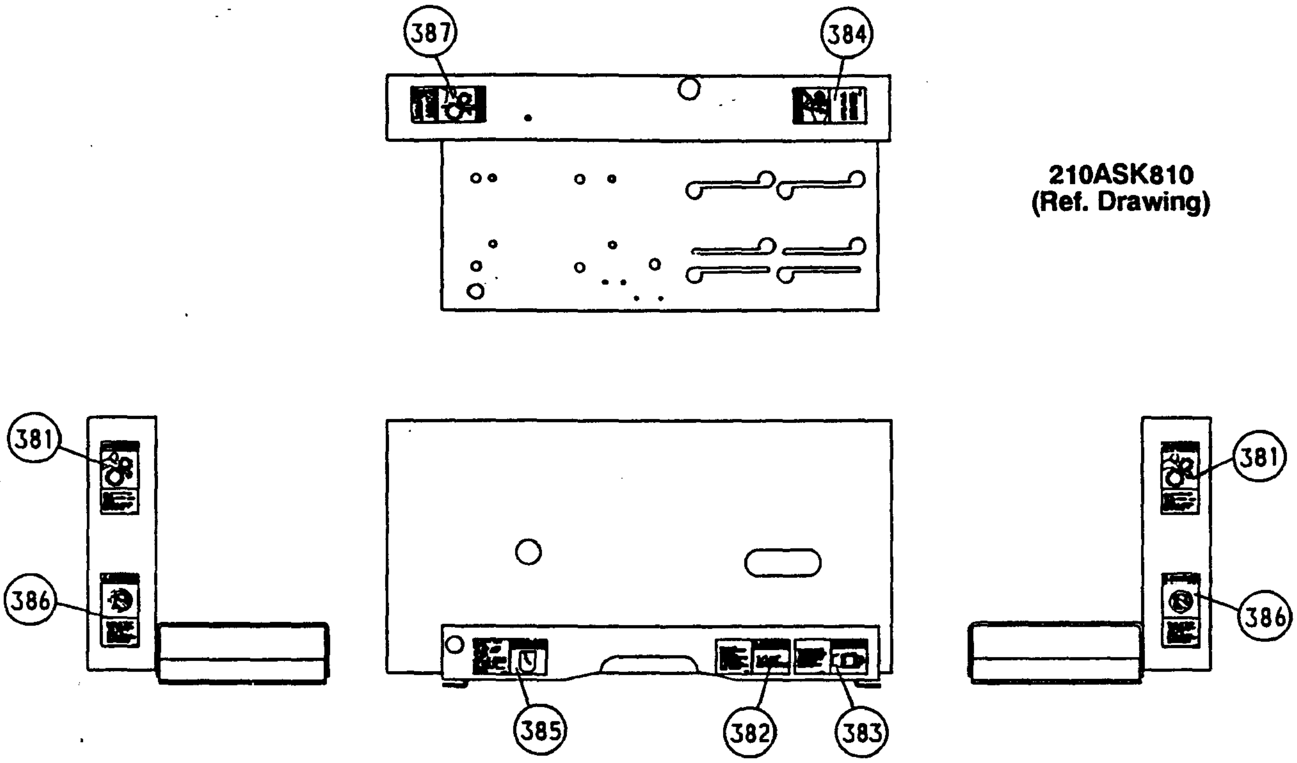


202ASK546-A
(Ref. Drawing)

GROUP PART NO.	H.P.	VOLTAGE	REF. NO. 1 STARTER (1)	REF. NO. 2 O/L HEATER (3)	REF. NO. 3 VOLTAGE DECAL (1)	REF. NO. 4 BRACKET (1)	REF. NO. 5 SCREW (6)
218ASK4016	7-1/2	200	209ASK661	24CA2604	69F51	202ASK142	75LM72
219ASK4016	7-1/2	230	209ASK661	24CA2604	69F51	202ASK142	75LM72
220ASK4016	7-1/2	460	209ASK661	24CA2488	69F52	202ASK142	75LM72
221ASK4016	7-1/2	575	209ASK661	24CA2487	69F60	202ASK142	75LM72
209ASD4016	7-1/2	380	210ASK661	24CA2488	69F55	202ASK142	75LM72
222ASK4016	10	200	211ASK661	24CA2605	69F50	202ASK142	75LM72
223ASK4016	10	230	211ASK661	24CA2604	69F51	202ASK142	75LM72
225ASK4016	10	460	211ASK661	24CA2488	69F52	202ASK142	75LM72
227ASK4016	10	575	209ASK661	24CA2488	69F60	202ASK142	75LM72
224ASK4016	10	380	210ASK661	24CA2604	69F55	202ASK142	75LM72

See Page 37 for Wiring Diagram.

Order by Part Number and Description. Reference Numbers for your convenience only.



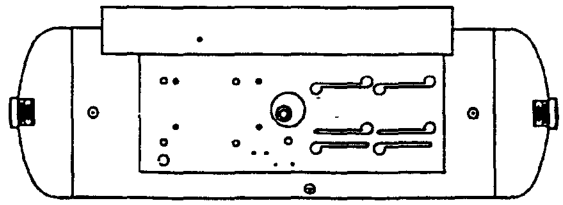
210ASK810
(Ref. Drawing)

IDENTIFICATION AND INSTRUCTION GROUP
(BASE MOUNTED UNIT)

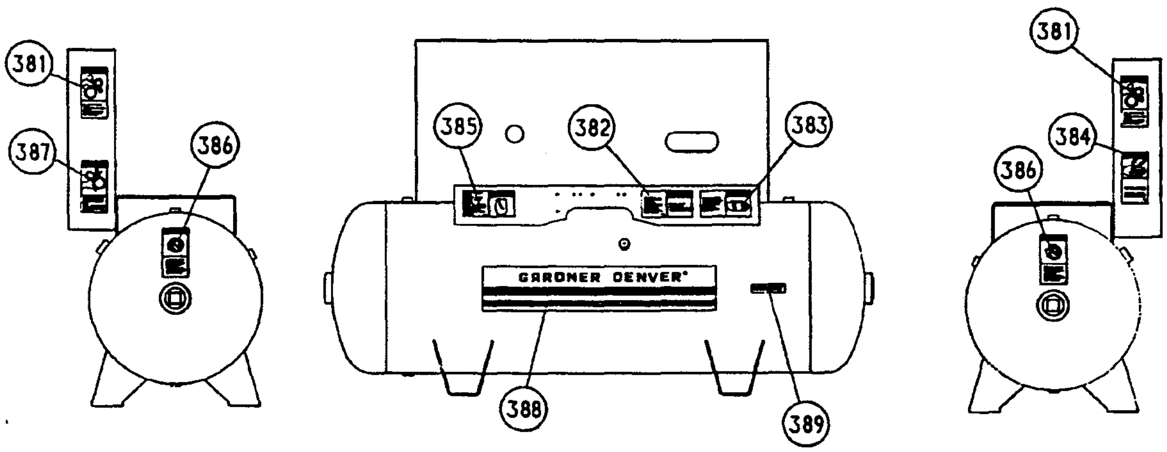
Ref. No.	Name of Part	QTY	PART NO.
381	DECAL-WARNING	2	207EAQ077
382	DECAL-DANGER	1	203ASL077
383	DECAL-WARNING	1	204ASL077
384	DECAL-WARNING	1	213EAQ077
385	DECAL-WARNING	1	202ASL077
386	DECAL-DANGER	2	206EAQ077
387	DECAL-WARNING	1	200ASL077

For Decal Information see pages 26 and 27.

Order by Part Number and Description. Reference Numbers for your convenience only.



211ASK810
(Ref. Drawing)



IDENTIFICATION AND INSTRUCTION GROUP
(TANK MOUNTED UNIT)

Ref. No.	Name of Part	QTY	PART NO.
381	DECAL-WARNING	2	207EAQ077
382	DECAL-DANGER	1	203ASL077
383	DECAL-WARNING	1	204ASL077
384	DECAL-WARNING	1	213EAQ077
385	DECAL-WARNING	1	202ASL077
386	DECAL-DANGER	2	206EAQ077
387	DECAL-WARNING	1	200ASL077
388	DECAL-TOUGH BREED	1	202ASD077
389	DECAL	1	200ATD077

For Decal Information see pages 26 and 27.

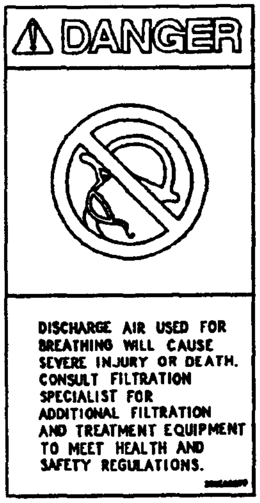
DECALS

DANGER

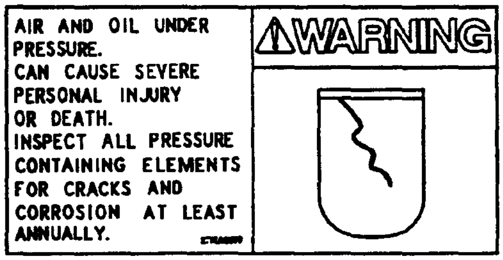
HIGH VOLTAGE.
ROTATING MACHINERY.
AIR AND OIL
UNDER PRESSURE.
IMPROPER APPLICATION
OR MODIFICATION
OF EQUIPMENT WILL
CAUSE SEVERE PERSONAL
INJURY OR DEATH.

DO NOT MODIFY
UNIT WITHOUT
WRITTEN PERMISSION
FROM MANUFACTURER.

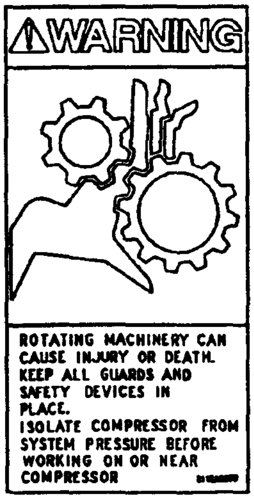
203ASL077



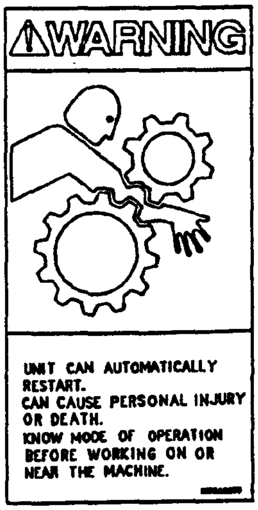
206EAQ077



202ASL077

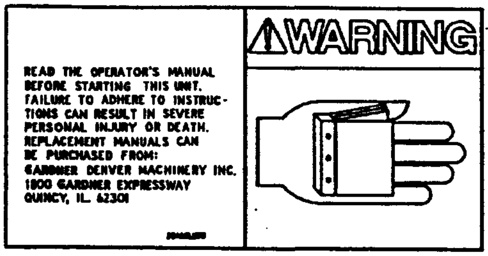


200ASL077

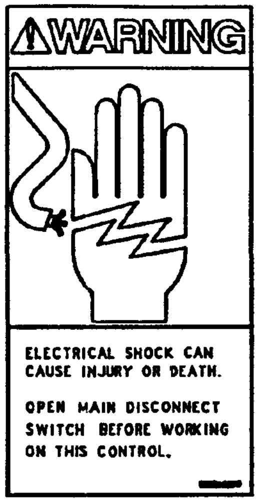


207EAQ077

DECALS



204ASL077



213EAQ077

THIS UNIT MEETS THE REQUIREMENTS
OF CALIFORNIA UNFIRED PRESSURE
VESSEL SAFETY ORDER 462 (M) (2).

200ATD077

REPAIR KITS AND ACCESSORIES

Your Gardner Denver compressor is designed and manufactured for many years of reliable operation. All components are engineered to exacting specifications, which will function together as a system to provide maximum efficiency. To insure the continuing integrity of compressor operation, use only original quality genuine Gardner Denver replacement parts and accessories.

Name of Part	Qty.	Part No.
CYLINDER KIT		200ASK6002
CRANKCASE/CYLINDER	1	205ATS013
PLUG-SQHD PIPE	1	64AA4
PLUG	1	64B4
PLATE-INSPECTION	1	201ASL052
GASKET-INSPECTION PLATE	1	204ATS715
SCREW-HEX CAP	4	75A33
PLUG-SQHD PIPE	1	64AA7
ROD-OIL LEVEL	1	201ASK491
O-RING	1	25AM18
GASKET	1	202ASK715
GASKET KIT		200ASK6007
SEAL-OIL	1	60G47
SHIM SET-CUP	1	77B18
GASKET-INSPECTION PLATE	1	204ATS715
GASKET	1	202ASK715
GASKET	1	203ASK715
GASKET	3	204ASK715
O-RING	3	25BC100
O-RING	1	25AM18
PISTON RING KIT		ASK80827
RING-RETAINING	4	74D45
RING-PISTON	2	65V13
PISTON RING ASSEMBLY	1	65AM352
RING-PISTON	3	65V12
PISTON RING ASSEMBLY	1	65AM351
SUCTION FILTER		
FILTER/SILENCER, DRY TYPE, HOODED	1	5L176
* (REPLACEMENT ELEMENT)	1	2109946
VALVE KIT		200ASK6017
SUCTION UNLOADING VALVE ASSEMBLY (LP)	2	201ASK2029
SUCTION UNLOADING VALVE ASSEMBLY (HP)	1	202ASK2029
GASKET	1	202ASK715
GASKET	1	203ASK715
DISCHARGE VALVE ASSEMBLY	3	201ASK2031
INSTRUCTION SHEET	1	200ASK1255

* May be purchased separately.

FORWARD

Gardner Denver compressors are the result of advanced engineering and skilled manufacturing. To be assured of receiving maximum service from this machine the owner must exercise care in its operation and maintenance. This book is written to give the operator and maintenance department essential information for day-to-day operation, maintenance and adjustment. Careful adherence to these instructions will result in economical operation and minimum downtime.

⚠ DANGER
Danger is used to indicate the presence of a hazard which will cause severe personal injury, death, or substantial propery damage if the warning is ignored.

⚠ WARNING
Warning is used to indicate the presence of a hazard which can cause severe personal injury, death, or substantial propery damage if the warning is ignored.

⚠ CAUTION
Caution is used to indicate the presence of a hazard which will or can cause minor personal injury or propery damage if the warning is ignored.

NOTICE
Notice is used to notify people of installation, operation or maintenence information which is important but not hazard-related.

SAFETY PRECAUTIONS

Safety is everybody's business and is based on your use of good common sense. All situations or circumstances cannot always be predicted and covered by established rules. Therefore, use your past experience, watch out for safety hazards and be cautious.

Some general safety precautions are given below:

⚠ DANGER

Failure to observe the following will result in injury to or death of personnel.

- **Do not operate unit if safety devices are not operating properly. Check periodically. Never bypass safety devices.**
- **Keep fingers and clothing away from revolving fan, belts and sheaves.**
- **Do not use the air discharged from this unit for breathing -- not suitable for human consumption.**
- **Do not loosen or remove the oil filler plug, drain plugs, covers, or, break any connections, Etc., in the compressor air or oil system until the unit is shut down and the air pressure has been relieved.**
- **Electrical shock will result in injury or death to personnel. Open main disconnect switch before working on the control.**
- **Compressor unit must be grounded in accordance with National Electrical Code.**
- **Disconnect the compressor unit from its power source before working on the unit -- this machine is automatically controlled and may start at any time.**
- **Do not modify unit without written permission from Manufacturer's Engineering Department.**

⚠ WARNING

Failure to observe these notices could result in personal injury or damage to equipment:

- **Stop unit if any repairs or adjustments on or around the compressor are required.**
- **All compressed air supply hoses exceeding 1/2 inch inside diameter should have an excess flow valve. (OSHA Regulation, Section 1926.302)**
- **Do not exceed the rated maximum pressure value shown on the nameplate.**
- **Bearing can be damaged by passage of current. Do not electric weld on the compressor or base.**
- **Inspect the air receiver for fatigue cracks and inspect all pipe and tube connections for looseness or leakage on at least an annual basis.**

The Installation and Operating Instructions should be read carefully before starting the unit.

LOCATION - The compressor should be installed in a clean, well-lighted place, with plenty of space all around it, and in such a manner as to be accessible from all sides. Do not place unit too near other machinery or too close to the wall. Unit should be set on a firm foundation, with the feet shimmed to eliminate rocking and undue stresses when bolted to the foundation.

PIPING - Air discharge pipe must be full size of discharge opening on air cylinder. The discharge pipe should be as short and direct as possible, eliminating short bends and fittings and avoiding pockets. *If for any reason it is necessary to install a valve between compressor and receiver, it is imperative that a pressure relief valve be placed in the line between compressor and the valve.*

DANGER

Do not operate the compressor without the proper pressure relief valve. Overpressure operation may cause severe damage to equipment and personal injury.

As the air cools in being carried through the distributing lines to the point at which it is to be used, it deposits moisture mixed with a small amount of oil. This moisture is objectionable in pneumatic tools, sand blasting, paint spray work and similar operations. Much of the trouble with water in the air lines can be overcome if small receivers to act as collecting tanks are put in the lines at frequent intervals, otherwise suitable moisture traps should be used.

AIR RECEIVER - When possible locate the air receiver outside the building where it has an opportunity to radiate most of the heat. Drain cock should be located at the lowest point in the receiver for drawing off at least once a day the accumulated oil and water. Where there is danger of freezing, pressure relief valve should be located on the inside wall, preferably with the compressor control equipment. *All pressure relief valves should be tested daily by hand to be sure that they are functioning properly.*

LUBRICATING SYSTEM - All ASJ and ASK models are splash lubricated. All APJ and APK models are pump lubricated.

"V" BELT DRIVE - "V" belt drive consists of a number of rubber-fabric composition belts operating in grooved pulleys. Adjustable motor base is provided to take up stretch of belts. The belts should be run only fairly tight. Slight inequalities of length in the various strands should cause no concern as belts will equalize on tight side under load. No belt dressing of any sort is required. Always install a complete set of new belts when belts become worn.

COVERS AND GUARDS

DANGER

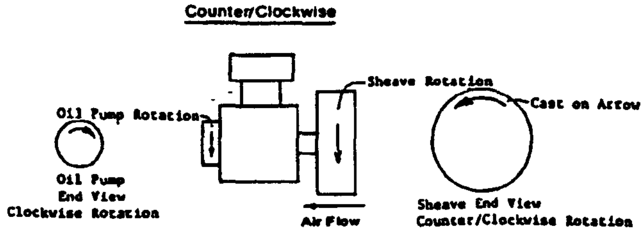
All compressor covers and guards must be securely fastened in proper position at all times when the pump is operating to avoid personal injury or death from moving parts. In addition, all moving parts on the entire compressor package, including but not limited to engine or motors, drive shafts, belts, pulleys, etc., Must be equipped with guards or covers, which must also be securely fastened in proper position at all times when equipment is operating. Covers and guards are intended to not only protect against personal injury or death, but to also protect the equipment from damage from foreign objects.

AIR FILTER - The intake of every compressor should be equipped with an air filter to prevent dust and other abrasives from being drawn into the cylinders.

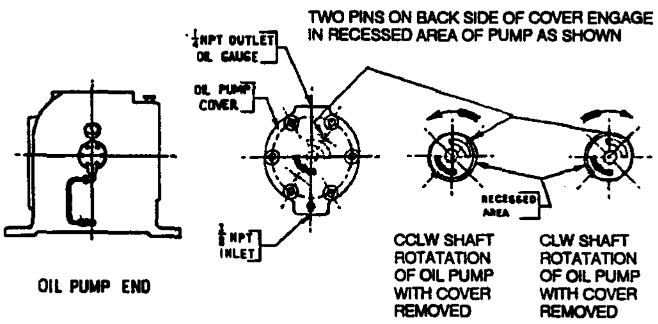
In cases where no air filter is installed, the company will assume no responsibility for excessive wear of pistons, piston rings, cylinder bore or valve details, even though such wear occurs very soon after compressor is installed. To operate properly, the filters must be kept clean.

PRESTART CHECK - Before starting the unit for the first time, be certain that all the accessory items shipped loose with the unit are properly installed; i.e., compressor air filter, pressure relief valve, etc.

Check over the electrical connections to see that all connections are tight and properly made before throwing the switch.



ROTATION AS VIEWED FROM SHEAVE END



NOTE: SUCTION PORT OF PUMP SHADED

⚠ WARNING

ROTATION - the compressor must be run in the proper direction so that fan will blow air over compressor and for pump to operate. The motor leads must be connected to give the required direction of rotation.

NOTICE

Oil pump rotation pre-set. Refer to illustration to reverse operation.

Go over all bolts, nuts, and valve clamp screws to see that they are tight.

⚠ CAUTION

Break-in oil supplied in crankcase from factory. Change oil after 50 hours and refill the crankcase with lubricating oil.

INITIAL STARTING - When starting for the first time, be certain that all items in the prestart have been complied with.

On initial start or after the compressor has been overhauled, run the compressor with the receiver outlet valves wide open for about ten minutes so that oil will be distributed over all wearing surfaces. When sure that the unit is operating satisfactorily, partly close the receiver valve and gradually bring the pressure up to normal working pressure.

When starting up a new or rebuilt compressor, run the unit fully loaded for the first 40 hours to ensure proper seating of the rings.

LUBRICATION - Oil level in the crankcase must be maintained. Add oil as required to maintain the correct

Cold Weather Operation: 0° F to 32° F Ambient -

Compressor Oil .... ISO Viscosity Grade 32

Warm Weather Operation: 32° F to 90° F Ambient -

Gardner Denver AEON 500 Lubricant .... ISO Viscosity Grade 68*

Warm Weather Operation: Above 90° F Ambient -

Gardner Denver AEON 500 Lubricant .... ISO Viscosity Grade 100**

* AEON 500 (SAE20) available in 6 pack of 1 Gallon Containers - Part Number 28H60
or 5 Gallon Pail - Part Number 28H58
or 55 Gallon Drum - Part Number 28G12.

** AEON 500 (SAE30) available in 6 pack of 1 Gallon Containers - Part Number 28G22
or 5 Gallon Pail - Part Number 28G19
or 55 Gallon Drum - Part Number 28G13.

level. The viscosity required for various operating temperature ranges are given in the table on the previous page.

Correct weight of oil for existing temperatures is most important. Oil which is too heavy cannot be picked up by the oil pump or splash freely and will cause bearing damage and subsequent failure.

Approximately three (3) pints of oil are required to fill the crankcase.

OIL QUALITY - There are many brands of lubricating oils which are represented by the suppliers as meeting the specifications for vertical compressor lubrication. The ability of an oil to meet the minimum performance level for a particular application is determined by the supplier. Therefore, the responsibility for the QUALITY of the oil and its PERFORMANCE IN SERVICE RESTS WITH THE OIL SUPPLIER.

OIL CHANGE - When a new or overhauled unit is placed in service, the oil should be changed at the end of the first 50 hours of operation. The oil should be changed again after the next 100 hours operation so that all polishing residue from working parts will be removed from the crankcase.

Subsequent oil change periods must be determined by checking the discoloration and physical condition of the oil in the crankcase. Due to dust, dirt and atmospheric conditions being different at various locations, it is not practical to definitely state how often the lubricating oil in the crankcase should be changed. Service given the air filter and crankcase breather also has a direct bearing on the oil change interval, as does high humidity conditions which contribute to formation of varnish deposits through oxidation of the oil. The period for changing oil is therefore regulated by local conditions. The oil, however, should not be used for more than 500 hours.

Always provide clean containers, funnels and clean storage of oil and cleaning fluids. Changing oil will be of little benefit if done improperly.

Fill crankcase through the opening. Check level with the dipstick. Wipe away all dirt before removing the oil filler plug. After unit has operated for several minutes, check oil level and add if necessary.

When starting the unit after an oil change, start slowly under no-load until assured the oil reaches all moving parts.

Condensate accumulation in the crankcase will often occur as a result of high humidity conditions, wide temperature range and intermittent service.

⚠ DANGER

Before and during maintenance work be absolutely sure these rules are followed:

A. Main electrical switch for motor driven units is off and marked so it cannot be accidentally turned on.

B. Pressure in air system is completely released.

C. Never reach hand into crankcase without being conscious of the fact that the crankshaft can rotate due to the position of the counterweights.

D. Proper equipment and tools are used.

MAIN BEARING ADJUSTMENT - Main bearings are Timken tapered roller type and seldom require adjustment. They are correctly adjusted at the factory by means of thin shims under the bearing end plate. Should adjustment become necessary, both bearings are adjusted simultaneously by removing the required number of shims from beneath the end plate opposite the drive end. This adjustment must be made with care so that bearings will not be too tight.

CONNECTING ROD - To tighten the bronze connecting rod, remove the handhole plate and bolts from connecting rod cap and shims. Peel off one shim and replace shims and cap, making sure they are in the same position as before removal. They are marked to match the rod. Tighten bolts and test for fit by turning the crankshaft by hand.

The proper torque for tightening the connecting rod bolt on the bronze rods is 28-31 foot pounds dry. Each bolt must be pulled up evenly on each side.

⚠ CAUTION

Do not pull up each bolt to rating separately as this will cause the rod bore to deform to an out-of-round condition.

Replace handhole plate.

CRANKSHAFT OIL SEAL must be installed with the lips of the seal facing in toward the oil side to retain oil in crankcase.

VALVES - The suction and discharge valves of a compressor are vital working parts and must receive careful attention at regular intervals. The intervals for inspection and cleaning of the valves will depend on the quality and carbon-forming tendency of the oil used to lubricate the compressor. Other factors regulating these intervals are prevailing dust, dirt and atmospheric conditions. How often the air filters are cleaned and serviced will also have a bearing on the valve inspection and cleaning interval.

Inspect and clean all the valves every 1000 hours or every four months, whichever occurs first, until experience indicates the proper cleaning interval.

If it is necessary to take a valve apart, note the manner in which the various parts are arranged so that proper relation of parts will be followed in reassembling valve.

The unloader plunger o-rings must be lubricated with high temperature o-ring grease whenever the valves are serviced. Standard "gun grease" is not suitable because it will vaporize or liquify and run out of the bore at operating temperatures.

⚠ CAUTION

Be absolutely sure that valve disc is not pinched between the seat and bumper so that they cannot lift. When replacing a valve, see that seat gasket is in good shape.

If gasket is damaged, install a new one.

When reinstalling the valves, one drop of #290 Loctite may be used on the threads to ensure that the valve does not loosen in operation.

Valves and valve seats must be kept clean. The presence of any deposit on valves indicates that either intake air is dirty or the wrong kind of oil is being used.

It is a good idea to have spare valve assemblies available. If complete suction and discharge valves are carried as spares, the operator will be able to remove and replace a valve in minimum time and can clean the dirty valve at leisure.

⚠ DANGER

Never run the compressor with a valve that does not operate properly as a leaky valve will cause excessive temperatures and may cause an explosion in air receiver or discharge line.

ELECTRO-PNEUMATIC DUAL TYPE CONTROL SYSTEM - This control consists of an air pressure switch and a 3-way solenoid valve.

This control system is the electrical equivalent of a pneumatic unloader pilot. It also has greater flexibility and several advantages not found in the pneumatic pilot. One being that it is electrically fail-safe, that is, when there is a power failure the solenoid valve coil is de-energized to allow compressor air from the air receiver to flow to the compressor suction unloading valves to allow the compressor to restart unloaded.

The compressor with this control can be operated either constant speed or Auto-Start/Stop, depending on how the pressure switch is wired into the motor starter. See wiring diagram 202ASK546 at the end of the manual.

CONSTANT SPEED - Constant speed operation is recommended for applications where air requirements are moderately heavy most of the time. The pressure switch contacts are wired in series with the coil of the solenoid valve. The receiver pressure increases until the opening point of the pressure switch is reached. The opening of the pressure switch de-energizes the solenoid valve and unloads the compressor. When the receiver pressure drops to the closing point of the pressure switch, the solenoid valve coil is energized loading up the compressor. This loading and unloading continues in response to the air requirements as long as the compressor is running.

AUTO-START/STOP - Auto-Start/Stop operation is recommended for applications where air requirements are of a short duration or intermittent periods of time. The pressure switch contacts are wired in series with the coil of the motor starter. The receiver pressure increases until the opening point of the pressure switch is reached, the opening of the pressure switch de-energizes the solenoid valve coil, unloading the compressor, and the motor starter coil, shutting down the compressor. When the receiver pressure drops to the closing point of the pressure switch, the motor starter coil and solenoid valve are energized starting the compressor motor. As the motor accelerates the compressed air in the compressor suction unloading valve chambers slowly bleeds through the solenoid valve to the atmosphere allowing the compressor to come up to full speed before being fully loaded.

This starting and stopping of the compressor continues in response to air requirements until unit is turned off.

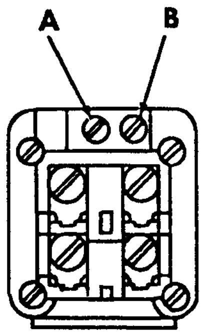
DUAL - Dual control is recommended for applications where air requirements vary over a wide range, for example, constant speed operation for day shift and Auto-Start/Stop operation for night shift. Dual control operation requires a manual selection of operation which is accomplished with a separate or built into starter, Hand-Off-Auto, selector switch.

Reset Pressure Range

A. Turn clockwise to increase and counterclockwise to decrease pressure.

Differential Adjustment

B. Turn clockwise to increase pressure and counterclockwise to decrease pressure.



PRESSURE SWITCH ADJUSTMENT DIAGRAM

SOLENOID VALVE - The solenoid valve is a 3-way normally open valve with a selected voltage coil. See the parts list for solenoid valve and replacement coil part numbers.

PRESSURE SWITCH - The pressure switch consists of a diaphragm assembly, switch mechanism, terminal block and enclosure. Pressure switch action opens contacts on pressure rise and closes contacts on pressure fall. Pressure adjustments and wiring connections are made from the top with a screwdriver. Pressure switches are supplied pre-set. See parts list for part numbers. If non-standard pressure settings are required, see the diagram on the next page for pressure range resetting instructions.

OPTIONAL STARTER - The starter box contains 2 main components:

1. Magnetic Starter
2. "HAND-OFF AUTO" Selector Switch

1. The magnetic starter is basically an electrically operated switch consisting of a contactor and an overload relay. Inside the contactor are 3 main contacts and a magnetic coil. When the coil is energized the contacts open stopping motor. The overload relay provides motor-running overcurrent protection containing 3 overload heaters and an overload contact.

   If the motor is overloaded, the overload contact trips open by the heat created by the current flowing through the overload heaters. The contact opening de-energizes the CR relay which de-energizes contactor coil thus stopping the motor.
2. The "Hand-Off Auto" selector switch provides manual selection of operation of dual control.

The starter is wired per wiring diagram 202ASK546 included at the end of the manual.

MOTOR LUBRICATION - Long time satisfactory operation of an electric motor depends in large measure on proper lubrication of the bearings. The following charts show recommended grease qualities and regreasing intervals for ball bearing motors. For additional information refer to the motor manufacturer's instructions. The following procedure should be used in regreasing:

1. Stop the unit.
2. Disconnect the unit from the power supply.
3. Remove the relief plug and free hole of hardened grease.
4. Wipe lubrication fittings clean and add grease with a hand-operated grease gun.
5. Leave the relief plug temporarily off. Reconnect unit and run for about 20 minutes to expell the excess grease.
6. Stop the unit. Replace the relief plug.
7. Restart the unit.

⚠ WARNING

Rotating machinery can cause injury or death. Open main disconnect before working on electric motor.

ELECTRIC MOTOR GREASE RECOMMENDATIONS

	Standard Service	High Temperature
Worked Penetration	265-296	20-240
Viscosity, SSU At 100°F	400-550	475-525
Soap Type	Lithium	Lithium
N-H Bomb, Minimum Hours For 20 PSI Drop at 210°F.	750	1000
Bleeding, Maximum Weight % In 500 Hours 212°F.	10	3
Rust Inhibiting	Yes	Yes

ELECTRIC MOTOR REGREASING INTERVAL

Type of Service	Typical Examples	Rating	Relubrication Interval
Standard	One- or Two-Shift Operation	150 HP & Below	18 Months
Severe	Continuous Operation	150 HP & Below	9 Months
Very Severe	Dirty Locations, High Ambient Temperature	150 HP & Below	4 Months

STANDARD DIMENSIONS & RUNNING CLEARANCES

UNIT COLD
(New Parts)

	Compressor LP	Compressor HP
Cylinder Bore	4.750/4.751	2.500/2.501
Piston Ring Land Diameter	4.722/4.717	2.481/2.476
Piston to Cylinder (At Ring Land)	.028/.034	.019/.025
Piston Skirt Diameter	4.7405/4.7395	2.4990/2.4985
Piston to Cylinder (At Skirt)	.0095/.0115	.0010/.0025
Ring Gap - Compression.	.005/.015	.003/.013
Ring Side Clearance (Compression)	.002/.004	.002/.004
Rail Ring Gap - Oil	.010/.050	.015/.055
Piston Pin Bore in Piston	.8755/.8760	.8755/.8760
Piston Pin to Connecting Rod.	.0003/.0010	.0003/.0010
Piston Pin to Piston.	.0003/.0010	.0003/.0010
Piston Pin Diameter	.8752/.8750	.8752/.8750
Piston Pin Bore in Connecting Rod	.8755/.8760	.8755/.8760
Connecting Rod to Crankpin.	.002/.003	
Connecting Rod Bore	1.6250/1.6255	
Crankpin Diameter	1.6230/1.6225	
Rod Side Clearance.	.007/.020	
Crankshaft Diameter (At Main Bearing)	1.502/1.501	
Main Bearing ID	1.5005/1.5000	
Housing Bore (Main Bearing)	2.9985/2.9995	
Main Bearing OD	3.000/3.001	
Main Bearing End Clearance.	.002/.003	

TORQUE DATA (DRY)
(Foot-Pounds)

Connecting Rod Bolts.	22-24
Crankcase End Plate Bolts	28-31
Cylinder Head Bolts	28-31
Inspection Plate Bolts.	16-18
Suction Unloading Valve Nut	15-17
Suction Unloading Valve Cylinder Bolts.	16-18
Valve Center Bolt	15-17
Valve Seat to Head	80-90

WIRING DIAGRAM

NOTE 'A' - COMPRESSOR POWER SUPPLY DISCONNECTING MEANS - FUSED SWITCH OR CIRCUIT BREAKER CAN BE A SEPARATE ITEM OR BUILT INTO STARTER ENCLOSURE

NOTE 'B' - SINCE MOST AC MOTORS ARE WOUND FOR DUAL VOLTAGE, BE CERTAIN LEADS ARE CONNECTED, USING THE DATA SUPPLIED WITH THE MOTOR, FOR THE OPERATING VOLTAGE. IF MOTOR CONNECTION DATA IS MISSING ON A DUAL VOLTAGE MOTOR, CONTACT THE MOTOR MANUFACTURER LOCAL SALES OFFICE OR AUTHORIZED SERVICE SHOP GIVING COMPLETE NAMEPLATE INFORMATION SO THAT THEY CAN FIND OUT WHAT THE CORRECT CONNECTIONS ARE. THERE ARE TWO TYPES OF MOTOR WINDINGS, WYE AND DELTA AND THEIR CONNECTIONS ARE NOT IDENTICAL FOR THE LOW VOLTAGE CONNECTION OF A NINE LEAD MOTOR. A THREE-PHASE FULL-VOLTAGE STARTER IS SHOWN.

MOTOR FOR PART WINDING, WYE-DELTA AND OTHER TYPES OF MULTI-LEAD REDUCED VOLTAGE (CURRENT) STARTERS ARE TO BE CONNECTED PER THE WIRING DIAGRAM SUPPLIED WITH THE STARTER FOR THE CORRECT VOLTAGE.

NOTE 'C' - EQUIPMENT MUST BE GROUNDED IN ACCORDANCE WITH NATIONAL ELECTRIC CODE (N.E.C.) TABLE 250-95.

NOTE 'D' - FUSED CONTROL TRANSFORMER (OPTIONAL) BUILT INTO STARTER. EXTRA CAPACITY IS PROVIDED FOR THE MAGNETIC UNLOADER SOLENOID ONLY. ADDITIONAL CAPACITY WILL BE REQUIRED FOR OTHER DEVICES. IF NO TRANSFORMER IS USED, CONNECTION IS PER DASHED LINE (SEE NOTE 'E')

NOTE 'E' - MOTOR CONTROL CIRCUITS MUST HAVE SHORT CIRCUIT PROTECTION IN ACCORDANCE WITH N.E.C. ARTICLE 430-72. CONTROL CIRCUITS SHALL HAVE SHORT CIRCUIT PROTECTION (FUSES, ETC.) IN ALL INSTANCES BECAUSE THE CONTROL CIRCUIT WIRING LEAVES THE STARTER ENCLOSURE TO GO TO THE EXTERNAL DEVICES.

NOTE 'F' - LOW VOLTAGE (50 TO 150 VOLT MAX. TO GROUND) CONTROL CIRCUITS MUST BE GROUNDED PER N.E.C. ARTICLE 250-5.

NOTE 'G' - WHEN THE CONTROL CIRCUIT VOLTAGE IS FROM A SEPARATE POWER (VOLTAGE) SOURCE AND IS NOT CONTROLLED BY THE MOTOR POWER SUPPLY DISCONNECTING MEANS, A DISCONNECT SWITCH (DS) INTERLOCK SHALL BE MOUNTED IMMEDIATELY ADJACENT TO THE MOTOR POWER SUPPLY DISCONNECTING MEANS AND WIRED AS SHOWN IN THE SCHEMATIC WIRING DIAGRAMS.

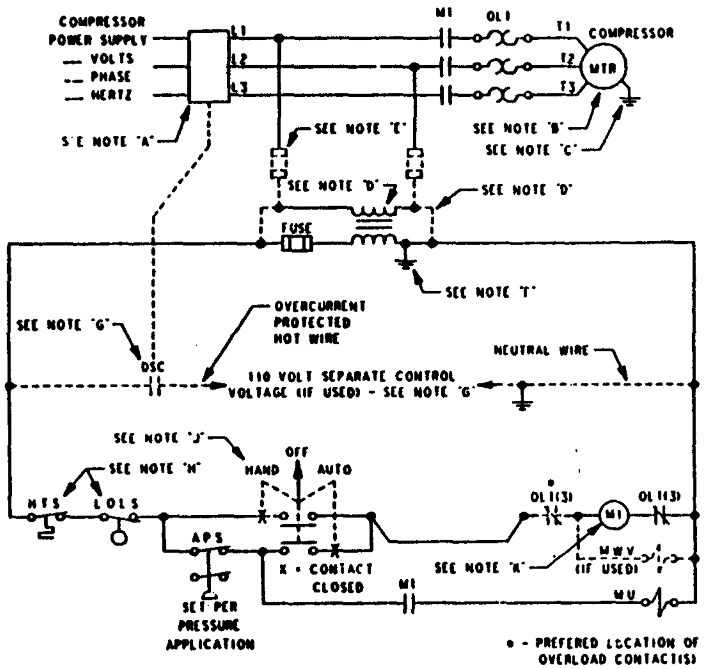
THIS INTERLOCKING DEVICE (DS) MAY BE AN AUXILIARY (AUX.) OR ELECTRICAL INTERLOCK (E.I.) CONTACT OPERATED BY THE HANDLE OF THE MOTOR POWER SUPPLY DISCONNECTING MEANS.

WHEN THIS DISCONNECT SWITCH (DS) INTERLOCK IS A SEPARATE DEVICE, IT SHALL BE USED TO TURN THE CONTROL CIRCUIT 'OFF' BEFORE OPERATING THE MOTOR POWER SUPPLY DISCONNECTING MEANS. SEE N.E.C. ARTICLE 430-74.

NOTE 'H' - HIGH AIR TEMPERATURE SWITCH OR LOW OIL LEVEL SWITCH PROTECTIVE SHUTDOWN DEVICE(S) MUST HAVE MANUAL RESET TO PREVENT AUTOMATIC RESTART AFTER A TROUBLE CONDITION SHUTDOWN.

NOTE 'J' - CONTROL SWITCH BUILT INTO STARTER.

NOTE 'K' - TYPICAL FULL VOLTAGE STARTER SHOWN WITH COIL TO O.L., O.L. TO L2 AND COIL TO INTERLOCK (HOLDING CONTACT) TERMINAL NO. 3 JUMPERS REMOVED. IN SOME INSTANCES IT MAY BE PREFERABLE TO REMOVE THESE FACTORY-WIRED JUMPERS BEFORE WIRING UNIT PER THE SCHEMATIC WIRING DIAGRAM.



DUAL CONTROL

• - PREFERED LOCATION OF OVERLOAD CONTACT(S) WHEN CONTROL CIRCUIT IS GROUNDED FOR LOW VOLTAGE CONTROL

202ASK546-A
(Ref. Drawing)

INSTALLATION AND MAINTENANCE INSTRUCTIONS

3-WAY MINIATURE SIZE SOLENOID VALVES
NORMALLY CLOSED, NORMALLY OPEN AND UNIVERSAL OPERATION
1/8 NPT – 3/64, 1/16, 3/32 AND 1/8 ORIFICE
BRASS AND STAINLESS STEEL CONSTRUCTION

BULLETIN
8320
ASCO
FORM NO. V6055

DESCRIPTION

Bulletin 8320 valves are 3-way, direct-acting, miniature size solenoid valves with all three pipe connections located in the valve body. Valves are of rugged brass or stainless steel construction. Standard valves have a General Purpose NEMA Type 1 Solenoid Enclosure. Valves may also be equipped with a solenoid enclorure which is designed to meet NEMA Type 4 — Watertight, NEMA Type 7 (C or D) Hazardous Locations — Class I, Groups C or D and NEMA Type 9 (E, F or G) Hazardous Locations — Class II, Groups E, F or G. Installation and Maintenance Instructions for the Explosion-Proof/Watertight Solenoid Enclosure are shown on Form No. V5391.

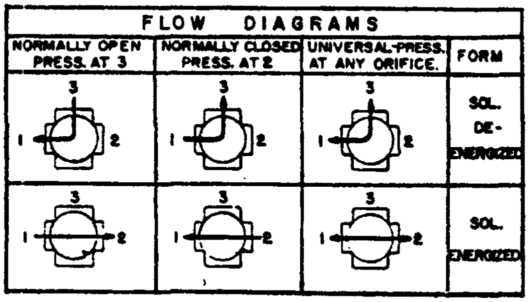
OPERATION

Normally Closed: Applies pressure when solenoid is energized; exhausts pressure when solenoid is de-energized. When solenoid is energized, flow is from Connection "2" to Connection "1." Connection "3" is closed. When solenoid is de-energized, flow is from Connection "1" to Connection "3." Connection "2" is closed.

Normally Open: Applies pressure when solenoid is de-energized; exhausts pressure when solenoid is energized. When solenoid is energized, flow is from Connection "1" to Connection "2." Connection "3" is closed. When solenoid is de-energized, flow is from Connection "3" to Connection "1." Connection "2" is closed.

Universal: For normally closed or normally open operation, selection or diversion of pressure can be applied to Connection "1," "2" or "3."

NOTE: To change from normally closed to normally open or universal operation, consult factory.



MANUAL OPERATOR (Optional)

Manual operator allows manual operation during an interruption of electrical power or when otherwise desired. Two types of manual operators are available — push type (Suffix MO) and screw type (Suffix MS). To operate valve manually with push type operator, push stem at base of valve body as far upward as possible. Valve will now be in the same position as when the solenoid is energized. Removing pressure from stem will release manual operator to original position. To operate valve with a screw type manual operator, rotate manual operator stem at base of valve body clockwise until it hits a stop. Valve will now be in the same position as when the solenoid is energized. Rotate manual operator stem fully counterclockwise before operating valve electrically.

INSTALLATION

Check nameplate for correct catalog number, pressure, voltage and service.

TEMPERATURE LIMITATIONS

For maximum valve ambient and fluid temperatures, refer to chart below. For higher ambient and fluid temperatures, consult factory. Check catalog number prefix and watt rating on nameplate to determine the maximum temperatures.

Construction	Watt Rating	Catalog Number Prefix	Coil Class	Maximum Ambient Temp.°F	Maximum Fluid Temp.°F
A-C Construction (Alternating Current)	6	None, DA or S	A	77	180
		DB, LB, SB DF, FT or SF	H or F	122	200
		HT	H	140	200
	9*	None, DP or SP	F	77	180
D-C Construction (Direct Current)	9.7	None, FT HT, LB, S or SF	A,F or H	77	120

*Catalog Nos. 8320B130, 8320B131, 8320B134, 8320B135, 8320B138, 8320B139, 8320A140, 8320A141, 8320A144, 8320A145, 8320A148 and 8320A149 are limited to a fluid temperature of 140°F.

POSITIONING

This valve is designed to perform properly when mounted in any position. However, for optimum life and performance, the solenoid should be mounted vertical and upright so as to reduce the possibility of foreign matter accumulating in the core tube area.

MOUNTING

For mounting dimensions of mounting bracket, refer to Figure 1.

PIPING

Connect piping or tubing to valve according to markings on valve body. Refer to flow diagrams provided. Apply pipe compound sparingly to male pipe threads only; if applied to valve threads, it may enter the valve and cause operational difficulty. Pipe strain should be avoided by the proper support and alignment of piping. When tightening the connections, do not use the valve body or solenoid as a lever. Wrenches applied to valve body or piping are to be located as close as possible to connection point.

IMPORTANT: For the protection of the solenoid valve, install a strainer or filter suitable for the service involved in the inlet side as close to the valve as possible. Periodic cleaning is required depending on service conditions. See Bulletins 8600, 8601 and 8602 for strainers.

WIRING

Wiring must comply with Local and National Electrical Codes. Housings for all solenoids are provided with accommodations or connections for 1/2 inch conduit. The general purpose solenoid enclosure may be rotated to facilitate wiring by removing the retaining cap or clip. CAUTION: When metal retaining clip disengages, it will spring upward. Rotate solenoid enclosure to desired position. Replace retaining cap or clip before operating.

NOTE: Alternating current (A-C) and direct current (D-C) solenoids are built differently. To convert from one to the other, it is necessary to change the complete solenoid, including the plugnut/core tube sub-assembly and core assembly.

SOLENOID TEMPERATURE

Standard catalog valves are supplied with coils designed for continuous duty service. When the solenoid is energized for a long period, the solenoid enclosure becomes hot and can be touched with the hand only for an instant. This is a safe operating temperature. Any excessive heating will be indicated by the smoke and odor of burning coil insulation.

MAINTENANCE

WARNING: Turn off electrical power supply and depressurize valve before making repairs. It is not necessary to remove the valve from the pipe line for repairs.

CLEANING

A periodic cleaning of all solenoid valves is desirable. The time between cleanings will vary depending on medium and service conditions. In general, if the voltage to the coil is correct, sluggish valve operation, excessive noise or leakage will indicate that cleaning is required. Clean valve strainer or filter when cleaning solenoid valve.

PREVENTIVE MAINTENANCE

1. Keep the medium flowing through the valve as free from dirt and foreign material as possible.
2. While in service, operate the valve at least once a month to insure proper opening and closing.
3. Periodic inspection (depending on medium and service conditions) of internal valve parts for damage or excessive wear is recommended. Thoroughly clean all parts. Replace any parts that are worn or damaged.

IMPROPER OPERATION

1. **Faulty Control Circuit:** Check the electrical system by energizing the solenoid. A metallic click signifies the solenoid is operating. Absence of the click indicates loss of power supply. Check for loose or blown-out fuses, open-circuited or grounded coil, broken lead wires or splice connections.
2. **Burned-Out Coil:** Check for open-circuited coil. Replace coil, if necessary.
3. **Low Voltage:** Check voltage across the coil leads. Voltage must be at least 85% of nameplate rating.
4. **Incorrect Pressure:** Check valve pressure. Pressure to valve must be within range specified on nameplate.
5. **Excessive Leakage:** Disassemble valve and clean all parts. Replace worn or damaged parts with a complete Spare Parts Kit for best results.

COIL REPLACEMENT (Refer to Figure 1)

Turn off electrical power supply and disconnect coil lead wires. Proceed in the following manner:

1. Remove retaining cap or clip, nameplate and cover. CAUTION: When metal retaining clip disengages, it will spring upward.
2. Slip the yoke containing the coil, sleeves and insulating washers off the plugnut/core tube sub-assembly. Insulating washers (2) are omitted when a molded coil is used.
3. Slip coil, sleeves and insulating washers from yoke.
4. Reassemble in reverse order of disassembly paying careful attention to exploded view provided for identification and placement of parts.

CAUTION: Solenoid must be fully reassembled as the housing and internal parts are part of and complete the magnetic circuit. Place an insulating washer at each end of coil, if required.

VALVE DISASSEMBLY

Depressurize valve and turn off electrical power supply. Proceed in the following manner:

1. Remove retaining cap or clip and slip the entire solenoid enclosure off the plugnut/core tube sub-assembly. CAUTION: When metal retaining clip disengages, it will spring upward. NOTE: For valve with an Explosion-Proof/Watertight Solenoid Enclosure, the solenoid may be removed as a complete unit by unscrewing the solenoid base sub-assembly.
2. Unscrew valve bonnet with special wrench adapter provided in the Spare Parts Kit (special wrench adapter Order No. 158-477-1).
3. Remove plugnut/core tube sub-assembly with valve bonnet and bonnet gasket attached.
4. Remove core spring, core assembly and body gasket.
5. Unscrew end cap or manual operator assembly and remove disc spring, disc, disc holder and body gasket.
6. All parts are now accessible for cleaning or replacement. Replace worn or damaged parts with a complete Spare Parts Kit for best results.

..VE REASSEMBLY

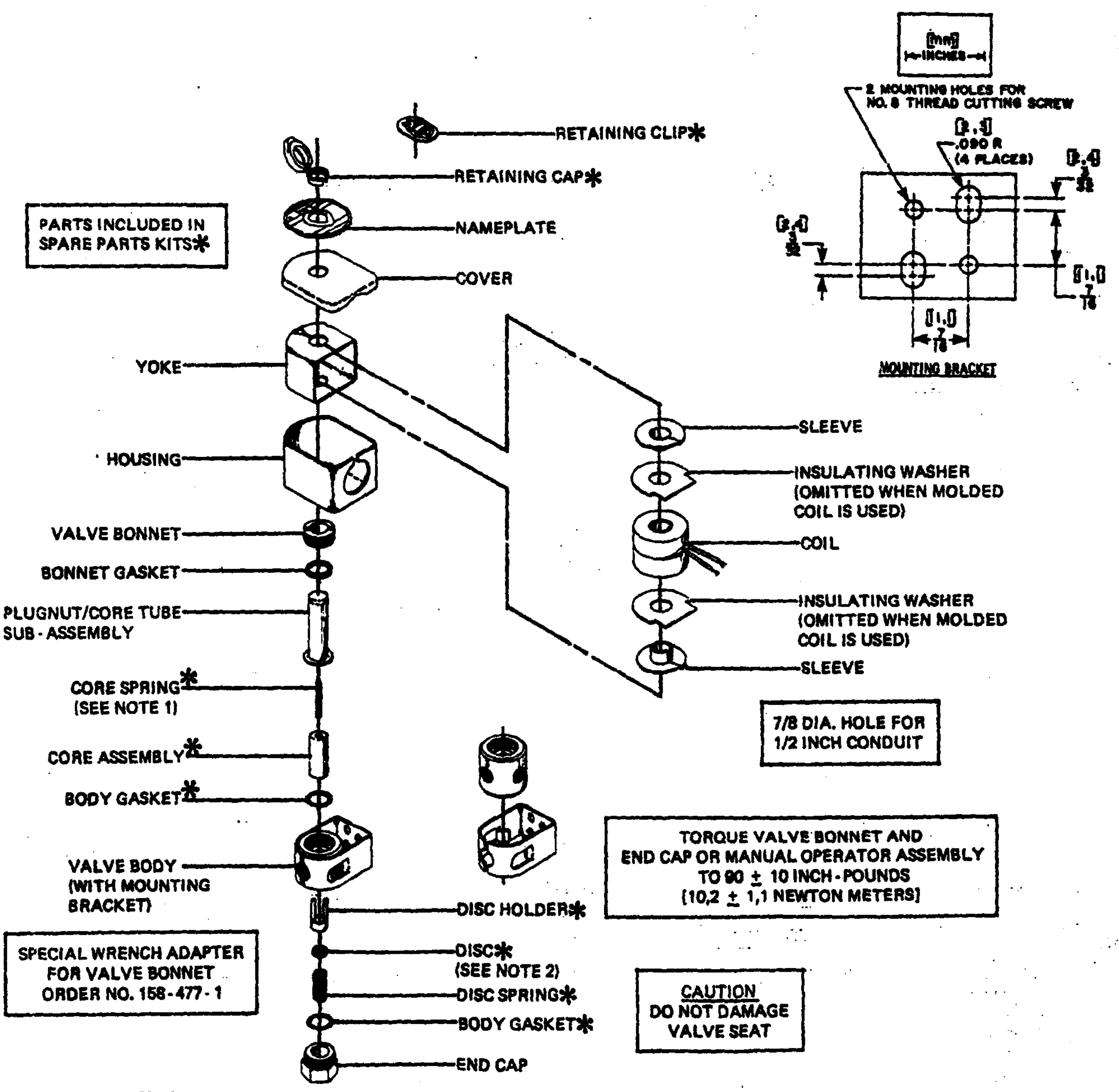
..eassemble in reverse order of disassembly paying careful attention to ..xploded view provided for identification and placement of parts.
..ubricate all gaskets with Dow Corning Corporation's MOLYKOTE® 111 compound or an equivalent high grade silicone grease.
Replace disc holder, disc, disc spring, body gasket and end cap. IMPORTANT: Some valves have a disc with a conical point on one side. Be sure conical point on disc faces orifice in valve body. Torque end cap (or manual operator assembly) to 90 ± 10 inch-pounds [10,2 ± 1,1 newton meters].
Replace body gasket and install core spring into core assembly. Install wide end of core spring into core assembly first, closed end protrudes from top of core assembly.
Position core assembly and core spring into plugnut/core tube subassembly. Install plugnut/core tube sub-assembly with core assembly and core spring in valve body. Torque valve bonnet to 90 ± 10 inch-pounds [10,2 ± 1,1 newton meters].

6. Replace solenoid enclosure and retaining cap or clip. NOTE: For valves with an Explosion-Proof/Watertight Solenoid Enclosure, the solenoid may be assembled as a complete unit.
7. After maintenance, operate the valve a few times to be sure of proper operation.

SPARE PARTS KITS

Spare Parts Kits and Coils are available for ASCO valves. Parts marked with an asterisk (*) are supplied in Spare Parts Kits.

ORDERING INFORMATION FOR SPARE PARTS KITS
When Ordering Spare Parts Kits or Coils, Specify Valve Catalog Number, Serial Number and Voltage.



PARTS INCLUDED IN SPARE PARTS KITS*

7/8 DIA. HOLE FOR 1/2 INCH CONDUIT

TORQUE VALVE BONNET AND END CAP OR MANUAL OPERATOR ASSEMBLY TO 90 ± 10 INCH-POUNDS [10,2 ± 1,1 NEWTON METERS]

SPECIAL WRENCH ADAPTER FOR VALVE BONNET ORDER NO. 158-477-1

CAUTION
DO NOT DAMAGE VALVE SEAT

NOTES:
1. INSTALL WIDE END OF CORE SPRING IN CORE ASSEMBLY FIRST. CLOSED END OF CORE SPRING PROTRUDES FROM TOP OF CORE ASSEMBLY.
2. IF DISC HAS A CONICAL POINT ON ONE SIDE, BE SURE CONICAL POINT ON DISC FACES ORIFICE IN VALVE BODY.

Bulletin 8320
General Purpose Solenoid Enclosure Shown.
For Explosion-Proof Solenoid Enclosure, See Form No. V-5391.

Figure 1.

INSTALLATION AND MAINTENANCE

Supersedes GEH-2301K, GEI-56122C

SINGLE AND POLYPHASE BALL BEARING MOTORS

All Enclosures

Frames 143-449

SAFE MOTOR OPERATION

WARNING:

High voltage and rotating parts of electrical machinery can cause serious or fatal injury. Its installation, operation and maintenance should be performed by qualified personnel only. Familiarization with NEMA MG2 Safety Standard for Construction and Guide for Selection, Installation and Use of Fractional and Integral HP Motors and Generators, the National Electrical Code and sound local practices is recommended.

For equipment covered by these instructions, it is important to observe safety precautions to protect personnel from possible injury. Personnel should be instructed to:

Avoid contact with energized circuits. Disconnect all power sources before attempting maintenance or repair.

Avoid contact with rotating parts and be sure that shaft key is fully captive before motor is energized.

Avoid contact with the start or run capacitors in single-phase motors until a safe discharge procedure has been followed.

Act with care and in accordance with prescribed procedures in handling, lifting, installing, operating and maintaining the equipment. Do not lift motor and driven equipment with motor lifting means. If eyebolts are used for lifting motors, they must be securely tightened, and the direction of the lift must not exceed 15-degree angle with the shank of the eyebolt.

Do not use motors with automatic-reset thermal protection where unexpected starting of equipment might be hazardous to personnel. Provide proper safeguards for personnel against possible failure of motor-mounted brake, particularly on applications involving over-hauling loads.

Safe maintenance practices and qualified personnel are imperative. Before initiating maintenance procedures, be sure that all power sources are disconnected from the machine and accessories to avoid electric shock and personal injury from rotating parts. If a high-potential insulation test is required, procedures and precautions outlined in NEMA Standards MG1 should be followed.

FAILURE TO PROPERLY GROUND MOTOR MAY CAUSE SERIOUS INJURY TO PERSONNEL. GROUNDING SHOULD BE IN ACCORDANCE WITH THE NATIONAL ELECTRICAL CODE AND CONSISTENT WITH SOUND LOCAL PRACTICE.

INSTALLATION

1. LOCATION

a. **Dripproof Motors** are designed for installation in a well ventilated place where the atmosphere is reasonably free of dirt and moisture.

b. **Standard Enclosed Motors** are designed for installation where motor may be exposed to dirt, moisture and most outdoor conditions.

c. **Severe-duty Enclosed Motors** are designed for installation in highly corrosive or excessively moist atmospheres.

d. **Explosion-Proof Motors** bearing the Underwriters' Laboratories label designating the motor U/L Class and Group as defined in the National Electrical Code are designed for operation in areas classified by local authorities as hazardous in accordance with standards set forth in that Code.

2. MOUNTING

a. **Mount motors** securely on a firm, flat base. Grout in larger motors, if necessary. Ball-bearing motors, except vertical high-thrust motors, can be sidewall or ceiling mounted. Ball bearing motors, up to and including 360-frame diameter, can be vertically mounted. The standard transition and/or sliding bases are suitable for floor mounting. For other locations, check the factory for base recommendations.

Remove drain plugs from the frame of enclosed motors used outdoors or in other high moisture area.

b. Align motors accurately. For direct drive, use flexible couplings if possible. For drive recommendations, consult drive or equipment manufacturers or the General Electric Company.

c. Mounting bolts must be carefully tightened to prevent changes in alignment and possible damage to the equipment. It is recommended that a washer be used under each nut or bolt head to get a secure hold on the motor feet; or, as an alternate, flanged nuts or bolts may be used. The recommended tightening torques (for medium carbon steel bolts, identified by three radial lines at 120 degrees on the head are:

Bolt Size	Recommended Torque (Ft-lb) Minimum	Maximum
⅜	25	37
½	60	90
⅝	120	180
¾	210	320

d. Tighten belts only enough to prevent slippage. Belt speed should not exceed 5000 ft. per min.

e. The application of pulleys, sheaves, sprockets and gears on motor shafts is shown in NEMA MG1-14.07. The application of the V-belt dimensions to alternating-current motors is shown in MG1-14.42A. (see Table). V-belt sheave pitch diameters should not be less than the values shown in table at right.

Sheave ratios greater than 5:1 and center-to-center distances less than the diameter of the large sheave should be referred to the Company.

3. POWER SUPPLY & CONNECTIONS

a. **Nameplate** voltage and frequency should agree with power supply. Motor will operate satisfactorily on line voltage within 10% of nameplate value; or frequency within 5% combined variation not to exceed 10%.

b. **Dual voltage motors** can be connected for the desired voltage by following instructions on nameplate or connection diagram.

V-belt sheave Pitch Diameters

Horsepower				V-Belt Sheave, Minimum Diameter, Inches	
Synchronous Speed, RPM				Conventional A, B, C, D, E*	Narrow 3V, 5V, 8V+
3600	1800	1200	900	Pitch Diameter	Outside Dia.
1½	1	¾	½	2.2	2.2
2-3	1½-2	1	¾	2.4	2.4
—	3	1½	1	2.4	2.4
—	—	2	1½	2.4	2.4
5	—	—	—	2.6	2.4
7½-10	5-7½	3-5	2-3	3.0	3.0
15	10	7½	5	3.8	3.8
20-25	15	10	7½	4.4	4.4
	20	15	10	4.6	4.4
	25	-	—	5.0	4.4
	30	20	15	5.4	5.2
	40	25	20	6.0	6.0
	50	30-40	25-30	6.8	6.8
	60	—	—	7.4	7.4
	—	50	40	8.2	8.2
	75	—	—	9.0	8.6
	—	60	—	9.0	8.0
	—	—	50	9.0	8.4
	100	—	—	10	8.6
	—	75	60	10	10
	125	—	—	11.5	10.5
	—	100	—	11	10
	—	—	75	10.5	9.5
	150	—	—	—	9.5
	—	125	100	12.5	12
	200	—	—	—	13.2

* Max sheave width = 2(N-W) - 1/4". (N—W is approximate usable shaft length.)

+ Maximum sheave width = N—W.

c. **Wiring** of motor and control, overload protection and grounding should be in accordance with National Electrical Code and local building codes.

If wire size is selected from the following table, single-phase motor performance will not be adversely affected by voltage drop in the branch circuit.

GENERAL ELECTRIC

Individual Branch Circuits for Single-Phase Motor						
Motor HP	Volts	Max * Fuse Amps	Minimum wire gauge no. for branch circuit lengths indicated			
			0-50 ft *	100 ft.	200 ft.	500 ft
¼	230	25	14	12	10	6
	115	45	12	8	6	2
1	230	25	14	14	12	8
	115	50	12	8	6	—
1½	230	30	14	12	10	6
	115	60	10	6	4	—
2	230	40	14	12	8	4
	115	80	10	6	—	—
3	230	60	12	10	8	4
	115	110	8	8	—	—
5	230	90	10	8	6	2
7½	230	125	8	6	—	—
10	230	150	6	6	—	—

*Values based on National Electrical Code.

4. THERMAL PROTECTORS

a. the words "**Thermally Protected**" on the nameplate identify motors having built in protection against dangerous overheating.

Manual reset protectors are reset after motor cools by pressing external reset button.

Automatic reset protectors (no external button) reset automatically after motor cools.

WARNING: Where unexpected starting would be dangerous, do not use automatic reset protection.

OPERATION

a. If the motor has been stored in a damp location, **dry out** thoroughly before operating. Do not exceed a temperature of 85°C (185 F) in drying.

b. **Operate no-load** to check rotation and for free running. To reverse rotation: three-phase, interchange two line leads; two-phase, interchange leads T_1 and T_3; one-phase, follow the connection nameplate or label on the motor.

c. **Operate under load** for an initial period of at least one hour to observe whether any unusual noise or hot spots develop.

d. **Check** the operating current against the nameplate current. Do not exceed the value of nameplate amperes times service factor (if any) under steady continuous load.

MAINTENANCE

1. INSPECTION

a. **Inspect** motor at regular intervals. Keep motor clean and ventilating openings clear.

2. LUBRICATION

a. **Ball bearing motors** are adequately lubricated at the factory. Motors with regreasing facilities should be relubricated at intervals consistent with the type of service (see table) to provide maximum bearing life. Excessive or too frequent lubrication may damage the motor.

b. **Relubricate** with General Electric D6-A2C5 grease unless special grease is specified on nameplate. Relubricate while warm with the shaft stationary for safety and best purging of old grease.

WARNING. If relubrication is performed with the motor running, stay clear of rotating parts.

c. **On drive end** - Insert the lubrication fitting on motors with pipe plugs. Remove the other plug for grease relief on all motors. Clean grease relief opening of any hardened grease. Be sure fittings are clean and free of dirt. Using a low-pressure hand-operated grease gun, pump in clean recommended grease until new grease appears at the relief hole. After relubricating, allow the motor to run for ten minutes before replacing relief plug.

d. **On opposite drive end** — For dripproof motors, follow the same procedures as for the drive end. For totally enclosed fan-cooled motors:

Frames 182-326 — Remove caps on the fan cover for access to the grease plugs. Follow the greasing procedure for the drive end.

Frames 364-449 — Follow the procedure for the drive end except that the grease relief pipe extending through the fan cover acts as a reservoir for purged grease should be removed occasionally during regreasing. Run the motor for 20 minutes after regreasing before replacing the pipe.

e. **Motors not having pipe plugs or grease fittings in bearing housings** can be relubricated by removing endshields from motor, cleaning grease cavity and refilling the cavity with recommended grease.

CAUTION: Bearing and grease must be kept free of dirt.

3. EXPLOSION—PROOF MOTORS

a. **Explosion-proof motors** contain special features and are manufactured in accordance with U/L and carry their label. Therefore, it is recommended that repairs be made at a General Electric Apparatus Service Shop which has been authorized to make such repairs.

4. MOTOR WINDINGS

a. **To clean**, use a soft brush and, if necessary, a slow-acting solvent in a well-ventilated room.

Type of Service	Typical Examples	Hp Range	Relubrication Interval	
			Horizontal	Vertical
Easy	Valves; door openers; portable floor sanders; motors operating infrequently (1 hour per day)	½-7½ 10-40 50-150 200-350	10 yrs 7 yrs 4 yrs 3 yrs	9 yrs 3 yrs 1½ yrs 9 mos
Standard	Machine tools, air-conditioning apparatus; conveyors, 1 or 2 shifts; garage compressors; refrigeration machinery; laundry machinery; textile machinery; oil-well pumps; wood-working machinery.	½-7½ 10-40 50-150 200-350	7 yrs 4 yrs 1½ yrs 1 yr	3 yrs 1 yr 6 mos 3 mos
Severe	Motors for fans, M-G sets, etc., that run 24 hours per day, 365 days per year, coal and mining machinery; motors subject to severe vibration; steel-mill service.	½-7½ 10-40 50-150 200-350	4 yrs 1½ yrs 9 mos 6 mos	1½ yrs 6 mos 3 mos 1½ mos
Very Severe	Dirty, vibrating applications; where end of shaft is hot (pumps and fans); high ambient.	½-7½ 10-40 50-150 200-350	9 mos 4 mos 4 mos 3 mos	6 mos 3 mos 2 mos 1 mo

SERVICE

Your GE motor should be serviced only by qualified persons who have the proper tools and equipment. Fast, dependable in-warranty or out-of-warranty service for your motor can be obtained from any of General Electric's nationwide network of authorized Electric Motor Servicenters. Consult the Yellow Pages of your telephone directory for the Servicenter nearest you.

Special Additional Instructions For Vertical "P" Base Motors

> Warning: Lifting devises are normally intended to be used in handling the motor only, and are not intended to lift the combined weight of the motor and its connected load. However, if a spreader bar is used to provide parallel lifting forces in line with the axis of the motor and precaution is used to avoid shock loading, connected loads not exceeding 200 percent of the motor weight can normally be safely handled with the motor lifing devices.

Normal-Thrust Motors

Normal-thrust motors utilize heavy-duty, deep-groove ball bearings which are suitable for some continuous up or down axial-thrust load. Since overloading greatly reduces bearing life, th amount of thrust applied should not exceed the recommended values.

End-Play Adjustment

Standard high-thrust motors are designed to withstand only momentary up-thrust. This up-thrust, which can exist for a few seconds during starting, is taken by the guide (upper) bearing. To prevent the thrust (lower) bearing from losing radial stability during this time, the motor end play is limited to a few thousandths of an inch by shims inserted in the housing above the guide bearing. This adjustment is made at the factory and need not be disturbed on a new motor. However, should the motor be disassembled for any reason, the adjustment must be made upon reassembly to avoid damaging the bearings. Whenever these motors are reassembled, the shims should be replaced and the end play checked to see that it falls within the allowable 0.005 to 0.007 inch.

Special Additional Instructions For Wound Rotor Motors (Types M and MR)

Collector Rings

Before putting a wound rotor motor into service, be sure that the collector rings are clean and have a polished surface. The brushes should be set down on the collector surfaces with a good fit.

The brushes should move freely in the holder and at the same time make firm, even contact with the collector rings. When installing a new brush, fit it carefully to the collector ring. Be sure that the pigtail conductors are securely fastened to and make good contact with the brush holder.

Maintenance

Collector rings, brushes, brush holders and brush studs should be examined for wear and dust accumulation at regular intervals. Ordinarily, the rings will require only occasional wiping using a piece of canvas or non-linting cloth. Do not let dust or dirt, and particularly carbon dust, accumulate on the brush holders, rings or the collector shell. Continuously rated wound rotor motors should be inspected every three months and short-time rated motors every six months.

GENERAL ELECTRIC

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

GENERAL ELECTRIC COMPANY • Motor Business Group • 2000 Taylor Street • Fort Wayne, IN 46801-2205

Installation & Maintenance Instructions

ASCO Red-Hat II™

OPEN-FRAME, GENERAL PURPOSE, WATERTIGHT/EXPLOSIONPROOF SOLENOIDS

SERIES 8003G 8202G

Form No.V6584R3

—SERVICE NOTICE—

ASCO® solenoid valves with design change letter "G" in the catalog number (example: 8210G 1) have an epoxy encapsulated ASCO® Red Hat II® solenoid. This solenoid replaces some of the solenoids with metal enclosures and open-frame constructions. Follow these installation and maintenance instructions if your valve or operator uses this solenoid.

DESCRIPTION

Catalog numbers 8003G and 8202G are epoxy encapsulated pull-type solenoids. The green solenoid with lead wires and 1/2" conduit connection is designed to meet Enclosure Type 1-General Purpose, Type 2-Dripproof, Types 3 and 3S-Raintight, and Types 4 and 4X-Watertight. The black solenoid on catalog numbers prefixed "EF" is designed to meet Enclosure Types 3 and 3S-Raintight, Types 4 and 4X-Watertight, Types 6 and 6P-Submersible, Type 7 (A, B, C, & D) Explosionproof Class I, Groups A, B, C, & D and Type 9 (E, F, & G)-Dust-Ignitionproof Class II, Groups E, F, & G. The Class II, Groups F & G Dust Locations designation is not applicable for solenoids or solenoid valves used for steam service or when a class "H" solenoid is used. See *Temperature Limitations* section for solenoid identification and nameplate/retainer for service. When installed just as a solenoid and not attached to an ASCO valve, the core has a 0.250-28 UNF-2B tapped hole, 0.38 or 0.63 minimum full thread.

Catalog numbers 8202G1, 8202G3, 8202G5 and 8202G7 are epoxy encapsulated push-type, reverse-acting solenoids having the same enclosure types as previously stated for Catalog numbers 8003G1 and 8003G2

Series 8003G and 8202G solenoids are available in:

- **Open-Frame Construction:** The green solenoid may be supplied with 1/4" spade, screw, or DIN terminals. (Refer to Figure 4)
- **Panel Mounted Construction:** These solenoids are specifically designed to be panel mounted by the customer through a panel having a .062 to .093 maximum wall thickness. Refer to Figure 1 and section on *Installation of Panel Mounted Solenoid.*

Optional Features For Type 1 - General Purpose Construction Only

- **Junction Box:** This junction box construction meets Enclosure Types 2,3,3S,4, and 4X. Only solenoids with 1/4" spade or screw terminals may have a junction box. The junction box provides a 1/2" conduit connection, grounding and spade or screw terminal connections within the junction box (See Figure 5).
- **DIN Plug Connector Kit No.K236-034:** Use this kit only for solenoids with DIN terminals. The DIN plug connector kit provides a two pole with grounding contact DIN Type 43650 construction (See Figure 6).

OPERATION

Series 8003G - When the solenoid is energized, the core is drawn into the solenoid base sub-assembly. IMPORTANT: **When the solenoid is de-energized, the initial return force for the core, whether developed by spring, pressure, or weight, must exert a minimum force to overcome residual magnetism created by the solenoid. Minimum return force for AC Construction is 11 ounces, and 5 ounces for DC construction.**

Series 8202G - When the solenoid is energized, the disc holder assembly seats against the orifice. When the solenoid is de-energized, the disc holder assembly returns. IMPORTANT: **Initial return force for the disc or disc holder assembly, whether developed by spring, pressure, or weight, must exert a minimum force to overcome residual magnetism created by the solenoid. Minimum return force is 1 pound, 5 ounces.**

INSTALLATION

Check nameplate for correct catalog number, service, and wattage. Check front of solenoid for voltage and frequency.

⚠ WARNING: To prevent the possibility of electrical shock from the accessibility of live parts, install the open-frame solenoid in an enclosure.

For Black Enclosure Types 7 and 9 Only

⚠ CAUTION: **To prevent fire or explosion, do not install solenoid and/or valve where ignition temperature of hazardous atmosphere is less than 165° C. On valves used for steam service or when a class "H" solenoid is used, do not install in hazardous atmosphere where ignition temperature is less than 180°C. See nameplate/retainer for service.**

NOTE: These solenoids have an internal non-resetable thermal fuse to limit solenoid temperature in the event that extraordinary conditions occur which could cause excessive temperatures. These conditions include high input voltage, a jammed core, excessive ambient temperature or a shorted solenoid, etc. This unique feature is a standard feature only in solenoids with black explosionproof/dust-ignitionproof enclosures (Types 7 & 9).

IMPORTANT: **To protect the solenoid valve or operator, install a strainer or filter, suitable for the service involved in the inlet side as close to the valve or operator as possible. Clean periodically depending on service conditions. See ASCO Series 8600, 8601, and 8602 for strainers.**

Temperature Limitations

For maximum valve ambient temperatures, refer to chart. The temperature limitations listed, only indicate maximum application temperatures for field wiring rated at 90°C. Check catalog number prefix and watt rating on nameplate to determine maximum ambient temperature. See valve installation and maintenance instructions for maximum fluid temperature. NOTE: For steam service, refer to *Wiring* section, *Junction Box* for temperature rating of supply wires.

Temperature Limitations For Series 8003G or 8202G Solenoids for use on Valves Rated at 10.1, 11.6, 17.1, or 22.6 Watts

Watt Rating	Catalog Number Coil Prefix	Class of Insulation	Maximum † Ambient Temp. °F
10.1 & 17.1	None, FB, KF, KP SC, SD, SF, & SP	F	125
10.1 & 17.1	HB, HT, KB, KH, SS, ST, SU,	H	140
11.6 & 22.6	None, FB,KF, KP, SC, SD, SF, & SP	F	104
11.6 & 22.6	HP, HT, KB, KH, SS, ST, SU, & SV	H	104

† Minimum ambient temperature -40° F (-40° C).

Positioning

This solenoid is designed to perform properly when mounted in any position. However, for optimum life and performance, the solenoid should be mounted vertically and upright to reduce the possibility of foreign matter accumulating in the solenoid base sub-assembly area.

Wiring

Wiring must comply with local codes and the National Electrical Code. All solenoids supplied with lead wires are provided with a grounding wire which is green or green with yellow stripes and a 1/2" conduit connection. To facilitate wiring, the solenoid may be rotated 360°. For the watertight and explosionproof solenoid, electrical fittings must be approved for use in the approved hazardous locations.

Additional Wiring Instructions For Optional Features:

- **Open-Frame solenoid with 1/4" spade terminals.**

For solenoids supplied with screw terminal connections use #12-18 AWG stranded copper wire rated at 90°C or greater. Torque terminal block screws to 10 ± 2 in-lbs [1,0 ± 1,2 Nm]. A tapped hole is provided in the solenoid for grounding, use a #10-32 machine screw. Torque grounding screw to 15 - 20 in-lbs [1,7 - 2,3 Nm]. On solenoids with screw terminals, the socket head screw holding the terminal block to the solenoid is the grounding screw. Torque the screw to 15 - 20 in-lbs [1,7 - 2,3 Nm] with a 5/32" hex key wrench.

- **Junction Box**

The junction box is used with spade or screw terminal solenoids only and is provided with a grounding screw and a 1/2" conduit connection. Connect #12-18 AWG standard copper wire only to the screw terminals. Within the junction box use field wire that is rated 90°C or greater for connections. For steam service use 105°C rated wire up to 50 psi or use 125°C rated wire above 50 psi. After electrical hookup, replace cover gasket, cover, and screws. Tighten screws evenly in a crisscross manner.

- **DIN Plug Connector Kit No.K236-034**

1. The open-frame solenoid is provided with DIN terminals to accommodate the plug connector kit.
2. Remove center screw from plug connector. Using a small screwdriver, pry terminal block from connector cover.
3. Use #12-18 AWG stranded copper wire rated at 90°C or greater for connections. Strip wire leads back approximately 1/4" for installation in socket terminals. The use of wire-end sleeves is also recommended for these socket terminals. Maximum length of wire-end sleeves to be approximately 1/4". Tinning of the ends of the lead wires is not recommended.
4. Thread wire through gland nut, gland gasket, washer, and connector cover.

NOTE: Connector housing may be rotated in 90° increments from position shown for alternate positioning of cable entry.

5. Check DIN connector terminal block for electrical markings. Then make electrical hookup to terminal block according to markings on it. Snap terminal block into connector cover and install center screw.
6. Position connector gasket on solenoid and install plug connector. Torque center screw to 5 ± 1 in-lbs [0,6 ± 1,1 Nm].

NOTE: Alternating current (AC) and direct current (DC) solenoids are built differently. To convert from one to the other, it may be necessary to change the complete solenoid including the core and solenoid base sub-assembly, not just the solenoid. Consult ASCO.

Installation of Solenoid

Solenoids may be assembled as a complete unit. Tightening is accomplished by means of a hex flange at the base of the solenoid.

Installation of Panel Mounted Solenoid (See Figure 1)

1. Disassemble solenoid following instruction under *Solenoid Replacement* then proceed.
2. Install solenoid base sub-assembly through customer panel.
3. Position finger spring washer on opposite side of panel over solenoid base sub-assembly.
4. Replace solenoid, nameplate/retainer and red cap.
5. Make electrical hookup, see *Wiring* section.

Solenoid Temperature

Standard solenoids are designed for continuous duty service. When the solenoid is energized for a long period, the solenoid becomes hot and can be touched by hand only for an instant. This is a safe operating temperature.

MAINTENANCE

⚠ WARNING: To prevent the possibility of personal injury or property damage, turn off electrical power, depressurize solenoid operator and/or valve, and vent fluid to a safe area before servicing.

Cleaning

All solenoid operators and valves should be cleaned periodically. The time between cleaning will vary depending on medium and service conditions. In general, if the voltage to the solenoid is correct, sluggish valve operation, excessive noise or leakage will indicate that cleaning is required. Clean strainer or filter when cleaning the valve.

Preventive Maintenance

- Keep the medium flowing through the solenoid operator or valve as free from dirt and foreign material as possible.
- While in service, the solenoid operator or valve should be operated at least once a month to insure proper opening and closing.
- Depending on the medium and service conditions, periodic inspection of internal valve parts for damage or excessive wear is recommended. Thoroughly clean all parts. Replace any worn or damaged parts.

Causes of Improper Operation

- **Faulty Control Circuit:** Check the electrical system by energizing the solenoid. A metallic *click* signifies that the solenoid is operating. Absence of the *click* indicates loss of power supply. Check for loose or blown fuses, open-circuited or grounded solenoid, broken lead wires or splice connections.
- **Burned-Out Solenoid:** Check for open-circuited solenoid. Replace if necessary. Check supply voltage; it must be the same as specified on nameplate/retainer and marked on the solenoid. Check ambient temperature and check that the core is not jammed.
- **Low Voltage:** Check voltage across the solenoid leads. Voltage must be at least 85% of rated voltage.

Solenoid Replacement

1. Disconnect conduit, coil leads, and grounding wire.

NOTE: Any optional parts attached to the old solenoid must be reinstalled on the new solenoid. For 3-way construction, piping or tubing must be removed from pipe adapter.

2. Disassemble solenoids with optional features as follows:

- **Spade or Screw Terminals**
  Remove terminal connections, grounding screw, grounding wire, and terminal block (screw terminal type only).

NOTE: For screw terminals, the socket head screw holding the terminal block serves as a grounding screw.

- **Junction Box**
  Remove conduit and socket head screw (use 5/32" hex key wrench) from center of junction box. Disconnect junction box from solenoid.
- **DIN Plug Connector**
  Remove center screw from DIN plug connector. Disconnect DIN plug connector from adapter. Remove socket head screw (use 5/32" hex key wrench), DIN terminal adapter, and gasket from solenoid.

3. Snap off red cap from top of solenoid base sub-assembly. For 3-way construction with pipe adapter (Figure 3), remove pipe adapter, nameplate and solenoid. Omit steps 4 and 5.
4. Push down on solenoid. Then using a suitable screwdriver, insert blade between solenoid and nameplate/retainer. Pry up slightly and push to remove.

NOTE: Series 8202G solenoids have a spacer between the nameplate/retainer and solenoid.

5. Remove solenoid from solenoid base sub-assembly.
6. Reassemble in reverse order of disassembly. Use exploded views for identification and placement of parts.
7. Torque pipe adapter to 90 inch-pounds maximum [10,2 Nm maximum]. Then make up piping or tubing to pipe adapter on solenoid.

Disassembly and Reassembly of Solenoids

1. Remove solenoid, see *Solenoid Replacement.*
2. Remove finger spring washer form solenoid base sub-assembly. For 3-way construction, remove plugnut gasket.
3. Unscrew solenoid base sub-assembly from valve body.
4. Remove internal solenoid parts for cleaning or replacement. Use exploded views for identification and placement of parts.
5. If the solenoid is part of a valve, refer to basic valve installation and maintenance instructions for further disassembly.
6. Torque solenoid base sub-assembly and adapter to 175±25 in-lbs [19,8±2,8 Nm].

ORDERING INFORMATION FOR ASCO SOLENOIDS

When Ordering Solenoids for ASCO Solenoid Operators or Valves, order the number stamped on the solenoid. Also specify voltage and frequency.

Torque Chart

Part Name	Torque Value in Inch-Pounds	Torque Value in Newton-Meters
solenoid base sub-assembly/adapter	175 ± 25	19,8 ± 2,8
pipe adapter	90 maximum	10,2 maximum

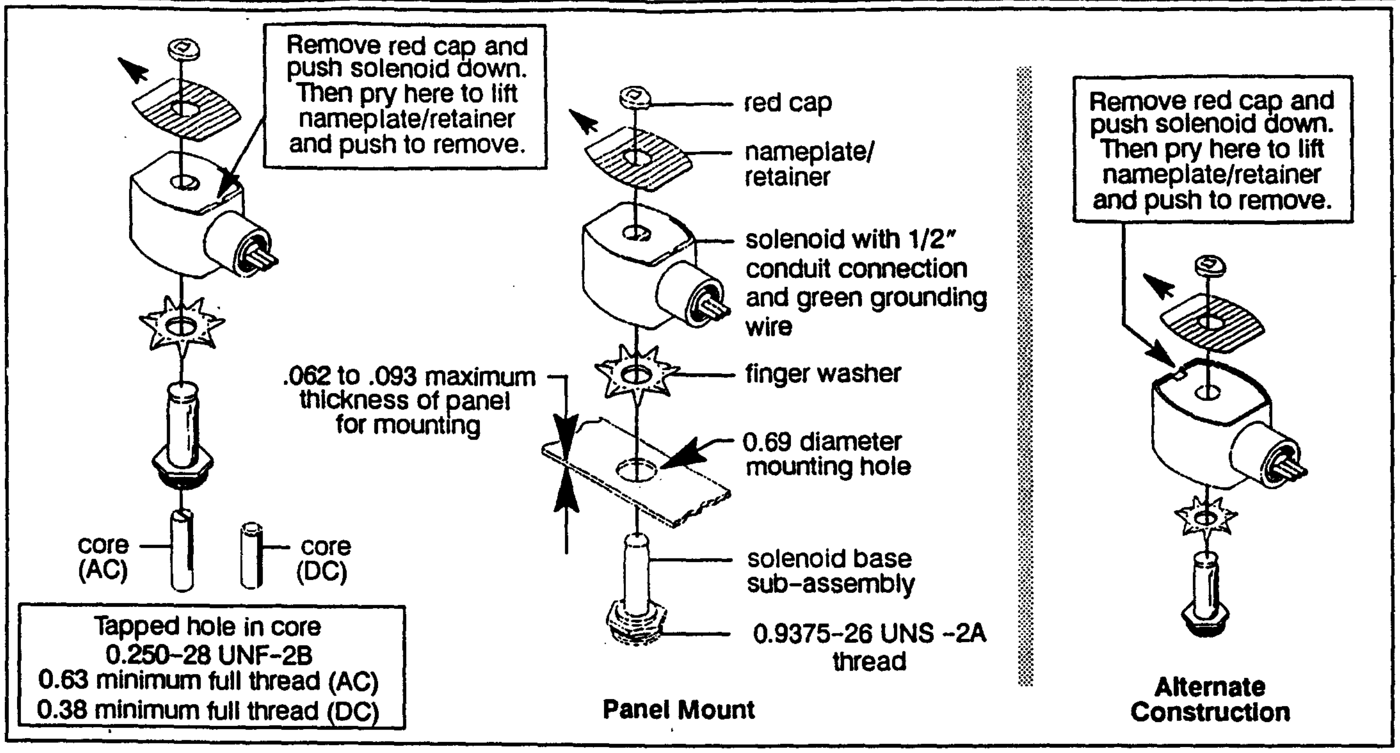


Figure 1. Series 8003G solenoids

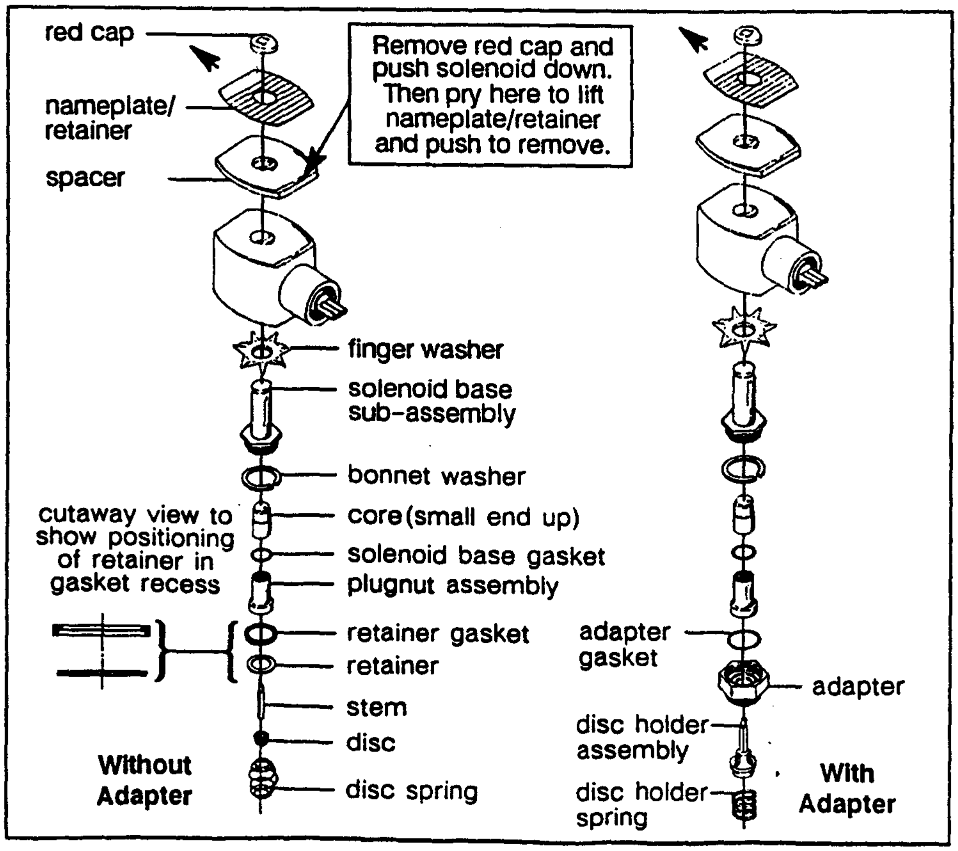


Figure 2. Series 8202G solenoids

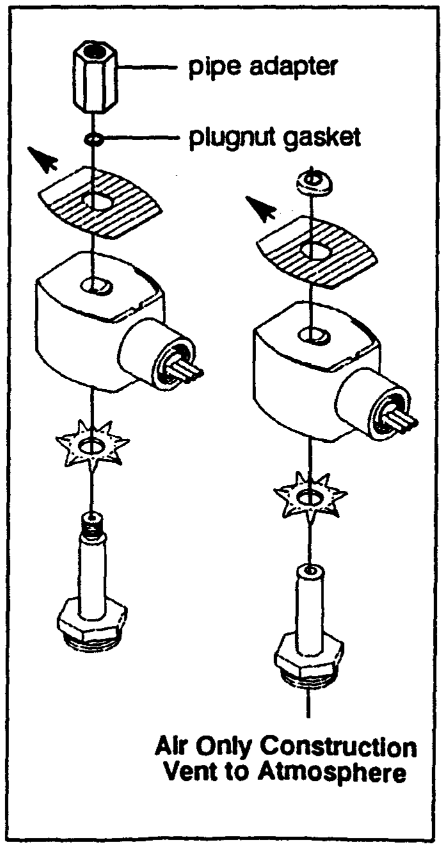


Figure 3. 3-Way Construction

Torque Chart

Part Name	Torque Value in Inch-Pounds	Torque Value in Newton-Meters
terminal block screws	10 ± 2	1,1 ± 0,2
socket head screw	15 - 20	1,7 - 2,3
center screw	5 ± 1	0,6 ± 0,1

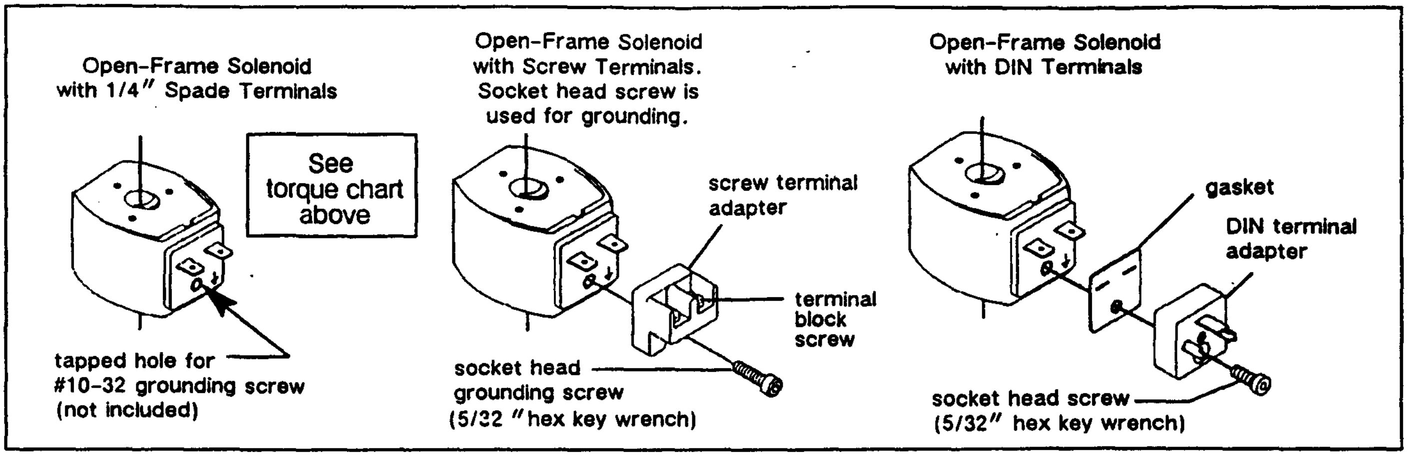


Figure 4. Open-frame solenoids

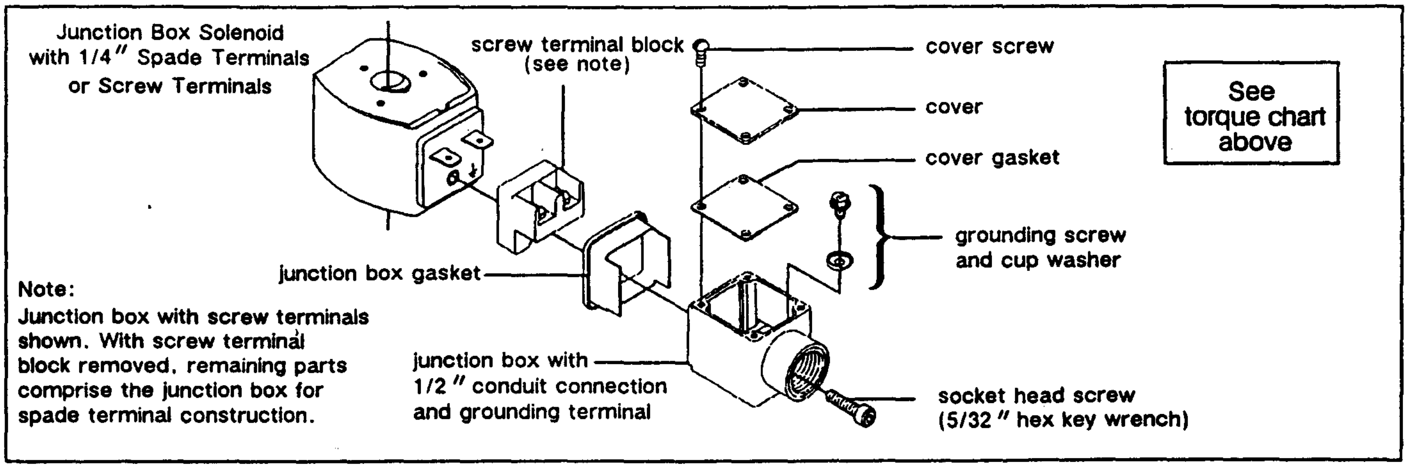


Figure 5. Junction box (optional feature)

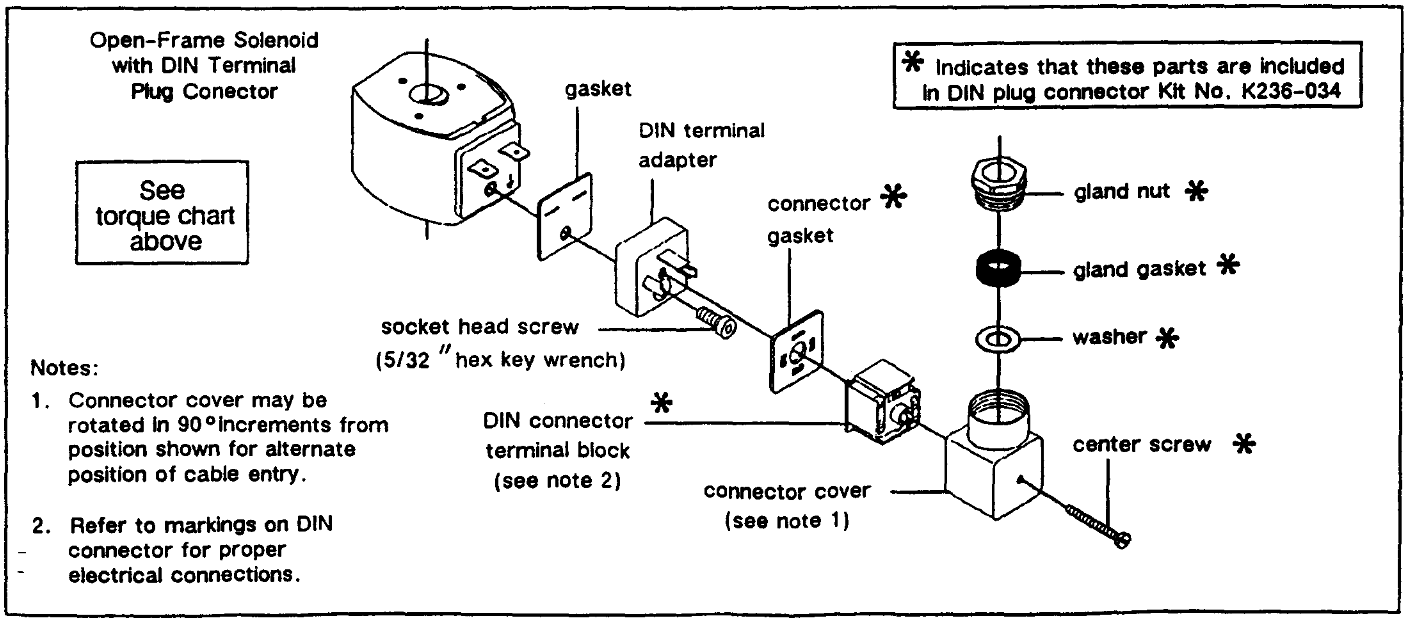
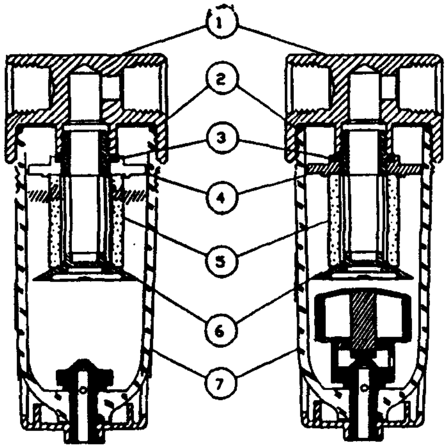


Figure 6. DIN plug connector kit No. K236-034 (optional feature)



MODEL F50
MANUAL DRAIN FILTER

MODEL FD50
AUTOMATIC DRAIN FILTER

FILTER OPTIONS

PREFIX	DESCRIPTION
B	METAL BOWL

SUFFIX	DESCRIPTION
T	TOP MOUNTING BRACKET
W	BRITISH BSP THREADS
D	CONSTANT BLEED DRAIN FOR COALESCENT FILTERS

KEY	DESCRIPTION	PART NUMBERS F50	FD50	FC50
1	HEAD	103-15-•	130-15-•	130-37-•
2	O'RING	KX406-23	KX406-23	KX406-23
3	O'RING	103-95	103-95	103-95
4	BAFFLE	10F-02	10F-02	————
5	ELEMENT••	130-27	130-27	————
6	STEM	10F-03	10F-03	————
7	BOWL ASSEMBLY	PA10F-130	PA10FD-130	PA10F-130
8	CARTRIDGE ASSEMBLY•••	————	————	A10F-09

• = SPECIFY 1/8" OR 1/4" PIPE PORTS
•• = ORDER KIT KA130-27 FOR FILTERS THAT HAVE A ONE PIECE ELEMENT ASSEMBLY. THESES ELEMENT ASSEMBLIES WERE USED IN FILTERS THAT WERE ORDERED BEFORE DECEMBER 1989
••• = ORDER KIT KA10F-09 FOR FILTERS THAT HAVE CARTRIDGES WITH A 5/8-18 UNF THREAD. THESE CARTRIDGES WERE USED IN FILTERS ORDERED BEFORE DECEMBER 1989

INSTALLATION:

Install unit as near as possible to the device it is to serve. Filters separate water and heavier solids by the centrifuging action of baffle #4. Water and solids are trapped in the bowl by stem #6. Solids too light to be removed by centrifugal force are retained by filter element #5. Water is discharged by automatic internal drain (AID) incorporated in the PA10FD-130 bowl assembly. The AID is operated whenever pressure fluctuations occur in the bowl assembly PA10FD-130. The manual drain assembly is operated by pushing up on the bottom of bowl assembly PA10D-130.

MAINTENANCE:

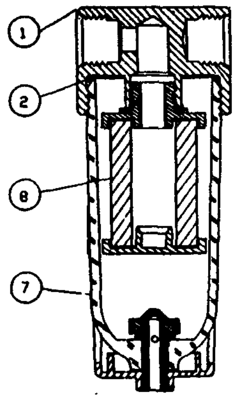
To clean or service unit, shut off air pressure and disassemble unit. Remove bowl assembly #7 by turning counterclockwise. To remove the filter element #5, insert a screwdriver in the slot located at the bottom of stem #6. Turn stem #6 counterclockwise until it is free of the head #1. Do not clean element in cleaning agents. Replacement is recommended. Plastic bowls may be cleaned with soap and water or kerosene.

To service the AID disassemble and clean. Order D50 for replacement or order PA10FD-130 for new bowl assembly with AID installed.

CAUTION:

Plastic bowls may deteriorate and fail if exposed to paint thinners and removers, certain degreasing fluids, synthetic clean-in solvents and chemicals such as: Acetone, Ethyl Acetate, Ethylene Dichloride, Toluene or any fluids which contain these chemicals. The bowls can be damaged by contact with Phosphate Ester or other synthetic lubricants.

Use only original equipment o'rings in contact with bowl. Standard o'rings will cause bowls to crack.



MODEL FC50
COALESCENT FILTER

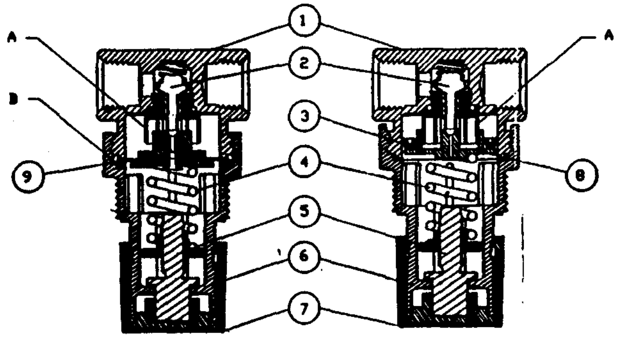
COALESCENT INSTALLATION:

Unit should be installed downstream of conventional M/P filter to extend the life of the coalescent cartridge. cartridge #8 should be replaced when the pressure differential across the cartridge reaches 8 to 10 psid (0.55 to 0.69 bar). The sump area should be drained when liquid level reaches the bottom of the cartridge or an automatic drain filter should be used.

MAINTENANCE:

Replace the cartridge assembly by shutting off the air pressure, removing the bowl assembly #7, and unscrewing the cartridge assembly #8. Be sure the o'ring is seated when the new cartridge assembly is installed. Cartridges should be installed hand tight.

SEE CAUTION NOTE FOR BOWL CARE



MODEL R56
DIAPHRAGM REGULATOR

MODEL R55
PISTON REGULATOR

KEY	DESCRIPTION	PART NUMBERS R55	R56
1	BODY	33-262-•	33-262-•
2	VALVE KIT	KA33-09M	KA33-09M
3	U-CUP	————	406-41
4	MAIN SPRING	KV33-104	KV33-104
5	ADJUSTING SCREW ASS'Y	A33-75	A33-75
6	DOME KIT	KA10R-02	KA10R-02
7	KNOB	10R-62	10R-62
8	PISTON ASSEMBLY	————	KA10R-09
9	DIAPHRAGM ASSEMBLY	KA10R-07	————

• = SPECIFY 1/8" OR 1/4" PIPE PORTS

INSTALLATION:

Install unit as near as possible to the device it is to serve. Filters should be installed immediately ahead of the regulator to insure a supply of clean air.

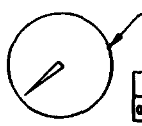
Pressure regulators reduce the supply air pressure to the required operating pressure by spring #4 loading on diaphragm assembly #9 (or piston assembly #8), which opens and closes valve #2 to maintain set pressure with flow thru the regulator. Overpressure is relieved when pressure on the diaphragm (piston ass'y) exceeds the spring loading on the diaphragm (piston ass'y).

ADJUSTMENT AND MAINTENANCE:

Clockwise turning of adjustment knob #7 will increase secondary pressure. Push up on adjusting knob to lock. If air supply is kept clean, regulator should provide long periods of uninterrupted service. Erratic operation or loss of regulation is usually due to dirt or a leaking seal.

REPAIR INSTRUCTIONS:

To repair regulator shut off air supply, reduce spring load to zero by adjusting knob counterclockwise. The dome can be removed by unscrewing it counterclockwise. The diaphragm (piston ass'y) can then be removed. The supply valve can be removed by unscrewing valve seat "A". If the regulator cannot be repaired by cleaning, the operating parts should be replaced. See parts list. When the regulator is reassembled, make sure all seals are correctly located. The u-cup #3 must be generously lubricated with Parker O'ring Lube upon reassembly. The valve seat should be torqued to 3-5 in-lbs. The clamping washer "B" should be between the diaphragm and the dome. The dome should be torqued to 40-50 in-lbs.



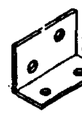
GAGES MUST BE ORDERED SEPERATELY

70M00		60M00		30M00	
0-160PSI	0-10.9BAR	0-60PSI	0-4BAR	0-30PSI	0-2BAR

REGULATOR OPTIONS

SUFFIX	DESCRIPTION
FR	FRONT & REAR GAGE PORT
L	LIGHT SPRING 0-50 PSI, 0-3.4 BAR, PART #33-104L
L15	LIGHT SPRING 0-15 PSI, 0-1 BAR, PART #33-113
L30	LIGHT SPRING 0-30 PSI, 0-2 BAR, PART #33-114
P	PANEL MOUNT, 1-7/8 HOLE REQUIRED PANEL THICKNESS UP TO 5/32"
W	BRITISH BSP THREADS
A	NON-RELIEVING REPLACEMENT NON-RELIEVING PISTON #10R-08A, REPLACEMENT NON-RELIEVING DIAPHRAGM #A10R-13

MOUNTING BRACKET AND NUT FOR R55, R56. ORDER #A33-62 (SHOWN HALF SCALE)

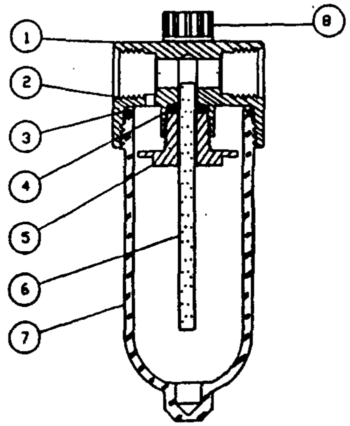


TOP MOUNTING BRACKET KIT FOR FILTERS AND LUBRICATORS PART #K50-01 (SHOWN HALF SCALE)

LUBRICATOR OPTIONS

PREFIX	DESCRIPTION
B	METAL DOME

SUFFIX	DESCRIPTION
Q	QUICK FILL
T'	TOP MOUNTING BRACKET
W	BRITISH BSP THREADS
Y	HI-YEILD PART #203-15-•



MODEL L50
WICK LUBRICATOR

KEY	DESCRIPTION	PART NUMBERS
1	HEAD	203-15-•
2	HEAD ASSEMBLY	K203-15-•
3	O'RING	KX406-23
4	GROMMET	203-2P
5	PACKING NUT	203-102
6	WICK	M203-3PCG
7	BOWL'	130-16LDC
8	FILL PLUG ASSEMBLY	A60L-17

• = SPECIFY 1/8" OR 1/4" PIPE PORTS

INSTALLATION:

Install unit as near as possible to the device it is to serve. To insure prompt feeding of the lubricated device, the hose or piping from the lubricator must be pre-oiled at installation. Multiple hook-ups from a single unit are not recommended.

Demand feed lubricators function by exposing an oil laden sintered bronze wick to air flow. Oil is carried from bowl #7 to the air passage by capillary attraction. The amount of wick exposed and the air flow will determine the amount of oil delivery. To increase oil delivery, loosen packing nut #5 and raise wick #6. To reduce oil delivery, lower wick. Three lines will be visible on wick at minimum setting. NOTE: wick adjustment is not normally required. Factory settings will be satisfactory for most applications.

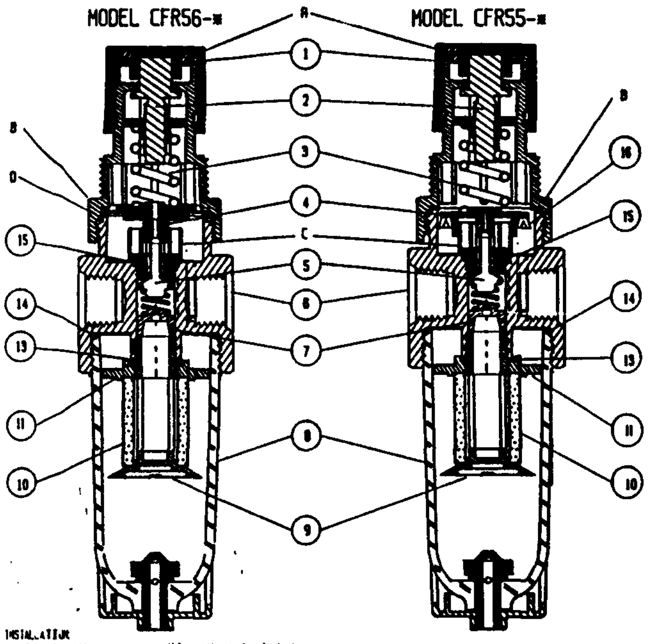
MAINTENANCE:

The lubricator reservoir bowl is filled through fill port in head. Shut off pressure before removing fill plug. Fill with light spindle oil 80-120 SSU @ 100° F. Do not use compound oils containing graphites, soap fillers, etc. To clean or service lubricator, shut off air pressure and disassemble. Remove bowl #7 by turning counterclock-

Sintered bronze wicks should give long trouble free service. They can be cleaned only by soaking several hours in a suitable solvent, then blowing them out with compressed air or steam. Replacement is recommended.

SEE CAUTION NOTE FOR BOWL CARE

DRAWN BY MET 12-31-91	MINIATURE INSTALLATION, PARTS, AND INSTRUCTION SHEET	DWG NO A754



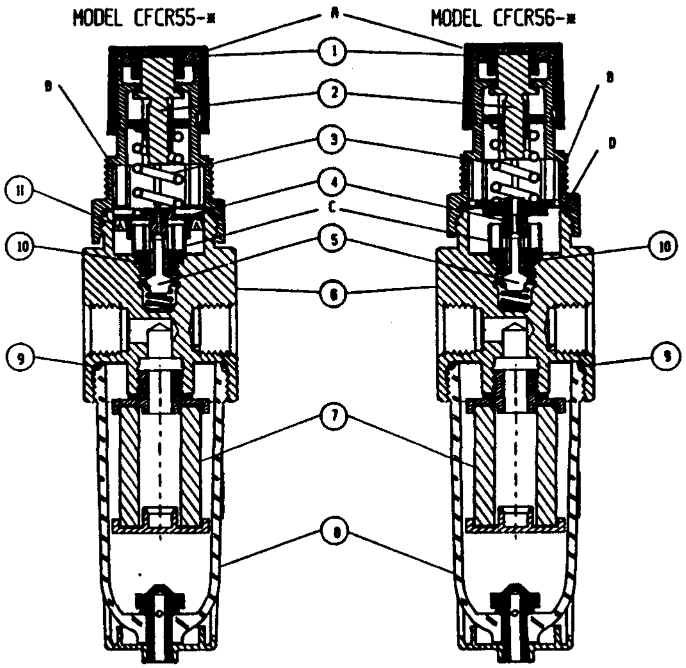
KEY	DESCRIPTION	PART, KIT, SALES ASSEMBLY CFRS6	CFRS5	CFDRS5 CFDRS6
1	DOME KIT	KA10R-02	KA10R-02	KA10R-02
2	ADJ. SCREW ASS'Y	A33-75	A33-75	A33-75
3	SPRING KIT	KY33-104	KY33-104	KY33-104
4	PISTON/DIAPHRAGM KIT	KA10R-07	KA10R-09	[illegible]
5	VALVE KIT	KAA33-09M	KAA33-09M	KAA33-09M
6	BODY	33-262-*	33-262-*	33-262-*
7	SPRING REST	10C-02	10C-02	10C-02
8	BOWL ASSEMBLY	PA10F-130	PA10F-130	PA10FD-130
9	STEM	10F-03	10F-03	10F-03
10	ELEMENT **	130-27	130-27	130-27
11	BAFFLE	10F-02	10F-02	10F-02
12	AUTOMATIC INT. DRAIN	———	———	D50
13	O'RING	103-95	103-95	103-95
14	O'RING	KX406-23	KX406-23	KX406-23
15	O'RING	KV35-20	KV35-20	KV35-20
16	U-CUP	———	406-41	406-41

* = SPECIFY 1/8" OR 1/4" PIPE PORTS

** = ORDER KIT KA130-27 FOR CFR'S THAT HAVE A ONE PIECE ELEMENT ASSEMBLY. THESE ASSEMBLIES WERE USED IN CFR'S THAT WERE ORDERED BEFORE DECEMBER 1989

KEY	DESCRIPTION	PART, KIT, SALES ASS'Y CFCRS5	CFCRS6
1	DOME KIT	KA10R-02	KA10R-02
2	ADJ. SCREW ASS'Y	A33-75	A33-75
3	SPRING KIT	KY33-104	KY33-104
4	DIAPHRAGM/PISTON ASS'Y	KA10R-09	KA10R-07
5	VALVE KIT	KAA33-09M	KAA33-09M
6	BODY	33-366-*	33-366-*
7	CARTRIDGE ASS'Y	A10F-09	A10F-09
8	BOWL ASS'Y	PA10F-130	PA10F-130
9	O'RING	KX406-23	KX406-23
10	O'RING	KV35-20	KV35-20
11	U-CUP	406-41	———
12	AUTOMATIC INT. DRAIN	———	———

* = SPECIFY 1/8" OR 1/4" PIPE PORTS



INSTALLATION

Install unit as near as possible to the device it is to serve. Filters separate water and heavier solids by the centrifuging action of the baffle #11. Water and solids are trapped in the bowl by stem #9. Solids too light to be removed by centrifugal force are retained by filter element #10. Water is discharged by automatic internal drain (AID) incorporated in the PA10FD-130 bowl assembly. The AID is operated whenever pressure fluctuations occur in the bowl assembly PA10FD-130. The manual drain assembly is operated by pushing up on the bottom of bowl assembly PA10F-130.

The regulator reduces supply air pressure to the required operating pressure by spring #3 loading on diaphragm assembly #4 (or piston assembly). Reduced operating pressure is sensed by diaphragm (piston assembly), which opens and closes valve #5. To maintain set pressure with flow thru the regulator, overpressure is relieved when pressure on the diaphragm (piston ass'y) exceeds the spring loading on the diaphragm (piston ass'y).

ADJUSTMENT:

Clockwise turning of adjustment knob "A" will increase secondary pressure. Push up on adjusting knob to lock. If air supply is kept clean, regulator should provide long periods of uninterrupted service. Erratic operation or loss of regulation is usually due to dirt or a leaking seal.

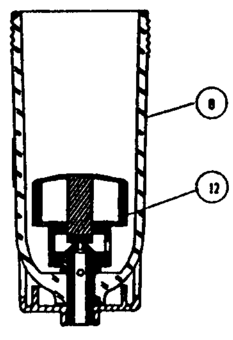
FILTER MAINTENANCE:

To clean or service unit, shut off air pressure and disassemble unit. Remove bowl assembly #8 by turning counter clockwise. To remove the filter element #10 insert a screwdriver in the slot located at the bottom of stem #9. Turn stem counter-clockwise until it is free of the body #6. Do not clean element in cleaning agents. Replacement is recommended. Plastic bowls may be cleaned with soap and water or kerosene.

To service the AID disassemble and clean. Order D50 for replacement or order PA10FD-130 for new bowl assembly with AID installed

REGULATOR REPAIR INSTRUCTIONS:

To repair regulator, shut off air supply, reduce spring load to zero by adjusting knob counterclockwise. The dome "B" can be removed by unscrewing it counterclockwise. The diaphragm (piston ass'y) can then be removed. The supply valve can be removed by unscrewing valve seat "C". If the regulator cannot be repaired by cleaning, the operating parts should be replaced. See parts list. When the regulator is reassembled, make sure all seals are correctly located. The u-cup #16 must be generously lubricated with Parker O'ring Lube upon reassembly. The valve seat should be torqued to 3-5 in-lbs. The clamping washer "D" should be between the diaphragm and the dome. The dome should be torqued to 40-50 in-lbs.



AUTOMATIC INTERNAL DRAIN BOWL ASSEMBLY FOR MODELS

CFDRS5-*
CFDRS6-*

70MOD		80MOD		30MOD	
0-160 PSI	0-10.9 BAR	0-80 PSI	0-4 BAR	0-30 PSI	0-2 BAR

GAGES MUST BE ORDERED SEPARATELY

OPTIONS:

PREFIX	DESCRIPTION
B	METAL BOWL
SUFFIX	**DESCRIPTION**
E4	SINTERED BRONZE ELEMENT 20 MICROMETRES (MICRON) PART #130-27E4
E5	SINTERED BRONZE ELEMENT 5 MICROMETRES (MICRON) PART #130-27E5
NG	NO GAGE PORTS
L	LIGHT SPRING 0-50 PSI (0-3.4 BAR) PART #33-104L
L15	LIGHT SPRING 0-15 PSI (0-1 BAR) PART #33-113
L30	LIGHT SPRING 0-30 PSI (0-2 BAR) PART #33-114
P	PANEL MOUNT 1-7/8 HOLE REQUIRED, PANEL THICKNESS UP TO 5/32" PART #33-73
N	BRITISH BSP THREADS
- D	CONSTANT BLEED DRAIN FOR COALESCENT CFR'S

CAUTION

Plastic bowls may deteriorate and fail if exposed to paint thinners and removers, certain degreasing fluids & synthetic cleaning solvents and chemicals such as: Acetone, Ethyl Acetate, Ethylene Dicloride, Toluene or any fluids which contain these chemicals. The bowls can be damaged by contact with Phosphate Ester or other synthetic lubricants.

Use only original equipment o'rings in contact with bowl. Standard o'rings will cause bowl to crack.

INSTALLATION

Unit should be installed downstream of conventional W/P filter with the standard 40 micrometre filter element to extend the life of the coalescent cartridge. The cartridge #7 should be replaced when the pressure differential across the cartridge reaches 8 to 10 psid (0.55 to 0.69 bar). The sump area should be drained when liquid level reaches the bottom of the cartridge or a automatic drain filter should be used.

Pressure regulators reduce the supply air pressure to the required operating pressure by spring #2 loading on diaphragm assembly #4 (or piston assembly). Reduced operating pressure is sensed by diaphragm (piston assembly), which opens and closes valve #5. To maintain set pressure with flow thru regulator, overpressure is relieved when pressure on the diaphragm (piston ass'y) exceeds the spring loading on the diaphragm (piston ass'y).

ADJUSTMENT:

Clockwise turning of adjustment knob "A" will increase secondary pressure. Push up on adjustment knob to lock. If air supply is kept clean, regulator should provide long periods of uninterrupted service. Erratic operation or loss of regulation is usually due to dirt or a leaking seal

MAINTENANCE:

Replace the cartridge assembly by shutting off the air pressure and removing the bowl assembly #8, and unscrewing the cartridge assembly #7. Be sure the o'ring is seated when the new cartridge assembly is installed. Cartridges should be installed hand tight.

REGULATOR REPAIR INSTRUCTIONS:

To repair regulator, shut off air supply, reduce spring load to zero by adjusting knob counterclockwise The dome "B" can be removed by unscrewing it counterclockwise. The diaphragm (piston ass'y) can then be removed. The supply valve can be removed by unscrewing valve seat "C". If the regulator cannot be repaired by cleaning, the operating parts should be replaced. The valve seat should be torqued to 3-5 in-lbs. The clamping washer "D" should be between the diaphragm and the dome The dome should be torqued to 40-50 in-lbs.

TITLE	DRAWN BY	CK BY	SCALE	DWG NO
MINIATURE INSTALLATION PARTS AND INSTRUCTIONS SHEET	MET 10/12/89		FULL	A781

rdner Denver

NOTE: USE BALL POINT PEN - PRESS HARD!

To Be Completed By Authorized Start Up Personnel

MAIL TO:
Gardner Denver Machinery Inc.
1800 Gardner Expressway
Quincy, IL 62301
(ATTN: Service Manager)

RECIPROCATING COMPRESSORS
START-UP CHECK LIST - WARRANTY REGISTRATION

To Validate Warranty, Complete and Return to Factory Within (10) Days of Initial Operation

pany Name: ______________________
ess: ______________________
____
: ______________________ Zip: __________

Machine S/N: ______________________
Machine Model: ______________________
Cylinder Size ______________________
Start-Up Date: ______________________

s a Check List Only! It does not replace the instructions contained in the Service Manual. ALWAYS refer to the Service Manual for proper procedures, methods, and ing specifications.

ide Data and (✓) Box as Reviewed: Review for Correctness of Assembly, Tightness, Proper and/or Safe Operation.

ECTION

Overall appearance and condition of unit is good, except as noted below
Check warning tags
Remove long term storage protection, if purchased or installed
Check one: ☐ Foundation ☐ Isolators
☐ Steel Plate/Felt Pad ☐ Other

ing and Tightness:

Bolts & Nuts: Compressor, Compressor Base & Foundation
Flywheel/Sheave Hub
Final shimming of unit with dial indicator
Coupling/belts alignment and/or tension
Pipe connections and fittings (tight/leak free

Air Filter: ☐ Local ☐ Remote Mounted

Installed properly
Ingesting uncontaminated air
Accessible for servicing
With welded inlet pipe install screen for 24 hours
I ing inspected and thoroughly cleaned

Relief valve(s): Proper location and size; operate properly
Inlet and discharge piping of correct length and size (see manual)
Discharge piping sloped down, away from compressor (w/dropleg)
Control air piping of proper size, with hand valve installed
Water piping, sized correctly, and connected properly
(See manual for water flow)
Water PSIG between 40-75 PSIG at full flow rate
Water solenoid valve installed
Condensate traps installed, operational and primed, if necessary
Water flow controls/regulators: operate and adjusted properly
Water system: ☐ City ☐ Closed Loop ☐ Well
☐ Tower ☐ Other

rication

Crankcase thoroughly cleaned and wiped
Lubrication filled to correct levels with proper AEON lubricant
Type of oil used:
In crankcase ______________ In lubricator ______________
Top and bottom valve removed from each cylinder and cylinder checked for moisture, rust or foreign material
Lubricator primed. Setting (drops per minute per cylinder)
1st ______ 2nd ______ 3rd ______ 4th ______ Rods ______
Crankcase and cylinder components prelubed
Crankshaft rolled over by hand, all parts move freely

Striking Clearances

1)Top ______ 2)Top ______ 3)Top ______ 4)Top ______
Bottom ______ Bottom ______ Bottom ______ Bottom ______

Electrical Connections

☐ Wiring checked per print and machine properly grounded
☐ All connections checked for tightness and good contact
☐ Motor leads properly connected, taped and wrapped
☐ Correct heater size for motor protection

Operation and Data

Compressor nameplate: PSI ______ RPM ______
☐ Checked for correct rotation
☐ Operated unloaded and then loaded unit per instructions in manual
☐ Oil pressure within specs: (at operating temp.) ______ PSIG
☐ Gauges, meters, panel lights operational
☐ After run in, rechecked oil levels, lube feed to cylinders and rods, and belt tension (if applicable)
☐ Air pressure switch settings: 1) ____ to ____ 2) ____ to ____
3) ____ to ____ 4) ____ to ____

With unit fully loaded and temp. stabilized record:
Discharge water temp. ________ °F
Discharage air temp: 1st stage ______ °F 2nd stage ______ °F
Via: ☐ Pyrometer ☐ Thermometer 3rd stage ______ °F
Intercooler air pressure: 1) ________ PSIG 2) ________ PSIG
Intercooler Vacuum: 1) ______ Inches Hg 2) ______ Inches Hg
Compressor Discharge: ________ PSIG
Inlet pressure (atmospheric, Hg or PSIG) ______________
Motor Mfr. ______________ S/N ______________
Nameplate amps ______ HP ______ S.F. ______ Volts ______
Starter Mfr. ______ Type ______ Size ______ Heater Size ______
Operation line voltage: AB ______ BC ______ AC ______
Full load amps: T1-________ T2-________ T3-________
Unloaded amps: T1-________ T2-________ T3-________

Review the following with owner personnel:

☐ Correct operating procedures ☐ Recommended routine maintenance
☐ Safety precautions ☐ Each section of the operator's manual
☐ Recommended list of spare parts to keep on hand
☐ Machine is leak free. **NOTE:** Within 10 days, owner should inspect for any leaks that may have developed, and retighten connections

T STARTED AND PERFORMING WELL: Yes ____ No ____. Describe environment/remarks: ______________________
____
____

se , int/Type

tomer Contact ______________________
ne ______________________
ler Signature ______________________

Distributor Name/Location
____
Started By ______________________
Company Represented ______________________

WHITE- Factory Copy — *CANARY - Engr. Systems Copy* — PINK - Distributor Copy (When started by Distributor) — GOLDENROD - Owner Copy

Backflow Preventer

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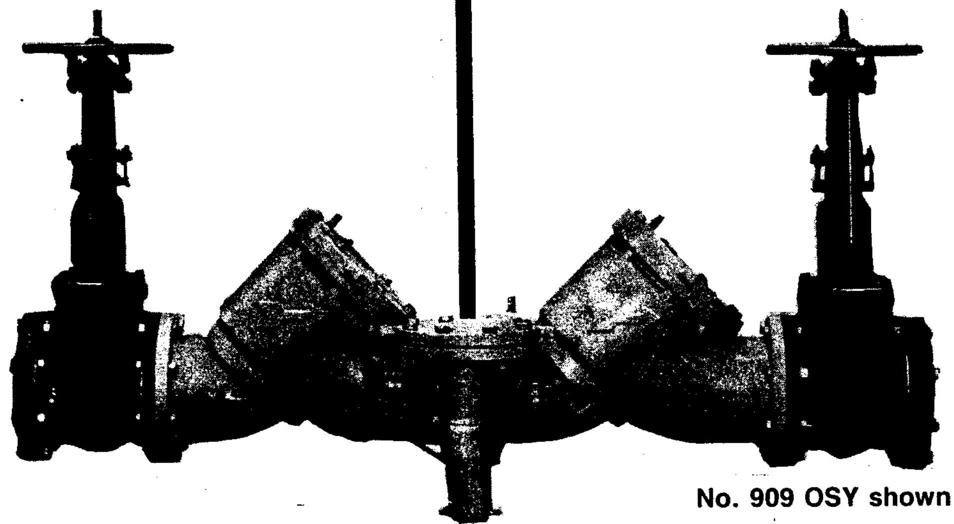
IMPORTANT: Inquire with governing authorities for local installation requirements.

WITH OS&Y GATE VALVES

Series 909

Sizes 2½"- 10"

REDUCED PRESSURE ZONE BACKFLOW PREVENTERS



No. 909 OSY shown

• BACKFLOW PREVENTION • CONTAINMENT • CROSS CONNECTION CONTROL

No. 909 standardly supplied with NRS gate valve shut-offs.
Options: (options can be combined)

Suffix	Sizes 2½"- 10"
S	-with epoxy coated strainer.
M1	-with bronze body, Sizes: 2½", 3".
OSY	-with OS&Y gate valve shut-offs.
QT	-with ¼ turn, ball valve shut-offs 2½"- 6".
QT-FDA	-with FDA epoxy coated ball valve shut-offs.
RW	-with resilient wedge shut-off valves.
LF	-without shut-off valves.

IMPORTANT

Backflow prevention assemblies **MUST** be installed by a licensed journeyman tradesperson, who is recognized by the authority having jurisdiction, and inspected for compliance with local safety codes. Certified testing and maintenance are required to ensure proper function and maximum effectiveness of assemblies. These services must begin upon installation and be provided at **intervals not to exceed one year** and as system conditions warrant.

INSTALLATION, SERVICE, REPLACEMENT PARTS and MAINTENANCE

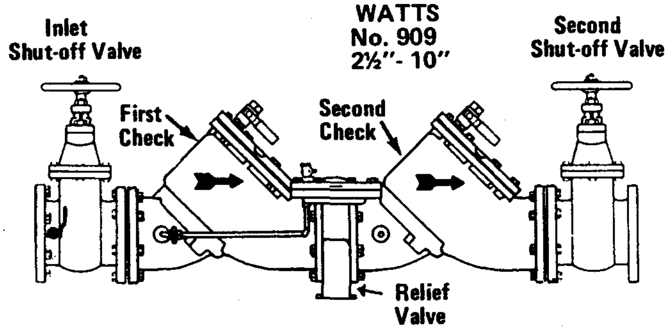
For field testing procedure see page 4 and send for S-FT-TK-9A, IS-TK-DP or IS-TK-DR
For trouble shooting guide, see page 7
For other repair kits and service parts, send for RP-BPD
For technical assistance, see back page

"ATTN. INSTALLER: After installation, please leave this Instruction Sheet for occupant's information."

World Class Valves
WATTS® REGULATOR
Since 1874
HDQTRS: 815 Chestnut St., N. Andover, MA 01845
MAIL: Box 628, Lawrence, MA 01842 **Telex:** 94-7460
Tel. (508) 688-1811 **Fax:** (508) 794-1848/794-1674
International Subsidiaries: Watts Regulator of Canada Ltd.
Tel. (416) 851 8591 Fax: (416) 851 8788
Watts Regulator (Nederland)b.v. Telex: 844 35365

LIMITED WARRANTY: Watts Regulator Company warrants each product against defects in material and workmanship for a period of one year from the date of original shipment. In the event of such defects within the warranty period, the Company will, at its option, replace or recondition the product without charge. This shall constitute the exclusive remedy for breach of warranty, and the Company shall not be responsible for any incidental or consequential damages, including, without limitation, damages or other costs resulting from labor charges, delays, vandalism, negligence, fouling caused by foreign material, damage from adverse water conditions, chemicals, or any other circumstances over which the Company has no control. This warranty shall be invalidated by any abuse, misuse, misapplication or improper installation of the product. THE COMPANY MAKES NO OTHER WARRANTIES EXPRESS OR IMPLIED EXCEPT AS PROVIDED IN THIS LIMITED WARRANTY.

Basic Installation Instructions



Watts 2½"- 10" 909 High Capacity Relief Series:
Location and Installation Considerations

1. Backflow preventers must be installed in high-visibility locations in order to allow for immediate notice of telltale discharge or other malfunction. This location should also facilitate testing and servicing, and protect against freezing and vandalism.

2. Installing a backflow preventer in a pit or vault is not recommended. However, if this becomes necessary, Watts highly recommends that a licensed journeyman tradesperson, who is recognized by the authority having jurisdiction, be consulted to ensure that **all local codes and required safety provisions are met.** An air gap below the relief port must be maintained so as to avoid flooding and submersion of the assembly, which may lead to a cross connection. *Please refer to Figure No. 1 for further information.

3. A strainer should be installed ahead of the backflow preventer to protect all internal components from unnecessary fouling.

CAUTION: Do not install a strainer ahead of the backflow preventer on seldom-used, emergency water lines (i.e. fire sprinkler lines). The strainer mesh could potentially become clogged with debris present in the water and cause water blockage during an emergency.

4. Normal discharge and nuisance spitting are accommodated by the use of a Watts air gap fitting and a fabricated indirect waste line. Floor drains of the same size **MUST** be provided in case of excessive discharge. *Please refer to Figure no. 1 and Figure No. 2 for further information.

5. When a 909 Series backflow preventer is installed for dead-end service applications (i.e. boiler feed lines, cooling tower make-up or other equipment with periodic flow requirements), discharge from the relief vent may occur due to water supply pressure fluctuation during static no-flow conditons. A check valve may be required ahead of the backflow preventer. *Please see "Troubleshooting", Page 7, **prior to installation.**

6. The 909 Series backflow preventer is designed so that the critical level of the relief valve is positioned below the first check. This unique feature allows the valve to be **installed either vertically (flow direction down) or horizontally.** *Please see Figure 3.

7. The relief valve module on 2½"- 10" 909 Series assemblies may be turned to discharge to the opposite side. To do so, unbolt the relief valve and turn the relief valve discharge port to the opposite side. Mount the high pressure hose on the opposite. This should be done by a licensed journeyman tradesperson, who is recognized by the authority having jurisdiction and only when space is critical for testing or repair.

8. ASSEMBLY: If the backflow preventer is disassembled during installation, it **MUST** be reassembled in its **proper order.** The gate valve with the test cock is to be mounted on the inlet side of the backflow preventer. The test cock must be on the inlet side of the wedge. *Please see Diagram No. 1. Failure to reassemble correctly will result in possible water damage due to excessive discharge from the relief port/vent and possible malfunction of the backflow preventer.

9. Installation procedures must comply with all state and local codes and must be completed by a licensed journeyman tradesperson who is recognized by the authority having jurisdiction. Please see Page 3 for specific installation procedures.

10. Prior to installation, thoroughly flush all pipe lines to remove any foreign matter.

11. START UP at Initial Installations and After Servicing: The downstream shut-off should be closed. Slowly open upstream shut-off and allow the backflow preventer to fill slowly. Bleed air at each test cock. When backflow preventer is filled, slowly open the downstream shut-off and fill the water supply system This is necessary to avoid dislodging "O" rings or causing damage to internal components.

12. TEST: The 909 Series backflow preventer must be tested by a certified tester at the time of installation in order to ascertain that the assembly is in full working order and may be relied upon to protect the safe drinking water as per applicable standard.

Figure 1

Series 909 RELIEF VALVE DISCHARGE RATES

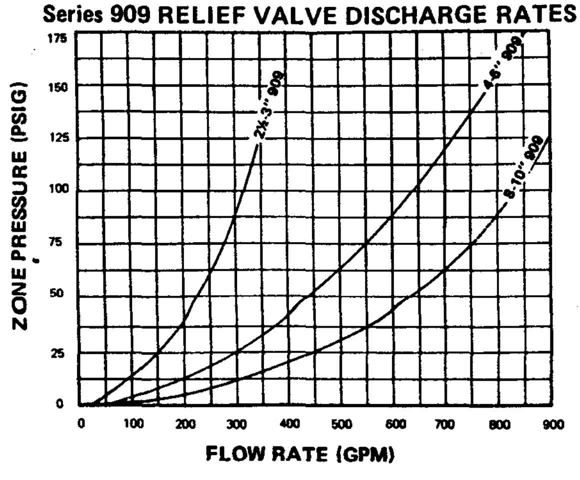


Figure 2

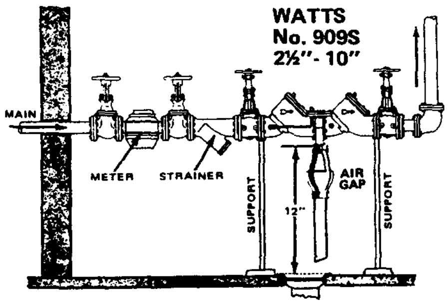
Typical Flow Rates as sized by floor drain manufacturers:

2" 55GPM
3" 112GPM
4" 170GPM
5" 350GPM
6" 450GPM
8" 760GPM

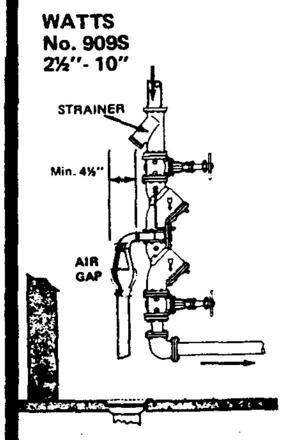
Installation - Indoors Figure 3

For indoor installations, it is important that the device be easily accessible to facilitate testing and servicing. Series 909 may be installed either vertically (flow direction down) or horizontally. If it is located in a line close to wall, be sure the test cocks are easily accessible. A drain line and air gap should be piped from the relief valve connection as shown, where evidence of discharge will be clearly visible and so that water damage will not occur. Therefore, never install in concealed locations.

*** For Air Gap information contact your technical sales representative on back page.**



HORIZONTAL INSTALLATION



VERTICAL INSTALLATION – DOWNWARD FLOW

***Note: For non-strainer models, test cock must be located on the first or inlet shut-off valve.**

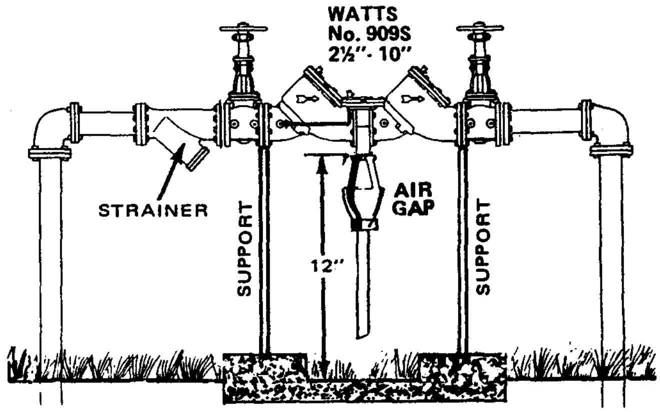
Installation - Outside Building Above Ground Figure 4

In an area where freezing conditions **do not occur,** Series 909 can be installed outside of a building. The most satisfactory installation is above ground and should be installed in this manner whenever possible.

In an area where freezing conditions **can occur,** Series 909 should be installed in a properly insulated utility building or shelter.

Series 909 may be installed in a vertical or horizontal line and in an accessible location to facilitate testing and servicing. A discharge line should be piped from the air gap at the relief valve connection making sure that there is adequate drainage. Never pipe the discharge line directly into a drainage ditch, sewer or sump. Series 909 should never be installed where any part of the unit could become submerged in standing water. Consideration should be given to the installation of external support structure as applicable.

It is generally recommended that backflow preventers never be placed in pits unless absolutely necessary and then only when approved by local codes. In such cases, a modified pit installation is preferred.



NOTE: When installed vertically the direction of flow must be down.

Installation - Parallel Devices Figure 5

CONSULT LOCAL CODES FOR APPROVAL

Two or more smaller size devices can be piped in parallel (when approved) to serve a larger supply pipe main. This type of installation is employed where increased capacity is needed beyond that provided by a single valve and permits testing or servicing of an individual valve without shutting down the complete line.

The number of devices used in parallel should be determined by the engineer's judgement based on the operating conditons of a specific installation.

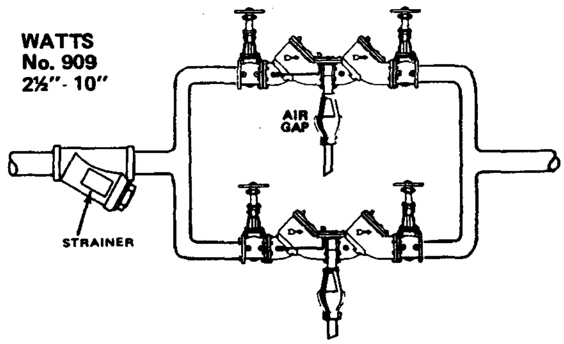


TABLE ONE – CAPACITY REQUIRED FOR SYSTEM

50 GPM	100 GPM	150 GPM	200 GPM	250 GPM	350 GPM	450 GPM	640 GPM	1000 GPM	2000 GPM	3000 GPM	5000 GPM
Two ¾" Devices	Two 1" Devices	Two 1¼" Devices	Two 1½" Device	Two 1½" Devices	Two 2" Devices	Two 2½" Devices	Two 3" Devices	Two 4" Devices	Two 6" Devices	Two 8" Devices	Two 10" Devices

Table shows total capacity provided with dual valve installations of various sizes.

(Drawings not to scale)

Testing-Reduced Pressure Zone Backflow Preventers

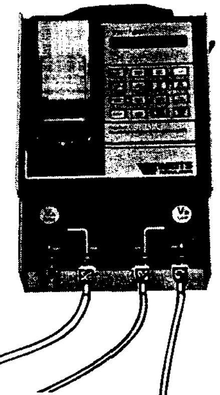
Reduced pressure zone backflow preventers must be inspected and tested periodically, in accordance with local codes, to ensure proper operation of check valves within the unit.

A differential pressure gauge is recommended for Test No. 1 rather than a manometer for the following reasons: It utilizes minimum time to perform the test. It eliminates the necessity of closing the inlet gate valve which could release pipe scale and foreign matter into the backflow preventer. Only a slight amount of water is 'spilled" in test. A mercury manometer could cause a pollution hazard.

TEST SET UP

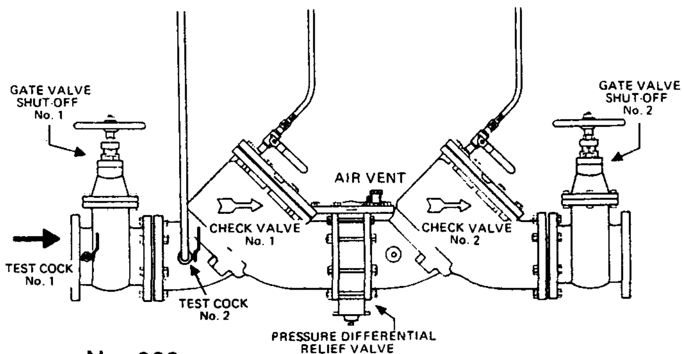
Close Valves (A), (B), and (C) on Test Kit.
Connect the No. 2 Test Cock of the device to the "HIGH" Hose. (Color – Yellow)
Connect the No. 3 Test Cock of the device to the "LOW" Hose. (Color – White)
Close No. 2 gate valve of the device.
Open Test Cocks No. 2 and No. 3.
Open "Vent" (C) valve.
Open "High" (A) valve and bleed to atmosphere until all the air is expelled.
Close the "High" (A) valve. Open the "Low" (B) valve and bleed to atmosphere until all air is expelled. Close "Low" (B) valve. Close "Vent" (C) valve.
Connect the No. 4 Test Cock of the device to the "VENT" Hose. (Color – Blue)

TK-DP Test Kit



HIGH HOSE (Color – Yellow) LOW HOSE (Color – White) VENT HOSE (Color – Blue)

Schematic Diagram



No. 909 (shown)

TEST PROCEDURE

FIELD TEST EQUIPMENT REQUIRED

REDUCED PRESSURE PRINCIPLE BACKFLOW PREVENTER TEST KIT

TEST No. 1

PURPOSE:
To test Check Valve No. 2 for tightness against reverse flow.

REQUIREMENTS:
Valve must be tight against reverse flow under all pressure differentials. Slowly open the "High" (A) and "Vent" (C) valves and keep the "Low" (B) valve closed. Open the No. 4 test cock. Indicated pressure differential will decrease slightly. If pressure differential continues to decrease (until the vent opens) the No. 2 Check Valve is reported as "leaking" and needs to be repaired.

TEST No. 2

PURPOSE:
To test Gate Valve No. 2 for tightness.

REQUIREMENTS: After passing test No. 1 continue to test No. 2 by closing Test Cock No. 2. The indicated pressure differential will decrease slightly. If pressure differential continues to decrease (approaching "zero") the No. 2 Gate Valve is reported to be "leaking" and needs to be repaired.

TEST No. 3

PURPOSE:
To test Check Valve No. 1 for tightness.

REQUIREMENTS:
Valve must be tight against reverse flow under all pressure differentials. Close "High" (A) valve and open Test Cock No. 2. Close Test Cock No. 4. Disconnect "Vent" Hose at Test Cock No. 4. Open valves (B) and (C) bleeding to atmosphere, then closing valve (B) restores the system to a normal static condition. Observe the pressure differential gauge. If there is a decrease in the indicated value, the No. 1 Check Valve is reported as "leaking" and needs to be repaired.

TEST No. 4

PURPOSE:
To test operation of pressure differential relief valve.

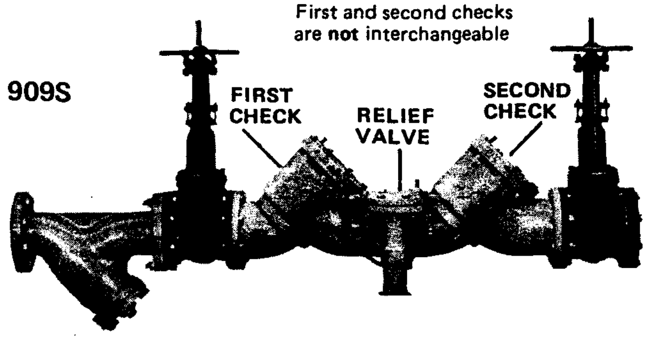
REQUIREMENTS:
The pressure differential relief valve must operate and maintain the "zone" between the two check valves at least 2 psi less than the supply pressure. Close "Vent" (C) valve. Open the "High" (A) valve. Open the "Low" (B) valve very slowly until the differential gauge needle starts to drop. Hold the valve at this position and observe the gauge reading at the moment the first discharge is noted from the relief valve. Record this as the opening differential pressure of the relief valve. If pressure differential is greater than 2 psi valve needs to be repaired.

NOTE: It is important that the differential gauge needle drops slowly.

Close Test Cocks Nos. 2 and 3. Use "Vent" Hose to relieve pressure from test kit by opening valves (A), (B) and (C). Remove all test equipment and open No. 2 gate valve of the device.

For complete testing information send for S-FT-TK-9A, IS-TK-DP or IS-TK-DR.

Servicing First and Second Checks 2½ - 10"



NOTE:
No special tools required to service Series 909

1. Remove the hatch cover bolts. NOTE: The 909 is designed so that when the bolts are backed off ½ ", all the spring load is released from the cover and retained by the check module. **CAUTION: Be sure to verify this before removing all the bolts.**

2. Lift the check valve module straight out taking care not to hit and damage the seat ring.

3. The seat ring may be removed and replaced by pulling out the two wire retainers on sizes 4"- 10" while on sizes 2½ "- 3", one quarter-turn twist removes seat. The wire retainers are 10" long. One is drawn out clockwise and the other is drawn out counter clockwise.

4. With the retainer wires removed, the seat ring can be lifted straight up and removed.

5. **CAUTION:** The check valve spring is in compression. The spring load is captured by the two spring retainers and the stem. The spring retainers are not to be removed for servicing. If there is a need to replace the spring, spring retainer or stem, an assembled module must be obtained from the factory. These modules **are not** interchangeable, be sure to replace the first check with a first check module and the second check with a second check module.

6. To replace the disc on sizes 2½ "- 4" simply remove the retaining nut or for sizes 6"- 10" remove the allen head socket screws. Reverse this procedure to install the new disc.

For further details contact your technical sales representative, see back page.

Series 909 (All Models)- Sizes 2½"-3" FIRST AND SECOND CHECK SERVICE PARTS KIT
Kit includes:
A- Disc & Spring Assembly C- Seat "O" Ring
B- Seat D- Cover "O" Ring

Ordering Code No.	Kit No.	Size (In.)	Description
881471	19BFP-RK	2½", 3"	1st Check Service Kit
881476	24BFP-RK	2½", 3"	2nd Check Service Kit

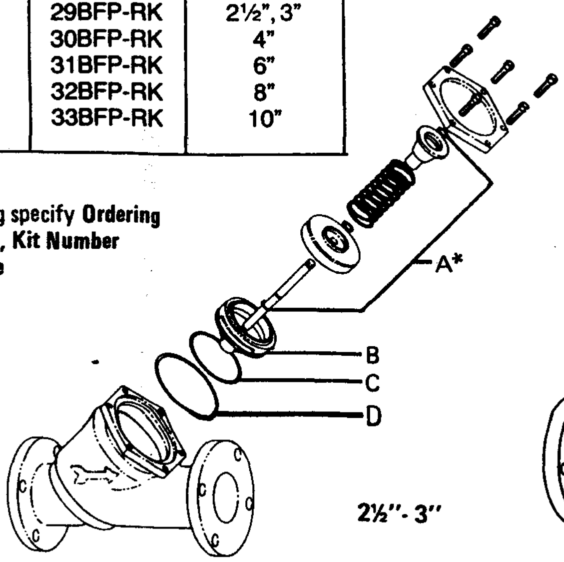
Series 909 (All Models)-Sizes 4"-10" FIRST AND SECOND CHECK SERVICE PARTS KIT
Kit Includes:
A- Disc & Spring Assembly C- Seat "O" Ring
B- Seat D- Cover "O" Ring

Ordering Code No.	Kit No.	Size Inches	Description
881472	20BFP-RK	4"	1st Check Service Kit
881473	21BFP-RK	6"	1st Check Service Kit
881474	22BFP-RK	8"	1st Check Service Kit
881475	23BFP-RK	10"	1st Check Service Kit
881477	25BFP-RK	4"	2nd Check Service Kit
881478	26BFP-RK	6"	2nd Check Service Kit
881379	27BFP-RK	8"	2nd Check Service Kit
881480	28BFP-RK	10"	2nd Check Service Kit

Series 909 (All Models)- Sizes 2½"-10" FIRST AND SECOND CHECK SERVICE RUBBER PARTS KIT
Kit Includes: "O" Rings, Check Discs, Lubricant

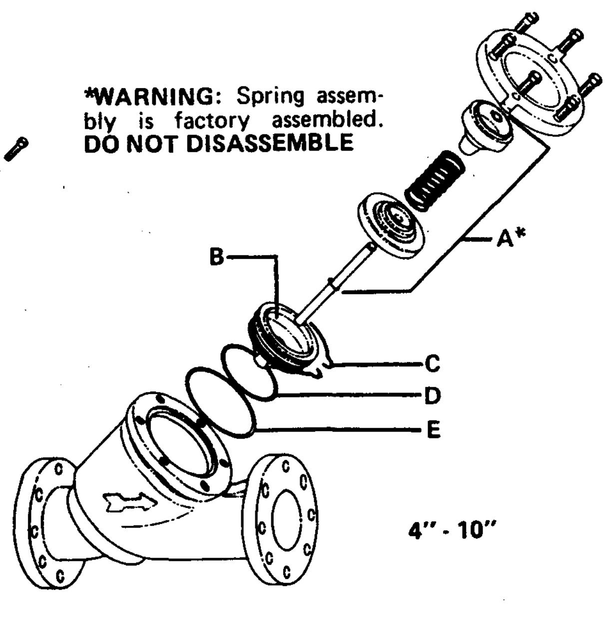
Ordering Code No.	Kit No.	Size (In.)
833901	29BFP-RK	2½", 3"
881335	30BFP-RK	4"
881340	31BFP-RK	6"
881348	32BFP-RK	8"
881352	33BFP-RK	10"

When oredring specify Ordering Code Number, Kit Number and Valve Size



2½"- 3"

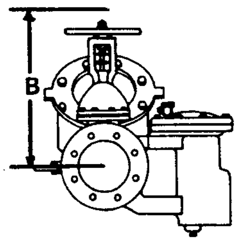
*WARNING: Spring assembly is factory assembled. **DO NOT DISASSEMBLE**



4" - 10"

Servicing the Relief Valve 2½ - 10"

Relief Module



Clearance Required for Servicing

	A	B
2½-3	10"	11"
4	15"	14"
6	15"	16"
8	23"	21"
10	25"	21"

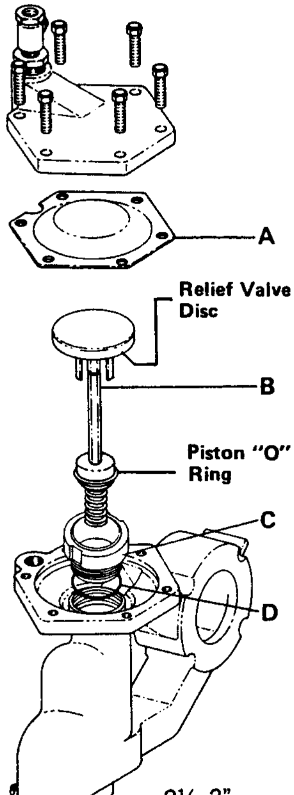
1. Remove the relief valve cover bolts. Note the 909 is designed so that when the bolts are backed off ½" all the relief valve spring load is retained by the bottom plug spring module. **CAUTION:** Be sure to verify this before removing all the bolts.

2. Remove the cover and diaphragm (A). The relief valve piston assembly (B) can be lifted straight up and out.

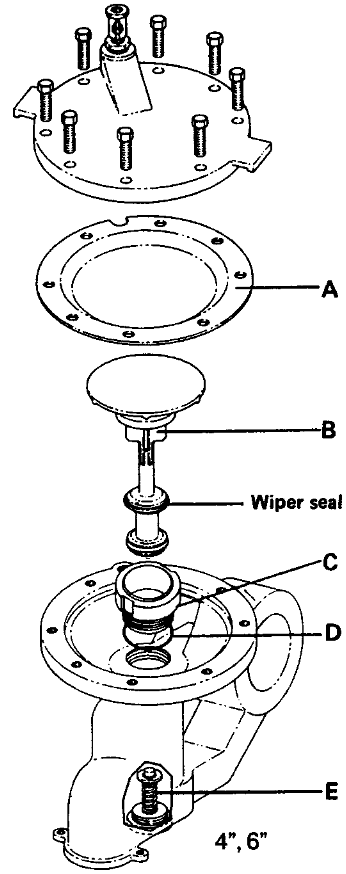
3. Replace the wiper seal and piston "O" ring and apply grease to the "O" ring.

4. To replace the relief valve disc, hold the upper guide fin and unscrew the diaphragm pressure plate. It may be necessary to lightly tap the cast webs and the pressure plate to loosen. Replace with a new disc holder assembly and "O" ring. Note: the disc rubber is molded into the disc holder and is supplied as a disc holder assembly.

5. Removal of the bottom spring assembly (E). During normal field service there is no need to remove the bottom plug spring assembly other than inspection. It can be removed by simply unscrewing with a large pipe wrench. **CAUTION:** The spring as retained on the bottom plug is highly loaded. NO attempt should be made in the field to remove the spring. For replacement, a complete bottom plug assembly must be obtained from the factory.



2½, 3"



4", 6"

For further details contact your technical sales representative, see back page.

Series 909 (All Models)-Sizes 2½"-3" RELIEF VALVE SERVICE KIT

Kit Includes:

A - Diaphragm C - Seat

B - Relief Valve Assembly D - "O" Ring and Lubricant

Ordering Code No.	Kit No.	Size (In.)
881483	59BFP-RK	2½", 3"

Series 909-Sizes 4"-10" RELIEF VALVE SERVICE PARTS KIT

Kit includes:

A-Diaphragm D-"0" Ring

B-Relief Valve Assembly E-Bottom Plug and Assembly and Lubricant

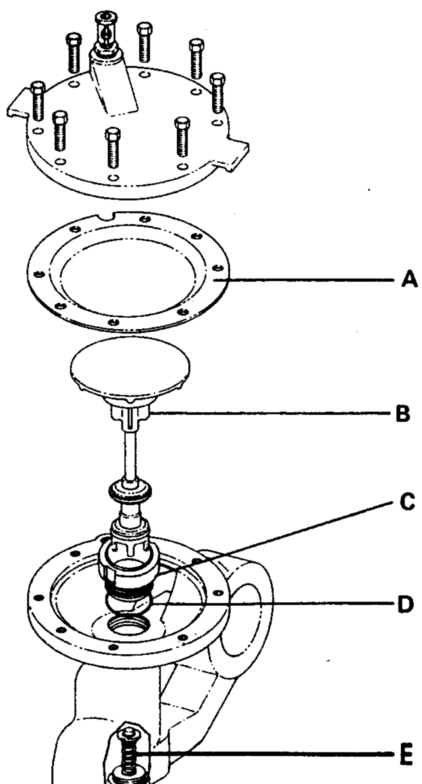
C-Seat

Ordering Code No.	Kit No.	Size (In.)
881484	60BFP-RK	4", 6"
881485	61BFP-RK	8", 10"

Series 909-Sizes 2½"-10" RELIEF VALVE RUBBER PARTS KIT †

Kit Includes "0" Rings, Check Discs, Diaphragm, Piston Seal, Lubricant

Ordering Code No.	Kit No.	Size (In.)
833902	56BFP-RK	2½, 3"
881345	57BFP-RK	4", 6"
881350	58BFP-RK	8", 10"



8", 10"

 †Note: To replace all rubber in a **Complete Valve** requires both the first and second check valve rubber parts kit and relief valve rubber parts kit.

TROUBLE SHOOTING GUIDE –
Backflow Preventers

PROBLEM	CAUSE	SHOULD VALVE BE REPLACED?	SOLUTION
A. Valve spits periodically from the vent.			
	A.1 Fluctuating supply pressure.	No	**A.1** Install a soft seated check valve immediately upstream of the device. (Watts ¾"-2" No. 601 bronze valve.)
	A.2 Fluctuating downstream pressure.	No	**A.2** Install a soft seated check valve downstream of the device close as possible to the shut-off valve. (Watts ¾"-2" No. 601 bronze valve.)
B. Valve drips continually from the vent.			
	B.1 Fouled first check.	No	**B.1** Flush valve. If flushing does not resolve problem, disassemble valve and clean or replace the first check.
	B.2 Damaged or fouled relief valve seat.	No	**B.2** Clean or replace the relief valve seat.
	B.3 Relief valve piston "O" ring not free to move due to pipe scale, dirt or build up of mineral deposits.	No	**B.3** Clean, grease or replace the piston "O" ring.
	B.4 Excessive back pressure, freezing, or water hammer has distorted the second check.	No	**B.4** Eliminate source of excessive backpressure or water hammer in the system downstream of the device. Use Watts No. 601 to dampen out backpressure and No. 15 to eliminate water hammer. Replace defective second check assembly. In case of freezing; thaw, disassemble, and inspect internal components. Replace as necessary.
	B.5 Electrolysis of relief valve seat or first check seats.	No	**B.5** Replace relief valve seat or inlet cover. Install dielectric unions (Watts series 3001 through 3006). Electrically ground the piping system and/or electrically isolate the device with plastic pipe immediately upstream and downstream of the device.
	B.6 Deterioration of checks due to high temp. water usage.	No	**B.6** Replace plastic checks with stainless steel checks or replace complete unit with No. 909HW.
C. Valve exhibits high pressure drop.			
	C.1 Fouled strainer.	No	**C.1** Clean strainer element or replace.
	C.2 Valve too small for flows encountered.	Yes	**C.2** Install proper size device based upon flow requirements.
D. No water flows downstream of valve.			
	D. Valve installed backwards.	No	**D.** Install valve in accordance with flow direction arrow.
E. Valve does not test properly.			
	E.1 Follow test procedure prescribed by USC foundation manual section 9.	No	**E.1, E.2** Clean or replace gate valve with full port ball valves or resilient wedge shut-off valves.
	E.2 Leaky downstream gate valve.	No	
F. Valve quickly and repeatedly fouls following servicing.			
	F. Debris in pipe line is too fine to be trapped by strainer	No	**F.** Install finer mesh strainer element in the strainer.
G. Water spillage on floor.			
	G. Transposed checks 2½"-10" valves	No	**G.** If valve is disassembled during installation, caution must be exercised to install check valves in their proper order. Inlet shut-off valve, **first** check, relief valve, **second** check, second shut-off valve.
H. Winterization of backflow preventers.			**H.** Electric heat-tape wrap closely together around valve body. Build a small shelter around the valve with a large light bulb installed and left on at all times. If supply line is not used during the winter, removal of the complete body is the best. This would create an air gap to eliminate any possible backflow.

For technical assistance, call your authorized Watts agent.

		Telephone #	Fax #
Trayco Sales, Inc.	P.O. Box 653, Lynnfield, MA 01940	617 334-6078	617 334-2859
W. P. Haney Co., Inc.	51 Norfolk Ave., South Easton, MA 02375	508 238-2030	508 238-8353
E. W. Leonard, Inc.	Ray Palmer Rd., P.O. Box 371, Moodus, CT 06469-0371	203 873-8691	203 873-8693
WMS Sales, Inc.	9580 County Rd., Clarence Center, NY 14032	716 741-9575	716 632-0633
WMS Sales, Inc.	7437 Meadowbrook Dr., Baldwinsville, NY 13027	315 622-0763	315 622-0764
WMS Sales, Inc.	4 McMillen Place, Delmar, NY 12054	518 475-1017	
Edwards, Platt & Deely, Inc.	1 Stone Place, Bronxville, NY 10708	Office:212 671-6400	914 337-5069
	(Warehouse: 263 Royal Ave., Hawthorne, NJ 07506)	800 433-3158	
		Warehouse: N.Y.914 337-5511	
Vernon Bitzer Associates, Inc.	138 Railroad Dr., Northhampton Ind. Pk., Ivyland, PA 18974	215 953-1400	215 953-1250
Bruce Parrott, N.E. Reg. Mgr.	815 Chestnut St., North Andover, MA 01845	508 688-1811	508 794-1848

SOUTHEASTERN REGION

		Telephone #	Fax #
RMI	Glenfield Bus. Ctr., 2535 Mechanicsville Tpk., Richmond, VA 23223	804 643-7355	804 643-7380
Smith & Stevenson	4935 Chastain Ave., Charlotte, NC 28210	704 525-3388	704 525-6749
Central Sales Company	1612 Fourth Ave. North, Nashville, TN 37208	615 259-9022	615 259-9024
Central Sales Company	2170 York Ave., Memphis, TN 38104	901 278-2251	901 272-1614
Spotswood Associates	6700 Best Friend Rd., Norcross, (Atlanta) GA 30071-2919	404 447-1227	404 263-6899
Distributor Sales of Florida	6520 35th St. North, Pinellas Park, FL 33565	813 527-6651	813 528-0602
Earl L. Griffin Co.	2776 B.M. Montgomery St., Birmingham, AL 35209	205 879-3469	205 870-5027
Earl L. Griffin Co.	6517 Buggy Whip Court, Mobile, AL 36695	205 661-1199	
Billingsley & Associates, Inc.	5609-D Salmen St., Harahan, LA 70123	504 733-7624	504 733-6904
Billingsley & Associates, Inc.	478 Cheyenne Lane, Madison, MS 39110	601 856-7565	601 856-8390
JLM & Assoc., Inc.	1147 Americo Miranda Caparra Terrace, Rio Piedras, PR 09922	809 782-4244	809 781-7970
The Joyce Agency, Inc.	10520 Warwick Ave., Fairfax, VA 22030	703 591-2808	703 591-0826
	(Warehouse: 7313 Boudinot Dr., Springfield, VA)		
J. B. O'Connor Company, Inc.	P.O. Box 12927 Pittsburgh , PA 15241	412 745-5300	412 745-7420
Hugh M. Cunningham, Inc.	4309 N. Beltwood Pkwy., Dallas, TX 75244-3294	214 661-0222	214 490-6678
Hugh M. Cunningham, Inc.	1999 Kolfahl, Houston, TX 77023	713 923-2371	713 923-8357
Hugh M. Cunningham, Inc.	5130 Service Center, San Antonio, TX 78218	512 661-4161	512 661-0954
Bill Johnson, S.E. Reg. Director	P.O. Box 140153, Orlando, FL 32814-0153	407 895-3461	407 895-3462

MIDWEST REGION

		Telephone #	Fax #
Mid-Continent Marketing Services Ltd.	1724 Armitage Ct., Addison, IL 60101	708 953-1211	708 953-1067
Mid-Continent Marketing Services Ltd.	10109 Apple Spice Dr., Indianapolis, IN 46236	317 823-1532	317 823-1663
Advance Industrial Marketing Ltd.	923 South Bird St., Sun Prairie, WI 53590	608 837-5005	608 837-2368
Dave Watson Associates	1325 West Beecher, Adrian, MI 49221	517 263-8988	517 263-2328
The Harris-Billings Co.	P.O. Box 41304, 1920 Annapolis Lane North, Plymouth, MN 55441	612 559-9400	612 559-8239
Mack McClain & Associates, Inc.	1537 Ohio St., Des Moines, IA 50314	515 288-0184	515 288-5049
Mack McClain & Associates, Inc.	15090 West 116th St., Olathe, KS 66062	913 339-6677	913 339-9518
Mack McClain & Associates, Inc.	16037 "N" Circle, Omaha, NE 68135	402 896-8804	402 896-8807
Pro-Spec, Inc.	P.O. Box 472226, Tulsa, OK 74145	918 664-5642	918 664-6069
J. W. Sullivan Company	7901 Manchester Ave., St. Louis, MO 63143	314 644-5454	314 644-5527
Disney-McLane, Inc.	2704 Colerain Ave., Cincinnati, OH 45225	513 541-1682	513 541-0073
Madsen-Bayer & Associates, Inc.	2510 Englewood Dr., Columbus, OH 43219	614 476-1833	614 476-1846
Madsen-Bayer & Associates, Inc.	4640 Warner Rd., Garfield Heights, OH 44125	216 641-5808	216 641-5546
Gary S. Gilpin Sales Co.	4468 Emberson Ave., Louisville, KY 40209	502 367-2178	502 367-9080
Don Sinsabaugh, MidWest Reg. Sales Mgr.	42 W. 597 Steeple Chase, St. Charles, IL 60175	708 377-3671	708 513-5063

WESTERN REGION

		Telephone #	Fax #
R. C. Hartnett & Associates	30852 Huntwood Ave., Hayward, CA 94544	415 471-7200	415 471-4441
Hollabaugh Brothers & Associates	1260 6th Ave. South, Seattle, WA 98134-1308	206 467-0346	206 467-8368
Hollabaugh Brothers & Associates	3028 S.E. 17th Ave., Portland, OR 97202	503 238-0313	503 235-2824
R. E. Fitzpatrick Sales, Inc.	16 East 8th Ave., Midvale, UT 84047	801 566-7156	801 566-4979
Fanning & Associates, Inc.	625 East 70th Ave., Denver, CO 80229	303 289-4191	303 286-9069
Benisek Associates	2267 Yates Ave., Los Angeles, CA 90040	213 685-9900	213 887-2090
R. D. Wager Company.	2012 West 4th St., Tempe, AZ 85281	602 968-8586	602 829-7682
Rocky Mountain Marketing	3300 Princeton N.E., N-27, Albuquerque, NM 87107	505 883-4405	505 881-3767
Crown Sales	360 Mokauea St., Honolulu, HI 96819	808 845-7881	808 841-4504
Jim Engard, West Reg. Sales Mgr.	749 Renate Way, Paso Robles, CA 93446	805 239-8852	805 239-8859
Steve Govero, Market Mgr. Backflow	276 Ginger Ln., Paso Robles, CA 93446	805 237-2413	805 237-2265

INTERNATIONAL

		Telephone #	Fax #
HDQTRS: Watts Regulator Co./EXPORT	815 Chestnut St., No Andover, MA 01845 **Telex:** 94-7460	508 688-1811	508 794-1848
			508 794-1674
Watts Regulator of Canada Ltd.	441 Hanlan Rd., Woodbridge, Ontario L4L3T1, Canada	416 851-8591	416 851-8788
Walmar	24 Gurdwara Rd., Nepean Ontario K2E 8A2	613 225-9774	613 225-2972
Currie Agencies Ltd.	3117 Underhill Ave., Burnaby, B.C. V5A 3C8	604 420-6070	604 420-9022
Polymex Controles Inc.	1375 Boul Charest Ouest, Suite 6, Quebec City, Quebec G1N 2E7	418 682-1690	418 682-8743
Watts Regulator of Canada Ltd.	2690 Sabourin, Ville St. Laurent, Quebec H4S 1M2	514 337-9010	514 337-8843
Murray Krovats Sales Agency	941 C Erin St., Winnipeg, Manitoba R36 2W6	709 786-2747	709 775-3186
Bayers-Conte Sales Ltd.	1801-10th Ave. Southwest, Calgary, Alberta T3C 0K2	403 244-1818	403 245-9297
W.B. Gingerich Sales Ltd.	107 Hamilton Rd., New Hamburg, Ontario N0B 2G0	519 662-2460	519 662-2491
S.T.E. Fetterly & Son Ltd.	6080 Young St., Ste. 911, Halifax, NS B3K 5L8	902 454-9377	902 454-6085
Watts Regulator of Nederland b.v.	P.O. Box 98, 6960 AB Eerbeek, Holland Telex 844-35365	(011) 31-8-338-59028	8-338-52073

World Class Valves

WATTS® REGULATOR
WATTS REGULATOR COMPANY
Since 1874

Backflow Prevention Division

Building Heaters

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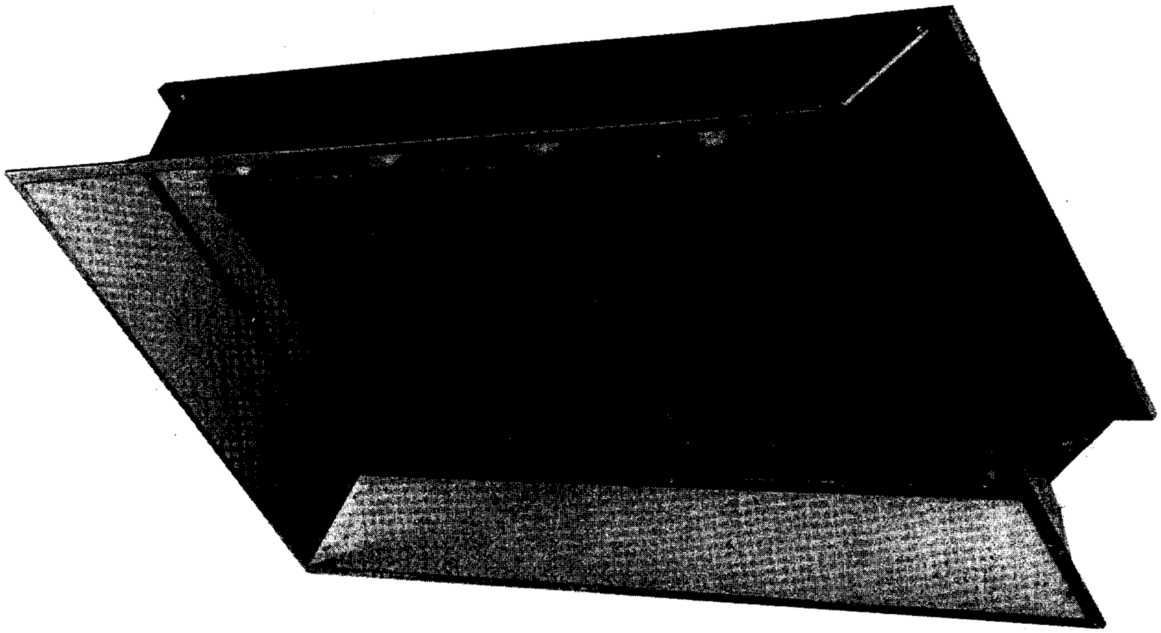


K-SERIES
HEATERS

INSTALLATION, OPERATION AND MAINTENANCE INSTRUCTIONS FOR HIGH-INTENSITY GAS INFRA-RED HEATERS

FOR YOUR SAFETY

If you smell gas: open windows; don't touch electrical switches, extinguish any open flames; evacuate the structure; and call your gas supplier immediately.

WARNING

Read all instructions carefully before attempting to install, operate or service this gas fired appliance. Failure to comply with instructions could result in unsafe operation, property damage, personal injury and/or death. A gas fired appliance could expose you to substances in fuel or from fuel combustion which have been determined by the State of California to cause cancer, birth defects or other reproductive harm. For industrial or commercial use only. Contact factory for further information. Retain these instructions for future reference.

CAUTION: PLEASE READ THESE INSTRUCTIONS COMPLETELY AND CAREFULLY BEFORE PROCEEDING WITH INSTALLATION. IF YOU HAVE ANY QUESTIONS, CALL SOLARONICS, INC. TOLL FREE AT 1-800-223-5335 BEFORE ATTEMPTING ANY INSTALLATION WORK.

K and KS SERIES INSTALLATION, OPERATION AND MAINTENANCE INSTRUCTIONS

— Table of Contents —

Solaronics HIGH-INTENSITY

JLARONICS

- A.G.A. and C.G.A. Design Certified.
- Tested under ANS Z83.6 latest edition and
- CAN1-2.16M81 and CAN1-2.17 M80.
- Natural or propane gas.
- Minimum inlet pressure:
  Natural gas – 7″ WC
  LP gas – 11″ WC
- Maximum inlet pressure:
  Natural or LP gas – 14″ WC
- Flexible inputs from 30,000 to 200,000 BTUH.
- Horizontal to 30° angle mounting.
- Compact and durable, modular design.
- All heaters shippable via UPS.
- Less maintenance – no moving parts.
- "Instant ON" – "Instant OFF."
- Requires no direct venting.
- Simple chain mounting.
- Factory prewired, prepiped and tested.

CERAMIC COMBUSTION SURFACE

- Cordierite-based, grooved ceramic tile.
- Permeable design with alternating rows of precision perforations terminating in slots.
- Minimum 0.045″ diameter perforations.
- Minimum 190 perforations per sq. inch.
- Up to 1850°F surface temperature.
- Capable of reaching full intensity temperature in less than 30 seconds.
- Stable flame – shorter and closer to ceramic.

PLENUM CHAMBER

- 20 gauge corrosion-free aluminized steel.
- One-piece fabrication.
- Seamless no-weld construction.
- Single screw removal for quick service.
- Stainless steel tile retainer clips.

NTURI MIXER

- ooth, seamless spun metal construction.
- Precision metering of proper air/gas mixture.
- Matched with ceramic port area.
- Inspirates 110-120% primary air.

MAIN FRAME

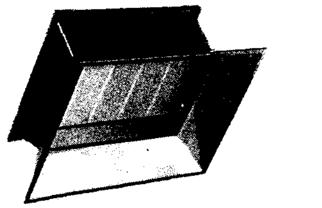
- 16 gauge corrosion-free aluminized steel.
- Stainless steel baffle.
- No weld construction.
- Double turned upper edge for rigidity.
- 3″×3″ corner reinforcement brackets.
- ⅜″ diameter mounting holes.
- Heat shield available for decreased clearances to combustibles.

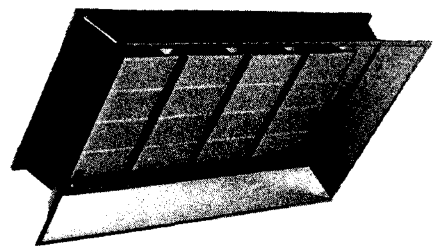
REFLECTOR

- 0.032″ highly polished aluminum.
- Double turned lower edge for rigidity.

CONTROLS

- Over 16 control arrangements.
- 100% safety shut-off available.
- 25V; 120V; or self-energizing thermostatic control.
- Direct spark; spark pilot; glow coil; or manual ignition.
- Field adjustable pilot gas regulator.
- Concealed pilot is protected from drafts.
- ½″ FPT gas inlet.


KS-1


K-4

MODELS & BTUH RATINGS

Model	Number	BTUH 000's Nat	BTUH 000's LP
KS-1	KS- 30[1]	30	
	KS- 35[1]	35	
	KS- 40	40	
	KS- 45	45	
	KS- 50	50	50
	KS- 55	55	
	KS- 60[2]	60	
K-1	K- 30[1]	30	
	K- 35[1]	35	
	K- 40	40	
	K- 45	45	
	K- 50	50	50
	K- 55	55	
	K- 60[2]	60	
K-2	K- 70	70	70
	K- 75	75	75
	K- 80	80	80
	K- 85	85	85
	K- 90	90	90
	K- 95	95	
	K-100	100	
K-3	K-110	110	
	K-120	120	120
	K-125	125	
	K-130	130	
	K-135	135	
	K-150	150	
K-4	K-160	160	160
	K-175	175	
	K-200	200	

SPECIFICATIONS

Model	KS-1[1] 30-50 MBTUH	KS-1[2] 55-60 MBTUH	K-1[1] 30-50 MBTUH	K-1[2] 55-60 MBTUH	K-2 70-100 MBTUH	K-3 110-150 MBTUH	K-4 160-200 MBTUH
Clearances to Combustibles:							
Side of Heater	30″	30″	30″	30″	36″	46″	48″
Back of Heater	30″	30″	30″	30″	30″	33″	33″
Top of Heater:							
Mounted 0°-29°[3]	60″	60″	60″	60″	62″	64″	68″
Mounted 30° Only	48″	48″	48″	48″	50″	58″	68″
W/Heat Shield 0°-29°[3]	34″	34″	28″	34″	38″	N/A	N/A
W/Heat Shield 30° Only	28″	34″	28″	28″	38″	N/A	N/A
Below Heater:							
Standard Reflector	80″	80″	80″	80″	105″	125″	140″
Parabolic Reflector	110″	110″	110″	110″	135″	165″	180″
Overall Dimensions:							
Height	16¾″	16¾″	23⅝″	23⅝″	25¼″	33⅞″	42½″
Width	23⅝″	23⅝″	16¾″	16¾″	23⅝″	23⅝″	23⅝″
Depth	8¾″	8¾″	8¾″	8¾″	8¾″	8¾″	8¾″
Mounting Hole Dimensions:							
Size – Diameter	⅜″	⅜″	⅜″	⅜″	⅜″	⅜″	⅜″
Height	14 11/16″	14 11/16″	13″	13″	23⅜″	34″	40½″
Width	13″	13″	14 11/16″	14 11/16″	13″	13″	13″
Radiating Surface:	173 sq.″	173 sq.″	173 sq.″	173 sq.″	346 sq.″	519 sq.″	692 sq.″
Shipping Weights Lbs.	26	26	26	26	36	49	62

CONTROL OPTIONS

Control Suffix Letters	Gas	Shut-Off	Voltage	Maximum Power Consumption	Ignition	Pilot
RC-N[4]	Natural	100%	None	None	Manual	Constant
RC-L[4]	LP	100%	None	None	Manual	Constant
TAN	Natural	100%	Millivolt	None	Manual	Constant
TAL	LP	100%	Millivolt	None	Manual	Constant
DKN	Natural		115V	35 VA	Glow coil	Constant
QKN	Natural		25V	40 VA	Glow coil	Constant
DSPN	Natural		115V	5 VA	Spark pilot	Intermittent
QSPN	Natural		25V	21 VA	Spark pilot	Intermittent
DSAN	Natural	100%	115V	6 VA	Direct spark	None
DSAL	LP	100%	115V	6 VA	Direct spark	None
QSAN	Natural	100%	25V	5 VA	Direct spark	None
QSAL	LP	100%	25V	5 VA	Direct spark	None
DAPN	Natural	100%	115V	31 VA	Spark pilot	Intermittent
QAPN	Natural	100%	25V	31 VA	Spark pilot	Intermittent
DAPL	LP	100%	115V	15 VA	Spark pilot	Intermittent
QAPL	LP	100%	25V	15 VA	Spark pilot	Intermittent

FOOTNOTES FOR TABLES:

[1] Models KS-30, KS-35, K-30 and K-35 not available in Canada.
[2] Models KS-60 and K-60 required with wire grid in Canada.
[3] Models K-70 through K-100 and K-160 mounted 5 to 29° only.
[4] All control options may be actuated by either a thermostat or ON/OFF switch with the exception of control suffix letters RC-N and RC-L which are pull chain operated.

MOUNT A COPY OF THESE INSTRUCTIONS ADJACENT TO THERMOSTAT
MOUNT A COPY OF THE ELECTRICAL SCHEMATIC ADJACENT TO HEATER

I. NOTES TO INSTALLING CONTRACTOR

Solaronics K and KS Series gas Infra-Red heaters are A.G.A. design certified for indoor installation only. They are designed and manufactured in compliance with American National Standards Institute appropriate standards. Solaronics Infra-Red heaters must be installed in accordance with applicable codes. In the absence of local codes, installation must be in accordance with the National Fuel Gas Code ANSI Z-223.1 - 1984 and its addendums or latest revisions. All electrical work must conform to the National Electrical Code ANSI/NFPA 70-1987 and its addendums or latest revisions. The installation must be in accordance with the requirements of the Occupational Safety and Health Act (OSHA). A number of excerpts from these standards are outlined in the following instructions. However, the installing contractor, or person, must be familiar with ALL of the various requirements and is responsible for the system's compliance with the applicable codes.

Refer to heater rating plate for model number, BTUH input, control suffix letters, voltage, mounting angle(s) and clearances to combustibles. Then proceed with the following:

Approval requirements for Infra-Red heaters, duct furnaces and unit heaters specify that the suspended type heaters shall be installed in accordance with certain sections of the National Fire Codes published by the National Fire Protection Association and various ANSI standards. SOME of the requirements are listed below.

Aircraft Hangars: Approval requirements are contained in ANSI/NFPA 490-1985 and, in general, are described as follows:

Chapter 5 Section "B" - "Suspended or Elevated Heaters" of NFPA 409-1985.

5-4.5.2 Specifies a clearance of ten feet (10'0") to the bottom of the heater from the highest surface of the wings or engine enclosures of whatever aircraft would be the highest to be housed in the hanger.

5-4.5.3 Specifies a minimum clearance of eight feet (8'0") from the floor in other sections of aircraft hangars, such as offices and shops, which communicate with the areas used for services or storage.

5-4.5.4 Specifies that the heaters must be located so as to be protected from damage by aircraft or other objects such as cranes and movable scaffolding. In addition, the heaters must be located so as to be accessible for servicing, adjustment, etc.

Public Garages: Approval requirements for public garages are contained in NFPA 88B-1985 and, in general, are described as follows in Section 3-2.3 "Suspended Unit Heaters."

3-2.3.1 Overhead heaters shall be installed at least eight feet (8'0") above the floor and in accordance with the conditions of their approval.

WARNING: In addition, they shall be located high enough so as to maintain the minimum distance to any combustibles (as noted on the heater nameplate) between the heaters and any vehicle parked below the heaters.

3-2.3.2 Distance between the heater and any adjacent combustible material (which is part of the building or its contents) shall conform to ANSI Z-223.1 1984 (NFPA 54-1984), National Fuel Gas Code.

Parking Structures: Approval requirements for parking structures are contained in NFPA 88A-1985 as described in Section 4.2.

General: All installation must be installed in accrodance with ANSI Z-223.1 1984 (NFPA 54-1984) National Fuel Gas Code especially:

Section 6.18 Covers the general provisions for installing Infra-Red heaters. Note the requirements for posting signs to specify the maximum permissible stacking height to maintain clearances from heaters to combustibles (6.18.2). Note also the fresh air requirement of four (4) CFM per 1,000 BTUH for Natural gas, and five (5) CFM per 1,000 BTUH for LP gas when operating in the unvented mode (6.18.3).

Section 5.1.10 Part A States that in commercial garages "overhead heaters shall be installed at least eight feet (8'0") above the floor. Overhead radiant type heaters shall be located at a sufficient height to avoid overheating vehicles parked underneath."

Section 5.2 Accessibility and clearance.

Section 5.3 Air for combustion and ventilation.

SOLARONICS HEATERS DO NOT QUALIFY FOR EXPLOSION PROOF INSTALLATION.

CAUTION: The installing contractor must be certain that the area in which the heaters will be installed does not contain corrosive or toxic fumes or that elements in the atmosphere do not produce corrosive or toxic fumes in the presence of an open flame.

K Series heaters are NOT recommended for use in enclosed swimming pool areas. Extremely high moisture and chlorine levels may cause corrosion of all metal parts and components. Please consult factory.

II. FOR YOUR SAFETY, IF YOU SMELL GAS:

A) OPEN WINDOWS.
B) DO NOT TOUCH ANY ELECTRICAL SWITCHES.
C) EXTINGUISH ANY OPEN FLAME.
D) CALL YOUR GAS SUPPLIER IMMEDIATELY.

III. K-SERIES SPECIFICATIONS

TABLE 1

MODELS & BTUH RATINGS			
Model	Number	BTUH 000's Nat	LP
KS-1	KS- 30[1]	30	
	KS- 35[1]	35	
	KS- 40	40	
	KS- 45	45	
	KS- 50	50	50
	KS- 55	55	
	KS- 60[2]	60	
K-1	K- 30[1]	30	
	K- 35[1]	35	
	K- 40	40	
	K- 45	45	
	K- 50	50	50
	K- 55	55	
	K- 60[2]	60	
K-2	K- 70	70	70
	K- 75	75	75
	K- 80	80	80
	K- 85	85	85
	K- 90	90	90
	K- 95	95	
	K-100	100	
K-3	K-110	110	
	K-120	120	120
	K-125	125	
	K-130	130	
	K-135	135	
	K-150	150	
K-4	K-160	160	160
	K-175	175	
	K-200	200	

TABLE 2

SPECIFICATIONS							
BTUH Rating	KS-1[1] 30-50 MBTUH	KS-1[2] 55-60 MBTUH	K-1[1] 30-50 MBTUH	Model K-1[2] 55-60 MBTUH	K-2 70-100 MBTUH	K-3 110-150 MBTUH	K-4 160-200 MBTUH
Clearances to Combustibles:							
Side of Heater	30″	30″	30″	30″	36″	46″	48″
Back of Heater	30″	30″	30″	30″	30″	33″	33″
Top of Heater:							
Mounted 0°-29°[3]	60″	60″	60″	60″	62″	64″	68″
Mounted 30° Only	48″	48″	48″	48″	50″	58″	68″
W/Heat Shield 0°-29°[3]	34″	34″	28″	34″	62″[4]	N/A	N/A
W/Heat Shield 30° Only	28″	34″	28″	28″	50″[4]	N/A	N/A
Below Heater:							
Standard Reflector	80″	80″	80″	80″	105″	125″	140″
Parabolic Reflector	110″	110″	110″	110″	135″	165″	180″
Overall Dimensions:							
Length	16¾″	16¾″	23⅝″	23⅝″	25¼″	33⅞″	42½″
Width	23⅝″	23⅝″	16¾″	16¾″	23⅝″	23⅝″	23⅝″
Depth	8¾″	8¾″	8¾″	8¾″	8¾″	8¾″	8¾″
Mounting Hole Dimensions:							
Size – Diameter	⅜″	⅜″	⅜″	⅜″	⅜″	⅜″	⅜″
Length	14 11/16″	14 11/16″	13″	13″	23⅜″	34″	40½″
Width	13″	13″	14 11/16″	14 11/16″	13″	13″	13″
Shipping Weights:							
Lbs. (UPS)	26	26	26	26	36	48	61

FOOTNOTES FOR TABLES:

[1] Models KS-30, KS-35, K-30 and K-35 not available in Canada.
[2] Models KS-60 and K-60 required with wire grid in Canada.
[3] Models K-70 through K-100 and K-160 mounted 5 to 29° only.
[4] Models K-2 (K-70 through K-100) presently being tested for lower clearances to combustibles. Please consult rep or factory.

NOTE 1: Gas pressure must be measured with a water or red oil manometer - NOT A DIAL GAUGE. All measurements must be made when this heater and all other gas burning equipment connected to the same gas meter are operating at maximum capacity.

NOTE 2: If inlet gas pressure exceeds 14" w.c., a regulator of the positive locking type must be installed in the gas supply line to this heater.

NOTE 3: If this heater is installed in a tightly closed, well insulated building, provisions must be made for supply of combustion air. One (1) square inch, or more of free area opening is required for each 1,000 BTUH of input.

IV. INSTALLATION

Figures 1 and 2 illustrate typical mounting arrangements for Solaronics heaters. Be certain to check local codes for mounting requirements and permission to use flexible gas connectors. Local codes may require rigid mounting. Heaters may be mounted at angles from 0 to 30 degrees as specified in Table 1, page 3. The gas manifold must be located on the low end for the K Series, (figure 1, page 9) or with the gas valve on the high side for the KS Series, (figure 2, page 10). DO NOT mount over 30 degrees as this will waste radiant energy by directing it to the opposite wall and will not meet A.G.A. requirements.

Where permissible, Solaronics recommends chain mounting. Number 1/0 Tenso chain (200# working load) is recommended. "S" hooks should be a minimum ¼" in diameter wire and the ends must be closed after installation. Heaters located in aircraft hangars or near overhead doors must be rigidly mounted to prevent swinging. THE INSTALLER is responsible for adequately fastening the chain or other mounting to the overhead building structure. The overhead structure, in turn, must be adequate to support the weight of the heater. UNDER NO CIRCUMSTANCES should either the gas supply line or the electrical supply line to the heater be used to provide any assistance in the suspension of the heater. DO NOT run any gas or electric service lines above or below the heater or near the path of the flue products from the heater.

INSURE THAT:

1) Clearances to combustibles (as shown on rating plate) are maintained. It is strongly recommended that more distance than the minimum clearance is maintained above the unit whether the construction is combustible or not. This will reduce and/or eliminate hot spots and staining of painted ceiling surfaces. If the unit must be close to the roof, or ceiling, interpose a non-combustible baffle (twice the size of the reflector) between the unit and the roof or ceiling. Allow at least 2" between the roof or ceiling and the non-combustible baffle. Allow at least 12" between the non-combustible baffle and the top of the heater.
2) Either piping or mounting is flexible (to prevent fatigue failure from vibration or thermal expansion).
3) Adequate clearances from heaters to sprinkler heads are maintained, or high temperature heads are installed. Check with factory.
4) Heaters are angle mounted from zero degrees (0) to thirty degrees (30) from the horizontal, only as specified in Table 2, page 3. See Figures 1 and 2, pages 9 & 10. Failure to adhere to this requirement voids all warranties and A.G.A. certification.
5) Space directly above and below the heater is free of objects that may overheat or prevent Infra-Red energy from reaching work areas.

PIPING: Adequate piping must be installed to provide the correct pressures to all heaters while operating, as listed under SPECIFICATIONS, page 3.

1) Provide a 1/8" N.P.T. plugged tap, accessible for test gauge connection, immediately upstream of the gas supply connection to the heater - pressure tap A - Figure 1, page 9.
2) An approved flexible connector with shut-off gas cock is suggested as a convenient method of connecting Infra-Red heaters to the gas supply (local codes permitting).
3) Use pipe joint compound resistant to the action of LP gas and provide a ground joint union ahead of the controls to permit servicing the heater(s).
4) Insure that the pressure regulator (if packed loose) is installed in the gas line to the heater and that the arrow on the regulator is pointing in the direction of the gas flow.
5) Check all lines for leaks with a soap solution - NEVER USE A FLAME.
6) DO NOT subject gas pressure regulators, flex connectors and gas cocks on the heater to test pressures over 14" WC while checking piping for leaks.
7) Purge all lines completely before attempting to ignite heaters.
8) Provide a drip leg in the gas supply line.
9) Always use two (2) wrenches when mating pipe connections to the heater. Excessive torque on the manifold may misalign gas orifices in relation to their position with the venturi.
10) Use new clean pipe to serve the heater. Inspect and clean out any chips or debris before installing the pipe and fittings.

ELECTRICAL

For wiring of controls on each heater see the wiring diagram included with each heater.
Basically, control systems are energized by either 120 volt AC, 24 volts AC, or millivolt systems. 24 volt systems require a step down transformer of sufficient VA rating to handle the number of heaters to be served. Special care must be used to size the wire for 24 volt systems. The use of "doorbell" wire over long distances may results in a voltage drop sufficient to prevent heater operation. Millivolt systems require NO external power, as the energy needed to operate the valve is generated by the power pile assembly.

Figures 3 and 4 illustrate typical wiring arrangements. Thermostats must be installed in the hot leg of a fused supply line. Assure sufficient thermostat ampacity rating and proper fuse sizing. Note that Figure 3 illustrates multi-zone control using one mechanical exhauster. Figure 4 illustrates a typical 24 volt system and the use of a combination thermostat and humidity controller. In some cases, a humidistat may be used alone to energize the exhauster on rise in building humidity.

The electrical contractor, or person, should insure the following:

1) Electrical supply to the heaters is of the proper voltage and that heaters are not energized until gas is available at the heaters. Otherwise, control components may fail.
2) Wiring, transformers, fusing and disconnects must conform to all applicable code requirements.
3) Wiring must NOT run directly over or under the heaters. It must NOT be close enough to overheat.
4) Each heater must be electrically grounded, in accordance with the National Electric Code, ANSI/NFPA 70-1987, at the time of installation.
5) If any of the original wire, as supplied with this equipment must be replaced, it must be replaced with Type TFF wire with a minimum of 2/64ths of an inch insulation thickness, or equivalent.

TABLE 3

MAXIMUM ELECTRICAL POWER CONSUMPTION					
Control Suffix	**Voltage**	**Volt Amps**	**Control Suffix**	**Voltage**	**Volt Amps**
DKN	115	35.0	QSAN	24	5.0
QKN	24	40.0	QSAL	24	5.0
DSPN	115	5.0	DAPN	115	31.0
QSPN	24	21.0	DAPL	115	31.0
DSAN	115	6.0	QAPN	24	15.0
DSAL	115	6.0	QAPL	24	15.0

NOTE: 1) The following control Suffixes have been omitted from this table as they do NOT require external power for operation: RCN; RCL; TAN and TAL.

2) The Electrical Power Consumption given is the power consumed during ignition.

V. VENTILATION

Every direct fired heater installation requires sufficient fresh air to provide adequate combustion air and removal of products of combustion. POSITIVE AIR DISPLACEMENT OF 4 CFM PER 1,000 BTU PER HOUR FOR NATURAL GAS AND 5 CFM PER 1,000 BTU PER HOUR FOR PROPANE GAS IS REQUIRED. Many older buildings have sufficient air leakage to satisfy these requirements. Tightly constructed, well insulated buildings require mechanically powered systems. This may be accomplished by the use of exhaust fans and fresh air intake openings. Exhaust fans alone will not be sufficient. Inlet air openings are required.

Mechanical exhaust fans are typically located at high points of the building. For flat roof areas, a series of small exhausters should be distributed over the roof areas and interlocked with various heating zones as shown on Figure 3. Local codes may permit the use of humidistat control to remove water vapor and products of combustion, as shown on Figure 4. Humidistat settings will typically be in the 40 to 55% relative humidity range.

Fresh air intake openings are typically located high on the building sidewalls on a level with the heaters. ONE SQUARE INCH OF NET FREE INLET AREA PER 1,000 BTU PER HOUR IS REQUIRED. Multiple inlets, well distributed, should be used and should direct air upwards to prevent drafts at floor level. Inlets are typically limited to 1 to 2 square feet in size.

Total area required can be computed by dividing exhaust CFM by 600 feet per minute.

VI. GENERAL

Uninsulated metal roof decks will cause condensation of water vapor, contained in the heater flue gas, on their undersides. Such decks must be insulated. Built up insulation and roofing on the exterior may be employed. Inside insulation that is permeable to water vapor must be sealed with a vapor barrier that contains no tears or gaps.

A DESIGN GUIDE is available from Solaronics to assist in the proper sizing and heater location of a gas fired Infra-Red heating system. Generally, the heaters should be located as shown in Tables 4 and 5 on pages 7 and 8 of the DESIGN GUIDE. This material is also presented in Table 3, page 8 of these instructions.

VII. OPERATION

Upon completion of the installation, piping, and wiring of all of the heaters and controls, the gas piping should be purged of all trapped air. Then open all gas cocks and electrically energize the system. Follow the procedure on the heater's Lighting Instruction Label to put the heaters into operation. Be certain to wait five (5) minutes between successive attempts to light as specified on the label instructions. In the case of multi-zone systems, work with one (1) zone at a time to place the heaters into operation.

VIII. MAINTENANCE

Figure 5 shows the general arrangement of the heater. Figures 6 and 7 show the electrode and pilot arrangements respectively.

Annual maintenance should be performed as follows:

1) Disconnect all power sources related to the installation and close the gas supply valve at heater.
2) With an air hose of 20 PSIG or less, blow off all accumulated dust and dirt.
   CAUTION: ALWAYS WEAR PROTECTIVE EYE GOGGLES WHEN CLEANING HEATERS.
3) Pass the hose over the ceramic surface and alternately into the venturi several times in succession.
4) If equipped with a pilot, thoroughly blow out all the pilot assembly passages.
5) If necessary, remove the pilot orifice and clean with a wire of less than 0.012" diameter.

To change the type of gas or BTUH rating of a heater, follow the procedure outlined below:

1) Contact the factory to obtain proper components and NEW RATING PLATES.
2) Turn off the electrical and gas supply.
3) Remove main and pilot orifices and replace with the new ones furnished.
4) Change the rating plate on the heater to correspond with the new type of gas and/or rating required.
5) Turn on the gas and electric supply and install a water or red oil manometer at test point B. Adjust the gas pressure regulator to the new value required. Remove manometer and reinstall test plug. Leak test with a soap solution.
6) Place the heater into operation as outlined under Section VII.

CAUTION: USE ONLY FACTORY APPROVED PARTS WHEN REPAIRING A SOLARONICS HEATER. ANY SUBSTITUTION OF PARTS WILL VOID A.G.A. CERTIFICATION AND ALL WARRANTIES. FAILURE TO COMPLY WITH THIS PROCEDURE MAY RESULT IN UNSAFE OPERATION, PERSONAL INJURY AND/OR PROPERTY DAMAGE.

IX. TROUBLESHOOTING GUIDE

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE ACTION
Carbon formation on ceramic surface or burner.	1. Misaligned orifice. 2. Obstruction in venturi tube. 3. Pilot depositing carbon. 4. Low gas pressure. 5. Wrong gas supplied to heater.	1. Consult sales agent or factory. 2. Clean with a bottle brush. 3. Clean pilot burner and check pilot orifice. 4. Provide required pressure. 5. Check label for type of gas required.
Electrical circuit closed but heater not functioning (for troubleshooting of specific control systems see wiring diagrams and sequence of operation sheets enclosed with each heater).	1. Lack of gas supply caused control system lockout. 2. Disconnected wiring. 3. Exhaust fan interlock (if used) is defective. 4. Electrical short. 5. Electrical power surge causing blown line fuse or tripped circuit breaker.	1. Purge air from gas supply line. Check if all gas supply connections are open. Turn thermostat "OFF" - wait five minutes and turn thermostat back to desired setting. 2. See wiring diagram to repair. 3. Replace or repair interlock. 4. Trace and correct. Replace line fuse or reset breaker if necessary. 5. Replace line fuse or reset breaker.
Control assembly is overheating.	1. Heater not mounted correctly.	1. Mount heater with angle from 0-30 degrees from horizontal as specified in Section III, page 3.
Gas odor.	1. Loose pipe connection.	1. Use soap solution to check connections and tighten if necessary.
Heater will not turn off.	1. Defective thermostat. 2. Stuck solenoid valve.	1. Break electrical circuit. Repair or replace thermostat. 2. Replace solenoid.
Burning of gas/air mixture inside plenum. (flashback)	1. Gas leaking from: manifold, control assembly, pilot connections causing gas ignition at orifice.	1. Check all connections with soap solution and tighten where necessary.

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE ACTION
Burning of gas/air mixture inside plenum. (flashback)	2. Separation of ceramic grids 3. Ceramic grid(s) cracked. 4. Heater mounted at incorrect angle. 5. Excessive drafts.	2. Replace burner assembly. 3. Replace burner assembly. 4. Check angle of heater. See heater nameplate. 5. Shield or relocate heater.
Direct spark fails to ignite main burner(s).	1. Ignition detection control defective. 2. Electrode improperly located. 3. Electrode ceramic cracked. 4. Electrode wire loose. 5. Gas valve fails to open. 6. Manifold gas pressure to low. 7. Electrode wire broken or frayed.	1. Replace control module. 2. Relocate to correct position. 3. Replace electrode. 4. Reconnect wire. 5. Replace gas valve. 6. Adjust regulator or inlet gas pressure to proper value. 7. Replace electrode.
No gas.	1. Air in gas line. 2. External manual shut-off valve closed. 3. External regulator sticking. 4. External regulator reversed.	1. Purge gas line. 2. Open valve. 3. Replace regulator. 4. Remove and install properly.
No pilot.	1. Pilot line, orifice or passage plugged with foreign matter. 2. Air in line. 3. Pilot solenoid valve inoperative.	1. Check and clean per periodic MAINTENANCE instructions, Section VIII, page 6. 2. Purge gas line. 3. Replace combination valve.
Pilot goes out on 100% shut-off when hold-down button is released.	1. Defective pilot interrupter in combination valve. 2. Defective pilot flame sensor. 3. Poor contact at valve end of sensing element, or corroded contact. 4. Insufficient heat on pilot flame sensor. 5. Improper pilot flame sensor location. 6. Low gas manifold pressure.	1. Replace combination valve. 2. Replace pilot flame sensor. 3. Insure clean and proper contact. 4. Check pilot orifice for size. Clean pilot burner. Check alignment of pilot to element. 5. Check position with respect to pilot. 6. Provide proper gas pressure.
Pilot burning, no gas to main burner(s).	1. Defective operator in combination valve. 2. No electrical power to solenoid in combination valve. 3. Thermostat or manual switch open. 4. Pilot flame sensor faulty. 5. Manual valve closed on combination valve. 6. Pilot flame not heating flame sensor.	1. Replace combination valve. 2. Check power supply and furnish proper voltage. 3. Close switch or raise the thermostat setting. 4. Replace sensor. 5. Turn valve to "ON" position. 6. Check pilot orifice size. Clean pilot burner. Check alignment of pilot to element.
Unit cycles on and off.	1. Insufficient heat on pilot element. 2. Drafty condition.	1. Check pilot orifice and clean out pilot burner. 2. Shield from wind.
Low ceramic surface temperature.	1. Low manifold gas pressure. 2. Low gas inlet pressure. 3. Orifice partially blocked with foreign matter. 4. Combustion by-products not adequately ventilated. 5. Manifold misaligned from excessive torque applied on pipe at installation. 6. Gas supply piping too small. 7. Spider web in venturi. 8. Foreign matter in venturi tube.	1. Adjust heater regulator until 6" WC for natural gas, or 10" WC for propane is obtained. 2. Adjust main supply regulator until at least 7" WC for natural gas, or 11" WC for propane precedes heater's control assembly. 3. See maintenance instructions under MAINTENANCE, Sec. VIII, pg. 6. 4. Provide adequate ventilation of by-products (4 CFM per 1,000 BTUH). See VENTILATION, Sec. V, pg. 6. 5. Replace Manifold. 6. Increase gas pressure or replace piping. 7. Remove with bottle brush. 8. See MAINTENANCE, Sec. VIII, page 6.
Dark spots on ceramic surface.	1. Foreign matter behind the ceramic surface. 2. Mud daubers inside burner assembly.	1. See MAINTENANCE, Sec. VIII, page 6. 2. Replace burner assembly.

CAUTION:
THE FOLLOWING IS A LIST OF APPLICATIONS IN WHICH SOLARONICS K-SERIES HEATERS SHOULD NOT BE USED.

1) Enclosed swimming pool areas.
2) Areas with contaminated atmospheres, i.e. high concentrations of trichlorethylene.
3) Un-protected outdoor applications, Solaronics heaters are A.G.A. design certified for indoor applications only. Check with factory if in doubt.
4) Explosion proof areas, such as paint spray booths, etc. - Check with factory before proposing such an application.
5) Process applications. The Solaronics K-Series heaters are intended for space heating only. Do not use for any other purpose.

BE SURE TO FOLLOW THE RECOMMENDATIONS REGARDING PERIODIC MAINTENANCE AND CLEANING OF SOLARONICS HEATERS.

TABLE 4

A) Recommended minimum mounting heights (feet)

SOLARONICS HIGH INTENSITY - K SERIES

NOTE: Use lower mounting height if personnel are not kept directly under heater.

Reflector	Standard		Parabolic	
Mounting Angle	**Horizontal**	**@30°**	**Horizontal**	**@30°**
Input - BTUH				
30,000	11.0-13.0	10.0-12.0	—	—
40,000	12.0-14.5	11.5-13.5	—	—
50,000	13.5-15.5	12.5-14.5	15.5-18.5	14.0-17.0
60,000	14.5-16.5	13.0-15.0	16.0-20.0	15.0-18.0
70,000	15.0-17.0	13.5-15.5	17.5-20.5	16.0-19.0
80,000	15.5-18.0	14.0-16.5	18.5-21.5	17.0-20.0
90,000	16.0-18.5	14.5-17.0	19.5-22.5	17.5-20.5
100,000	17.0-19.5	15.0-17.5	20.5-23.5	18.5-21.5
110,000	17.0-20.0	15.0-18.0	21.0-24.5	19.0-22.0
120,000	17.5-21.0	15.5-18.5	21.5-25.0	20.0-23.0
130,000	18.0-21.0	16.0-19.0	22.5-26.0	20.5-23.5
150,000	18.5-22.5	15.6-20.0	24.0-27.5	21.5-24.5
160,000	19.0-23.0	17.0-20.5	25.0-28.5	22.5-25.5
175,000	19.5-23.5	17.5-21.0	25.5-29.0	23.0-26.5
200,000	20.5-25.0	18.5-22.5	27.0-31.0	24.5-28.0

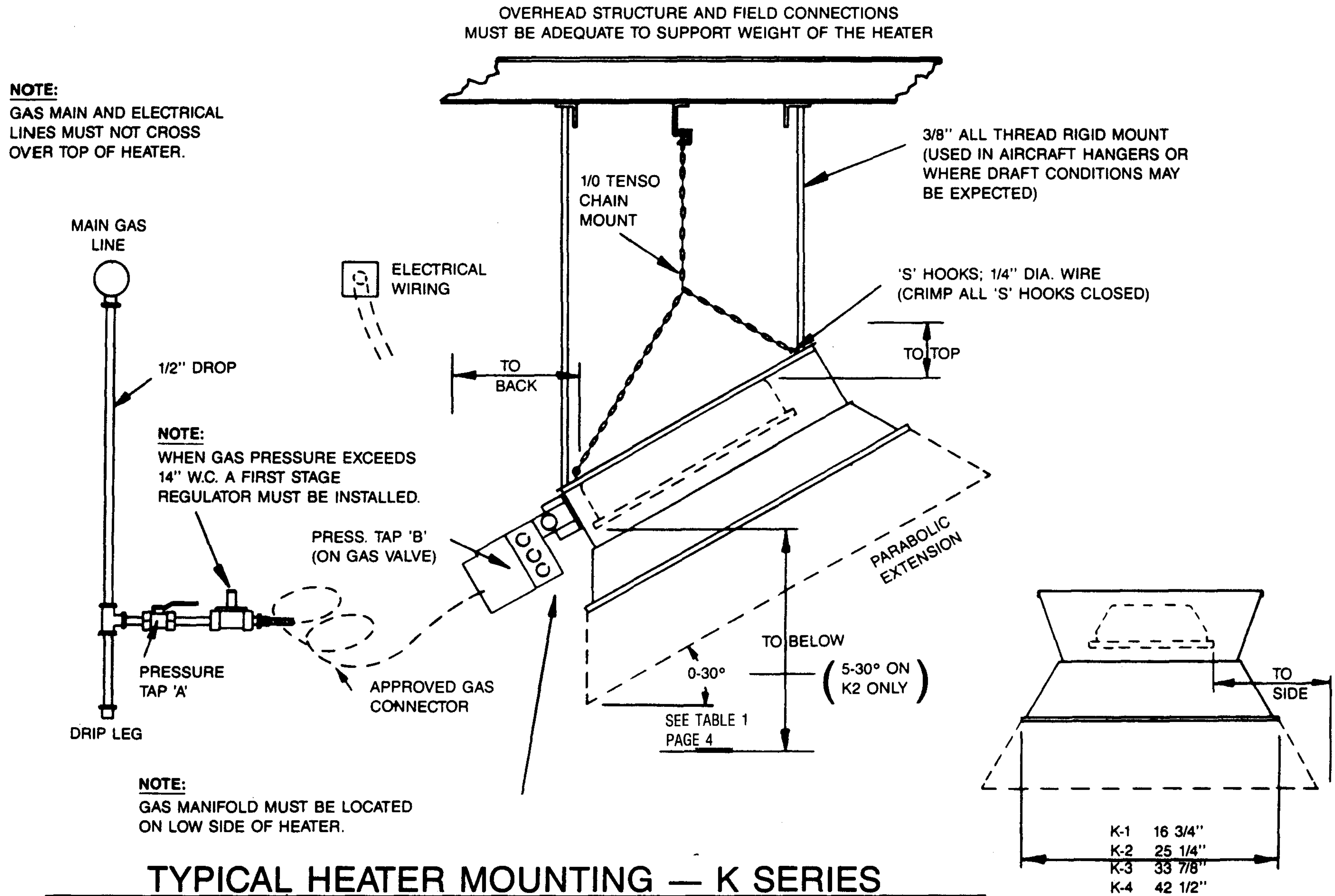
B) Maximum distance between heaters:

TWO TIMES MOUNTING HEIGHT.

TABLE 5

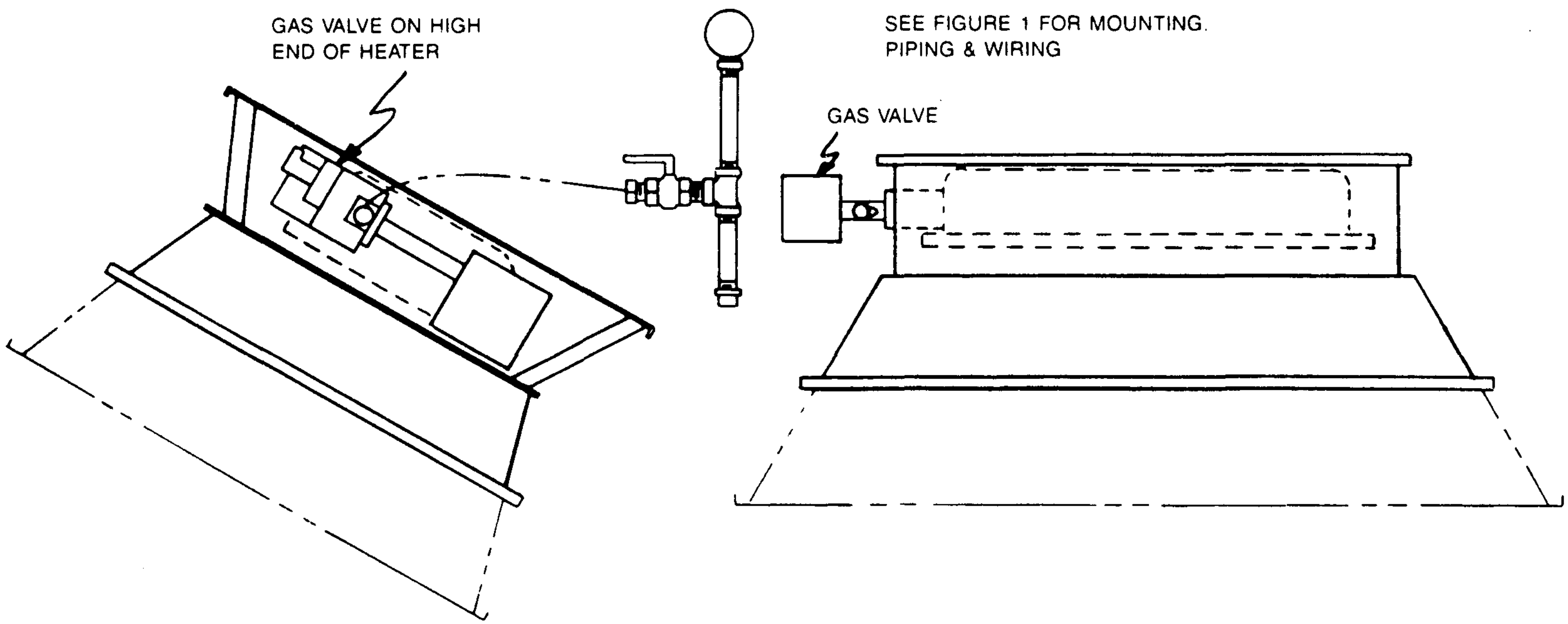
C) Other recommended distances:

Heater Series	**Distance from wall (horizontal mount)**		**Maximum distance between heater rows**
	Standard	**Parabolic**	
K-30 through K-40 K-30 through KS-40	8	5	90
K-45 through K-60 KS-45 through KS-60	12	9	100
K-70 through K-75	14	11	105
K-80 through K-100	16	12	110
K-110 through K-125	18	14	115
K-130 through K-150	20	15	120
K-160 through K-200	24	20	130



TYPICAL HEATER MOUNTING — K SERIES

FIGURE 1



TYPICAL HEATER MOUNTING — KS SERIES ONLY

FIGURE 2

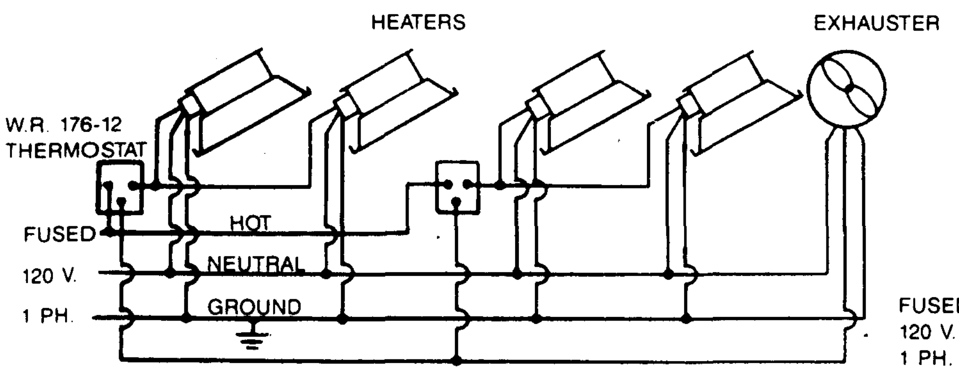


FIGURE 3

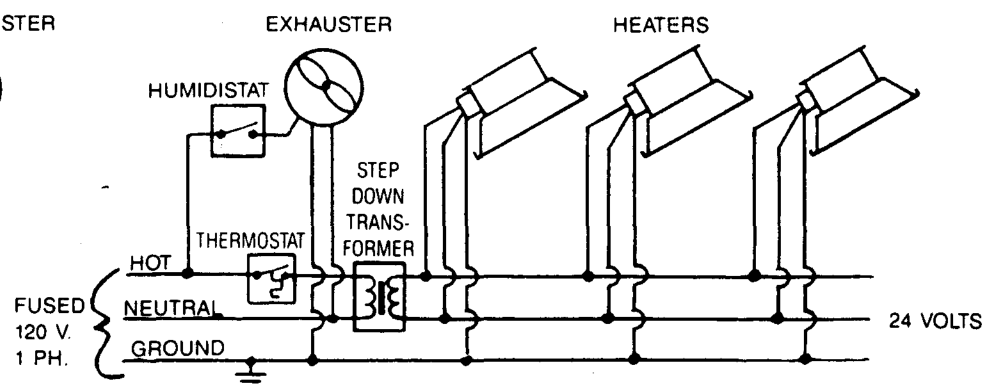


FIGURE 4

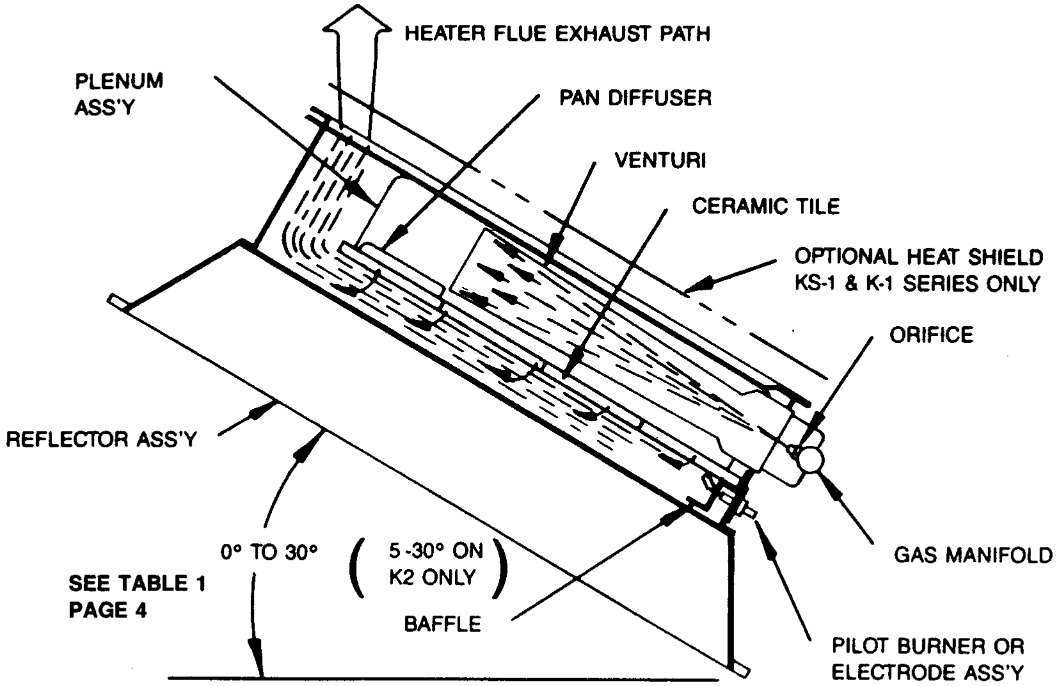


FIGURE 5

PILOT BURNER ASSEMBLY

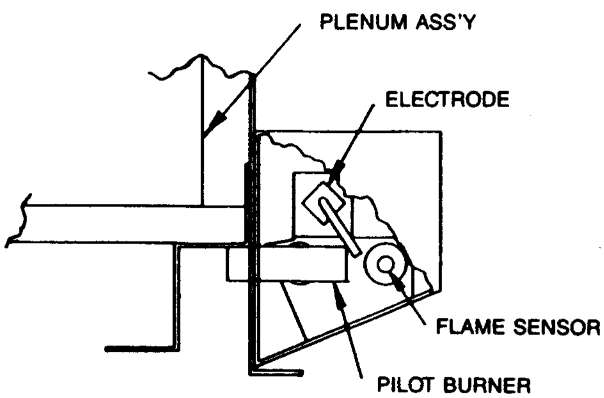


FIGURE 6

ELECTRODE ASSEMBLY
(DIRECT SPARK)

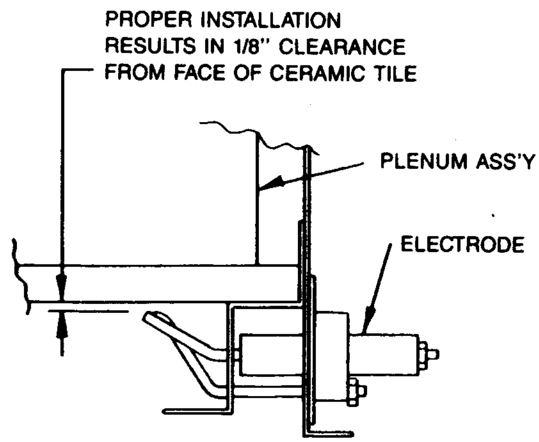


FIGURE 7

Solaronics®

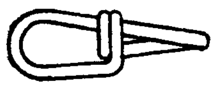
The Leader in Quality Infra-Red Heating

Chain Hanging Arrangement

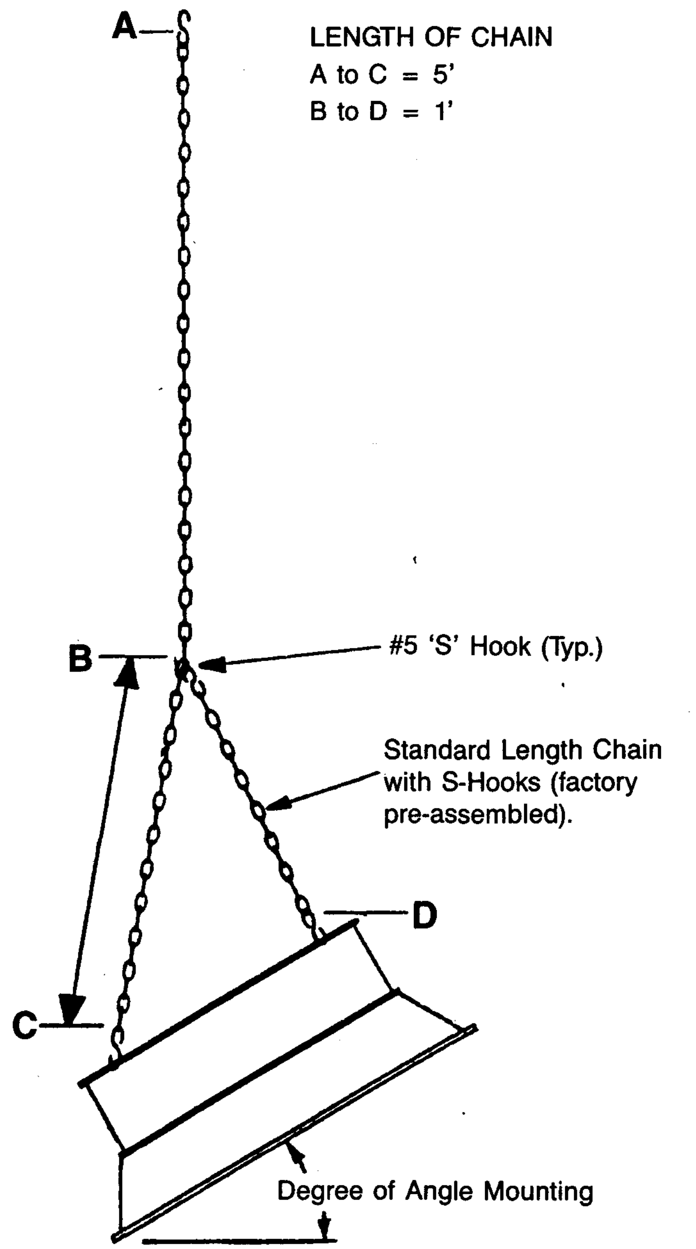
PART NO. CH-30 DM

CHAIN ARRANGEMENT TABLE

HEATER SERIES	NUMBER OF LOOPS B to C	DEGREE OF ANGLE MOUNTING
K, M & G	22	30
KS & MS	26	30
K, KS & G	17	0



One (1) Chain Link
= Two (2) Loops



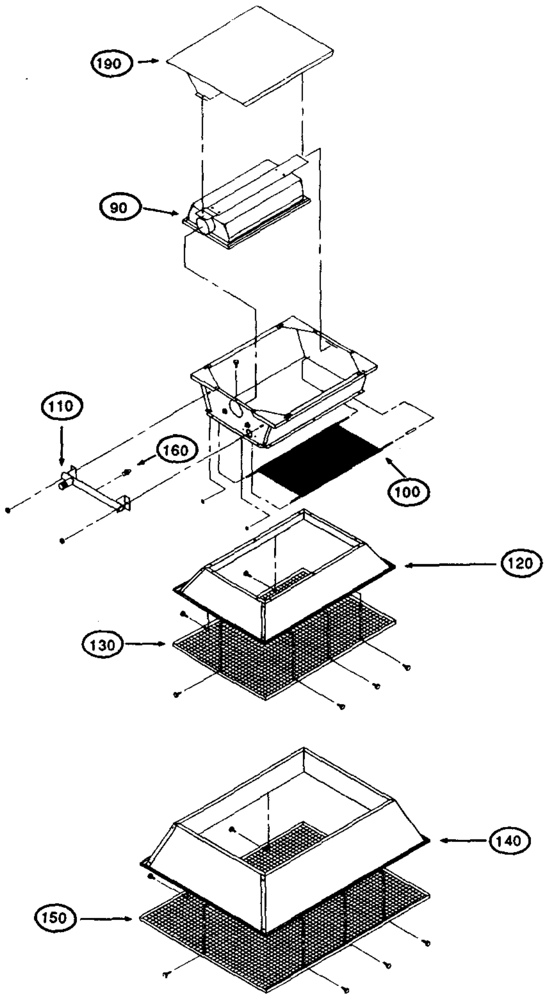
INSTRUCTIONS:
First, hang a single full length chain at desired height and attach to back of heater with S-hook. Then attach one end of the standard length chain with S-hooks (factory pre-assembled) to front of heater. Last, place other end of standard chain with S-hooks in appropriate loop (see table above) on the full length chain and close all S-hooks.

MODELS

K-1

KS-1

30 to 60 MBTUH



EXPLODED VIEW

DRAWING NUMBER
D-00K1-10-711

K-SERIES HEATER REPLACEMENT PARTS LIST

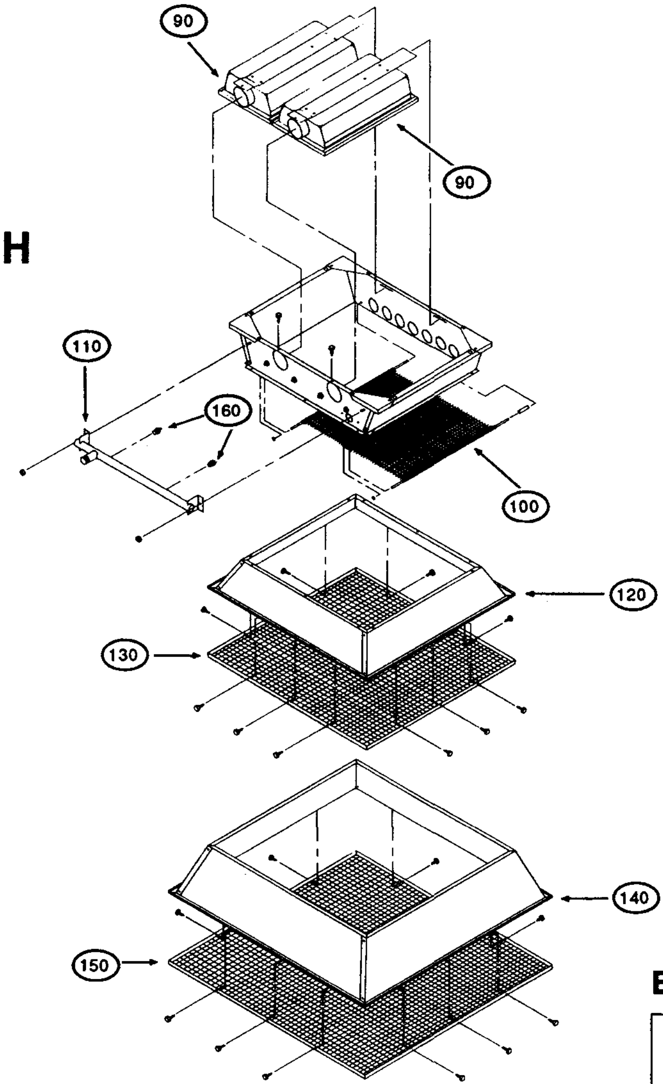
FOR HEATER MODELS: KS-1 AND K-1 RATED AT 30 TO 60 MBTUH INPUT.			
NO.	**PART NO.**	**QUANTITY**	**DESCRIPTION**
90	000K-10-033	1	K BURNER ASSEMBLY (COMBUSTION CHAMBER WITH TILE)
100	00K1-10-003	1	K1 WIRE GRID (ACCESSORY)
110	00K1-10-500	1	K1 GAS MANIFOLD
120	0M30-10-003-0	1	K1 STANDARD REFLECTOR ASSEMBLY
130	0M30-16-100	1	K1 STANDARD PROTECTIVE SCREEN (ACCESSORY)
140	0M30-10-007-0	1	K1 PARABOLIC REFLECTOR EXTENSION ASSEMBLY (ACCESSORY)
150	0M30-16-300	1	K1 PARABOLIC PROTECTIVE SCREEN (ACCESSORY)
160	000M-10-013-_*	1	K MAIN GAS ORIFICE *SPECIFY BTUH AND GAS DESIRED
190	000K-10-034-1 or 000K-10-503	1	HEAT SHIELD (ACCESSORY) FOR KS-1 AND K-1 HEATERS

Please indicate model number, control suffix letters and serial number when requesting replacement part information or ordering parts.

MODELS

K-2

70 to 100 MBTUH



EXPLODED VIEW

DRAWING NUMBER
D-00K2-10-713

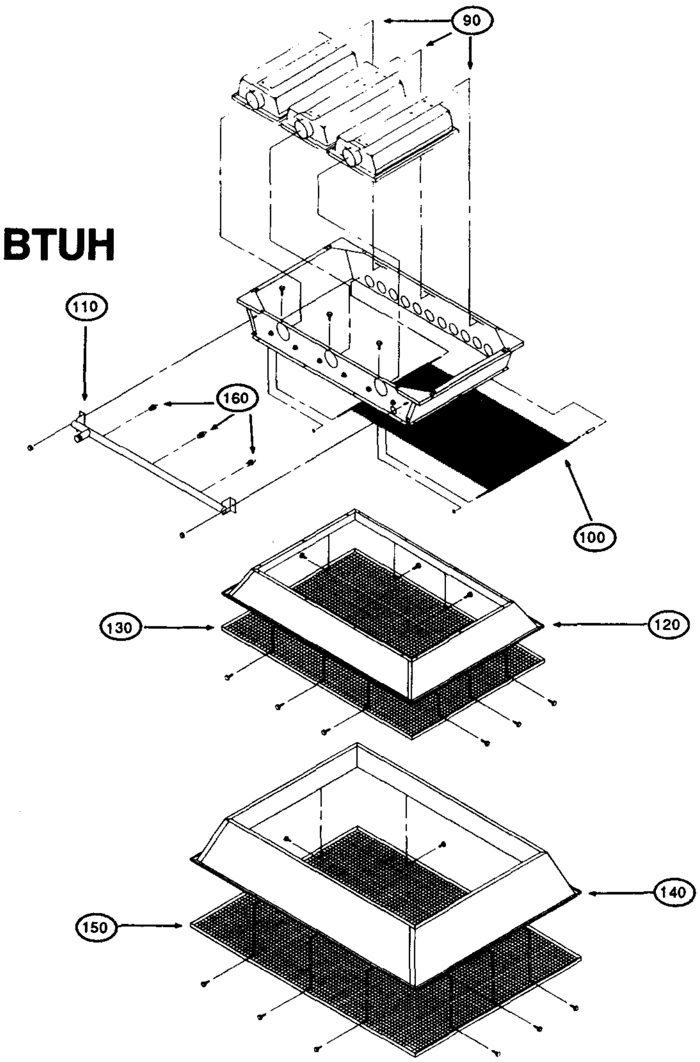
K-SERIES HEATER REPLACEMENT PARTS LIST

FOR HEATER MODELS: K-2 RATED AT 70 TO 100 MBTUH INPUT.

NO.	PART NO.	QUANTITY	DESCRIPTION
90	000K-10-033	2	K BURNER ASSEMBLY (COMBUSTION CHAMBER WITH TILE)
100	00K2-10-003	1	K2 WIRE GRID (ACCESSORY)
110	00K2-10-500	1	K2 GAS MANIFOLD
120	0M60-10-003-0	1	K2 STANDARD REFLECTOR ASSEMBLY
130	0M60-16-100	1	K2 STANDARD PROTECTIVE SCREEN (ACCESSORY)
140	0M60-10-008	1	K2 PARABOLIC REFLECTOR EXTENSION ASSEMBLY (ACCESSORY)
150	0M60-16-300-0	1	K2 PARABOLIC PROTECTIVE SCREEN (ACCESSORY)
160	000M-10-013-__*	2	K MAIN GAS ORIFICE *SPECIFY BTUH AND GAS DESIRED
190	00K2-10-005-1	1	K2 HEAT DEFLECTION (NOT SHOWN)

Please indicate model number, control suffix letters and serial number when requesting replacement part information or ordering parts.

MODELS
K-3
110 to 150 MBTUH



EXPLODED VIEW

DRAWING NUMBER
D-00K3-10-711

K-SERIES HEATER REPLACEMENT PARTS LIST

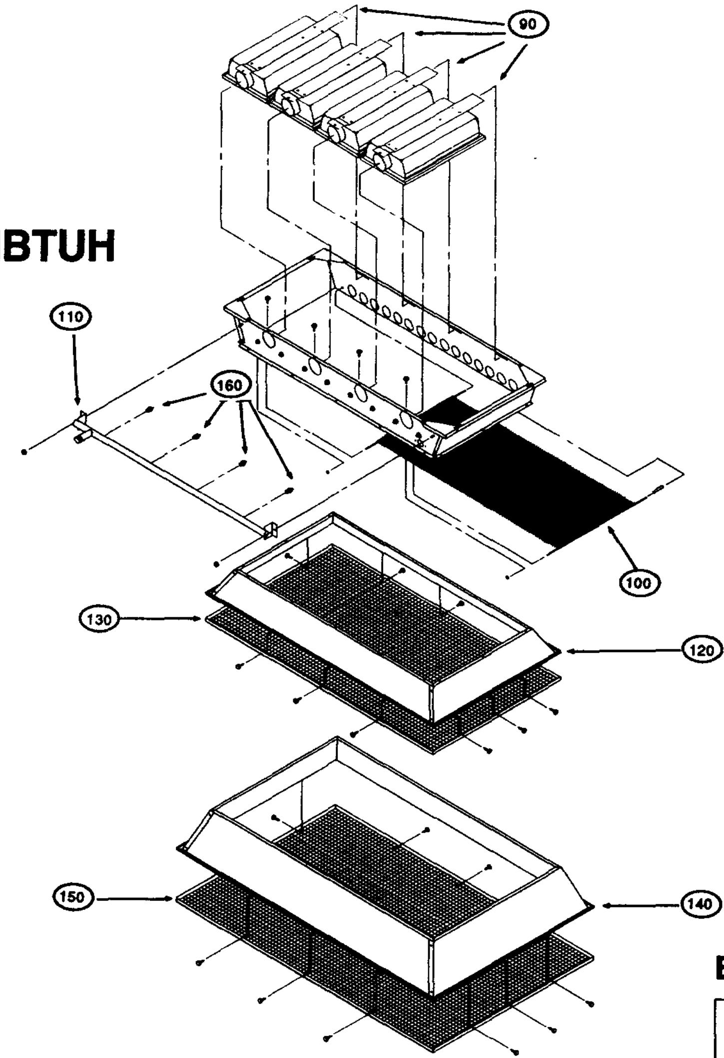
FOR HEATER MODELS: K-3 RATED AT 110 TO 150 MBTUH INPUT.			
NO.	**PART NO.**	**QUANTITY**	**DESCRIPTION**
90	000K-10-033	3	K BURNER ASSEMBLY (COMBUSTION CHAMBER WITH TILE)
100	00K3-10-003	1	K3 WIRE GRID (ACCESSORY)
110	00K3-10-500	1	K3 GAS MANIFOLD
120	0M90-10-001-0	1	K3 STANDARD REFLECTOR ASSEMBLY
130	0M90-16-100	1	K3 STANDARD PROTECTIVE SCREEN (ACCESSORY)
140	0M90-10-007-0	1	K3 PARABOLIC REFLECTOR EXTENSION ASSEMBLY (ACCESSORY)
150	0M90-16-300	1	K3 PARABOLIC PROTECTIVE SCREEN (ACCESSORY)
160	000M-10-013-__*	3	K MAIN GAS ORIFICE *SPECIFY BTUH AND GAS DESIRED

Please indicate model number, control suffix letters and serial number when requesting replacement part information or ordering parts.

MODELS

K-4

160 to 200 MBTUH



EXPLODED VIEW

DRAWING NUMBER
D-00K4-10-711

K-SERIES HEATER REPLACEMENT PARTS LIST

FOR HEATER MODELS: K-4 RATED AT 160 TO 200 MBTUH INPUT.			
NO.	PART NO.	QUANTITY	DESCRIPTION
90	000K-10-033	4	K BURNER ASSEMBLY (COMBUSTION CHAMBER WITH TILE)
100	00K4-10-003	1	K4 WIRE GRID (ACCESSORY)
110	00K4-10-500	1	K4 GAS MANIFOLD
120	M120-10-001-0	1	K4 STANDARD REFLECTOR ASSEMBLY
130	M120-16-100	1	K4 STANDARD PROTECTIVE SCREEN (ACCESSORY)
140	M120-10-007-0	1	K4 PARABOLIC REFLECTOR EXTENSION ASSEMBLY (ACCESSORY)
150	M120-16-300	1	K4 PARABOLIC PROTECTIVE SCREEN (ACCESSORY)
160	000M-10-013-__*	4	K MAIN GAS ORIFICE *SPECIFY BTUH AND GAS DESIRED

Please indicate model number, control suffix letters and serial number when requesting replacement part information or ordering parts.

SPDES Outfall Equipment

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INSTRUCTION MANUAL BFA SERIES

MODEL: BFA-5-150-6-CS

CUSTOMER	**: MC LAREN HART**
CUSTOMER P.O. NO.	**:**
PLENTY FILTERS JOB NO.	**: PF3461**
DRAWING NO.	**: GA-2149**

PLENTY PRODUCTS, INC.
6630 Roxburgh, Suite #175,
Houston, Texas 77041.

Tel: (713) 937 3863
Fax: (713) 937 0968

DESCRIPTION

1. Plenty Bag Filters are ruggedly constructed and durable. Operating conditions such as repeated shock, high and continued vibration do not effect the Filter case or the secure seating of its internal parts and filter media.

2. Standard Plenty Filter pressure vessels are designed to operate at up to 150 psi (10.5kg/cm2) maximum pressure. Recommended pressure drop of 25-30 PSIG for change out of filter bags is normal however, the frequency of bag changes can only be determine by experience in each individual process.

   FOR ACTUAL PRESSURE RATING OF THE FILTER UNITS PERTAINING TO THIS CONTRACT REFERENCE THE GA DRAWING

3. A Vent Valve should be installed in the 1/2" NPT cover connection. As air in the Filter vessel is displaced by liquid, an air pocket will form a the top of the vessel. Venting will allow the full surface area of the filter bag to be utilized. All air should be bled from the Filter be operating.

4. It is very **IMPORTANT** that the vessel be vented before opening the cover. It is recommended that the vessel be drained below the tubesheet before attempting to change the filter bags either by gravity draining or blow down with air or an acceptable inert gas.

INSERTION OF SNAP-RING BAG

1. Insert the filter bag into the basket (already installed) and form the bag to the contours by pressing against the basket.

2. Check positioning of the "O" ring(s) which should be properly seated in the Filter and Basket(s). The ring of the Filter bag must be seated in the edge provided by the basket.

3. Reinstall hold down ring and tighten securely.

PROPER CLOSING PROCEDURES

1. Close Cover Assembly carefully. Do not drop Cover as "O" ring positioning must remain undisturbed. Improper closing could cause sealing problems.

   For Filter Units with Spiral Wound Gaskets care should be taken again to ensure proper alignment and sealing.

2. Bring all hold down bolts into position.

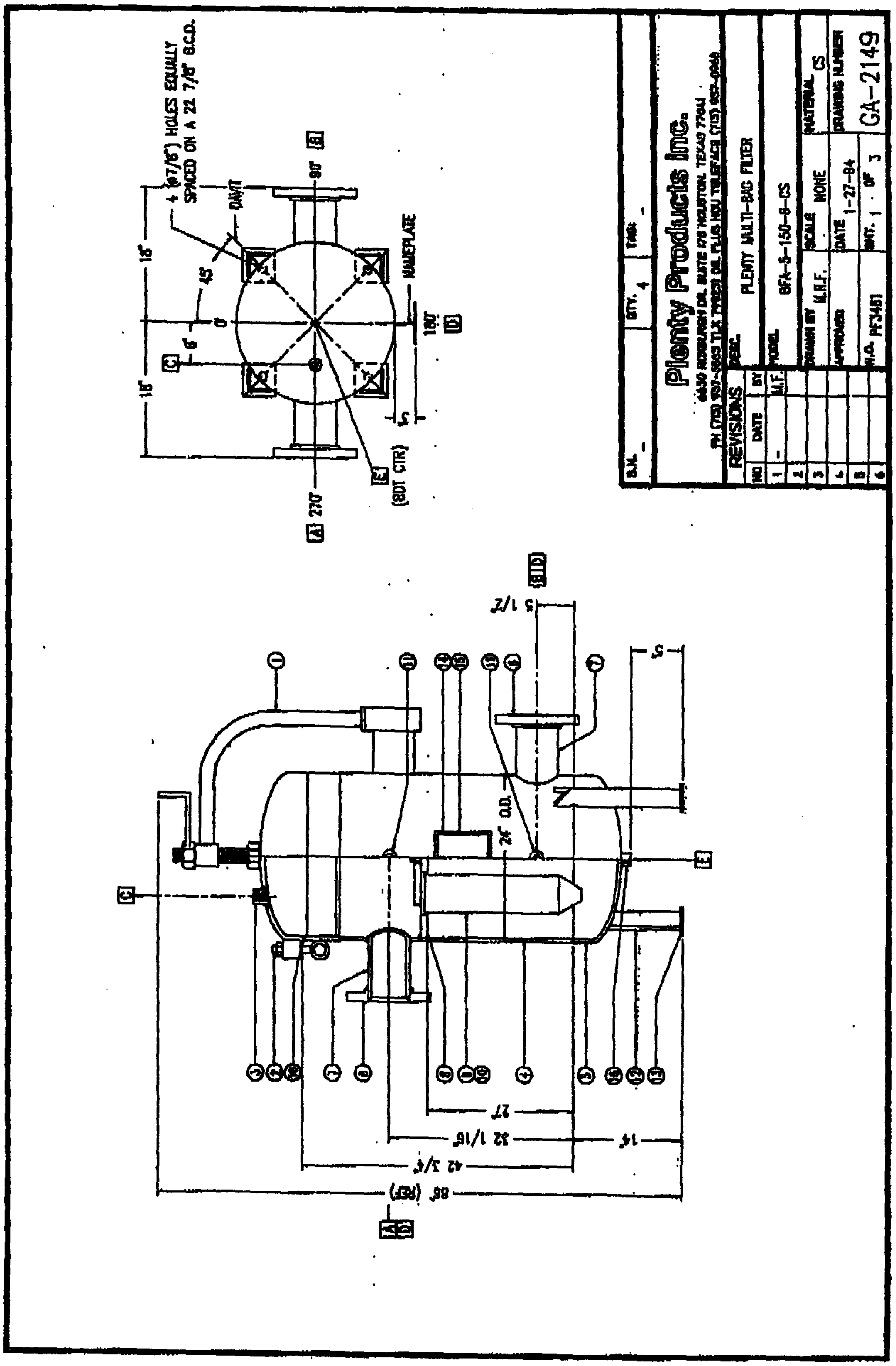
3. Hand tighten bolts.

4. Final tightening should be done by alternating 180 degrees until the Filter cover is tightly and evenly closed. This procedure must be followed to insure complete sealing.

THE FILTER IS AGAIN READY FOR OPERATION.

OPERATING COMPANY START UP PROCEDURES SHOULD BE FOLLOWED WHEN HANDLING HIGH PRESSURES AND DANGEROUS LIQUIDS.

SPARE PARTS AND REPLACEMENT MEDIA CALL 1-800-554-4225.


Plenty Products Inc.
PLENTY MULTI-BAG FILTER
MODEL BFA-5-150-6-CS
QTY. 4
DRAWN BY M.R.F.
SCALE NONE
MATERIAL CS
DATE 1-27-94
SHT. 1 OF 3
W.O. PF3481
DRAWING NUMBER GA-2149
REVISIONS
4 (Ø7/8") HOLES EQUALLY SPACED ON A 22 7/8" B.C.D.
DAVIT
NAMEPLATE
(BDT CTR)
24" O.D.
86" (REF)
42 3/4"
32 1/16"
27"
14"
5 1/2"
18"
6"
45°
0°
90°
180°
270°

NAT'L BD.
CERTIFIED BY: PF INC.

U

M.A.W.P.	150 PSI AT 100 °F
M.D.M.T.	-20 °F AT 150 PSI
SERIAL NO.	
YEAR BUILT	1994
HYDROSTATIC TEST	225 PSI
CORROSION ALLOWANCE	0.0"
MODEL NO.	BFA-5-150-6-CS
ELEMENT P.N.	-
MGR FOR	SEPARATION TECH.
P.O. NO.	30867

TAG -

Plenty
PLENTY PRODUCTS INC. 713-937-3863 HOUSTON, TEXAS 77041 FAX 713-937-0968

INSPECTION

IN HOUSE: ALL ITEMS ARE INSPECTED BY OUR QUALITY CONTROL REPRESENTATIVE.

CODE: YES
CUSTOMER: NO
THIRD PARTY: NO

CUSTOMER

SEPARATION TECHNOLOGIES INC.
PO BOX 559
MONROEVILLE, PA.
15146

LOCATION

McLAREN HART
2050 CORY DR.
SANDBORN N.Y. 14132

GENERAL NOTES

1. BOLT HOLES STRADDLE NORMAL VESSEL CENTERLINES UNLESS OTHERWISE NOTED

DESIGN DATA

CONSTRUCTION IN ACCORDANCE WITH LATEST EDITION OF:
ASME SECT. VIII, DIV. I "1992" ADD.

CODE STAMP: YES	NATL. BD.: YES
DESIGN PRESS (INT): 150	P.S.I.G. AT TEMP. 100 DEG.F
DESIGN PRESS (EXT): -	P.S.I.G. AT TEMP. - DEG.F
M.A.W.P.: 150	P.S.I.G. LIMITED BY: DESIGN
M.D.M.T.: -20 DEG.F	
M.A.P. (N&C):	P.S.I.G. LIMITED BY: N/A
HYDROSTATIC TEST (N&C): 225	P.S.I.G. FOR 1 HR.
CORROSION ALLOW: SHELL 0	HEAD 0 NOZZLE 0
P.W.H.T. (STRESS RELIEVE) -	MIN. AT: - DEG.F

RADIOGRAPHY: NONE
EFFICIENCY: (LONG SEAM) 100% (GIRTH SEAM) 70%
SURFACE PREP. SANDBLAST PER SSPC-SP6
PAINT SPEC. KEM-FLASH PRIMER, SHERWIN WILLIAMS NO. E61A45
-
-

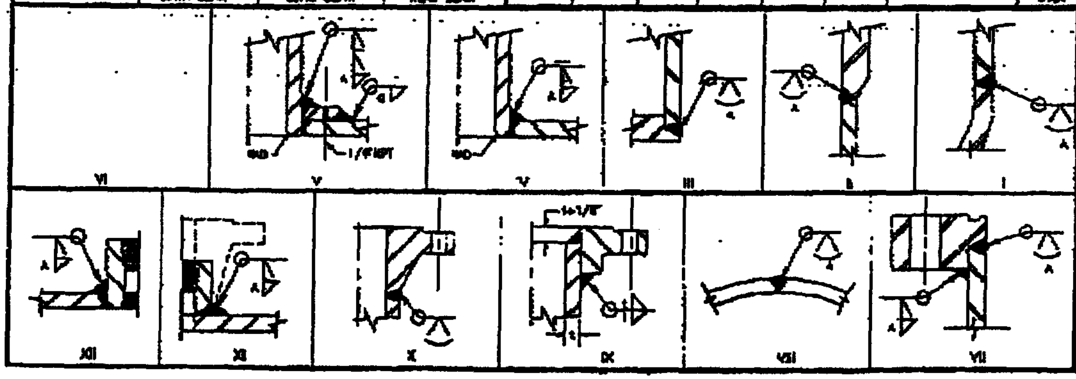
SP GR: -	EMPTY WT: -
CLEAN ΔP: -	FULL WT: -

NOZZLE SCHEDULE & WELDING DETAILS

NOZZLE NOTES
1) DRILL AND TAP 1/4" NPT HOLE IN REINFORCING PADS.
2) INSIDE EDGES OF NOZZLE NECKS SHALL BE ROUNDED TO 1/8" R OR HALF THE WALL THICKNESS IF LESS THAN 1/4".
3) GOUGE, GRIND OR CHIP INSIDE TO SOUND METAL BEFORE MAKING WELD
4) NOZZLE PROJ. ARE FROM SHORT SIDE
5) MANUFACTURING TOLERANCES SEE A-1014

	GIRTH SEAM	LONG SEAM	HEAD SEAM
WPS	P1-A	-	P1-A
WELD NO.	1	-	1

MARK	QTY.	SIZE	RATING	FACING	TYPE	SERVICE	NECK O.D.	NECK SCH.	PROJ. O.S.	PROJ. I.S.	REINFORCING PAD SIZE	WELDING DETAIL NO.	WELD SIZE A	WELD SIZE B	WELD SIZE C	WPS
E	1	1"	3000#	FNPT	CPLG	DRAIN	1.75"	-	1"	-		XI	.250"	-	-	P1-N
D	2	1/4"	3000#	FNPT	CPLG	DRAIN	3/4"	.105"	3/4"	-		XI	.250"	-	-	P1-N
C	1	1/2"	3000#	FNPT	CPLG	VENT	1 1/8"	.143"	1.25"	-		IV	.250"	-	-	P1-N
B	1	6"	150#	RAISED	SO	OUTLET	6 5/8"	40	6"	-		IV	.375"	-	-	P1-N
A	1	6"	150#	RAISED	SO	INLET	6 5/8"	40	6"	-		IV	.375"	-	-	P1-N



S.N. - QTY. 4. TAG: -

Plenty Products Inc.
6650 ROXBURGH DR. SUITE 175 HOUSTON, TEXAS 77041
PH (713) 937-3863 TLX 795259 GIL PLUS HOU TELEFACS (713) 937-0968

REVISIONS		
NO	DATE	BY
1	-	-
2		
3		
4		
5		
6		

SERVICE: PLENTY MULTI-BAG FILTER		
MODEL: BFA-5-150-6-CS		
DRAWN BY: M.R.F.	SCALE: NONE	MATERIAL: CS
APPROVED:	DATE: 1-24-94	DRAWING NUMBER
W.O. PF3461	SHT. 2 OF 3	GA-2149

Plenty Products Inc.

BILL OF MATERIALS

DESCRIPTION BFA-5-150-6-CS
P.O. NO. 30887 CUSTOMER SEPARATION TECHNOLOGIES INC.
DWG. NO. OA-2149 ITEM NO. –
MATERIAL FOR ONE NO. REQUIRED 4

BY M.R.F.
APR.

REV.	BY	DATE

LEGEND

JOB NO. PF3481
SHEET NO. 3 OF 3
DATE 1-27-94

DUE DATES
B.M. DWG.
MATL. SHIPPING
CODE STAMP YES

ITEM	NAME	NO. REQ'D	SIZE OR DESCRIPTION	TYPE MATERIAL	REMARKS	WT.	PRICE	P.O. NO.	ORDERED FROM	RECEIVING INSPECTION ACCEPTANCE	MTR'S REQD	UCS-79 & UG-81
1	DAVIT	1	COVER LIFT ASSY P/N A-1501	SA-36				–			–	
2	COVER	1	COVER ASSEMBLY P/N A-1525	SA-516-70				–			YES	
3	COUPLING	1	FULL COUPLING 1/2"-3000# FNPT	SA-105				–			–	
4	SHELL	1	PIPE 24" S-STD (.375" THK) X 38 1/4" LONG	SA-106B				–			–	
5	B HEAD	1	PLATE 3/8" NOM THK X 24" OD, 2:1 ELIP, 2" SF	SA-516-70				–			–	
6	FLANGE	2	FLANGE 6"-150# ANSI RFSO	SA-105				–			–	
7	NOZZLE	2	PIPE 6" S-40 X 6" LONG	SA-106B				–			–	
8	TUBESHEET	1	PLATE 3/4" THK X 23 1/16" OD, P/N A-5017	SA-36				–			–	
9	BASKET	5	PLENTY FILTER BASKET P/N A-1514	SA-240-316				–			–	
10	BAG	5	FILTER BAG NO.2 SIZE	POLYESTER				–			–	
11	COUPLING	2	HALF COUPLING 1/4"-3000# FNPT	SA-105				–			–	
12	LEG	4	ANGLE 1/4" THK X 2 1/2" X 2 1/2" X 17" LONG	SA-36				–			–	
13	FOOT	4	PLATE 1/4" THK X 3 1/2" X 3 1/2"	SA-36				–			–	
14	BRACKET	1	NAMEPLATE BRACKET P/N A-1814-1	SA-36				–			–	
15	NAMEPLATE	1	PLENTY ASME CODE NAMEPLATE	SA-240-304				–			–	
16	COUPLING	1	HALF COUPLING 1"-3000# FNPT	SA-105				–			–	
17												
18												
19												
20												
21												
22												
23												
24												
25												
26												
27												
28												
29												
30												

APPENDIX C-7

EQUIPMENT MANUFACTURER'S LITERATURE FOR THE SPDES OUTFALL SYSTEM

INSTRUCTION MANUAL

MODEL 3210

FLOWMETER

PART #60-3214-112

Isco, Inc.
531 Westgate Boulevard
Lincoln, Nebraska, U.S.A. 68528
PHONE: (800) 228-4373
FAX: (402) 474-6685

Outside the U.S.A.,
call (402) 474-2233
ISSUED: June 1, 1989
Revision P, 10-93

FOREWORD

This instruction manual is designed to help the operator gain a thorough understanding of the operation of the equipment. Isco recommends that this manual be read before placing the equipment into service.

Although reliability is designed into all equipment manufactured by Isco, there is always the possibility of a malfunction occurring. This manual may be used to assist the operator in diagnosing and repairing the malfunction, if possible.

Should the malfunction persist, call or write the Isco Customer Service Department for instructions. (Address: Isco Inc., Environmental Division, 531 Westgate Boulevard, Lincoln, NE 68528-1586; Phone: (800)228-4373 or (402)474-2233.) Simple difficulties can often be diagnosed over the phone. If it is necessary to return the equipment to the factory for service, please follow the shipping instructions provided by the Customer Service Department, including the use of the Return Authorization Number specified. Be sure to include a note describing the malfunction. This will aid in the prompt repair and return of the equipment.

Isco welcomes suggestions that would improve the information presented in this manual or enhance the operation of the equipment itself.

MODEL 3210

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

CHAPTER 1

1.0 INTRODUCTION - The first chapter of the Model 3210 Instruction Manual provides a general introduction to the flow meter. It includes a brief discussion of the organization of the manual, an overall description of the flow meter, and technical specifications.

1.1 Manual Organization - The purpose of this manual is to provide the user with the information necessary to operate, maintain, and service the Model 3210 Portable Recording Flow Meter. To accomplish this purpose, the manual is organized into five chapters. This first chapter is a general introduction to the flow meter. The second chapter contains information on how to prepare the flow meter for use and on operation. The third chapter provides details about available options. The fourth chapter has information about materials and construction of the flow meter and routine maintenance procedures. The fifth chapter contains servicing information to assist the user in correcting problems that may occur.

1.2 Description - The Model 3210, shown in Figure 1.2-1, uses ultrasonic level measurement. The flow meter will normally be used with some type of primary measuring device for measuring flow in an open channel. The Model 3210 has built-in standard level-to-flow conversions, which cover the vast majority of open channel flow measurement situations. Additionally, it allows the user to enter a nonstandard equation, or enter data points. The flow meter also has an optional eight-table, factory-programmed "Characterization PROM."

Figure 1.2-1 Model 3210 Flow Meter

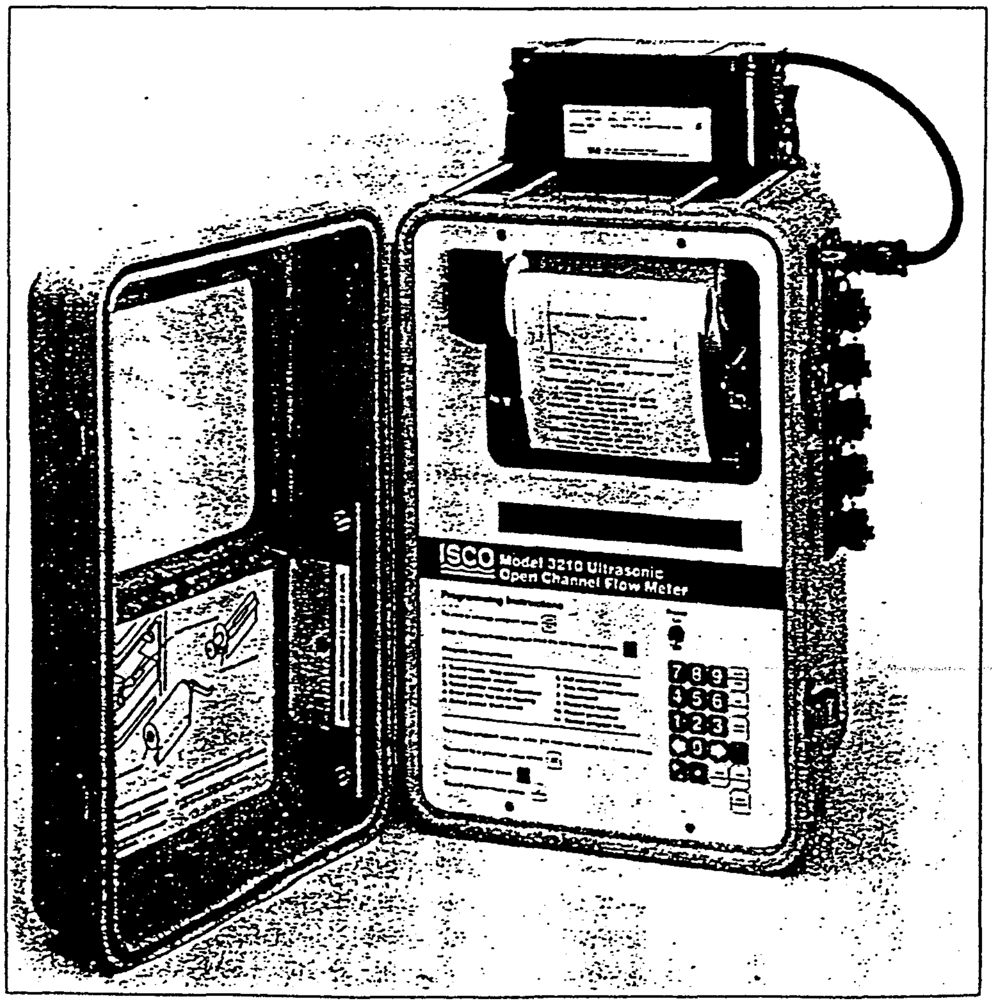
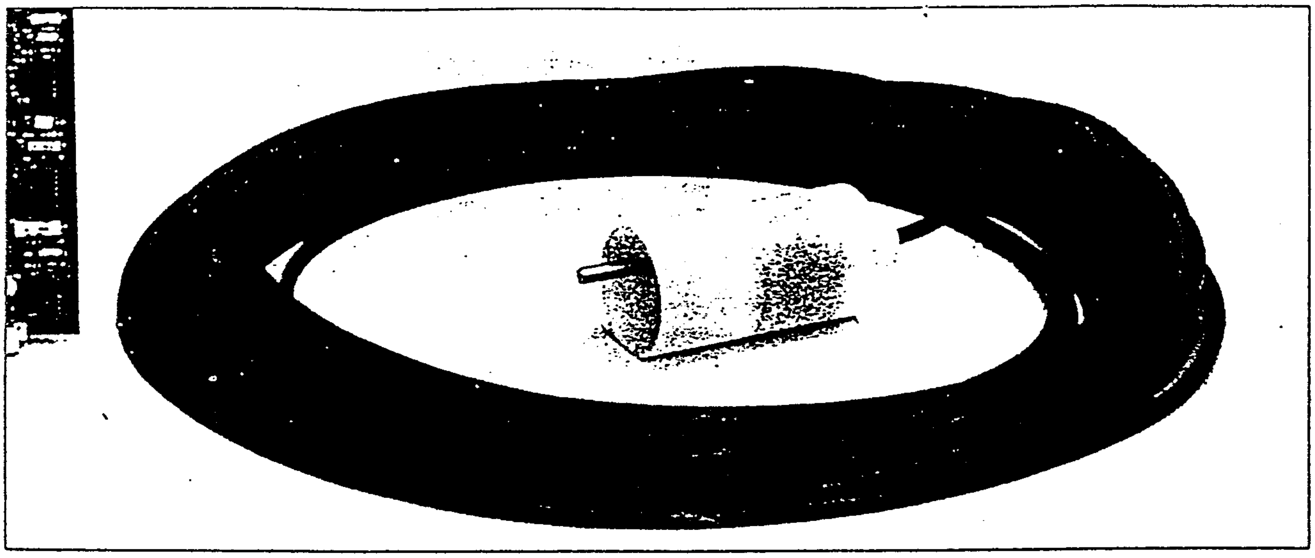


Figure 1.3-1 Ultrasonic Level Sensor



It periodically transmits an ultrasonic pulse to the surface of the stream. This pulse is then reflected back from the stream to the ultrasonic level sensor and the elapsed time of travel is converted by the Model 3210 Flow Meter to a level for the flow stream. Since the elapsed time is proportional to the distance from the ultrasonic level sensor to the liquid surface, the Model 3210 can calculate the distance to the water surface and from that, the head or liquid level. The ultrasonic level sensor also has a temperature probe built into its housing to measure ambient air temperature.

1.4 Controls, Indicators, and Connectors - The controls, indicators and connectors of the Model 3210 Flow Meter are listed in Table 1.4-1, and their functions are briefly described. Refer to Figure 1.4-1 for a view of the controls and indicators, and Figure 1.4-2 for a view of the connectors.

1.5 Technical Specifications - The technical specifications for the Model 3210 Flow Meter are found in Table 1.5-1. Paper roll longevity for the Model 3210 internal plotter is found in Table 1.5-1A below.

NOTE

Various accessories such as connect cables, etc., available for use with the Model 3210 Flow Meter are mentioned throughout this manual. The part numbers for these items are listed on an **Accessory Parts List**, which will be found at the back of Chapter 5. Part numbers for other equipment may be obtained from the factory.

Table 1.5-1A
Model 3210 Internal Plotter Paper Roll Longevity at Various Chart Speeds
(NOTE: Report generator is turned *off*.)

Chart Speed, In./Hr.	Time to Full Roll
4	195 Hours (8 1/8 Days)
2	16 1/4 Days
1	32 1/2 Days
0.5	65 Days

Figure 1.4-2 Side View of Flow Meter, Showing Connectors

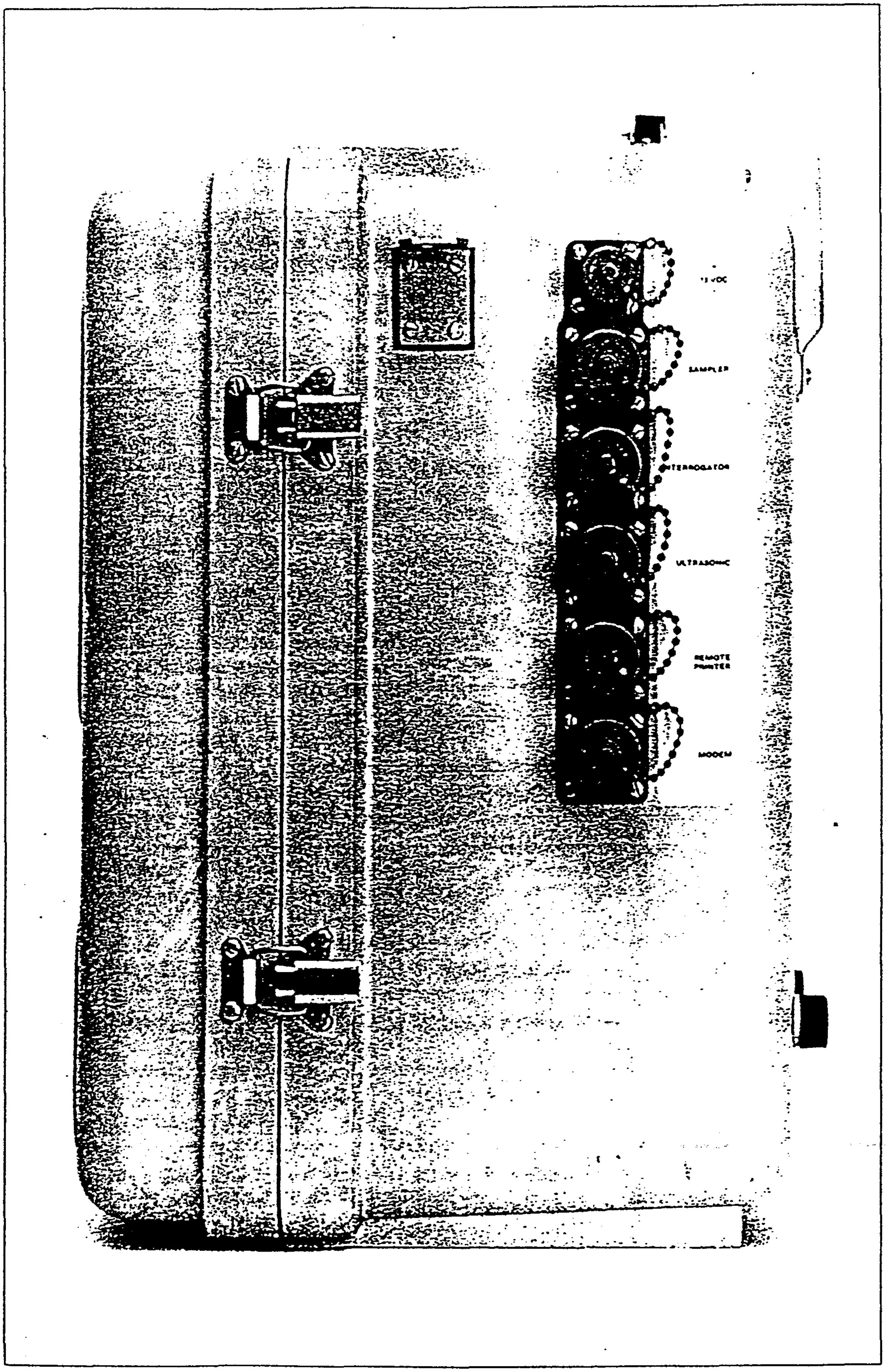


Table 1.5-1
Technical Specifications
of the Model 3210 Flow Meter

FLOW METER	
Size:	18" high × 11 1/2" wide × 10 3/4" deep. (45.7 cm high × 29.2 cm wide × 27.3 cm deep.)
Weight:	16 pounds (7.14 kg.)
Material:	High-impact molded polystyrene structural foam.
Type:	Self-certified NEMA 4X Enclosure.
Display Type:	2 line, 40 character/line alphanumeric dot matrix liquid crystal.
Power:	12 to 14 VDC; less than 26 mA average or 3.5 Amp. peak.
Typical Battery Life:	7 – 10 days w/plotter; 14 days w/o plotter (Standard 4 Ah Ni-Cd battery.)
Temp's - Operating and Storage:	(Oper.)0°F to 140°F [–18°C to 60°C.] (Stor.) –40°F to 158°F [–40°C to 70°C.]
Additional Power Required for Optional Equipment	
Modem:	60 mA maximum during operation.
Liquid Level Actuator:	70 mA maximum when actuated.
Model 2312 Plotter:	Average, 30 mA, typical.
High-Low Alarm Relay Box:	190 mA maximum with both relays actuated; 10 mA typical standby.
Internal Plotter	
Chart Speeds:	Off, 1/2, 1, 2, or 4 inches per hour.
Ribbon:	19.7 ft. (6 m) black nylon - replaceable.
Operating Speed:	1.5 lines per second at 68°F (20°C.)
Character Size:	0.09" high × 0.07" wide (2,4 mm × 1,7 mm), 12 pitch.
Plotter Recording Span: Chart Resolution: Display Resolution:	User-selected from 1/4 foot to more than 10 feet with one over-range. 1/240 of selected recording span. 0.001 foot (0,3 mm).
Paper:	4 1/2" wide × 65 ft. (11.4 cm × 19.8 m) plain white chart paper, replaceable roll.
Printer Reliability:	2.5 million lines MCBF (mean cycles before failure.)
Plotter Reports Printed:	Set up parameters, flow interval reports, Characterization PROM contents.
Plotter Recording Modes:	Level versus time, flow rate versus time; includes totalized flow, sampler events and rainfall.

CHAPTER 2

2.0 OPERATING PROCEDURES - This section of the manual contains detailed information on the Model 3210 Flow Meter. Included are sections on the operating theory, operating procedure, control and indicator descriptions, mounting methods, interconnection wiring, and set up procedure for the unit. Operating examples are also provided.

2.1 Operating Theory - Following is a description of the overall operating theory of the flow meter.

The Model 3210 is normally used to measure flow rate with a primary measuring device (weir or flume) or other open channel flow arrangement where a known relationship exists between level and flow rate. The Model 3210 can also be used to measure flow using the Manning equation. The level-measuring device is an ultrasonic level sensor which measures the liquid level in the flow stream. The flow meter electronically converts the level reading into a properly-scaled flow rate value. The flow meter also provides standard or optional flow-related output signals to be used for:

- Flow-proportional sampler pacing.
- Recording flow rate information on an external printer/plotter or circular chart recorder.
- Data transfer through a modem.
- Control of a 4 - 20 mA device.
- Data transfer by a laptop computer
- Control of a High-Low Alarm Relay Box

The flow meter contains microprocessor-controlled circuitry to make the computations necessary to calculate level and flow rates from the signals produced by the ultrasonic level sensor, store programming instructions from the user and operate the display and the internal plotter mechanism. An alphanumeric liquid crystal display (LCD) is provided both to show current total flow, level, and flow-rate information, and to prompt the user in programming the flow meter during initial set up or subsequent program changes. An internal plotter provides a "hard copy" printout of the information computed by the flow meter, plots level or flow rate, and generates reports. Connectors for other equipment which may be used with the Model 3210 are provided on the right side of the flow meter's case.

2.1.1 Ultrasonic Level Sensor Theory and Applications - The ultrasonic level sensor mounts over the flow stream and measures liquid level by emitting an ultrasonic pulse and measuring the time it takes for the echo to return from the surface of the liquid. The ultrasonic level sensor consists of an enclosure containing a single transducer, which acts both as the pulse transmitter and the echo receiver. Since the speed of the pulse through the air varies with temperature, compensation is built-in. A temperature sensor extends from the enclosure to measure ambient air temperature. The microprocessor program automatically compensates for speed-of-sound changes caused by air-temperature changes.

Transducer Operation - Several times a second, the ultrasonic level sensor emits an ultrasonic pulse. Once the pulse has been emitted, the transducer becomes a receiver or "microphone," ready to receive or "hear" the echo reflected back from the surface of the flow stream. When the echo is received, the transducer converts the sound energy into a small electrical pulse, which is amplified and detected by circuitry in the flow meter to produce an "echo received" signal. The time between the transmitted pulse and received echo is proportional to the distance between the transducer and the surface of the stream. This distance is used to determine the liquid level in the stream.

Noise - Background noise can interfere with the operation of the flow meter. This noise must be filtered out, or the flow meter may trigger on noise rather than the returned echo. The Model 3210 uses a tuned circuit to filter out unwanted noise outside the operating frequency. Noise in the operating frequency range ($\cong$40 kHz) can render the system unstable. Software algorithms are used to eliminate most sporadic noise pulses occurring within the the flow meter's operating frequency range.

Surface Objects - Objects or foam floating on the surface of the flow stream can absorb or weaken the ultrasonic pulses. If the pulses are severely reduced, a loss of echo will result. In less severe cases, the flow meter may experience an echo detection error.

Temperature - The velocity of sound at a given temperature may be approximated by the following equation:

$$\text{Velocity} = 1050 \times \sqrt{[1 + (\text{Temperature} \div 459.67)]}$$

Where Velocity is in feet per second and Temperature is in degrees F.

Temperature changes have a significant effect on the velocity of sound (approximately 7% between 32°F and 104°F). Accordingly, the Model 3210 provides temperature compensation. There is a temperature sensor embedded in the housing of the ultrasonic level sensor. However, the temperature of the transducer, level sensor, and air may not be exactly the same, and the temperature sensor cannot measure temperature perfectly. As a result, the equations used to calculate the velocity of sound in air are approximations, including the equation shown above.

Waves - Waves on the surface of the flow stream can deflect the sound energy so that it does not return to the transducer. Waves may also cause the sound to be returned to the transducer by an indirect path. In the first case, the flow meter will not receive an echo; in the second case, the additional time lapse will cause an echo error, indicated by an incorrect level reading. The model 3210 employs a software algorithm to reject from consideration sporadic readings which deviate substantially from the norm. However, if the waves are severe, the flow meter will not function and will indicate a "no echo" condition.

Wavelength - The wavelength of sound can be determined by dividing the velocity of the sound by the frequency. The frequency of the Model 3210 is about 40 kHz. The length of a 40 kHz sound wave is found by dividing 1125 by 40,000 which is 0.02815 ft. or 0.3378 inches.

Under ideal conditions it is possible to detect the same wave front of the returning echo. However, any noise or abnormal attenuation may cause the instrument to detect an earlier or a later wave. When the attenuation of the returned echo does not match the gain slope of the amplifier, the circuit will eventually detect a different cycle of the returned echo as the distance changes. The impact of this wave-detect error is determined by the wavelength. Higher frequencies (shorter wavelengths) produce smaller echo-detect errors. However, higher frequencies are absorbed more rapidly decreasing the maximum distance that can be measured with the same amount of power. The frequency of 40 kHz was selected for the Model 3210 as a suitable compromise.

Since the sound travels the distance twice (going and coming), the observed error is one-half of the wavelength or 0.014 ft. The Model 3210 uses a rectified detect circuit that can detect either the positive or negative peak. This allows the instrument to limit the error of proper wave detection to increments of one-half wavelength. This error is 0.007 ft.

Wind - Wind can blow the sound away or significantly reduce the intensity of the returned echo. Narrow beam angles, advantageous for measuring small flow streams, are a disadvantage in this situation. Likewise, greater distances to the surface of the flow stream are more affected by wind.

CHART ADVANCE - Pressing this key will cause the internal plotter to advance the chart at the fastest speed. The paper will advance as long as the key is pressed.

. (DECIMAL) - This key is used with the number keys when entering numeric values into the program.

NUMBER KEYS - The number keys are used to enter numeric values into the program. They may also be used to make a selection from the menus displayed on the LCD.

ENTER/PROGRAM STEP - When the flow meter is powered up, (that is, the power switch turned on), pressing this key will allow the user to enter the program to make changes. The user should be aware that the flow meter always has a program in it and is always in one of three states: (1) the flow meter is "off," but with a program retained in memory, (2) the flow meter is "on" and the program is running (displaying level, total flow, etc.), or (3) the flow meter is "on" with the program running, but allowing changes to be entered. Pressing ENTER/PROGRAM STEP puts the flow meter in the third condition by allowing the user to enter the program. It is also possible to view the program held in memory by pressing this key. The program step will be displayed and the selected entry will flash. Pressing this key after having made a selection from the displayed menu will cause the value entered or menu option displayed to be accepted into memory, after which the program will advance to the next step.

CLEAR ENTRY - This key provides the user with a way to return to a previous entry of a program step.

GO TO PROGRAM STEP - Pressing this key followed by pressing the number key or keys corresponding to a particular program step will cause the flow meter to display that program step. This allows the user a method to go directly to a specific program step. When this key is pressed, the following will appear on the top line of the display: ENTER PROGRAM STEP NUMBER 1-11. The user then selects the number of the program step he or she wishes to view and presses the ENTER/PROGRAM STEP key. If a correct value was entered, that step will be displayed. If an incorrect number was entered, the display will again show ENTER PROGRAM STEP NUMBER 1-11.

EXIT PROGRAM - This key is used to put the flow meter back into the "running" state after ENTER/PROGRAM STEP has allowed the user to make changes to the program. EXIT PROGRAM is also used to view stored data. Note that in certain cases, if the user attempts to exit after program changes have been made, a warning message will prompt the user to either continue with programming or exit and discard the changes. The user cannot change selections for a program step without having gone through all the "substeps" for that particular program step. (It is not necessary to change all the "substeps", but the user must step through all of them before any changed selections are entered into the program memory.) If the program lock is enabled, (step 11), the display will request entry of the pass number (3210) before allowing any changes to be entered into memory. Program step number 11 allows the user to disable this automatic lock feature; the lock must be disabled to enter any changes to the program.

PRINT REPORT - This key is used to print a flow data or level data report if the report generation feature has been enabled. Pressing this key provides the user with a report printed on the internal plotter. The printed report will begin at the last start interval and end at the current time. Pressing this key will not affect the scheduled time interval on which the report generator is to collect data; it gives the user a report running from the last report interval start time to the time the user presses the key.

2.2.3 Display - The flow meter display is used to prompt the user through the set up program, to display current program parameters, and to display total flow, present flow rate, and level. The display may be viewed through the window on the front door of the flow meter's cabinet when the door is closed. The display is a two-line, 40-character, dot matrix liquid crystal.

Simplified Operational Flowchart

Model 3210

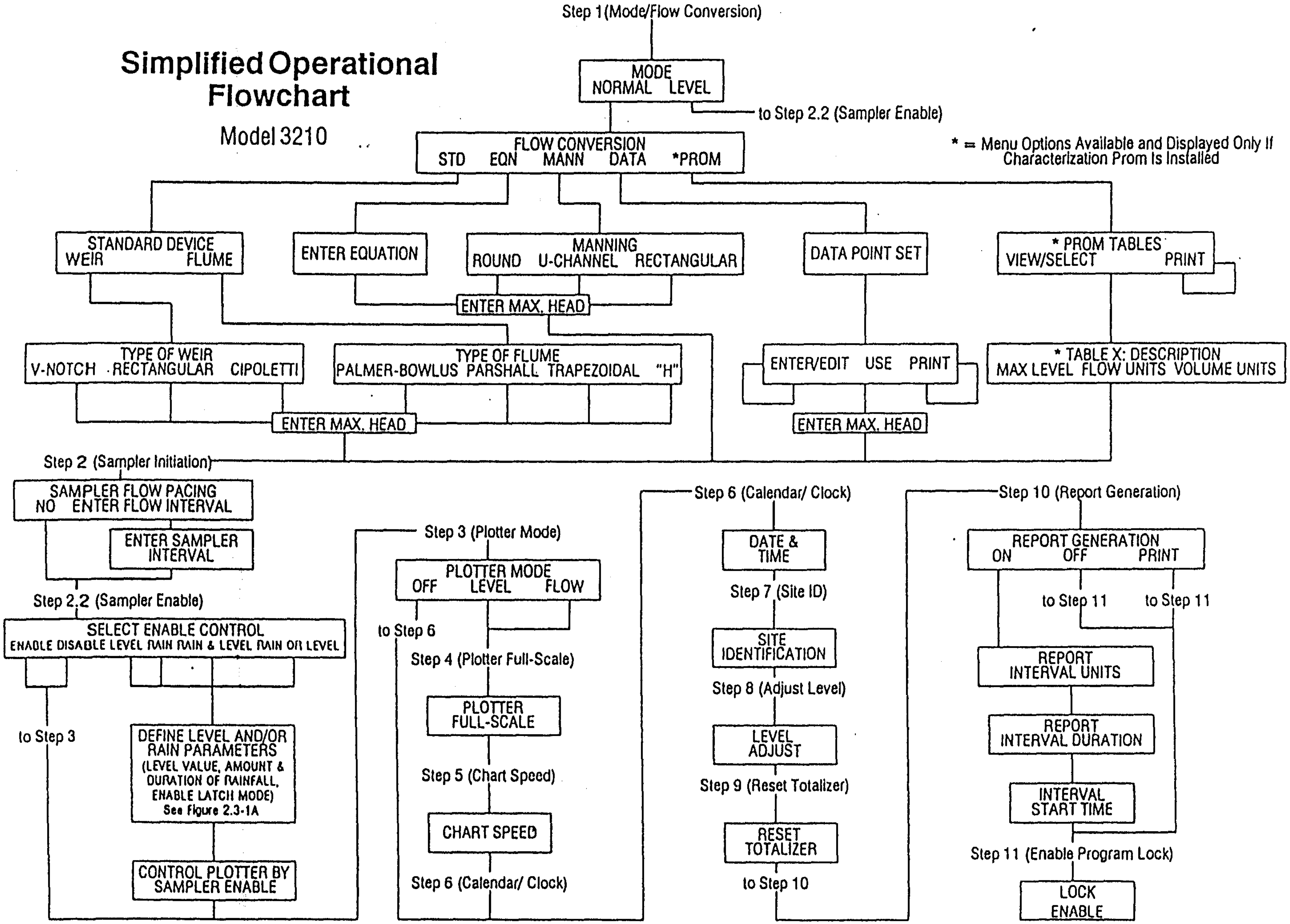


Figure 2.3-1 Simplified Flowchart for Programming the Model 3210 Flow Meter

Table 2.3-1
Equations Used in Model 3210
Built-in Flow Conversions
Note: Q = flow rate in cubic feet per second
H = head in feet

Type of Device	Flow Equation	Type of Device	Flow Equation
V-Notch Weir		Trapezoidal Flume*	
22 1/2°	$Q = 0.497H^{2.5}$	Large 60° V	$Q = 1.55H^{2.58}$
30°	$Q = 0.676H^{2.5}$	2" 45° WSC	$Q = 3.32H^{2.32}$
45°	$Q = 1.03H^{2.5}$	12" 45° SRCRC	$Q = 3.93H^{2.29}$
60°	$Q = 1.44H^{2.5}$		
90°	$Q = 2.50H^{2.5}$	Cipoletti Weir	$Q = 3.367LH^{1.5}$
			where: L = crest
			length in feet
Parshall Flume		Palmer-Bowlus Flume*	
1"	$Q = 0.338H^{1.55}$	6"	$Q = 2.18H^{1.9}$**
2"	$Q = 0.676H^{1.55}$	8"	$Q = 2.59H^{1.9}$
3"	$Q = 0.992H^{1.55}$	10"	$Q = 2.96H^{1.9}$
6"	$Q = 2.06H^{1.58}$	12"	$Q = 3.31H^{1.9}$
9"	$Q = 3.07H^{1.53}$	15"	$Q = 3.79H^{1.9}$
12"	$Q = 4.00H^{1.52}$	18"	$Q = 4.23H^{1.9}$
18"	$Q = 6.00H^{1.53}$	24"	$Q = 5.03H^{1.9}$
24"	$Q = 8.00H^{1.53}$	30"	$Q = 5.75H^{1.9}$
36"	$Q = 12.00H^{1.54}$	48"	$Q = 7.62H^{1.9}$
"H" Flume		Rectangular Weir	$Q = 3.330LH^{1.5}$
0.5'	$Q = 1.71H^{2.31}$**	Without	where: L = crest
0.75'	$Q = 1.85H^{2.31}$	End Contractions	length in feet
1.0'	$Q = 1.95H^{2.31}$		
1.5'	$Q = 2.11H^{2.31}$		
2.0'	$Q = 2.23H^{2.31}$	Rectangular Weir	$Q = 3.33(L-0.2H)H^{1.5}$
2.5'	$Q = 2.33H^{2.31}$	With	where: L = crest
3.0'	$Q = 2.41H^{2.31}$	End Contractions	length in feet
4.5'	$Q = 2.60H^{2.31}$		

*Palmer-Bowlus and Trapezoidal Flumes manufactured by Plasti-Fab, Tualatin, Oregon.
**Flow Equations for Palmer-Bowlus, "H", and Trapezoidal Flumes are approximations which fit data within 1% of full-scale flow rate.

2.3.3 Program Steps - Following is a list of the 11 program steps available to set up a flow monitoring program. Each program step is displayed in the following sequence on the dot matrix display. Repeatedly pressing the ENTER/PROGRAM STEP key will cause the flow meter to sequence through the steps in order, or the user can access a particular step by using the GO TO PROGRAM STEP key and entering the number of the desired step.

1. SELECT MODE OF OPERATION
2. SELECT SAMPLER FLOW PACING
3. SELECT PLOTTER MODE OF OPERATION
4. ENTER PLOTTER FULL-SCALE READING
5. SELECT PLOTTER CHART SPEED
6. SET CALENDAR/CLOCK
7. SITE IDENTIFICATION NUMBER
8. ADJUST LEVEL
9. RESET FLOW TOTALIZER
10. REPORT GENERATION
11. ENABLE LOCK

1.5	SELECT TYPE OF STANDARD DEVICE: 1. WEIR 2. FLUME

Line 1.5 above will be displayed if STD (standard) was selected in step 1.1.

1.6	SELECT TYPE OF WEIR: 1. V-NOTCH 2. RECTANGULAR 3. CIPOLETTI

Line 1.6 above will be displayed if WEIR was selected in step 1.5.

1.7	SELECT V-NOTCH WEIR ANGLE (IN DEGREES): 1. 90 2. 60 3. 45 4.30 5. 22.5

Line 1.7 above will be displayed if V-NOTCH was selected in step 1.6.

1.8	SELECT RECTANGULAR WEIR TYPE: END CONTRACTIONS: 1. YES 2. NO

Line 1.8 above will be displayed if RECTANGULAR was selected in step 1.6.

1.9	RECTANGULAR WEIR WITH END CONTRACTIONS: 1. ENTER CREST LENGTH: *XX.XX* FT.

Line 1.9 above will be displayed if YES was selected in step 1.8; FT or M would be displayed depending on what was selected in step 1.2.

1.10	RECTANGULAR WEIR WITHOUT END CONTRACTION 1. ENTER CREST LENGTH: *XX.XX* FT.

The previous line, 1.10 will be displayed if NO was selected in step 1.8; FT or M would be displayed depending on what was selected in step 1.2.)

1.11	CIPOLETTI WEIR: 1. ENTER CREST LENGTH: *XX.XX* FT.

Line 1.11 above will be displayed if CIPOLETTI was selected in step 1.6. Again FT or M will be displayed depending on what was selected in step 1.2.)

1.12	SELECT TYPE OF FLUME: 1. PAL-BOW 2. PARS 3. TRAP 4. H

PAL-BOW = Palmer-Bowlus; PARS = Parshall; TRAP = Trapezoidal; H = H Flume; line 1.12 above will be displayed if FLUME was selected in step 1.5.

1.13	SELECT SIZE 1. 6" 2. 8" 3. 10" 4. 12" 5. 15" 6. 18" 7. 24" 8. 30" 9. 48"

Line 1.13 above will be displayed if PAL-BOW was selected in step 1.12.

1.14	SELECT SIZE: 1. 1" 2. 2" 3. 3" 4. 6" 5. 9" 6. 12" 7. 18" 8. 24" 9. 36"

Line 1.14 above will be displayed if PARS was selected in step 1.12.

1.15	SELECT TYPE: 1. LG 60 V 2. 2" 45 WSC 3. 12" 45 SRCRC

1.27

```
SELECT FLOW UNITS FOR DATA POINT ENTRY:
:
```

See 1.3 for selections. Steps 1.26 and 1.27 above are skipped if data points have already been entered in this set.

1.28

```
SET X: XX POINTS SAVED 1. ADD POINT
2. USE   3. EDIT   4. PRINT   5. CLEAR SET
```

Skipped if there are no points entered in this set.

1.29

```
SET X: DATA POINT XX (PRESS EXIT TO QUIT)
ENTER: XX.XX FT   XXX.XXX CFS
```

Step 1.29 will be displayed if either ADD POINT or EDIT is selected. This step will be repeated until the user has entered up to 50 data points. When the EXIT key is pressed, the display will return to step 1.28. The user will then select USE and the flow meter will perform a three-point interpolation to calculate an equation if at least four data points have been entered.

NOTE

After FLOW CONVERSION TYPE has been selected (unless PROM has been selected), and the user has defined the primary device and its characteristics, entered an equation, data points, etc., the flow meter will display:

```
ENTER MAX HEAD - RANGE XXXX - XXXX
MAX HEAD IN (Units*) = XXXX (Units*)
```

*Units = Units of measure selected in 1.2. The user should select a value for MAX HEAD which is realistic for his or her application; the flow meter's internal resolution is based on this value. Do not arbitrarily select the largest range permissible.

2.0

```
SELECT SAMPLER FLOW PACING:
1. OFF   2. ENTER FLOW INTERVAL
```

If OFF is selected in step 2.0 above, the display will skip to step 2.2. If ENTER FLOW INTERVAL is selected, the flow meter will display the following:

2.1

```
ENTER SAMPLER INTERVAL: (range)
FLOW INTERVAL PER PULSE = XXXXXXXXXXX GAL
```

In step 2.1, the acceptable range will automatically be displayed in the parentheses as indicated above. The units of measure displayed will be the same as selected in step 1.4.

The following paragraphs provide descriptions of the programming steps necessary to control the "Sampler Enable" feature. Sampler Enable status may be viewed any time the flow meter is in the normal operating mode, displaying level or flow, by pressing the +/– key. "Sampler Enable" does not directly control the sampler. The settings programmed into the sampler determine whether the sampler will take time- or flow-paced samples. Time intervals and the number of flow pulses between samples are determined by the sampler's program. "Sampler Enable" lets the flow meter control whether the sampler runs its own program. There are several options for the "Sampler Enable" program. Selection of LEVEL, RAIN, LEVEL AND RAIN, or LEVEL OR RAIN will follow with additional displays requesting entry of a level value and latching for LEVEL, and an amount and a time interval for RAIN.

2.2.3 LEVEL - Selecting LEVEL will enable the sampler when the level in the flow stream has exceeded a certain value. This value is determined by the user. The user must also select whether the sampler will disable or remain enabled if the level then drops below the predetermined value. The following displays will appear. Whether feet or meters appears depends on the units of measure selected in 1.2.

2.2.3.1 | ENTER LEVEL AT WHICH TO ENABLE SAMPLER:
XXXX FT

2.2.3.1 | ENTER LEVEL AT WHICH TO ENABLE SAMPLER
XXXX M

In step 2.2.3.1 the user enters a level value. The sampler will be enabled if the liquid level rises above this value.

2.2.3.2 | ONCE ENABLED, KEEP SAMPLER ENABLED:
1. YES 2. NO

Step 2.2.3.2 allows the user to select whether the flow meter will disable the sampler when the conditions necessary for enabling have occurred but are no longer present. Selecting YES keeps the sampler enabled even if the enabling conditions are no longer present. The sampler will stay enabled until manually disabled. Selecting "NO" disables the sampler whenever the conditions required for enabling are no longer present. See **Figure 2.3-2 A**.

2.2.3.3 | SAMPLER CURRENTLY ENABLED, RESET TO
DISABLED STATE 1. YES 2. NO

Step 2.2.3.3 will only appear if YES was selected in 2.2.3.2, the level has risen above the level entered at step 2.2.3.1, but is currently below that level. Select YES from line 2.2.3.3 to disable the sampler. Selecting "YES" will disable the sampler only until the level entered in step 2.2.3.1 is reached again, re-enabling the sampler indefinitely. Selecting NO from step 2.2.3.3 will leave the sampler enabled. See **Figure 2.3-2 B.**

2.2.4 RAIN - Selecting RAIN will enable the sampler based on rainfall. It is necessary to have a *rain gauge* (see Chapter 3) attached to the flow meter to sense rainfall. The user must enter an amount for rainfall and also select a period of time during which the rain occurs. One of the following displays will appear, depending on the units of measure selected in step 1.2. Enter the amount of rainfall necessary to enable the sampler.

2.2.4.1 | ENTER RAINFALL AMOUNT (0.01 – 9.99)
0.01 IN

2.2.4.1 | ENTER RAINFALL AMOUNT (0,3 – 253,7)
0,3 mm

The following menus allow the user to select the time period for rainfall needed to enable the sampler. Selection of OTHER in any of these menus will advance the display to the next level of time options until the sequence repeats itself. These displays will only appear if rainfall was selected as part of "Sampler Enable."

2.2.4.2 | SELECT RAINFALL TIME: 1. 15 MIN
2. 30 MIN 3. 1 HR 4. 2 HR 5. OTHER

Selection of OTHER will advance the display to that shown below.

SELECT RAINFALL TIME: 1. 4 HR 2. 6 HR 3. 8 HR 4. 12 HR 5. 24 HR 6. OTHER

Selection of OTHER will advance the display to that shown below.

SELECT RAINFALL TIME: 1. 36 HR 2. 48 HR 3. OTHER

Selection of OTHER will cause the display to return to 2.2.4.2 above.

The following displays will appear after rainfall amount and time have been selected. Make the same selections as for 2.2.3.2 and 2.2.3.3 under "LEVEL."

2.2.4.3	ONCE ENABLED, KEEP SAMPLER ENABLED: 1. YES 2. NO

2.2.4.4	SAMPLER CURRENTLY ENABLED, RESET TO DISABLED STATE 1. YES 2. NO

2.2.5 RAIN OR LEVEL - Selection of RAIN OR LEVEL will enable the sampler when *either rainfall or level* conditions are met. The flow meter will first request entry of rainfall information identical to that for RAIN shown above in steps 2.2.4.1 and 2.2.4.2. Refer to those displays. After these selections are entered, the flow meter will request entry of level information identical to that shown for LEVEL shown in displays 2.2.3.1 and 2.2.3.2. Refer to those displays.

2.2.6 RAIN AND LEVEL - Selection of RAIN AND LEVEL will enable the sampler only when *both rainfall and level* conditions are met. The flow meter will first request entry of rainfall information identical to that for RAIN shown above in steps 2.2.4.1 and 2.2.4.2. Refer to those displays. After these selections are entered, the flow meter will request entry of level information identical to that shown for LEVEL shown in displays 2.2.3.1 and 2.2.3.2. Refer to those displays.

2.24	SELECT PLOTTER ON/OFF WITH SAMP ENAB: 1. YES 2. NO

Selecting NO from the line above will cause the SAMPLER ENABLE feature to have no effect on the operation of the plotter. Choosing YES will have the effect of turning the plotter on or off when the sampler is enabled or disabled. The plotter will not turn off with the sampler until it has printed a time-and-date line on the chart. When stopped, the plotter will print a line >- - - - - - - - - -< which crosses the entire chart. This line alerts the user that the chart generated by the plotter has not been running continuously. Note that the plotter *must still be set up to print* in step 3.

If the SAMPLER ENABLE feature is being overridden by a sampler control definition transmitted to the Model 3210 by programs of FLOWLINK, Isco's data processing and acquisition software, the following display will appear for the SAMPLER ENABLE programming step:

2.2	SAMPLER ENABLE OVERRIDDEN PRESS ANY KEY

3.0	SELECT PLOTTER MODE OF OPERATION: 1. OFF 2. LEVEL 3. FLOW

Line 3.0 on the previous page will be displayed if NORMAL was selected in step 1.0.

10.1

```
CLEAR REPORT DATA AFTER PRINT:
1. YES      2. NO
```

If YES is selected, the minimum level, maximum level, minimum flow, maximum flow, average flow, and the volume for the period would be cleared and the next report would cover a period from the current time to the next regularly scheduled report time.

10.2

```
REPORT INTERVAL TO BE IN:
1. HOURS   2. DAYS   3. MONTHS
```

10.3

```
ENTER INTERVAL IN HOURS:
XXXX HOURS
```

The report interval displayed will depend on what was selected in step 10.2.

10.4

```
ENTER THE INTERVAL START TIME:
YR:YYYY  MONTH:MM  DAY:DD  HR:HH  MIN:MM
```

11.0

```
ENABLE PROGRAM LOCK?
1. YES      2. NO
```

The programmed parameters can still be viewed, but not altered, when the LOCK is enabled. The unlock code number for the flow meter is the model number, 3210.) If the LOCK is enabled, the letter "L" will appear at the right side of the display when the flow meter is operating in the normal mode (displaying level or flow rates.) If the user enters the program to make changes, the display will ask for the password (3210). After the changes have been installed and the user exits the program, the program will lock and the "L" will reappear on the display after about 30 seconds. The "L" will stay off only if NO is chosen in step 11.

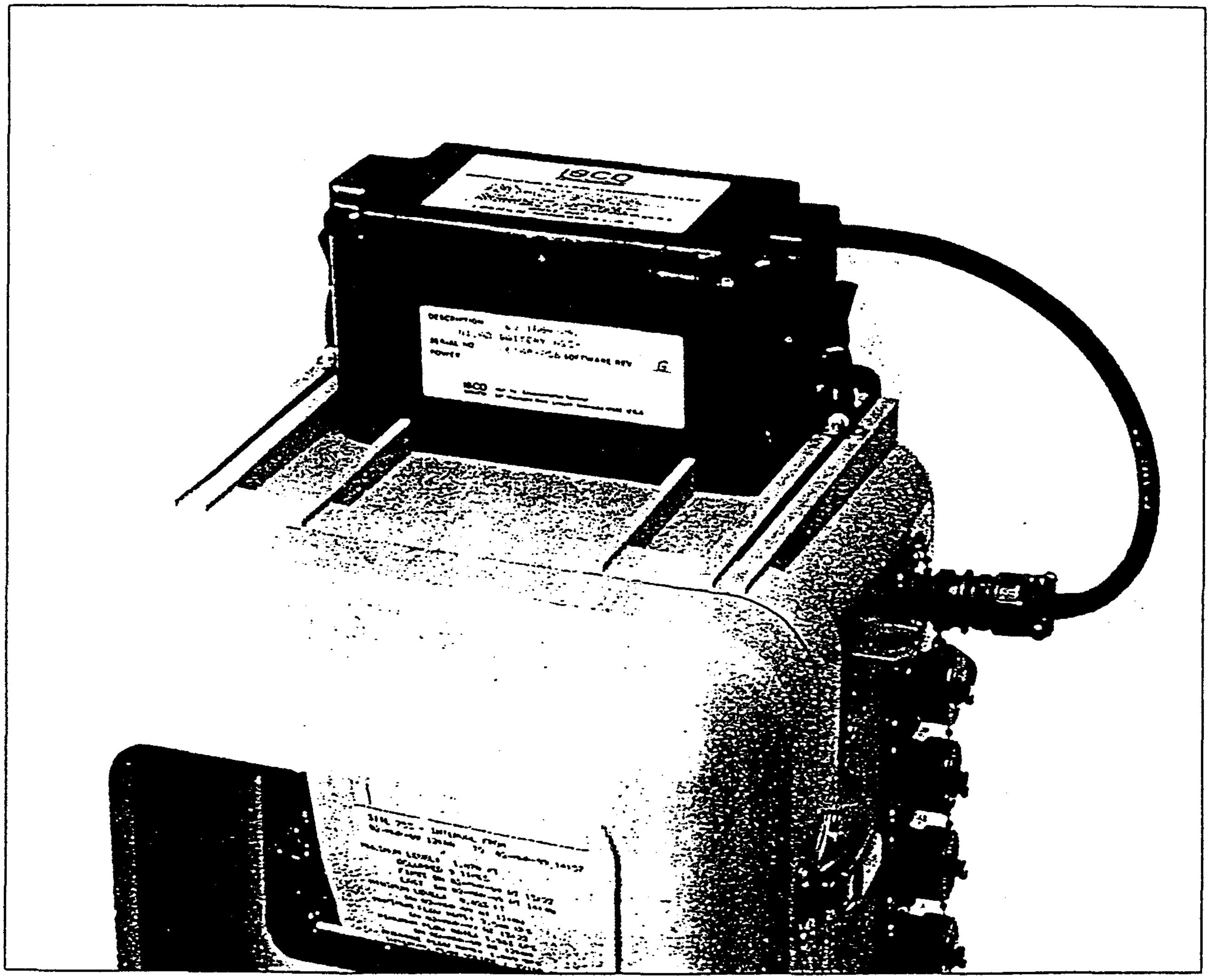
2.4 Preparation for Use - Relatively little needs to be done to prepare the Model 3210 Flow Meter for use. The flow meter is shipped with a roll of paper installed and a "standard" set of parameters programmed into the system memory ("example program," see Section 2.3.2). If the application calls for a Characterization Prom, this too, will have been programmed and installed at the factory. The user should familiarize himself or herself with the programming procedure described above and practice working through the program steps, so as to become comfortable with entering program parameters. Once decided, the user may ***write down*** programming entries may on the Programming Worksheet found at the back of this manual. The unit may be programmed in the shop, with the exception of Step 8, LEVEL ADJUST, rather than on the job site, if desired. This will minimize the possibility of dirt and contamination getting inside the flow meter.

Install Desiccant Canister - If the unit is new, the desiccant canister provided in the accessory package should be installed at this time. Loosen the two thumbscrews holding the bracket on the inside of the cabinet door. Install the desiccant canister under this bracket, with its viewing window visible. Then tighten the thumbscrews. The desiccant window should be blue. If the desiccant canister window is pink, the desiccant is saturated and should not be used before regeneration. (See Section 4.2.1 for information on regenerating the desiccant.) If the unit has been in use and has been returned for reprogramming, it should be cleaned and inspected as outlined in Section 4.1 of this manual.

Opening the Case - To gain access to the flow meter controls and internal plotter, the case must be opened. This is done by unlatching the two catches on the right side of the flow meter cabinet and opening the lid.

Keeping Lid Closed - The flow meter lid should be kept closed and latched whenever possible. This will protect the internal components from dirt and moisture, and will prolong the life of the desiccator.

Figure 2.4-1 A Battery Installed on Flow Meter



2.4.1.3 Isco AC Power Pack - As an option, an AC Power Pack is also available to power the flow meter. The standard power pack is designed for operation from 120 VAC, 50/60 Hz commercial power sources. An alternate version, designed for operation from 240 VAC, 50/60 Hz is also available. Both are supplied with a line cord for convenient attachment to the AC power source, and are capable of both operating the flow meter and charging the optional batteries. See Figure 2.4-1 B. Also available from Isco is the Battery-Backed Power Pack, which provides a regulated 12 VDC supply backed up by a 1.2 Ah Nicad battery pack, in a package the same size as the standard Power Pack. See Section 3.10.

Attaching the Power Pack - Mount the power pack on top of the flow meter cabinet in the same way as described for the battery pack in Section 2.4.1.2 above. Secure the power pack with the two rubber draw catches pulled over the brackets on the ends of the power pack case. Attach the short cable with the smaller connector to the top connector on the right side of the flow meter case. Connect the longer cord with the plug on it to an AC outlet. Refer to Section 4.5.2 for details concerning charging the batteries with the power pack.

2.4.1.4 External 12 Volt Direct Current Source - The flow meter may be powered from an external 12 VDC source, such as an automotive, motorcycle, gelled-electrolyte lead-acid battery ("gell cell") or marine battery; many users have found that a deep-cycle marine/RV battery is particularly well-suited to this application. However, batteries of this type will have to be mounted externally, as no provision has been made to mount them on the flow meter. A special optional connect cable is available to power the flow meter from an external battery.

Attaching the Battery - If the user wishes to power the flow meter with any of these batteries, plug the connector on the end of the external battery connect cable into the 12 VDC connector on the side of the flow meter. Connect the positive and negative leads on the other end of the cable to the positive and negative terminals of the battery. The positive lead of the cable can be identified by the red-painted clip. Use of corrosion-preventing washers on the battery terminals will prevent battery acid from attacking the connections and damaging the connect cable. (These are available from any auto parts supply house.)

CAUTION

Be sure of proper polarity before attaching clips to the battery. Never attach the flow meter to a source of unknown polarity or voltage. If in doubt, check with a reliable DC voltmeter. Never attach the flow meter directly to an AC-power source of any voltage under any circumstances. Failure to observe this warning may result in severe damage to the electrical components of the flow meter.

2.5 Flow Meter Mounting and Installation Procedures - Because the Model 3210 Flow Meter is a portable device, it may or may not be permanently installed. It may be suspended, in temporary installations, such as sewers, or permanently mounted in other installations, such as treatment plants, at the user's option.

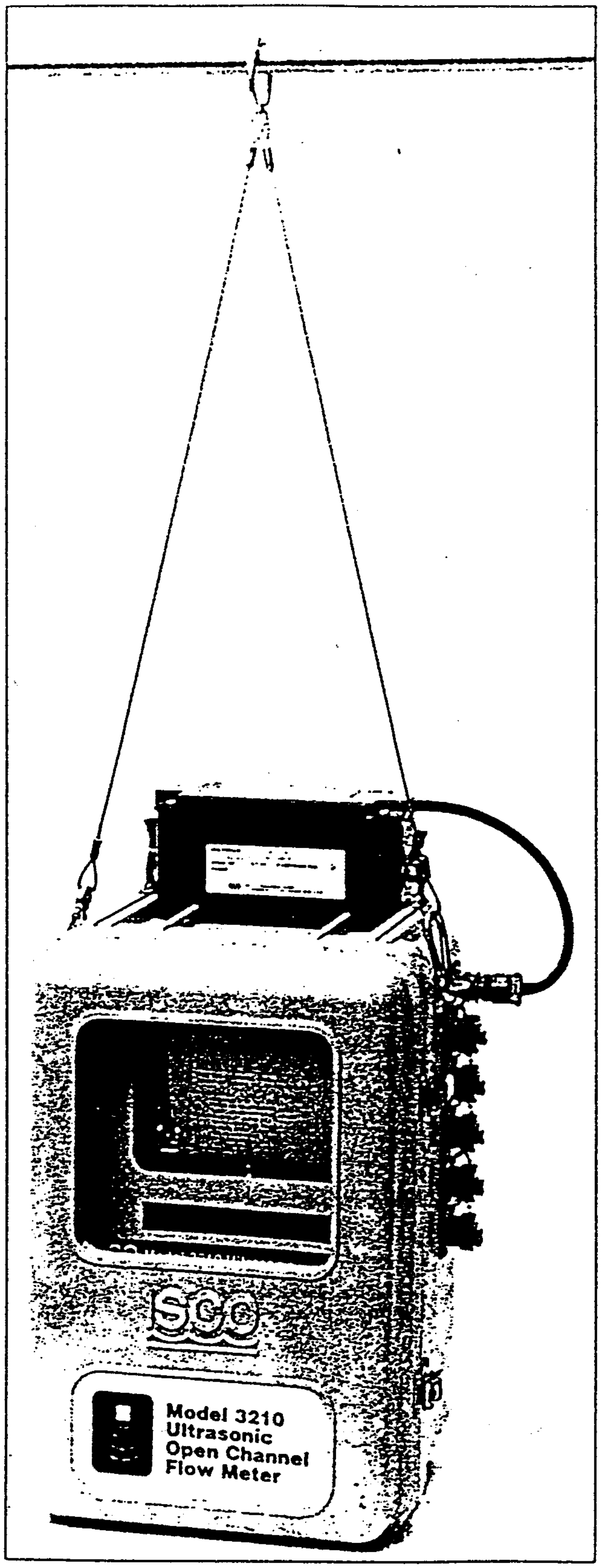
Carrying Handle - To assist in carrying the flow meter, a handle is provided in the instrument's accessory package. To use the handle, the handle hooks should be snapped into the two "L" shaped brackets at the top of either side of the flow meter case, as shown in Figure 1.2-1.

Location of the Flow Meter - Because it uses an ultrasonic level sensor, the Model 3210 Flow Meter does not have to be mounted directly above the primary device, or even close to the flow stream. The flow meter itself can be installed at a convenient, protected location and the ultrasonic level sensor cable routed to the place where the level sensor is mounted. For example, the flow meter may be mounted above the surface of the ground for protection and easy accessibility, and then the manhole has to be entered only once, for ultrasonic level sensor installation and calibration. The flow meter must be located within 275 feet of the ultrasonic level sensor, as this is the maximum length of cable available to connect the ultrasonic level sensor to the flow meter.

No special Mounting Requirement - The Model 3210 does not have any special requirements for mounting. It may be located on any relatively flat surface either horizontally as shown in Figure 2.5-1, supported by the two rubber feet and the stainless steel mounting bracket, or vertically as shown in Figure 1.2-1, supported by the two plastic formed feet. The flow meter may also be panel mounted, using the mounting bracket on the top rear of the case or suspended from a ladder rung or hook using the optional suspension harness, as shown in Figure 2.5-2. To use the suspension harness, the carrying handle should first be installed on the flow meter as described above. Then slip the loops on the ends of the harness cables onto the "L" shaped handle hooks as shown in Figure 1.2-1. The flow meter may now be suspended using the harness.

2.5.1 Safety Considerations - In field installations of Model 3210 Flow Meters and associated equipment, the safety of the personnel involved should be the foremost consideration. No project is so important or deadline so critical as to justify the risk of human life. The following sections provide safety procedures for working in and around manholes and sewers. The first section offers general safety advice; the second section deals with the special problem of poisonous gases found in sewers.

Figure 2.5-2 Model 3210 Suspended by Harness



manholes, strict safety procedures must be observed. Failure to do so could jeopardize not only your own life, but also the lives of other crew members.

"1. Hazards. There are many hazards connected with entering manholes. Some of the most common hazards are:

"Adverse Atmosphere. The manhole may contain flammable or poisonous gases or the atmosphere may be deficient in oxygen. Forced ventilation may be necessary.

"Deteriorated Rungs. Manhole steps may be corroded and not strong enough to support a man. It may be difficult to inspect the rungs because of poor lighting.

"Traffic. Whenever manholes are located in the traveled way, barricades and warning devices are essential to direct traffic away from an open manhole.

"Falling Object. Items placed near the manhole opening may fall and injure a worker in the manhole.

"Sharp Edges. Sharp edges of items in or near a manhole may cause cuts and bruises.

"Lifting Injuries. Unless proper tools are used to remove manhole covers, back injuries or injuries to hands and feet may result.

"2. Planning. Advance planning should include arrangements for test equipment, tools, ventilating equipment, protective clothing, traffic warning devices, ladders, safety harness, and adequate number of personnel. Hasty actions may result in serious injuries. Time spent in the manhole should be kept to a minimum.

"3. Adverse Atmosphere. (Refer to Table 2.5-1.) Before entering a manhole, tests should be made for explosive atmosphere, presence of hydrogen sulfide, and oxygen deficiency. Since combustible or toxic vapors may be heavier than air, the tests on the atmosphere must be run at least 3/4 of the way down the manhole.

"Whenever adverse atmosphere is encountered, forced ventilation must be used to create safe conditions. After the ventilating equipment has been operated for a few minutes, the atmosphere in the manhole should be retested before anyone enters the manhole.

"When explosive conditions are encountered, the ventilating blower should be placed upwind to prevent igniting any gas that is emerging from the opening. When a gasoline engine blower is used, it must be located so that exhaust fumes cannot enter the manhole.

Table 3.3-1
Hazardous Gases, Continued

Gas	Chemical Formula	Common Properties*	Specific Gravity or Vapor Density (Air = 1)	Physiological Effects	Max Safe 60 Min. Exposure (ppm)	Max Safe 8 Hr. Exposure (ppm)	Explosive Range (% by vol. in air.) Limits lower/upper	Likely Location of Highest Concentration	Most Common Sources	Simplest and Cheapest Safe Method of Testing
Hydrogen Sulfide	H_2S	Irritant and poisonous volatile compound. Rotten egg odor in small concentrations. Exposure for 2 to 15 min. at 0.01% impairs sense of smell. Odor not evident at high concentrations. Colorless. Flammable.	1.19	Impairs sense of smell, rapidly as concentration increases. Death in few minutes at 0.2%. Exposure to 0.07 to 0.1% rapidly causes acute poisoning. Paralyzes respiratory center.	200 to 300	20	4.3 45.0	Near bottom, but may be above bottom if air is heated and highly humid.	Coal gas, petroleum, sewer gas. Fumes from blasting under some conditions. Sludge gas.	1. H_2S Ampoule. 2. 5% by weight lead acetate solution.
Methane	CH_4	Simple asphyxiant. Colorless, odorless, tasteless, flammable.	0.55	Acts mechanically to deprive tissues of oxygen. Does not support life.	Probably no limit, provided oxygen percentage is sufficient for life.	—	5.0 15.0	At top, increasing to certain depth.	Natural gas, sludge gas, manufactured gas, sewer gas. Strata of sedimentary origin. In swamps or marshes.	1. Combustible gas indicator. 2. Oxygen deficiency indicator.
Nitrogen	N_2	Simple asphyxiant. Colorless, tasteless. Non-flammable Principal constituent of air (about 79%.)	0.97	Physiologically inert.	—	—	— —	Near top, but may be found near bottom.	Sewer gas, sludge gas. Also issues from some rock strata.	Oxygen deficiency indicator.
Nitrogen Oxides	NO N_2O NO_2	Colorless Colorless, sweet odor Reddish-brown. Irritating odor Deadly poison	1.04 1.53 1.58	60 to 150 ppm causes irritation and coughing. Asphyxiant 100 ppm dangerous 200 ppm fatal.	50	10	— —	Near bottom.	Industrial wastes. Common air pollutant.	NO_2 detector tube.
Oxygen (in air)	O_2	Colorless, odorless, tasteless. Supports combustion.	1.11	Normal air contains 20.8% of O_2. Man can tolerate down to 12%. Min. safe 8 hr. exposure, 14 to 16%. Below 10%, dangerous to life. Below 5 to 7% probably fatal.	—	—	— —	Variable at different levels.	Oxygen depletion from poor ventilation and absorption, or chemical consumption of oxygen.	Oxygen deficiency indicator.
Ozone	O_3	Irritant and poisonous. Strong electrical odor. Strong oxidizer. Colorless. At 1 ppm., strong sulfur-like odor.	1.66	Max. naturally occurring level 0.04 ppm. 0.05 ppm causes irritation of eyes and nose. 1 to 10 ppm causes headache, nausea; can cause coma. Symptoms similar to radiation damage.	0.08	0.04	— —	Near bottom.	Where ozone is used for disinfection.	Detectable odor at 0.015 ppm.
Sludge Gas	—**	Mostly a simple asphyxiant. May be practically odorless, colorless.	Variable	Will not support life.	No data. Would vary widely with composition.		5.3 19.3	Near top of structure	From digestion of sludge.	See components.
Sulfur Dioxide	SO_2	Colorless, pungent odor. Suffocating, corrosive, poisonous, non-flammable.	2.26	Inflammation of the eyes. 400 to 500 ppm immediately fatal.	50 to 100	10	— —	At bottom, can combine with water to form sulfurous acid.	Industrial waste, combustion, common air pollutant.	Detectable taste and odor at low concentrations.
Toluene	C_7H_8	Colorless. Benzene-like odor	3.14	At 200 - 500 ppm, headache, nausea, bad taste, lassitude.	200	100	1.27 7.0	At bottom.	Solvent.	Combustible gas indicator.
Turpentine	$C_{10}H_{16}$	Colorless, characteristic odor.	4.84	Eye irritation. Headache, dizziness, nausea, irritation of the kidneys.	—	100	0.8 —	At bottom.	Solvent, used in paint	1. Detectable odor at low concentrations. 2. Combustible gas indicator.
Xylene	C_8H_{10}	Colorless, flammable.	3.66	Narcotic in high concentrations. Less toxic than benzene.	—	100	1.1 7.0	At bottom.	Solvent.	Combustible gas indicator.

* Percentages shown represent volume of gas in air.

** Mostly methane and carbon dioxide with small amounts of hydrogen, nitrogen, hydrogen sulfide, and oxygen; occasionally traces of carbon monoxide.

"Avoid touching yourself above the collar until you have cleaned your hands.

"9. Emergencies. Every member of the crew should be instructed on procedures to be followed in cases of an emergency. It is the duty of each crew chief to have a list of emergency phone numbers, including the nearest hospital and ambulance service, police precinct, fire station, and rescue or general emergency number.

"10. Field Equipment. The following equipment will be available for use:

Blowers	Hard Hats
Breathing Apparatus	Harnesses
Coveralls	Manhole Irons
First Aid Kits	Pick Axes
Emergency Flashers	Rain Slickers
Flashlights	Ropes
Mirrors	Safety Vests
Gas Detectors	Traffic Cones
Gas Masks	Waders"
Gloves	

2.5.1.2 Lethal Atmospheres in Sewers - The following is an article written by Dr. Richard D. Pomeroy, and published in the October 1980 issue of "Deeds & Data" of the WPCF. Dr. Pomeroy is particularly well known for his studies, over a period of nearly 50 years, in the field of the control of hydrogen sulfide and other odors in sewers and treatment plants. He has personally worked in a great many functioning sewers. In the earlier years he did so, he admits, with little knowledge of the grave hazards to which he exposed himself.

"It is gratifying that the subject of hazards to people working in sewers is receiving much more attention than in past years, and good safety procedures are prescribed in various publications on this subject. It is essential that people know and use correct procedures.

"It is less important to know just what the hazardous components of sewer atmospheres are, as safety precautions should in general be broadly applicable, but there should be a reasonable understanding of this subject. It is disturbing to see statements in print that do not reflect true conditions.

"One of the most common errors is the assumption that people have died from a lack of oxygen. The human body is able to function very well with substantially reduced oxygen concentrations. No one worries about going to Santa Fe, New Mexico, (elev. 2100 m), where the partial pressure of oxygen is equal to 16.2 percent (a normal atmosphere is about 21 percent) oxygen. When first going there, a person may experience a little 'shortness of breath' following exercise. People in good health are not afraid to drive over the high passes in the Rocky Mountains. At Loveland Pass, oxygen pressure is 13.2 percent of a normal atmosphere. At the top of Mt. Whitney, oxygen is equal to 12.2 percent. Many hikers go there, and to higher peaks as well.

"After adequate acclimation, they may climb to the top of Mt. Everest, where oxygen is equal to only 6.7 percent.

"The lowest oxygen concentrations that I have observed in a sewer atmosphere was 13 percent. It was in a sealed chamber, near sea level, upstream from an inverted siphon on a metropolitan trunk. A man would be foolish to enter the chamber. Without ventilation, he might die, but not from lack of oxygen.

the result will influence a man's thinking about the seriousness of the real hazards. Most important, use ample ventilation, and do not enter a potentially hazardous structure except in a good safety harness with two men at the top who can lift you out."

2.6 General Mounting Considerations for the Ultrasonic Level Sensor - The location of the ultrasonic level sensor depends on the method of level-to-flow rate conversion to be used. The Model 3210 Flow Meter is usually used in conjunction with some type of primary measuring device, such as a weir or flume. The location of the ultrasonic level sensor with respect to the primary device depends on the type of primary device used. The head measuring point is usually defined for a given type of primary device. For example, the head measuring point of a weir is at least three times the maximum expected head upstream from the weir plate; for Parshall flumes, the head measuring point is $^1/_3$ of the way into the converging section; and for Palmer-Bowlus flumes, the head measuring point is at least $^1/_2$ pipe diameter upstream from the entrance to the flume. Refer to the *Isco Open Channel Flow Measurement Handbook* and to manufacturer's information about the primary device for more details.

User-Determined Mounting Location - If flow is measured by some other means, such as a gravity flow equation (Manning) or by calibrating a section of the flow channel, the user should determine the location of the ultrasonic level sensor. This location should be based on the hydraulic characteristics of the site and the method of level-to-flow rate conversion used.

NOTE

In open channel installations, where flow may exceed half of full pipe, the transducer ***must*** be placed as close as possible to the midpoint between the pipe entrance and exit of the U-Channel to ensure sensing over the least turbulent flow.

"Dead Band" - The ultrasonic level sensor should be mounted as close to the maximum expected level as possible. This minimizes many of the undesirable characteristics of ultrasonic distance measurement. However, the ultrasonic level sensor *must* be mounted at least one ft. higher than the maximum expected level, as shown in Figure 2.6-1. This is a result of a one ft. "dead zone" directly below the level sensor where no measurements can be taken.

Extension Cables for the Ultrasonic Level Sensor - Four different extension cable lengths, 25, 50, 100, and 250 feet, are available to connect to the ultrasonic level sensor. Isco recommends that the cable lengths *not* be cut by the customer. Extra cable should be coiled neatly by the flow meter. A steel reinforcing wire inside the cable makes it difficult to cut and the M/S connectors, which are sealed, cannot readily be replaced in the field. Electrical problems may also be encountered. For special lengths of cable, consult the factory.

Accidental Submersion Harmless - Since both ends of the ultrasonic level sensor are completely sealed, it should not be damaged by temporary submersion in the flow stream, should this accidentally occur. However, prolonged submersion should be avoided. Users should also realize that submersion will prevent the level sensor from working, even if it is not damaged. Prolonged submersion or submersion in dirty or greasy flow streams may cause the surface of the transducer to become coated with solid matter, which will cause it to malfunction until it is cleaned. If possible, mount the ultrasonic level sensor high enough above the flow stream to avoid submersion under normal circumstances.

2.6.1 Mounting the Ultrasonic Level Sensor - The ultrasonic level sensor can be mounted over the flow stream in various ways. It is up to the user to determine which method best fits the application. Mounting examples are shown in Figure 2.6-2. A $^3/_4$" male pipe thread with a conduit lock nut has been provided on the ultrasonic level sensor to connect the it to a mounting bracket or cable stiffener. An optional mounting bracket is available from Isco to mount the ultrasonic level sensor. This bracket is shown in Figure 2.6-2. The ultrasonic level sensor cable can also be run through conduit to the flow meter.

Figure 2.6-2 Mounting the Ultrasonic Level Sensor

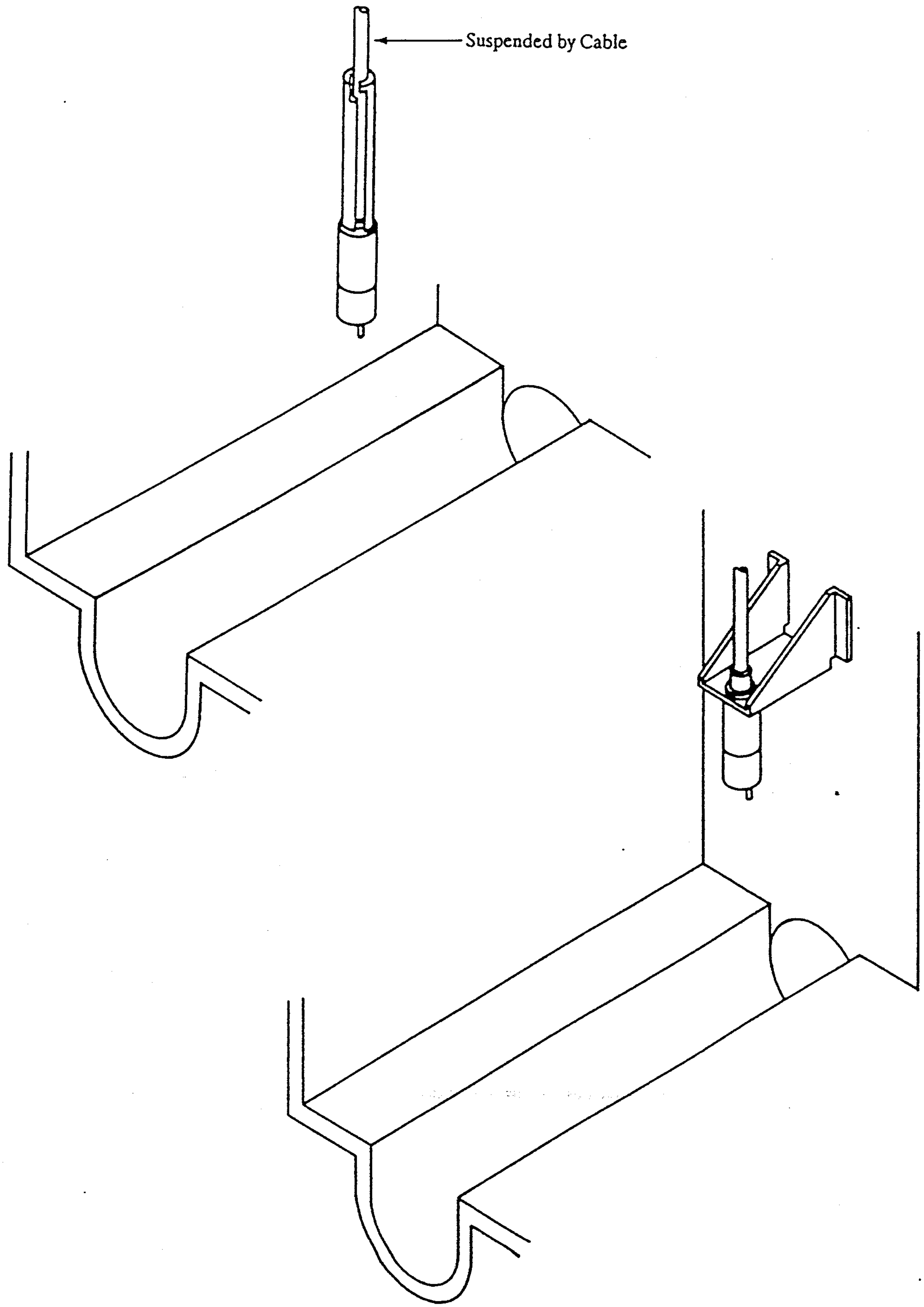


Figure 2.6-3 Foam and Oil on the Surface of the Flow Stream

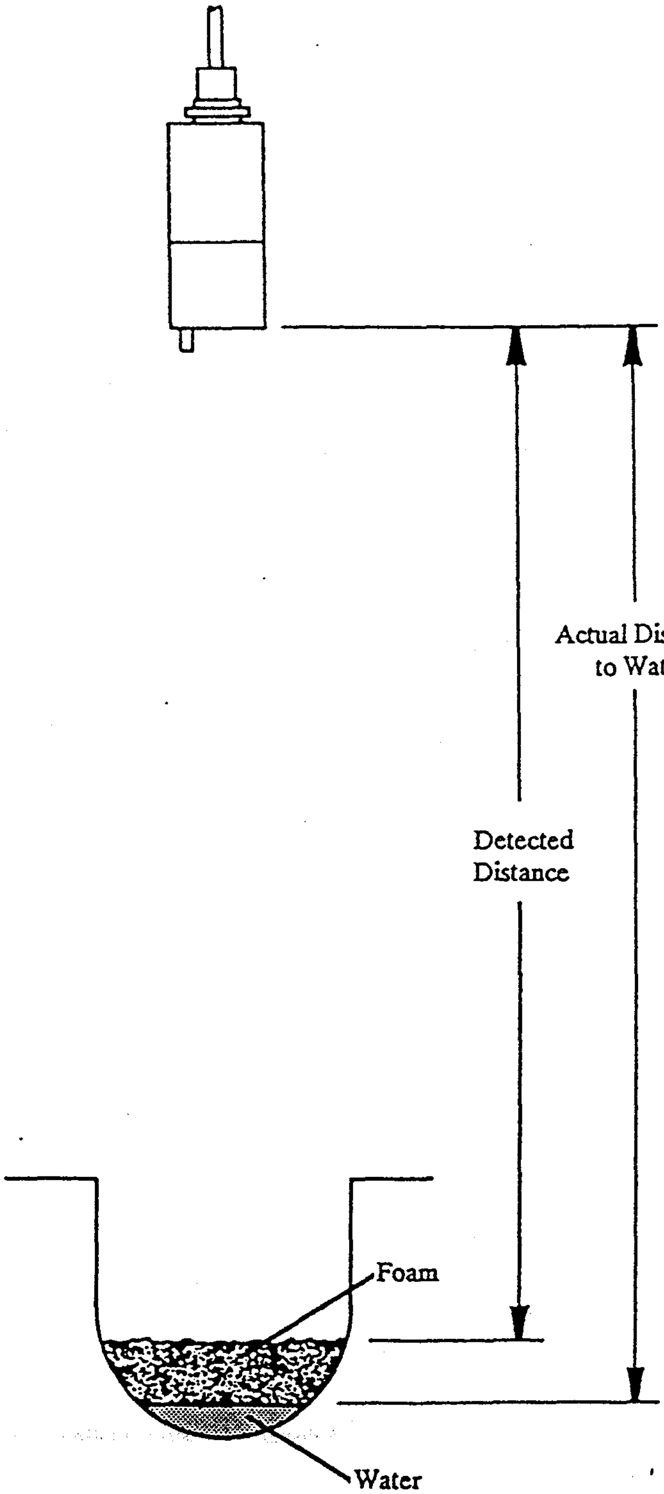
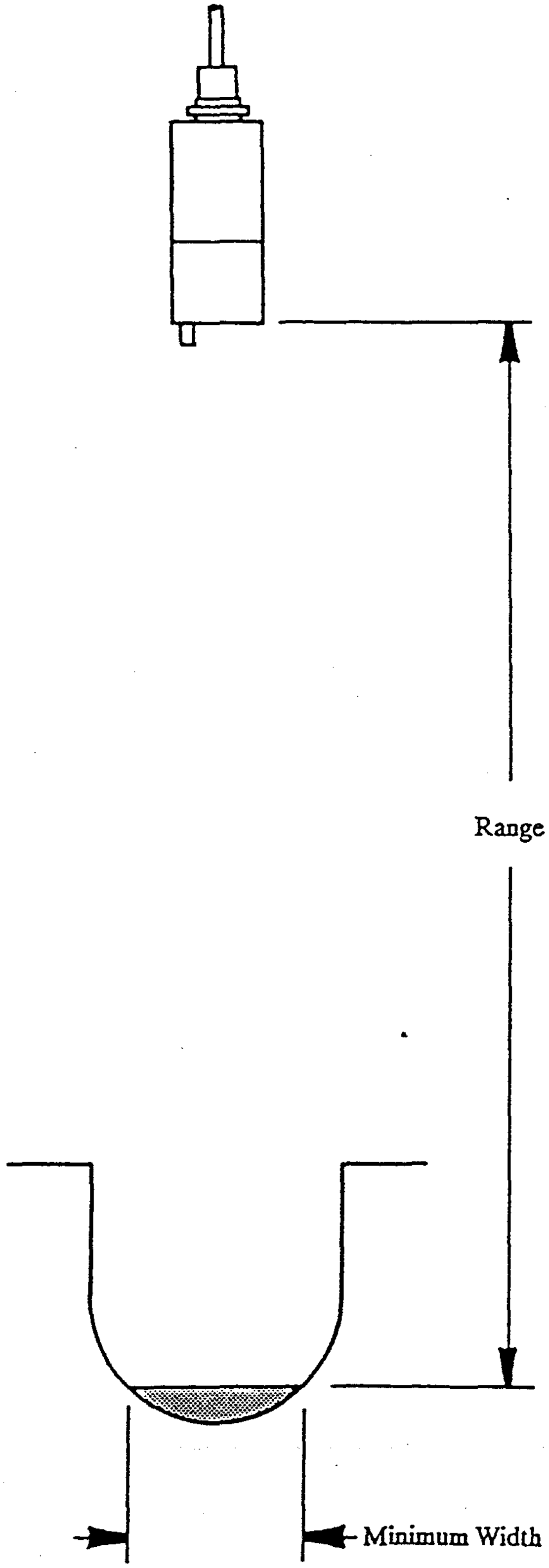


Figure 2.6-4 Small Pipes and Narrow Channels



Calibrate at "Expected" Temperature - The user should calibrate the level reading under temperature conditions as near as possible to those expected during operation. For small changes of level, the error due to temperature is determined by the product of the distance (from the transducer to the flow stream surface) and the temperature change. Calibrating the flow meter at the same temperature as the expected operating temperature will minimize this error.

Calibrate the "Zero Level" at Point Similar to Expected Level - Errors may be reduced by calibrating the Zero Level at a level which is close to that expected during operation.

Avoid Water Condensate - The ultrasonic level sensor will not operate properly if the bottom surface collects water droplets. This may occur if water condenses on the transducer surface as a result of high ambient humidity. Some users have found that mounting the ultrasonic level sensor horizontally and aiming it at a 45° angled reflector will keep water from collecting on the level sensor's radiating surface.

Avoid Foam, Oil and Turbulence - If the flow stream surface is absorbent (such as with foam) or very irregular (such as highly turbulent water), the ultrasonic echo may not be correctly reflected back to the ultrasonic level sensor. This can result in a false measurement or no measurement at all. If the foam is reflective, the system will detect the top of the foam rather than the liquid surface. Also, if grease or oil is floating on the flow stream surface, it will be detected rather than the liquid surface; refer to Figure 2.6-3.

Small Pipes and Channels - Small circular pipes, narrow channels, and small flumes may also cause problems with ultrasonic distance measurement. Since the ultrasonic pulse expands outwards at a beam angle of approximately 10° as it travels away from the ultrasonic level sensor, it may strike the sides of a channel or the sloping sides of a circular pipe with low flow. This can result in false echoes and incorrect level readings. The term "small channels" generally refers to "U" shaped channels and pipe inverts 10" in diameter and less. The term "small flumes" generally refers to 1" and 2" Parshall flumes. It should be noted that the level measuring point for many types of flumes (Palmer-Bowlus, Leopold-Lagco, etc.) is not in the flume, but upstream in the invert of the pipe; for these types of flumes the section of interest is in the pipe invert, not in the flume itself. Thus, care should be exercised in the use of 10" or smaller Palmer-Bowlus and Leopold-Lagco flumes.

Determining Suitability - The channel to be measured can be "pre-qualified" by a simple equation which will determine whether or not the channel is wide enough to allow correct positioning of the ultrasonic sensor. Since the beam angle is 10°, the equation is:

$$\text{Minimum Width} = .18 \times \text{Distance}$$

Where Distance is the distance from the bottom of the ultrasonic level sensor to the minimum expected level, as shown in Figure 2.6-4.

Possible Alternatives - Because of the characteristics of ultrasonic liquid measurement, there may be some installations where the ultrasonic method is either unreliable or inaccurate. In these instances it is worthwhile to consider use of the submerged probe level sensor (Isco Model 3220 Flow Meter) or use of the bubbler technique (Isco Model 3230 Flow Meter). Information on these companion units to the Model 3210 is available from their respective manuals or from the factory. Call for more information.

2.7 Interfacing Equipment - The Model 3210 Flow Meter may be used with a variety of other equipment. The following sections give instructions for connecting other equipment to the Model 3210.

2.7.1 Connection to a Sampler - The following sections describe the methods for connecting the Model 3210 to Isco and Non-Isco samplers.

2.8 Operating Examples - Following are operating examples showing the steps and entries necessary to program specific examples into the Model 3210 Flow Meter. The examples have been divided into several different groups of steps for clarity. Different programming objectives are accomplished with each group of steps. Note that the GO TO PROGRAM STEP key is used in each example to directly access the step being programmed, rather than working all the way through the program step-by-step, as would typically be done.

Types of Examples - The first example depicts selecting a primary device, entering the flow rate and establishing totalization. The second example describes setting up sampler initiation. The third example presents the steps necessary to set up the internal plotter. The fourth and fifth example show setting up the report generator. The sixth example involves entering an equation. The seventh example describes entering data points. The eighth example shows chart over-ranging, sampler event marking and bottle numbers. The ninth example shows a report generated by the Model 3210. The tenth example shows level adjustment. The eleventh example shows sampler enabling. An example using a Characterization Prom may be found in **Section 3.4.2 in Chapter 3.**

Display in Normal Operating Mode - As an introduction, we will provide descriptions of the display during normal operation and the format of the report generation feature. When the flow meter is in the FLOW MODE, total flow, flow rate, and level will be displayed. For example:

```
TOTAL          FLOW RATE        LEVEL
XXXXXX GAL  XXXXXX  GPS      +/-XX.XXFT
```

When the "LEVEL ONLY" mode is selected, the display will appear as follows:

```
LEVEL     HH:MM     DD-MM-YY
 +/-XX.XX FT
```

The user will also notice that there is a symbol, or icon, on the right side of the display which looks like three arrow heads radiating downward. This symbol is a representation of the ultrasonic pulses beaming towards the surface of the flow stream, and means the flow meter is operating in the normal manner. To the right of this symbol, the letter "L" may appear. This letter "L" means that the Program Lock, step 11, has been enabled.

When the flow meter is operating and the report generation feature has been selected, the internal plotter will routinely print out reports. The printed report will look similar to the following:

```
    SITE 317 INTERVAL FROM
    12-NOV-88 10:00 TO 13-NOV-88 10:00

MAXIMUM LEVEL: 5.781 FT
      ON 13-NOV-88 AT 06:48
MINIMUM LEVEL: 3.452 FT
      ON 13-NOV-88 AT 02:12
MAXIMUM FLOW RATE: 2.346 CFS
      ON 13-NOV-88 AT 06:48
MINIMUM FLOW RATE: 1.483 CFS
      ON 13-NOV-88 AT 02:12
AVERAGE FLOW RATE: 1.874 CFS
INTERVAL FLOW VOLUME: 100345 CFS
TOTAL FLOW VOLUME: 4023478 CF
NUMBER OF SAMPLES: 12
RAINFALL:0.18 IN
```

Another example of the report generated by the internal plotter may be found in **Section 2.8.9 and Figure 2.8-2.**

8. Press 1 (WEIR); then press ENTER.

Display:
```
SELECT TYPE OF WEIR:
1. V-NOTCH   2. RECTANGULAR   3. CIPOLETTI
```

9. Press 1 (V-NOTCH); then press ENTER.

Display:
```
SELECT V-NOTCH WEIR ANGLE:
1. 90   2. 60   3. 45   4. 30   5. 22.5
```

10. Press 2 (60); then press ENTER.

Display:
```
ENTER MAXIMUM HEAD:
MAXIMUM HEAD IN FEET = XX.XXX
```

11. Press 1; then press ENTER.

Display:
```
FLOW AT 100% LEVEL = 0.9325 MGD
PRESS   ANY   KEY
```

12. Press ENTER.

2.8.2 Enabling Sampler Initiation - This example describes the steps necessary to enable sampler initiation. The desired objective is to send a flow pulse to the sampler every 100,000 gallons, (0.1 MGAL), with the Model 3210 already totalizing in GAL.

1. Press GO TO–

Display:
```
ENTER PROGRAM STEP NUMBER 1-11
```

2. Press 2; then ENTER.

Display:
```
ENTER SAMPLER FLOW PACING
1. NO   2. ENTER FLOW INTERVAL
```

3. Press 2; then ENTER.

Display:
```
ENTER SAMPLER INTERVAL: (100 - 5000000)
INTERVAL PER PULSE = X.XXXXX GAL
```

(The numbers in the parentheses indicate the valid entry range.)

4. Press 1, followed by five 0's; then press ENTER.

2.8.3 Setting Up the Internal Plotter - It is desired to have a very detailed plot of flow rate. The maximum flow rate is known to be 0.9325 MGD. Flows are usually in the range of 0 - 0.5 MGD.

1. Press GO TO–

Display:
```
ENTER PROGRAM STEP NUMBER 1-11
```

2. Press 3, then ENTER.

Display:
```
SELECT PLOTTER MODE OF OPERATION
1. OFF   2. LEVEL   3. FLOW
```

Figure 2.8-1 Example Showing Chart Over-Ranging

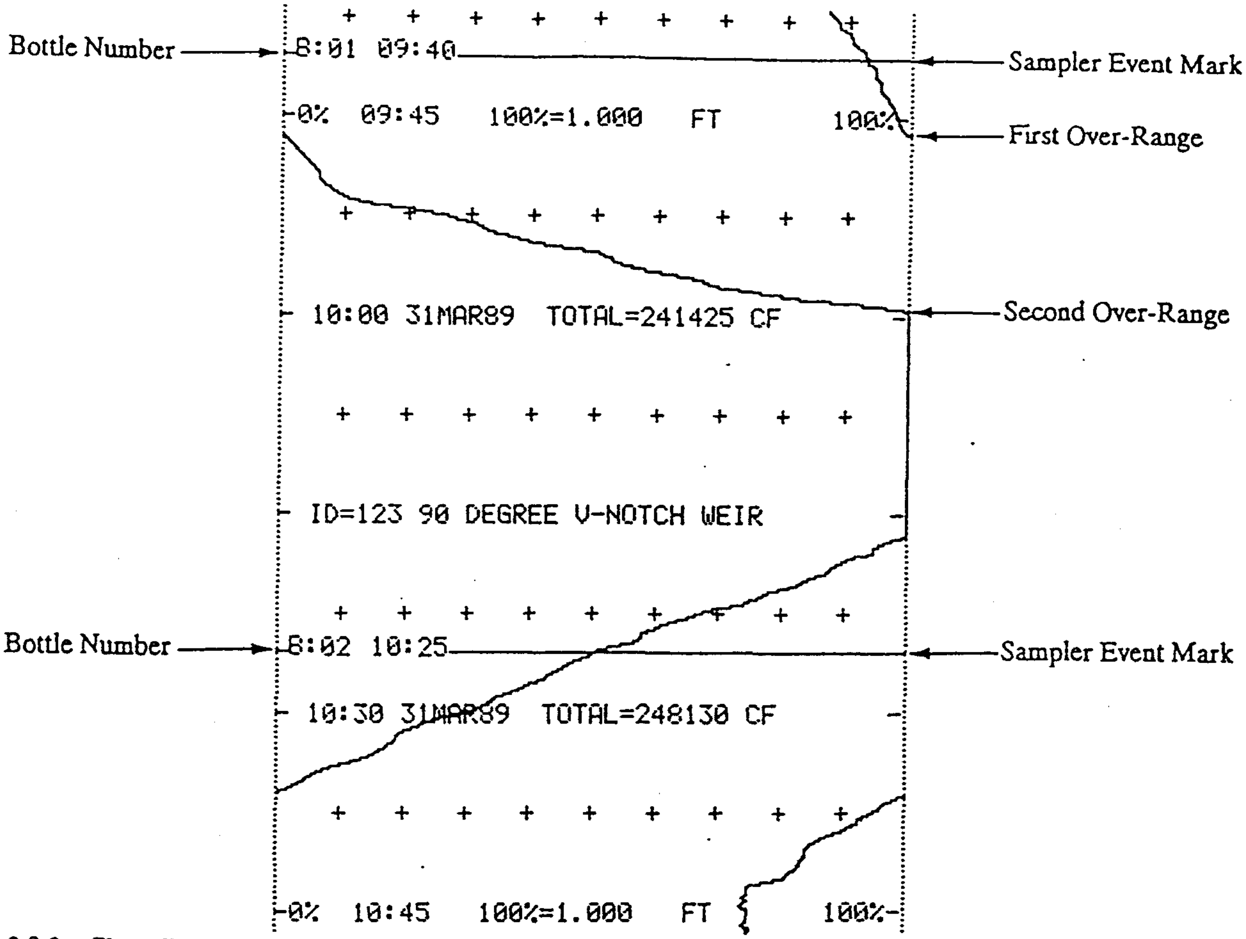


Figure 2.8-2 Chart Printed By Report Generator

```
------------------------------------------
  SITE 000 - INTERVAL FROM
  23-AUG-92 13:50   TO  25-AUG-92 13:50

MAXIMUM LEVEL:  0.898 FT
      OCCURRED 2 TIMES
      FIRST ON 24-AUG-92 AT 13:39
      LAST  ON 25-AUG-92 AT 13:30
MINIMUM LEVEL:  0.873 FT
      ON 25-AUG-92 AT 07:20
MAXIMUM FLOW RATE: 1.929 CFS
      OCCURRED 2 TIMES
      FIRST ON 24-AUG-92 AT 13:39
      LAST  ON 25-AUG-92 AT 13:30
MINIMUM FLOW RATE: 1.801 CFS
      ON 25-AUG-92 AT 07:20
AVERAGE FLOW RATE: 1.858 CFS
INTERVAL FLOW VOLUME : 321299 CF
TOTAL FLOW VOLUME : 641231 CF
NUMBER OF SAMPLES: 0
RAINFALL:  0.38 IN
------------------------------------------
```

Display:
```
SELECT FLOW CONVERSION TYPE:
1. STD  2. EQN  3. MANN  4. DATA
```

4. Press 2; then press Enter.

Display:
```
SELECT UNITS OF LEVEL MEASUREMENT
1. FEET  2. METERS
```

5. Press 1; then press Enter.

Display:
```
SELECT FLOW RATE UNITS
1. GPM  2. GPS  3. MGD  4. CFS  5. OTHER
```

6. Press 4; then press Enter.

Display:
```
SELECT TOTALIZED VOLUME UNITS:   1. CF
2. GAL  3. CM  4. AF  5. L  6. MGAL
```

7. Press 1; then press Enter.

Display:
```
ENTER EQUATION
CFS =  1.000 H^2.00 + 001.000 H^ 2.00
```

8. Press 1 - . (decimal) - 3 - 4; then press Enter. Press 2 - . (decimal) - 5; then press Enter.

Press Enter (to accept the '+' sign). Press . - 6; then press Enter.

Press 1 - . (decimal) - 3; then press Enter.

Display:
```
ENTER MAXIMUM HEAD
MAXIMUM HEAD IN FEET = 1.000
```

9. Press 2; then press Enter.

Display:
```
FLOW AT 100% LEVEL = 9.058 CFS
PRESS    ANY    KEY
```

10. Press Enter.

2.8.7 Data Point Entry - In this example, the user has a set of level and corresponding flow rate data points which characterize the particular open channel flow situation in use. They are as follows:

Level, (Meters)	Flow Rate, (Liters/Sec.)	Level (Meters)	Flow Rate, (Liters/Sec.)	Level, (Meters)	Flow Rate, (Liters/Sec.)
0.034	2.0	0.132	16.0	0.360	70.0
0.044	3.0	0.145	18.0	0.390	80.0
0.054	4.0	0.155	20.0	0.420	90.0
0.062	5.0	0.180	25.0	0.450	100.0
0.070	6.0	0.200	30.0	0.500	120.0
0.077	7.0	0.225	35.0	0.550	140.0
0.084	8.0	0.245	40.0	0.610	160.0
0.091	9.0	0.270	45.0	0.660	180.0
0.098	10.0	0.285	50.0	0.700	200.0
0.120	14.0	0.320	60.0		

11. Press 4; then press ENTER.

Display:

```
SET 1:  DATA POINT 1 (PRESS EXIT TO QUIT)
ENTER:  0.000 M    0.000 LPS
```

12. Press . (decimal) - 0 - 3 - 4; then press ENTER.

Press 2; then press ENTER.

Display:

```
SET 1:  DATA POINT 2 (PRESS EXIT TO QUIT)
ENTER:  0.000 M    0.000 LPS
```

Continue entry of the remaining data points until all are entered.

...Display:

```
SET 1  :DATA POINT 30 (PRESS EXIT TO QUIT)
ENTER:  0.000 M    0.000 LPS
```

13. Press EXIT to indicate your entry is complete.

Display:

```
SET 1:  29 POINTS SAVED    1. ADD POINT
2. USE  3. EDIT  4. CLEAR SET  5. PRINT
```

14. Press 5; then press ENTER.

Display:

```
PRINTING DATA POINT SET
PRESS ANY KEY TO ABORT PRINT
```

The internal plotter will print the entered data so the user may verify that all the data was entered correctly.

Display:

```
SET 1: 29 POINTS SAVED    1. ADD POINT
2. USE  3. EDIT  4.CLEAR SET  5. PRINT
```

15. If the data are correct, press 2; then press ENTER.

In calculating the flow conversion from data points, the Model 3210 uses a three point interpolation. The Model 3210 will not permit duplicate level entries. If the level data readings are not entered in order of increasing level, the Model 3210 will sort the data by level.

Display:

```
SORTING DATA
```

Display:

```
ENTER MAXIMUM HEAD:  ( 0.030 - 3.000)
MAXIMUM HEAD IN METER  =    1.000
```

16. Press . - 7, then ENTER.

Display:

```
FLOW AT 100% LEVEL  =  200.0 LPS
PRESS ANY KEY
```

17. Press ENTER.

2.8.8 Example Showing Chart Overranging and Sampler Event Marking - In the following example, the chart is set up to plot level at 4"/hour with a full-scale reading of one foot. Assume the flow meter is connected to an Isco Automatic Wastewater Sampler. See **Figure 2.8-1**, for an example of the chart. Note that between 09:45 and 10:00, the level goes above one foot

Rapidly Changing Flow - If the flow is rapidly changing, this process may have to be repeated several times until the flow meter's indicated level is accurately aligned with the actual liquid level.

Periodically Confirm Level Adjustment - Although the registration between the actual and indicated liquid levels should not change significantly, it is good practice to confirm the registration periodically and make adjustments as necessary.

Level Accuracy Vital - Accuracy in adjusting the flow meter's indicated level in the flow stream is vital to the overall accuracy of the Model 3210, particularly when measuring flow rate. Any error in the registration between actual and displayed levels will result in errors which become substantial as liquid levels increase. For example, if a 90° V-notch weir is being used in the 1.0 foot range, a 0.01 foot error (1% of full-scale head) in adjustment at an actual head of 0.20 foot will result in a 0.2% (of full-scale flow rate) error at this head, but this same 0.01 foot error at a 0.80 foot head will result in a 2% (of full-scale flow rate) error. Therefore this adjustment should be carefully and accurately made.

1. Press GO TO→.

Display:

ENTER PROGRAM STEP NUMBER 1-11

2. Press 8.

Display:

ADJUST LEVEL: ←/→KEYS OR ENTER VALUE ENTER PRESENT LEVEL: 2.583

3. Press 3 - . - 6 - 8 - 7; then press ENTER.

Display:

RESET FLOW TOTALIZER 1. YES 2. NO

4. Press the EXIT PROGRAM key.

Using the Arrow keys to Adjust Level - The flow meter will display the new level of 3.687. Note that in step 2, the display reads: ADJUST LEVEL: ←/→KEYS OR ENTER VALUE....ENTER PRESENT LEVEL: 2.583. The desired entry can also be made by pressing the →(ARROW RIGHT) key which will cause the number shown on the display to begin increasing. Release the key when near the desired number. If the →key is held too long and the number goes too high, pressing the ←(ARROW LEFT) key will cause the number displayed to rapidly decrease. Use the arrow keys when making small adjustments to the level or uncertain of the exact value needed. Use the number keys to enter a specific value. Note also that if a selection is made using the number keys, it cannot then be directly adjusted by using the arrow keys. It will be necessary to exit the program, and re-enter Step 8 to change the level with the arrow keys.

Program **LEVEL ADJUST** at job site only - Note that unlike all the other programming steps, the liquid level adjustment (Program Step 8) *must* be done in the field at the job site. It may be desirable to set up the remainder of the sampling program in the office, and then to use the GO TO PROGRAM STEP key to adjust the level in the field.

2.8.11 Example Showing Operation of the "Sampler Enable" Feature - A flow meter, sampler, and rain gauge are to be set up for a rainfall runoff study. Assume the current level is at 1.00 feet and sampler enabling is *on*. We wish to enable the sampler when a level of 1.15 feet is reached along with rainfall of 0.1" over a two hour time period, and then collect flow-paced samples until the sampler's program is completed. The sampler requires one flow pulse for every 1,000 gallons of flow. The internal plotter and the sampler will both be enabled only when the specified level (1.15 feet) and rainfall (0.1" over two hours) have occurred.

3.0 Optional Equipment - The third chapter of the Model 3210 instruction manual provides information on optional equipment available for use with the flow meter. Included will be sections describing the options and information about interconnection between the Model 3210 and the various options similar to that provided in Section 2.9. The following options are available for use with the Model 3210 Flow Meter:

- 3200W and 3200SH Series Modems
- Model 2312 Plotter
- Liquid Level Actuation (used with the Model 1640 Liquid Level Actuator)
- Characterization PROM
- Extension Cables for the Ultrasonic Level Sensor
- 4 - 20 mA Output Interface
- Tipping Bucket Rain Gauge
- Isco FLOWLINK™ Software
- High-Low Alarm Relay Box and Battery-Backed Power Pack

User-Installed Options - The Extension Cables for the ultrasonic level sensor and the 4 - 20 mA Output Interface are options which may be field-installed by the user at any time. The 3200 Modems, Liquid Level Actuator, and Characterization PROM all require some factory modification to the Model 3210 Flow Meter, and should be specified at the time the flow meter is ordered. If it is desired to add any of these options later, the flow meter will have to be returned to the factory for modifications.

3.1 Modem - The 3200W Series Modem consists of a circuit board mounted inside the flow meter's cabinet which makes it possible to transmit flow meter data over standard dial-up telephone lines. The modem also makes it possible for remotely located equipment to command the flow meter to perform certain operations. Modems allow digital equipment to "talk" and "listen" to other remotely-located digital equipment over telephone lines.

Modem Operation - Since the phone system cannot transmit digital pulses through its repeaters, digital equipment cannot communicate directly over phone lines. Modems convert digital data from the equipment to which they are connected into tones, which they transmit over the phone lines. When the equipment on the other end of the line answers through its own modem, its digital data response is also converted to tones and transmitted to the first modem. The first modem then converts the tones back to digital data to be interpreted by its associated digital equipment.

Modem Allows Use of Software Packages - The 3200W Series Modem is full duplex and it works in auto-answer mode. It operates at 1200 baud. This modem provides Bell 103 and 212A capability. A connect cable is provided to attach the modem to the telephone line. The 3200W Series Modem allows use of the Isco FLOWLINK™ Software, which causes the flow meter to set up and collect blocks of level data. The software can be used to read and view this collected data on a PC at a remote location. Other Isco FLOWLINK™ software packages may be used with this collected data to write reports. These software packages are covered in greater detail in an instruction manual.

3.1.1 Connection to a Line - Communications over telephone lines are governed by the Federal Communications Commission (FCC). The following instructions for connecting the Modem to the phone line have been approved by the FCC. The FCC has established rules which permit the modem to be directly connected to the telephone network. The line connection for the 3200 Series Modem should be provided by the local telephone company. Call them for information.

3.1.2 3200W Series Modem Circuit Board - This circuit board description is provided to help determine whether the modem is working. If a problem is found, Isco strongly suggests replacing the board or calling the factory to determine how to have the unit repaired. Since the modem is licensed by the FCC, changing any components may void the license.

Circuit Description - Refer to Figure 3.1-1 for a component layout and Figure 3.1-2 for a schematic diagram of the 3200W Series Modem. The modem consists of 2 ICs, U3, a controller, and U2, a modem chip that "talk" to the calling modem while providing "handshaking." The phone circuitry is isolated from the modem and other circuitry on the board. When the phone rings, the ring detector circuitry, IC U7, signals the Model 3230, which then turns the Modem on by turning on transistors Q1 and Q2. The processor then sets "Auto HS (handshaking)" and "RTS (Request to send - .)" The 3200W modem then connects the telephone line. This tells the calling modem that the call has been answered and stops the line from ringing. The calling modem sends a tone telling the modem in the Model 3230 to set the baud rate (300 or 1200.) The modem in the Model 3230 will automatically set the correct baud rate. The modem is normally set for the 1200 baud rate unless it is "told" differently. When the "handshaking" is completed, the modem sets the carrier detect signal. The data is then exchanged by the calling device and the Model 3230. If the phone jack is unplugged, the tones coming over the phone line will be lost and the carrier detect (CARRIER) and energy detect (ENERGY) signals will go low, signalling the Model 3230 to disconnect the phone line. IC U4 is a +5VDC regulator. U5 is an op-amp used to amplify the tone signals.

3.2 Connection to an Isco Model 2312 Plotter - The Model 2312 Plotter is available for use with the Model 3210 Flow Meter. This device generates both a strip chart-like record of flow rate versus time and a printed record of incremental total flow values, which are referenced to a real time and date. The Model 2312 attaches to the REMOTE PLOTTER/RAIN GAUGE connector. (This connector is a standard feature on flow meters made after July, 1991, but was optional before. Consult the factory if you wish to add this connector to a flow meter built before July, 1991.) If it is desired to use a Model 2312 plotter later, the Model 3210 will have to be returned to the factory for installation of these parts.

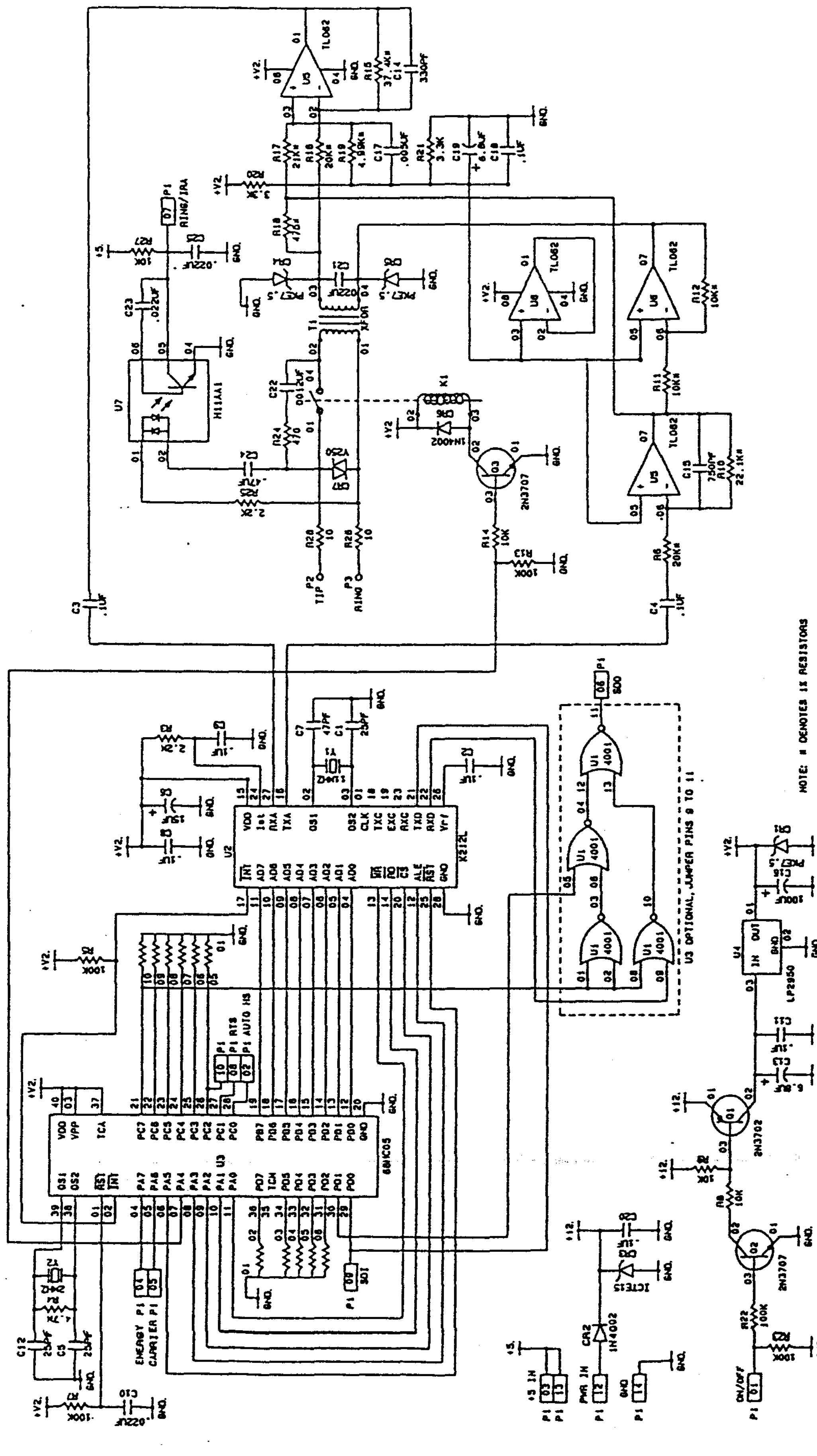
NOTE

Both the Model 3210 Flow Meter and the Model 2312 Plotter contain an internal clock/calendar. When the Model 2312 is connected to the Model 3210, the Model 3210 controls the clock/calendar for both units. The Model 3210 Flow Meter is not compatible with an earlier version, the Model 2310 Plotter. The flow meter transmits data that the Model 2310 cannot interpret; it will display error messages. It is possible to upgrade a Model 2310 Plotter to a Model 2312 Plotter. Consult the factory for details.

Connection to the Model 2312 - To connect the flow meter to the plotter, attach the four pin male connector on the cable available with the plotter to the REMOTE PLOTTER/RAIN GAUGE connector on the side of the flow meter. This is the fifth connector from the top. See Figure 1.4-2. Attach the connector on the other end of the cable to the FLOW METER connector on the plotter case. Refer to the plotter instruction manual for more information.

Increased Power Consumption - Note that when a plotter is connected to (and, as a result powered by) the flow meter, the current consumption of the two together will be significantly increased compared to that of the flow meter only. Thus, for battery-powered applications, the increased demand on the flow meter battery by the plotter should be recognized. In a battery-powered system consisting of an Isco sampler, a Model 3210 Flow Meter, and a Model 2312 Plotter, it is recommended that both the sampler and the flow meter be equipped with their own batteries.

Figure 3.1-2 Schematic Diagram of the 3200W Series Modem



NOTE

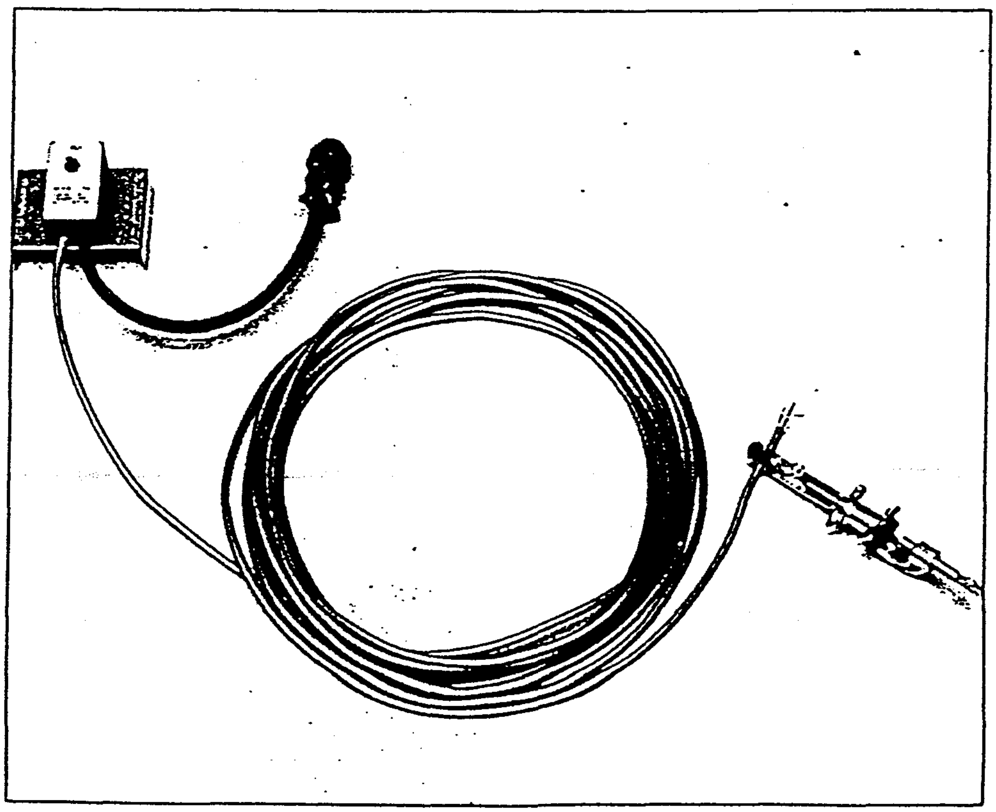
The electronics package in the Model 1640 Liquid Level Actuator is epoxy-encapsulated for protection and is not user-serviceable. If the unit fails to operate correctly, return it to Isco for repair.

3.3.3 Mounting the Liquid Level Actuator - Mount the sensor of the liquid level actuator rigidly above the flow stream using corrosion- and weather-resistant hardware. The sensor connects to the control box by a cable and must be within 22 feet of the flow meter. If it is necessary to mount the unit further from the flow meter, longer cable lengths are available from the factory. Figure 3.3-2 shows the sensor assembly mounted on the user-supplied stake (1" [2.5 cm] diameter maximum) with the clamp on the sensor's arm. The sensor mounts over the flow stream, with the stainless pin pointing down. Position the plastic rain deflector so it almost covers the probe on the end of the sensor. The rain deflector prevents rain from wetting the sensor and falsely activating the flow meter. Keep the rain deflector clean on the inside, as buildup of damp deposits might falsely turn on the flow meter. Also keep the vent hole on the side of the rain deflector unobstructed, so air can escape as the liquid level rises inside the deflector. The sensor will turn on when the water level reaches the stainless steel ring inside the rain deflector. Therefore, mount the sensor assembly so that the stainless ring, rather than the probe tip, is positioned at the height desired for actuation.

NOTE

If the flow meter is powered by 120 VAC, the Model 1640 will turn on when the liquid reaches the probe tip of the sensor, rather than the stainless steel ring inside the rain deflector. This is because the power pack has an earth ground which completes the circuit to the probe before the liquid level reaches the stainless ring.

Figure 3.3-1 Liquid Level Actuator



The Characterization PROM information printed in the report includes the following:

- Maximum Level and Units of Measure
- Flow Rate Units of Measure
- Totalized Flow Units of Measure
- Primary Device Identification (can be up to a 28 character string.)

Display Prompts - The software in the flow meter detects that a PROM is present and will add an additional choice (5. PROM) to the program menu at the SELECT CONVERSION TYPE step of the program. See Section 2.5. If PROM is selected, the following display will appear:

```
CHARACTERIZATION PROM TABLES:
1. VIEW/SELECT  2. PRINT
```

If PRINT is selected, the flow meter will print the information pertaining to each table, 1 through 8, and then display the same step as above with choice 1 as the default.

If VIEW/SELECT is selected, the flow meter will display the currently used table, in the following format:

```
TABLE X: 12" V-NOTCH COMBINATION WEIR
MAXHEAD: 2.5 FT  FLOW:  MGD  VOL: GAL
```

The *X* above represents the table number (one through eight) that is currently in use. The user may then press a number (1-8) to view the various tables or use the arrow keys to scroll through the different tables. Pressing the ENTER/PROGRAM STEP key would accept the currently viewed table and continue with the programming sequence. Pressing the EXIT PROGRAM key would exit from the step.

3.4.2 Programming Example Using a Characterization PROM - (PROM must be installed in unit.)

1. Press GO TO PROGRAM STEP key.

Display:
```
ENTER PROGRAM STEP NUMBER 1-11:  1
```

2. Press 1; then press the ENTER/PROGRAM STEP key.

Display:
```
SELECT MODE OF OPERATION:
1. FLOW  2. LEVEL ONLY
```

3. Press 1; then press ENTER.

Display:
```
SELECT FLOW CONVERSION TYPE:
1. STD  2. EQN  3. MANN  4. DATA  5. PROM
```

Note that the 5. PROM menu option only appears when the PROM is installed.

4. Press 5; then press ENTER.

Display:
```
CHARACTERIZATION PROM TABLES:
1. VIEW/SELECT  2. PRINT
```

5. Press 1; then press ENTER.

Display:
```
TABLE 1: 1' COMBINATION WEIR
MAXHEAD:  2.000 FT  FLOW: CFS  VOL: CF
```

Figure 3.6-1 4 - 20 mA Output Interface

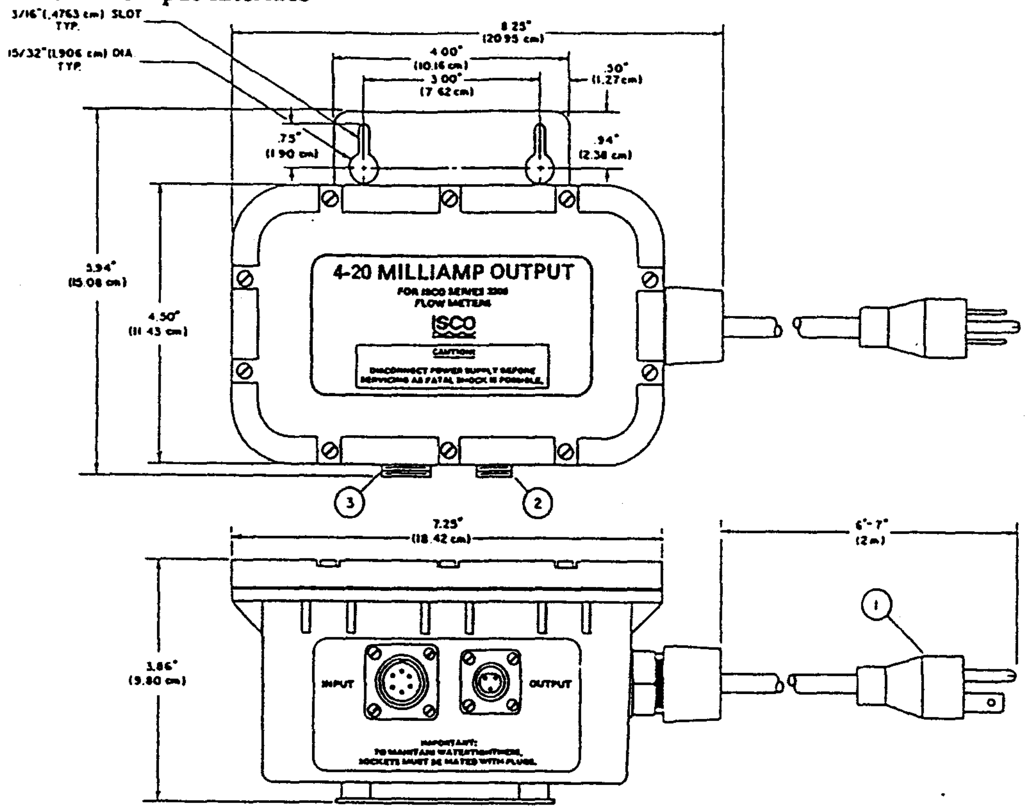


Table 3.6-1
4 - 20 mA Output Interface Specifications

Power:	120 VAC, ⅛ Amp. Line cord provided.
Output Connector:	3-pin male plug. Pin A: + current output. Pin B: – current output. Pin C: no connection.
Output Accuracy: Room Temperature: Over Operating Temperature Range:	 ±0.25% of full-scale. ±0.5% of full-scale.
Operating Temperature Range:	0°F to 140°F (–18°C to 60°C)
Resolution:	0.1% of full-scale.
Input Connector:	M/S type - 6-pin male. Pin B: – pulse input. Pin F: + pulse input. Pin A, C, D, E: no connection.
Isolation:	Output current optically isolated from flow meter.
Fusing:	Internal, ¼ Amp fuse on AC power input.
Adjustments/Calibration:	Factory-calibrated; used with compatible equipment within allowable range, unit should need no further adjustment.
Maximum Distance:	1500 Feet with 18 AWG wire.

Figure 3.6-2 Component Layout for the 4-20 mA Output Interface Printed Circuit Board

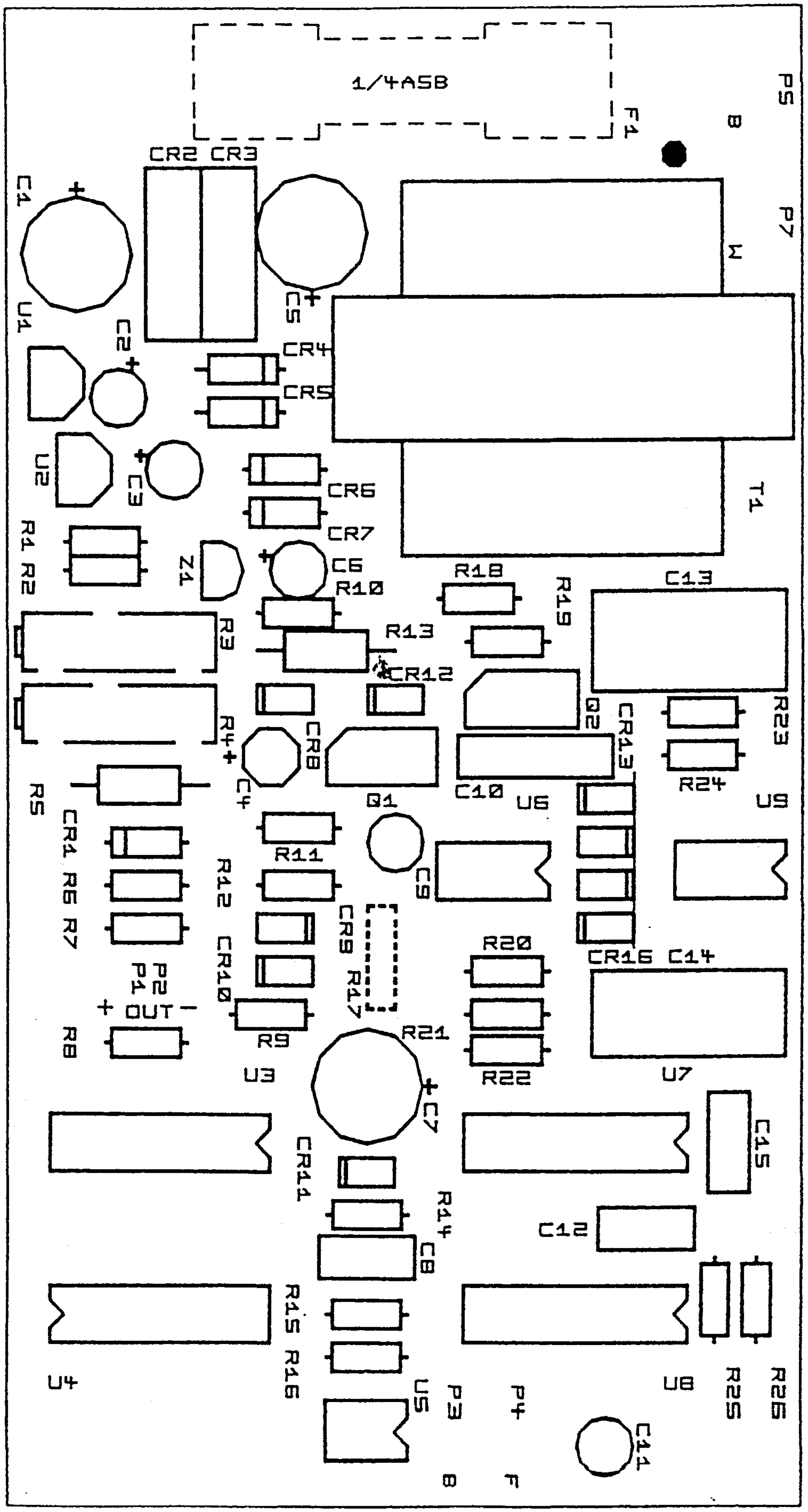


Figure 3.8-1 Components of the Laptop Computer

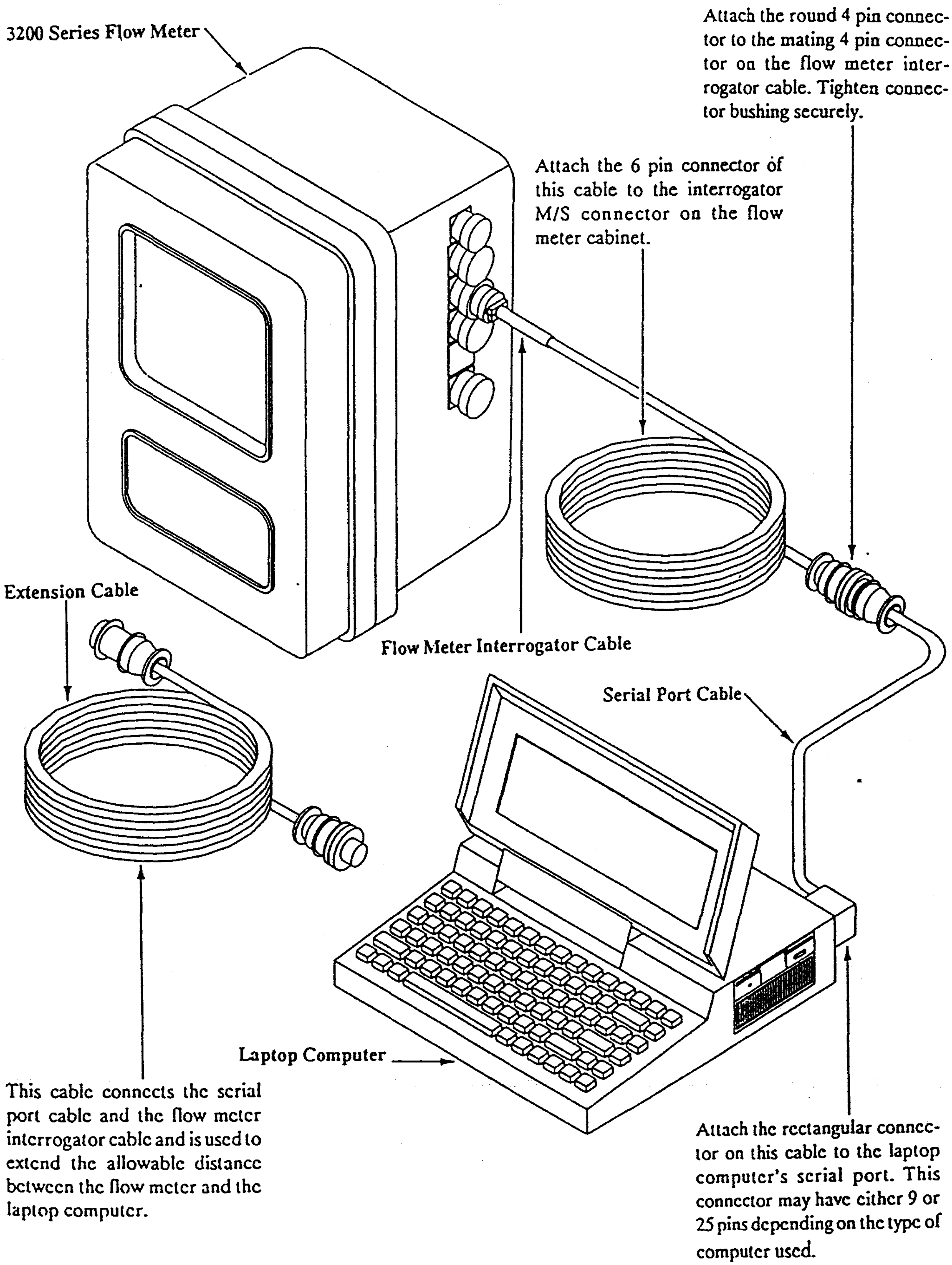
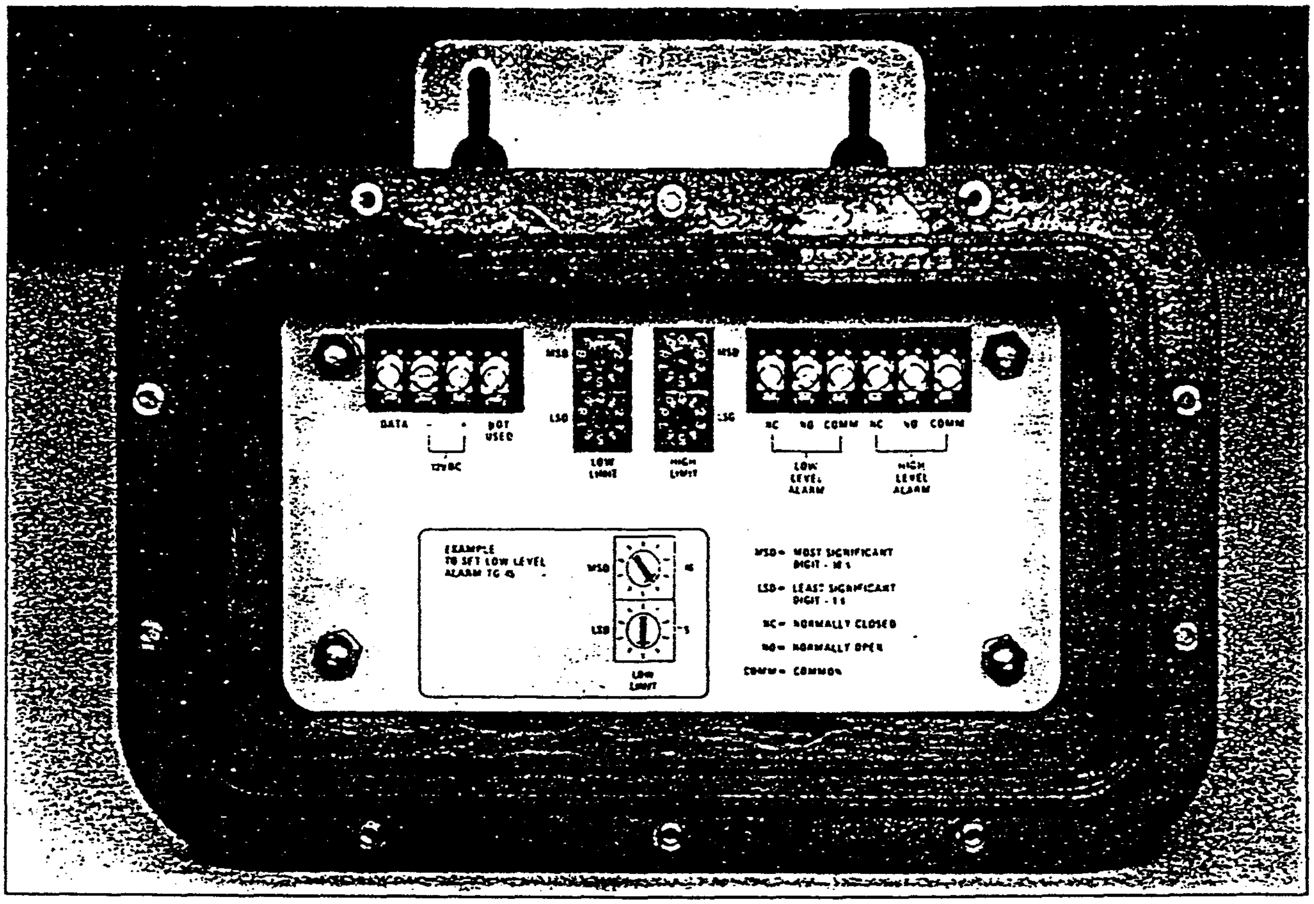


Figure 3.9-1 High-Low Alarm Relay Box (Cover Removed)



Connection With a Model 2312 Plotter or a Tipping Bucket Rain Gauge - If the installation includes a Model 2312 Plotter or tipping bucket rain gauge, the REMOTE PLOTTER/RAIN GAUGE connector on the flow meter is already used. Installations including a tipping bucket rain gauge and an alarm box will require a four-wire cable. It will be necessary to modify the connect cable to allow attachment of the alarm box. Consult the factory for details on this modification.

3.10 Battery-Backed Power Pack - The Isco Battery-Backed Power Pack combines a regulated 12 VDC, 5 Ampere power supply with a 1.2 Ampere-hour nickel-cadmium battery. The same physical size as a standard Isco battery pack or power supply, the Battery-Backed Power Pack provides both operating and backup power for an Isco Sampler or Flow Meter. The Battery-Backed Power Pack is listed by Underwriters Laboratories, Inc. (UL). The power pack connects to the AC supply with a line cord. A short cable with a two-pin M/S connector attaches to the flow meter or sampler. The purpose of this power pack is to provide an uninterruptible power source for installations of a flow meter or a sampler where continuous operation is critical during relatively short periods of AC power failure. After power is restored, an internal charger recharges the batteries.

NOTE

Use the Battery-Backed Power Pack only as an AC Power Pack with short-term battery backup. It is not intended as a substitute for an Isco Nickel-Cadmium battery pack. Due to space limitations, the batteries inside have only one fourth of the capacity of the standard four Ampere-hour nickel-cadmium battery pack.

Battery Capacity - Since the battery capacity of the Battery-Backed Power Pack is approximately one fourth that of a standard battery pack, you can expect the equipment to run approximately one fourth as long. Accordingly, a flow meter which will run for eight days on a standard battery pack will only run for two days before discharging the batteries if a power failure occurs and power is not restored.

Maintenance - The circuitry for the regulator, and charger are encapsulated in a thermosetting potting compound inside the case. Consequently, the electronics cannot be repaired if the unit is damaged. The battery pack is encased in wax, so it may be replaced, but this must be done by Isco. There are no user-serviceable parts inside the case except the fuse.

3.11 **Model 3200SH Short Haul Modem** - For users wishing to connect a Model 3210 Flow Meter (or flow meters) to a central computer located up to five miles away (depending on the baud rate used), Isco offers the Model 3200SH Short Haul Modem. This device fits inside the flow meter like the Model 3200W Modem described previously in this chapter. Users with the capability of running proprietary communications lines can communicate with their flow meter(s) at greater distances than possible with RS-232 lines. This system also makes unnecessary the use of expensive leased lines from the telephone company. Typical applications for flow meters to be equipped with a Model 3200SH Modem could be large treatment plants or industrial complexes.

NOTE

The Model 3200SH Modem is intended for use only with customer-installed and maintained proprietary data communications lines. This modem transmits pulses rather than tones, so it cannot operate through telephone company repeaters. Do not attempt to connect it to telephone equipment.

Single Flow Meter to a Computer - The Model 3200SH requires a companion modem, the **Computer Short Haul Modem**, to be installed at the computer. Maximum distance between the two modems is five miles (at 300 baud). Baud rates up to 4800 are possible, but the maximum operating distance decreases to one mile. This modem attaches to the RS-232 port of the computer and is provided with its own power supply. Maximum distance between the computer and this modem is 250 feet. Refer to the **Data Switch Manual** for more information about this device.

Multiple Flow Meters to a Computer - It is also possible to connect up to eight flow meters equipped with Model 3200SH Modems to a computer by using a device called the **Data Switch**. This device allows the computer operator to interrogate any one of eight flow meters connected to it. This device is capable of communicating through an RS-232 port, Model 3200SH Modems, or telephone company equipment. Additional information about the Data Switch is available from its instruction manual.

Short Haul Modem Operation - The Model 3200SH is designed for full duplex, asynchronous operation over two, DC-continuity, non-loaded, twisted pairs. This means that ***wire must be used***. The modem ***will not function*** over optical, RF, or microwave links. This modem converts the high and low digital data from the flow meter into pulses of different length which must be reconverted to digital data by a compatible modem at the other end of the communications loop. The Model 3200SH contains isolation and transient suppression to protect the modem and the associated flow meter from current loops and electrical transients. When the Model 3200SH is installed inside a flow meter, connections are made through a five-pin male M/S connector on the side of the flow meter case. When the modem is installed inside a Data Switch, barrier block screw terminals are used. For specifications of the Short Haul Modem, see **Table 3.11-1**.

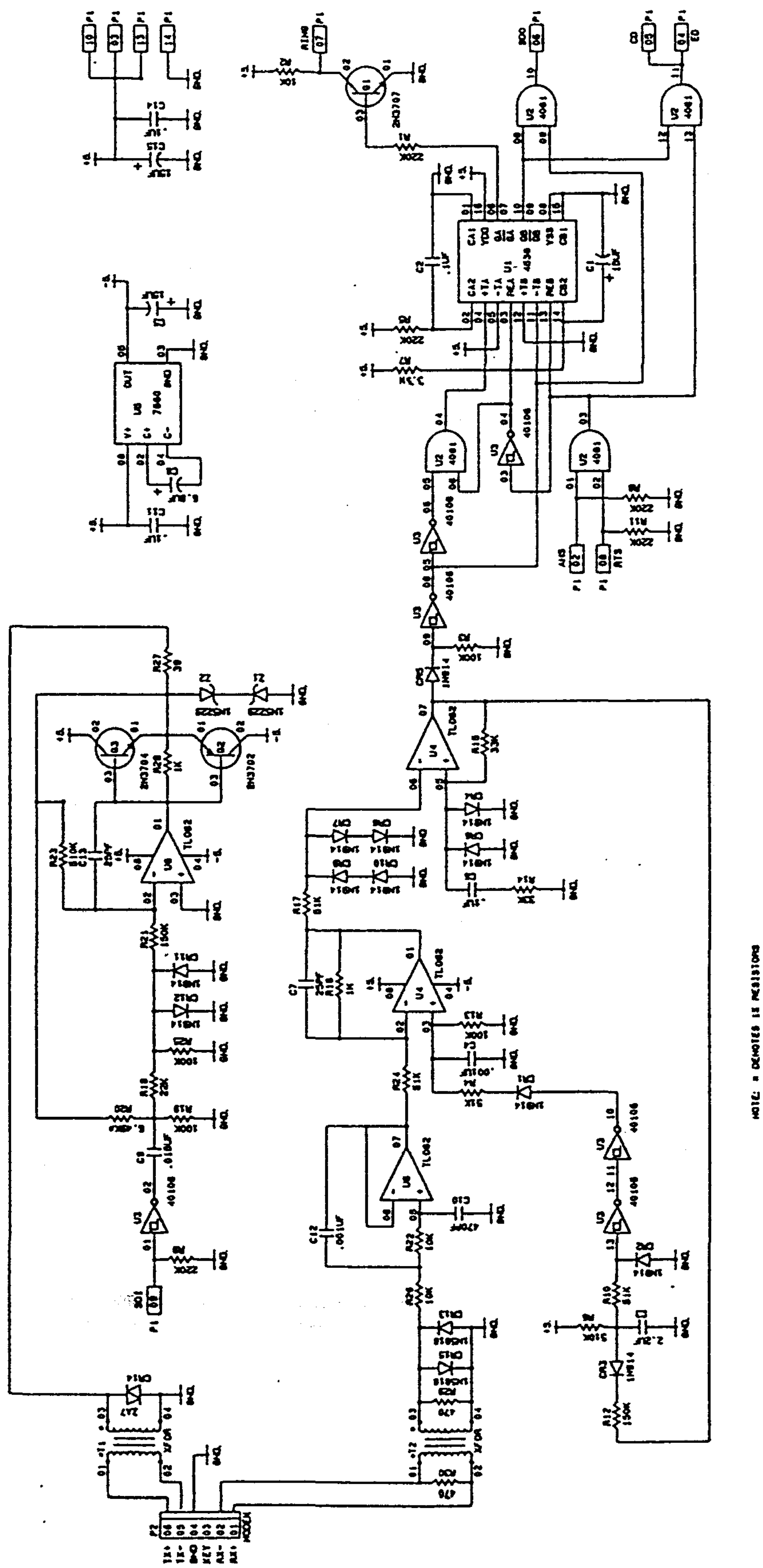
Table 3.11-1
Technical Specifications for the Model 3200SH Modem

Size:	3.8" × 5.6" (9,7 × 14,2 cm) (Same size as the Model 3200W).
Power:	5 VDC and 12 VDC supplied from the flow meter (or Data Switch.)
Short Haul Input/Output:	4 wires (2 twisted pairs); one pair for transmission and the other pair for reception from a *compatible* remote modem.[1]
Wire Requirements:	18 – 24 AWG with maximum capacitance of 25 pf (picofarad) per foot.[2]
Interface:	Interfaces to digital circuitry (serial data) inside a flow meter or a Data Switch.
Compatible Equipment:	All 3200 Series Flow Meters; the Data Switch; the Computer Short Haul Modem.
Transmission Mode:	Asynchronous Full Duplex.
Operating Distance:	1 mile minimum to 5 miles maximum.[3]
Operating Baud Rate:	300 to 4800 baud.
Operating Temperature:	0°F to 140°F. (–18°C to 60°C.)
Storage Temperature:	–40°F to 140°F. (–40°C to 60°C.)
External Connector:	5-pin male M/S type.
Electrical Isolation:	Transformers on both input and output loops; withstands 500 V surge or 300 V continuous; also breaks ground loops.
Transient Protection:	Solid state (fast diode) on transformer windings of both loops.

Notes

1. The remote compatible modem may be another Model 3200SH Modem installed inside of a Data Switch or a Computer Short Haul Modem.
2. Higher capacitance cable may be used, but this will reduce the maximum operating distance in proportion to the increase in capacitance. For example, doubling the capacitance would halve the distance.
3. Operating distance depends on two factors: (1) the capacitance of the line used and (2) the baud rate selected. Distances of five miles are possible with a baud rate of 300 and low capacitance lines. Because of the effect of capacitance on higher baud rates, at 4800 baud and with a line capacitance of 25 pf per foot, only one mile can be guaranteed.

Figure 3.11-2 Schematic Diagram for Model 3200SH Modem



CHAPTER 4

4.0 ROUTINE MAINTENANCE - This fourth chapter of the Model 3210 instruction manual provides detailed instructions on the care and routine maintenance necessary to keep the flow meter in top operating condition. Included are sections on cleaning the flow meter, reactivating the desiccator, maintaining the ultrasonic level sensor, servicing the internal plotter, and caring for the Nickel-cadmium battery pack.

Familiarization with maintenance procedures - It is strongly recommended that users become completely familiar with the routine maintenance procedures presented here. While the Model 3210 is ruggedly built to withstand severe field conditions, it will function best and remain most reliable if these simple procedures are learned and followed.

4.1 Care of the Flow Meter Case - If the lid is tightly latched, and all the M/S connectors on the side of the case are tightly capped, the case may be cleaned by spraying it with a hose or washing it with soapy water. Do *not* use a hose with a nozzle or a high pressure hose-and-wand such as is found at car washes. Do *not* immerse the flow meter in a tank of water to wash it. While designed to withstand accidental submersion in water, should that occur, the flow meter is not intended for routine submersion.

4.1.1 Care of the Case Seal - Periodically the case seal should be inspected and cleaned, if necessary. The ridge which extends around the edge of the back half of the flow meter cabinet, and which forms a seal with the groove in the cabinet door, should be free of dirt, sand, etc. If it isn't, clean it carefully with a damp cloth. The rubber gasket in the lid should also be clean; if not, it may be cleaned with a small brush and a damp cloth. If any of these cleaning procedures are done while the case is open, be careful not to allow any dirt or debris to fall inside the flow meter case; it is best to work on the flow meter with the case standing upright. If the seals are not properly maintained, they may leak, causing damage and eventual failure of the components inside.

4.1.2 Preventing Moisture Damage - To prevent moisture damage to internal components, the lid should be tightly latched at all times, except when it is necessary to access the front panel to change the program or change the paper roll. Do *not* routinely operate the flow meter with the case open. Doing so will expose the internal components to dirt and moisture; it will also cause the desiccant canister inside the case to be prematurely spent. The desiccant canister should be periodically inspected and recharged as necessary as described in Sections 4.2 and 4.2.1 below. It is also important to keep the external connectors clean by keeping the mating connectors or the protective caps tightly screwed down. Under severe operating conditions the *threads* of the connectors may be sprayed with a cleaner/lubricant (such as Jif manufactured by GC Electronics or WD-40 manufactured by the WD-40 Company) to prevent corrosion. Be careful not to spray any of the conductive terminals (pins or jacks) *inside* the connectors; residue from the sprays could cause intermittent or failed contacts.

4.2 Reactivation of the Internal Case Desiccant - As shown in Figure 4.2-1, the Model 3210 is equipped with a reusable desiccating canister attached by two thumbscrews to the inside of the flow meter's lid. This canister contains silica gel which attracts moisture trapped inside the flow meter's case when it is closed, keeping the inside of the case completely dry during shipment, storage and use. If the case is left open, the desiccant will attract moisture from the surrounding air. Eventually, its absorption capacity will be reached, and it will no longer be able to protect the internal components of the flow meter.

NOTE

Do *not* allow the flow meter to operate with a saturated desiccant canister. In most flow environments, gases are present in the atmosphere which can combine with available water vapor to form acids. The acids formed this way can corrode the internal compnents of the flow meter, ruining it. An active desiccant canister inhibits the formation of these acids by absorbing water vapor. Keep the lid closed whenever possible. Inspect and regenerate the canister when necessary.

4.3 Care of the Ultrasonic Level Sensor and Cables - The ultrasonic level sensor requires little maintenance. It is encapsulated for protection from the environment. The level sensor's transducer surface is aluminum, coated with Teflon film. Do not scratch or score the surface; the transducer may be damaged. Do not drop the assembly, nor attempt to take it apart. The ultrasonic level sensor contains no user-serviceable parts. If the transducer's surface becomes contaminated due to long-term use or accidental submersion, operation of the unit may be impaired. If this happens, clean the unit. Clean the case with a brush, but do not brush the transducer's surface or it may be damaged. Clean the surface of the transducer with a *gently* flowing stream of water.

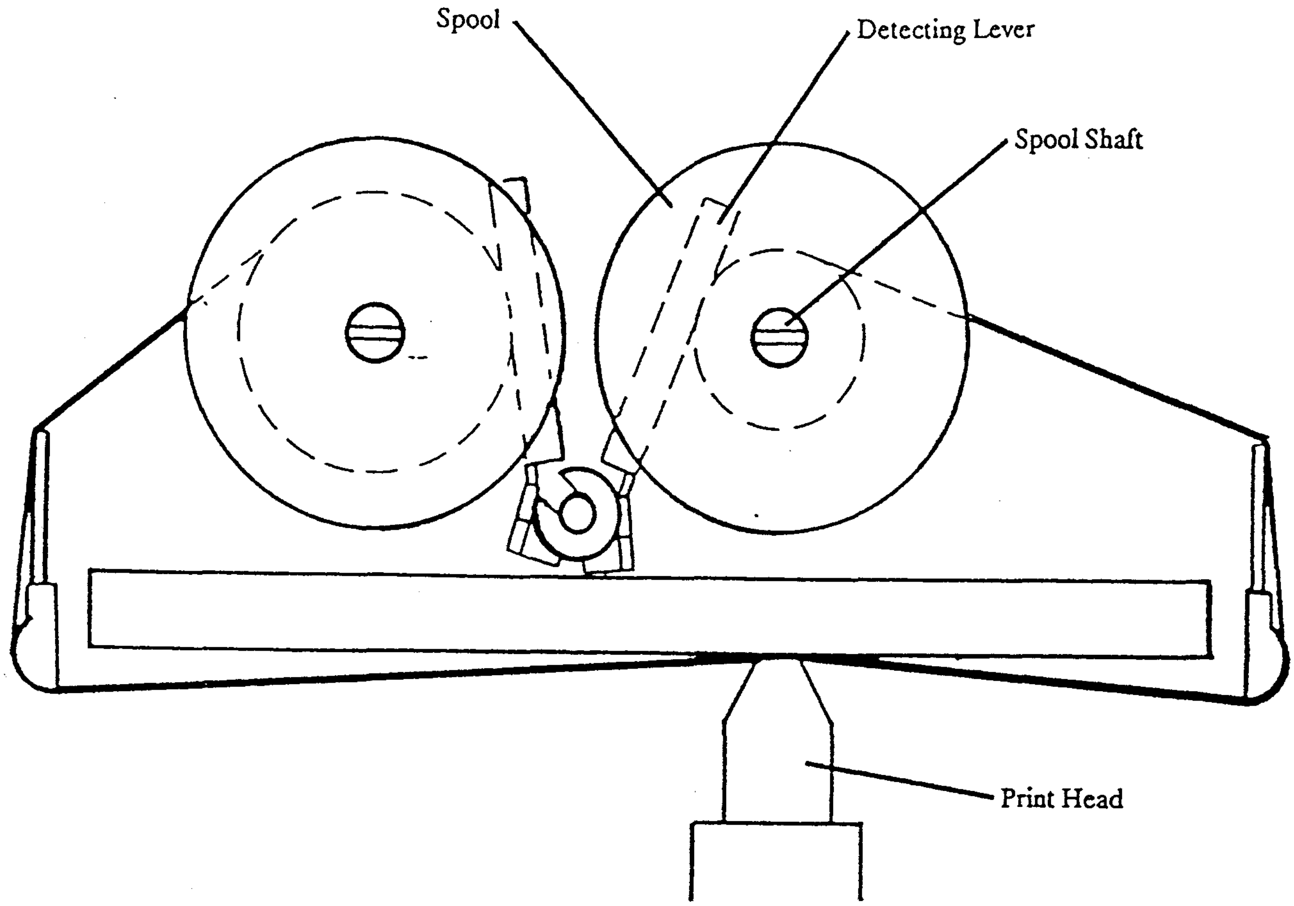
4.3.1 Cable Inspection - Inspect the cables connecting the ultrasonic level sensor to the flow meter periodically for deterioration caused by abuse or exposure to the elements. Damaged cables threaten the operation of the ultrasonic level sensor; replace them. Keep connectors clean and dry. In permanent installations, always install cables so they do not risk damage resulting from other activity taking place in the area. Cables repeatedly subjected to physical abuse will fail and should be installed in conduit for protection. In temporary installations, avoid leaving cables where they may be run over by heavy equipment.

4.4 Maintenance of the Internal Plotter - The internal plotter requires little periodic maintenance beyond changing the paper roll and changing the ink ribbon. Refer to the pictures provided for each section to clarify the explanations.

4.4.1 Changing the Roll of Paper - Refer to the label inside the Model 3210 cabinet and Figure 4.4-1. The roll of paper must be changed when it runs out, as the plotter will shut down. The end is near when a 1" pink band appears on the left side of the chart. To change the roll first locate the handle on the left side of the take-up roll. Pull straight out on this handle until the take-up roll comes off of the plotter. Remove the roll from the take-up spool by holding the handle and gear of the take-up spool in the one hand with the thumb lined up with one of the slots in the white end cap. Use your thumb to snap the white end cap free from the two black catches on the end of the spool. Then pull the paper roll off the spool with the other hand. Remove the feed spool by pulling on the handle extending from the right side of the plotter. Snap off the white end cap as described previously. Save the white end caps; they will be re-used. Remove the spent roll from the spool by holding the handle in one hand and pulling the roll from the spool with the other hand.

Installing the New Roll of Paper - After the spent roll has been removed, slide the new roll onto the feed spool so that it unrolls from the back side - facing away. Do this by lining up the slots in the cardboard tube with the raised guides on the feed spool. Re-attach the white end cap by wedging the two catches on the end of the spool into the two slots on the white end cap. Peel the paper back gently so that it will unroll freely. Using a knife or scissors, cut the end off the roll if it is torn; then fold it over on itself so that the end is straight and a little stiffer than a single thickness of the paper would be. Unroll a few inches of the paper and set the roll on top of the flow meter's cabinet. Feed the paper down the back of the internal plotter with fingers to where it touches the roller. Make sure the paper gets past the lever for the paper sensing switch. Then press the CHART ADVANCE key and hold it until the paper is fed through the internal plotter mechanism.

Figure 4.4-2 Changing the Ink Ribbon



Locate the three small pins on each spool of the ink ribbon and turn the spools so the pins face the gears on the two ribbon shafts. Replace the two spools on their respective shafts, pushing the detector levers out of the way so the spools will easily re-engage their gears. Gently rotate each spool to tighten the ink ribbon. Re-install the paper take-up roll if necessary, or proceed with the procedure outlined above if the roll of paper is also being replaced.

4.4.3 Lubrication and Disassembly Not Recommended - It is not necessary to provide any periodic lubrication to the internal plotter mechanism in the Model 3210 Flow Meter. The internal plotter mechanism has been designed for long life and trouble-free service without special maintenance, if it is not subjected to abuse. Isco recommends no attempt be made to oil or disassemble the mechanism should it malfunction. Oil attracts dirt; some oils can become gummy over a period of time and may cause parts of the mechanism to bind or stick. Attempts to disassemble the internal plotter mechanism may cause the frame or component parts to be bent or distorted. This will certainly cause malfunction. Do not force any part of the mechanism with tools or probes. Other than the roll of paper and the ink ribbon, the internal plotter mechanism contains no user-serviceable parts. Isco recommends the unit be returned to the factory for service should this become necessary.

4.5 Use and Charging of the Nickel-Cadmium Battery Pack - The Model 3210 Flow Meter may be powered from an Isco sampler, from an Isco AC Power Pack, or from an Isco Nickel-Cadmium Battery Pack. The power pack may also be used to charge the battery. See Figure 4.5-1. The following sections describe the use and charging of the battery and fuse replacement.

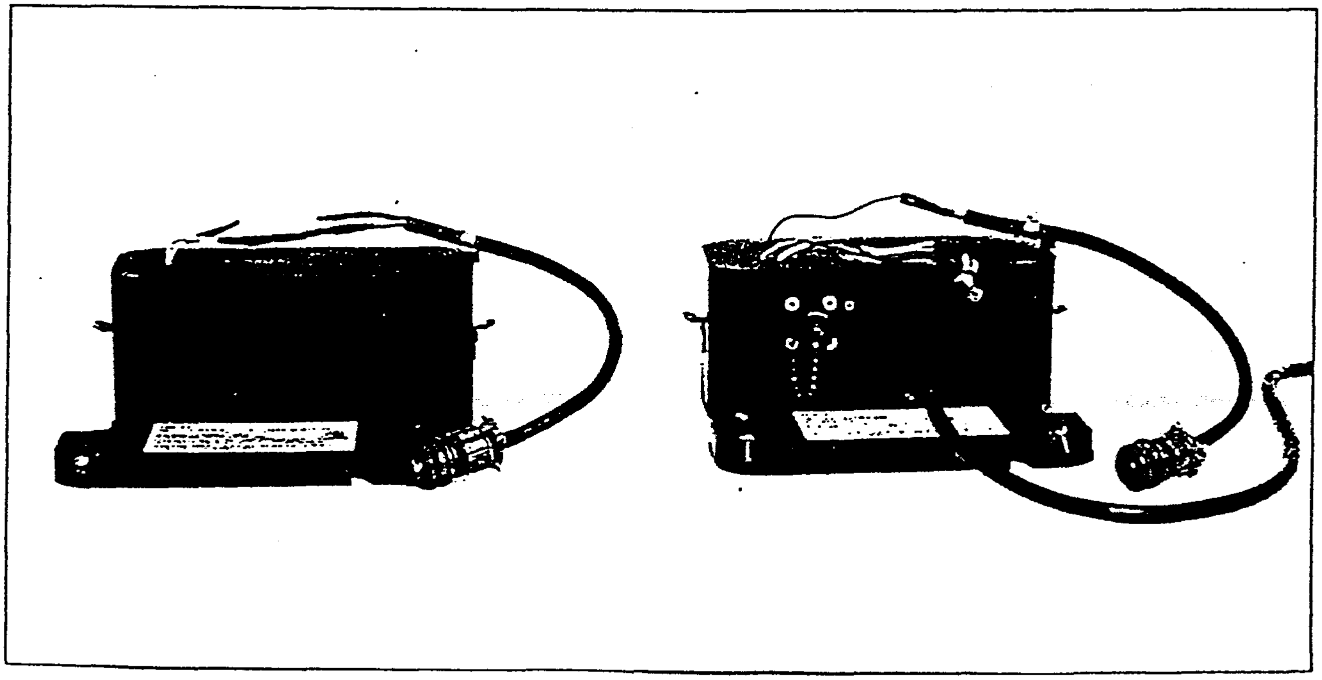
This condition is worsened if the batteries are stored in a hot place, such as a room near a furnace or boiler. This should not be much of a problem for users having only one or two flow meters and a few batteries, because the batteries will usually be in service. However, users with several instruments and many batteries to maintain may find it useful to number the batteries and keep some sort of log with the recharge dates for them. This will help ensure the batteries are returned to service soon after having been recharged. If in doubt about how long it has been since a battery was charged, simply recharge the battery again for a few hours before returning it to service.

4.5.2 Hazards of Overcharging - Overcharging a nickel-cadmium battery causes it to overheat. Heat gradually breaks down the separator material inside the battery. Repeated overcharging reduces the useable life of the battery.

Charging with Other Source - Isco does *not* recommend the use of any other charging apparatus to recharge the battery pack, as it is possible to ruin the batteries or the charger with incompatible equipment. Chargers delivering too much current to the batteries may make them overheat and vent water that cannot be replaced, causing premature failure. Chargers delivering too little current to the battery will never charge it completely. Do *not* attempt the use of any other charging apparatus without an *accurate* digital multimeter to monitor the *charging current*. Proper charging current is limited to 400 mA. *Be sure of proper polarity* before connecting any other charging apparatus. If an Isco Power Pack is used, the battery may be overcharged occasionally with little loss of capacity. Repeated overcharging should be avoided. Again, to ensure availability of maximum battery capacity, return the battery pack to service promptly after recharging.

4.5.3 "Memory" Effects - Previously, it was generally accepted that nickel-cadmium batteries exhibited "memory" effects, and that a complete charge/discharge cycle (exercising the battery) was necessary to maintain battery capacity. It is now known that the "memory" effect is not a problem under normal operating conditions, and if it should occur, it is temporary and may be reversed by a deep discharge and charge. If the battery is discharged to random depths, charged for random amounts of time, and subjected to various duty cycles, the "memory" effects will not be present.

Figure 4.5-2 Power Pack and Nickel-Cadmium Battery with Covers Removed

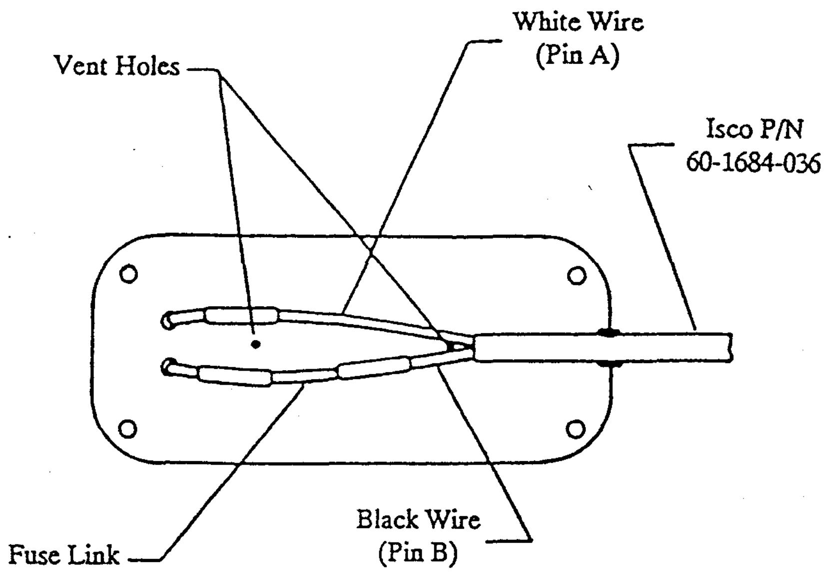


Nickel-Cadmium Battery

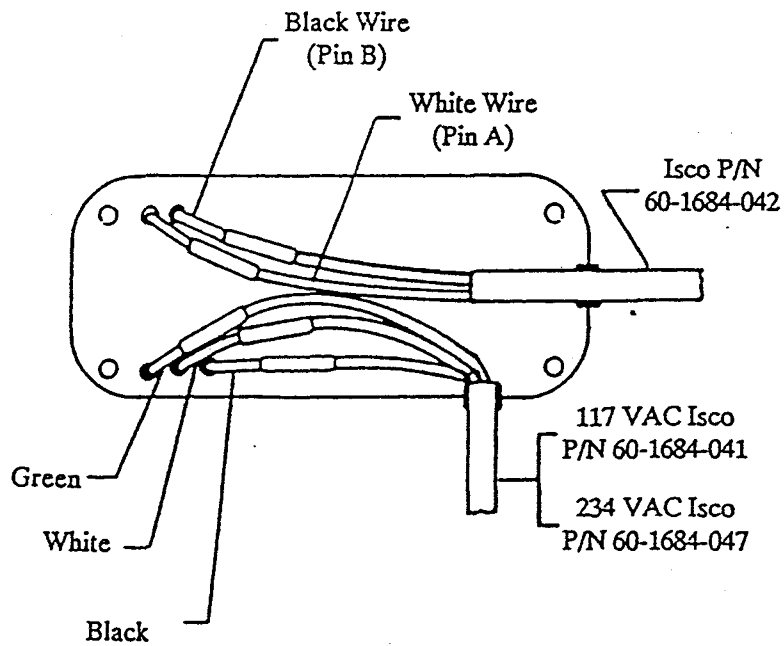
Power Pack

Figure 4.6-1 Case Wiring Connections - Power Pack and Nickel-Cadmium Battery

Battery Pack



Power Pack



CHAPTER 5

5.0 SERVICING AND TROUBLESHOOTING - The fifth chapter of the Model 3210 instruction manual provides servicing information and a troubleshooting guide to assist the user in correcting certain malfunctions which might occur. Included are sections providing information on accessing mechanical and electrical components, on fuse replacement, and on the care of CMOS circuitry in general. Also included is a troubleshooting section, an illustrated replacement parts list, an accessory parts list, and a programming worksheet.

5.1 Access to Mechanical and Electrical Components - The flow meter mechanical assembly may be removed from the cabinet for inspection and servicing, if necessary. First, remove the four screws, two at the top, and two at the bottom, which hold the flow meter chassis in the cabinet. The chassis may then be lifted out by carefully inserting the thumb or index finger from each hand into the upper right and lower left corner of the chassis opening which surrounds the internal plotter mechanism. See **Figure 5.1-1.** Do *not* attempt to lift the flow meter out of its case by holding on to any part of the plotter mechanism. Doing so may bend or distort part of the plotter, possibly damaging it. Once the chassis has cleared the case, it may be gripped by its edges with both hands and lifted free of the case.

5.2 Fuse Replacement - With the flow meter chassis out of the cabinet, the user may locate and change fuses. The fuses are located on the printed circuit board which is directly behind the keypad mounted on the front panel. They may be seen through the opening cut in the chassis around them. See **Figure 5.2-1.** The fuses are labeled F1, F2, and F3. The proper size for each of these fuses is:

F1 - 5 amp., fast blow
F2 - 5 amp., fast blow
F3 - 2 amp., fast blow

Always be sure to replace a blown fuse with one of the same value. Using a larger value fuse may cause serious damage to the flow meter or to its power supply.

5.3 Display Warnings - The Model 3210 LCD will display various warnings and error messages to warn the user of problems in the program, or difficulties inside the flow meter. Some messages request routine maintenance; others point out programming errors; still others indicate serious internal difficulties.

Following are typical warning messages displayed by the LCD:

NO PLOTTER POWER - CHECK FUSE - self-explanatory.
PLOTTER JAMMED – CHECK PAPER AND PRESS CHART ADVANCE TO CLEAR.
PLOTTER IS OUT OF PAPER - self-explanatory.

When the flow meter is powered up, it will run through a self-diagnostic routine before it can be programmed. It will display:

POWER UP TEST - PLEASE WAIT - then -
ROMS PASSED, CHECKING RAM - after which the unit will display its normal operating mode.

When the flow meter is turned off, the LCD will show:

POWER LOST/BATTERY LOW

NOTE

Pressing 4 and EXIT PROGRAM when powering up will cause all programmed entries to be lost. Accumulated data stored in the Model 3210 will also be lost.The flow meter will revert to the program originally entered at the factory. If this operation is performed, it will be necessary to re-program the unit to user specifications.

The following messages describe serious internal problems, indicating service is required:

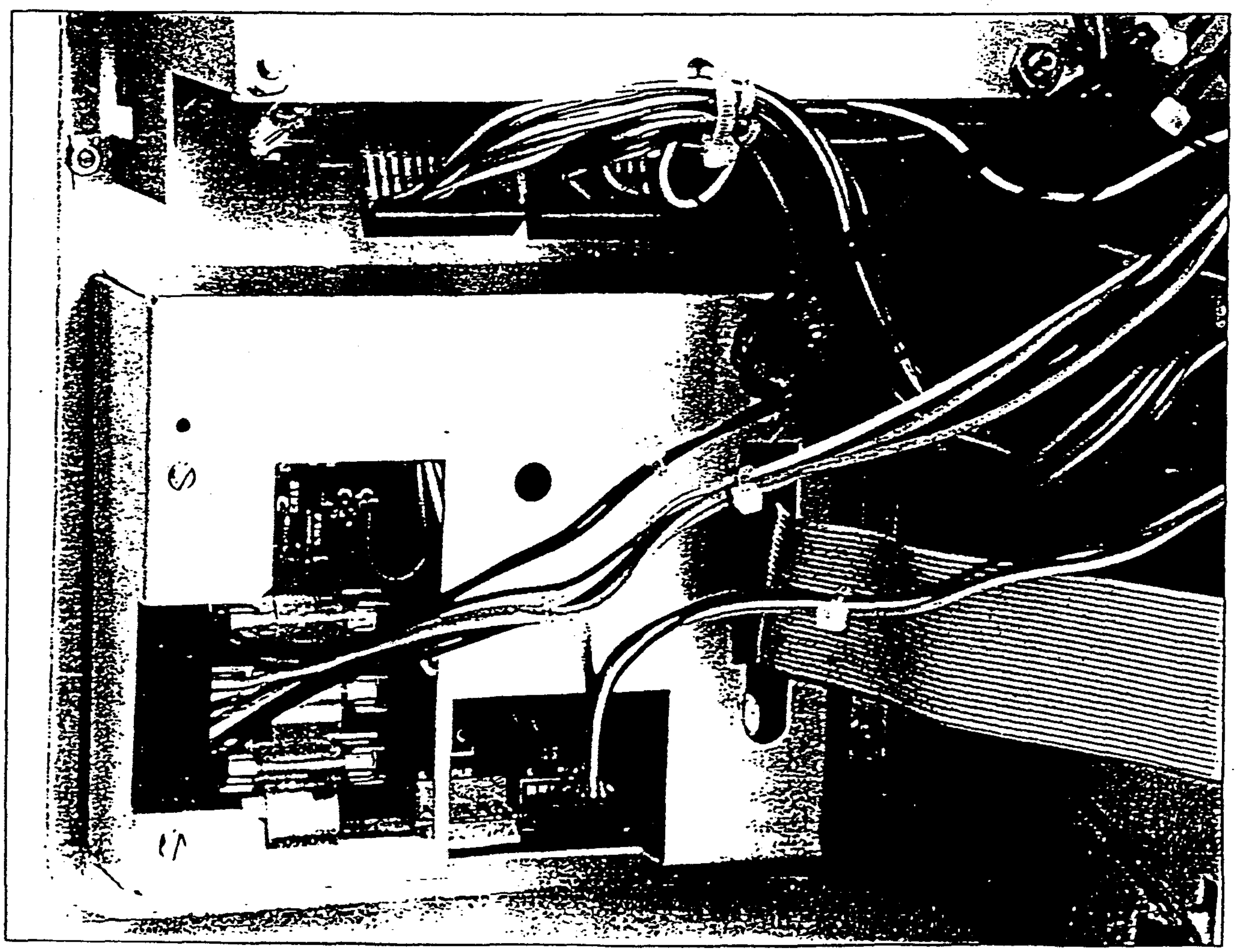
ROM CHECKSUM ERROR - or - FOUND BAD RAM - CALL CUSTOMER SERVICE

If these messages appear, the Isco Customer Service Department should be called for instructions at (800) 228-4373 or (402) 474-2233.

CAUTION

Users should not attempt to disassemble or repair the Model 3210 Flow Meter (other than changing fuses) unless skilled in the evaluation and repair of microprocessor-based circuitry. Isco recommends no attempt be made to disassemble or repair the plotter mechanism or display module.

Figure 5.2-1 Location of the Three Fuses



1. Never perform any work in a room with a carpeted floor.

2. Always roll up work clothes' sleeves so that the arms are in contact with the working surface.

3. Avoid using a work surface made of an extremely good insulator.

"Formica" or glass are good insulators and should be avoided. A metal surface is best; a wood surface is acceptable. Conductive grounding mats are available for work stations and are worthwhile if much repair is to be done.

4. The degree of hazard depends on the level of humidity.

Be particularly careful if the work area is extremely dry, or if the work is being done in the winter, when indoor forced heating and outdoor low temperatures cause the relative humidity level to be very low.

5. Keep yourself grounded when handling disassembled equipment.

When arriving at the work area, after a unit has been opened for repair, make an effort to always be touching the metal chassis before touching any of the circuit components.

6. Be especially careful handling the CMOS integrated circuits when they are removed from the rest of the circuitry.

Simply being connected to the rest of the circuitry provides some protection. Most of the circuitry is well-protected from damage caused by static discharge when the unit is powered up. However, an IC should never be replaced when the unit is turned on.

7. Individual CMOS semiconductors and built-up printed circuit boards should always be transported in conductive packaging.

Foil is satisfactory; metallized plastic bags are also available and work well. Ordinary plastic bags and "pink poly" are not satisfactory unless the legs or leads are also stuck into a block of black conductive foam. If replacement components that are purchased do not come in marked, protective packaging, do not use them. They may already be destroyed.

8. Once assembled and soldered, printed circuit boards are easily damaged by improper repair procedures.

Do not attempt to remove components, particularly ICs, from printed circuit boards unless skilled at this procedure. A defective component may be located, changed, and the unit still not work, if excessive heat or pressure has broken the foil traces or pulled the cores from holes on the board.

Contact Customer Service - If trouble symptoms persist and cannot be located, call the Customer Service Department, at (800) 228-4373 except outside the U.S.A. call (402) 474-2233.

5.5 Circuit Boards - The Model 3210 is a microprocessor-based instrument which executes a program stored in its program memory. The circuitry (hardware) is discussed below. The program (software) is discussed if it is necessary to describe the hardware. Because of the difficulty and specialized equipment necessary to check program "software," its detailed description is beyond the scope of this manual. The Model 3210 Flow Meter contains several printed circuit boards. The Keyboard circuit board is mounted just behind the keypad. The CPU and Plotter boards are inside the chassis on the left side of the flow meter. The display and its associated circuit board are assembled as a unit by the which generate the timing pulses within the ultrasonic circuit. Transistor Q2 drives the ultrasonic transducer through pulse transformer T1.

ICs U5, U7, and U8 provide a time-controlled-gain amplifier. U5 generates a ramp which increases gain with time. This allows the amplifier to provide larger amplification for the weaker echoes which result when the distance between the transducer and the flow stream increase.

Inductors L1 and L2 provide bandpass filtering for the ultrasonic pulse. IC U7, pins 5, 6, and 7 are the echo detector. Transistors Q1, Q3, and Q4 are used to damp the ringing of the transducer after it has been pulsed. The output of the echo amplifier goes to the VIA (versatile interface adapter) on the CPU board. The pulse out varies with time. The further the distance between the ultrasonic level sensor and the flow stream, the longer the time.

Plotter Section - Transistors Q7, Q9, Q10, Q12, Q15, Q17, and Q18 drive the solenoids on the printer head. Transistor Q8 drives the paper advance solenoid. Transistor Q5 drives the paper take-up motor. Transistors Q11, Q13, Q14, and Q16 drive the print head motor, which moves the print head across the paper. Transistor Q6 turns the plotter electronics off and on. Note that the driver transistors are power MOS devices; observe the same precautions with them as with any CMOS semiconductors.

IC U16 is a RAM which receives data from the microprocessor to be plotted. IC U18 is a counter which generates addresses for memory. IC U15 is a buffer which when enabled allows the microprocessor to write into the plotter's RAM. When the plotter is running, this IC is "off" and isolates the data bus in the plotter section from the data bus in the CPU section; it keeps the data from running back to the CPU.

IC U17 is a buffer which is enabled when the CPU is loading data into the RAM. It prevents the data from affecting the solenoid driver transistors. When the plotter is running, U17 transfers the data from the RAM to the solenoid driver transistors. ICs U10 and U11 generate timing signals for driving the paper advance and print head solenoids, and controlling the RAM. Pin 6 of P7 tells the electronics when it is time to print.

5.6 Replacement Parts List - A list of common replacement parts for use with the Model 3210 Flow Meter can be found at the end of this chapter. When ordering a replacement part, be sure to include the Isco assembly or part number, a complete description, and the serial number of the flow meter on which the part is going to be used.

5.7 Accessory Parts List - A list of optional and accessory parts used with the Model 3210 Flow Meter and described throughout this manual can be found at the end of the Replacement Parts List described in Section 5.6 above. When ordering an optional or accessory part, include the model number (if given), description, and Isco part number.

5.8 Programming Worksheet - A programming worksheet, designed to assist users in programming the Model 3210 Flow Meter, and useful for providing a printed "record" of the program entries selected can be found behind the Accessory Parts List described in Section 5.7 above.

Figure 5.5-2 Schematic Diagram for the Keyboard Printed Circuit Board

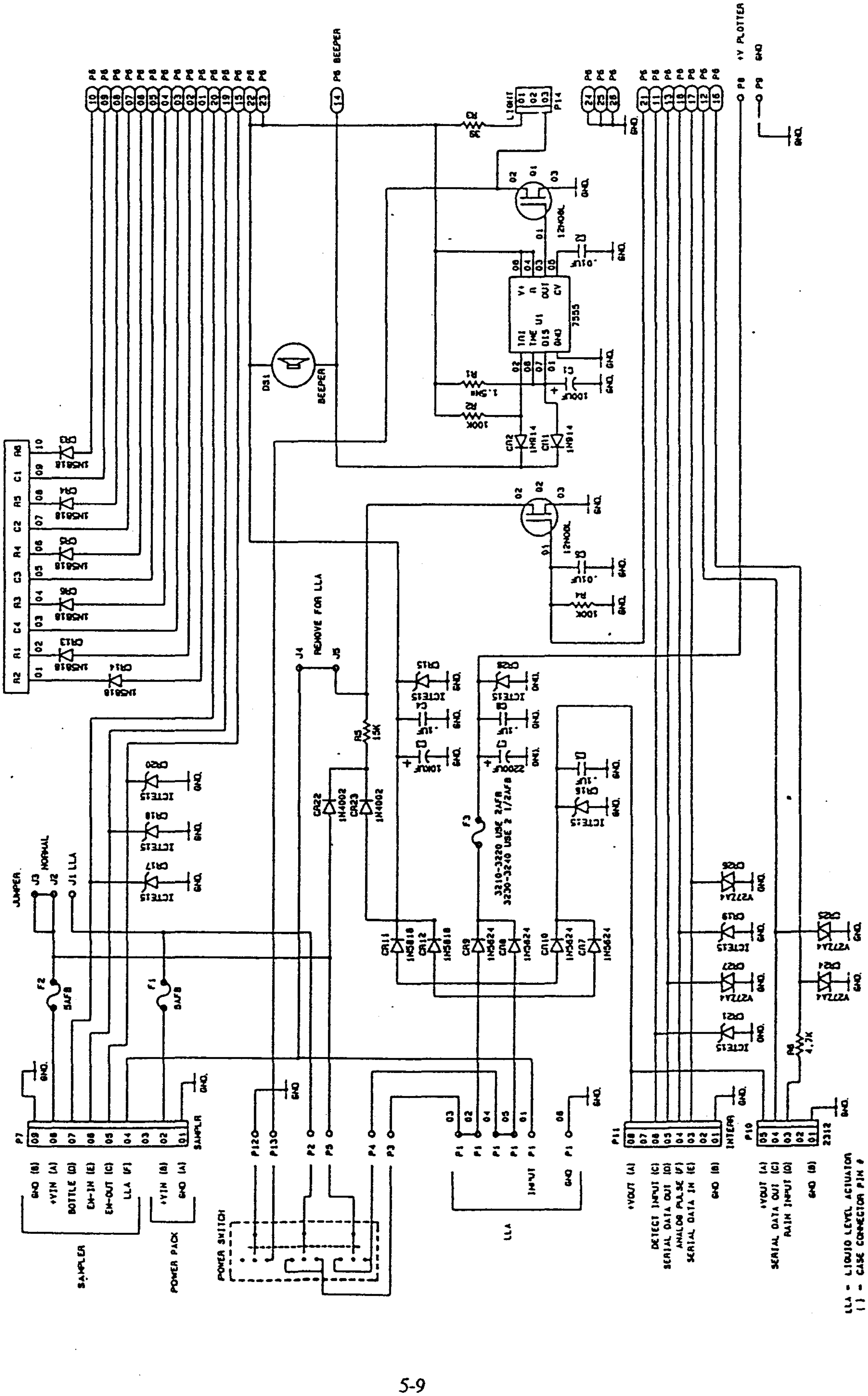


Figure 5.5-3 Component Layout for the CPU Printed Circuit Board

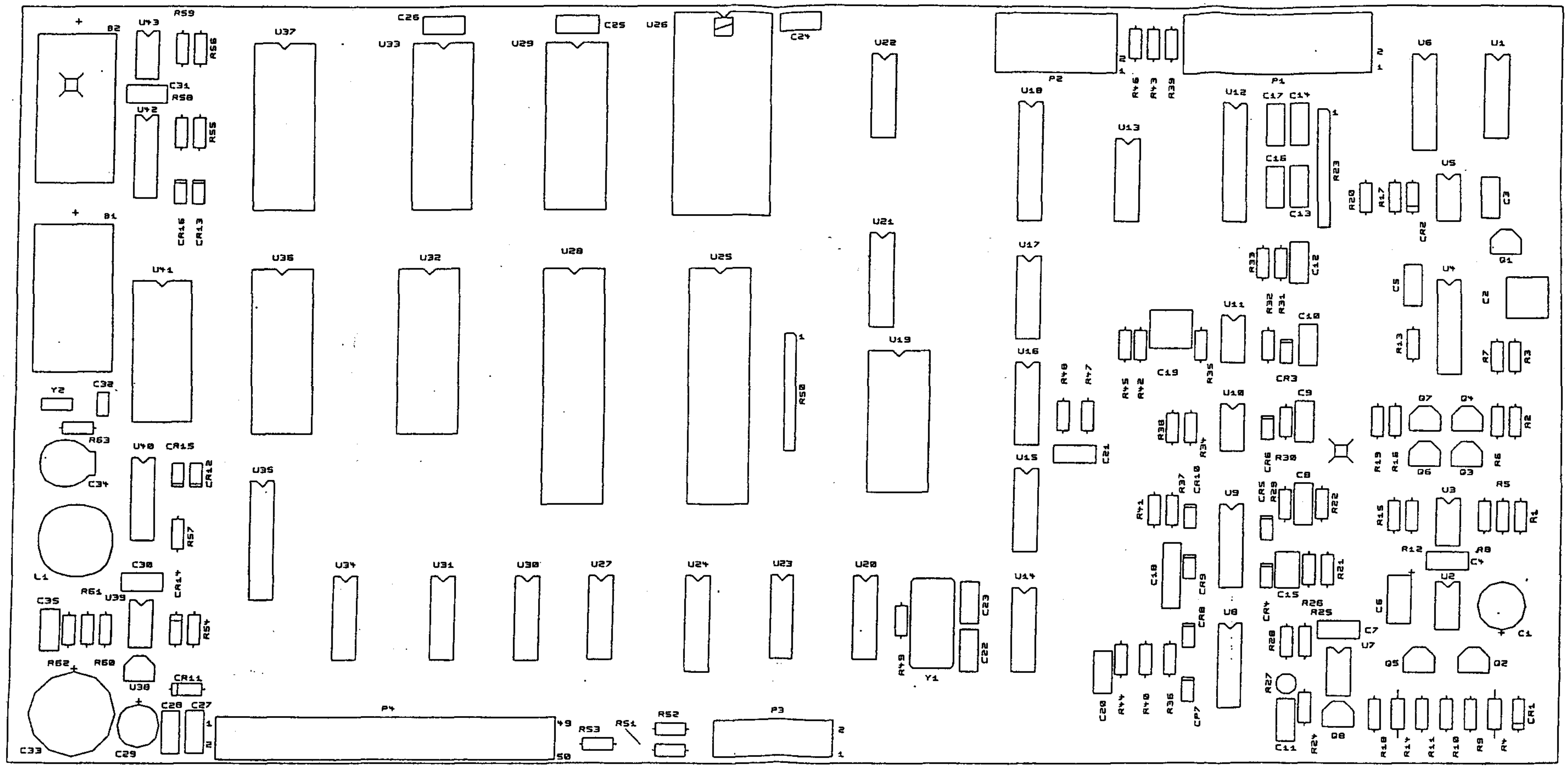
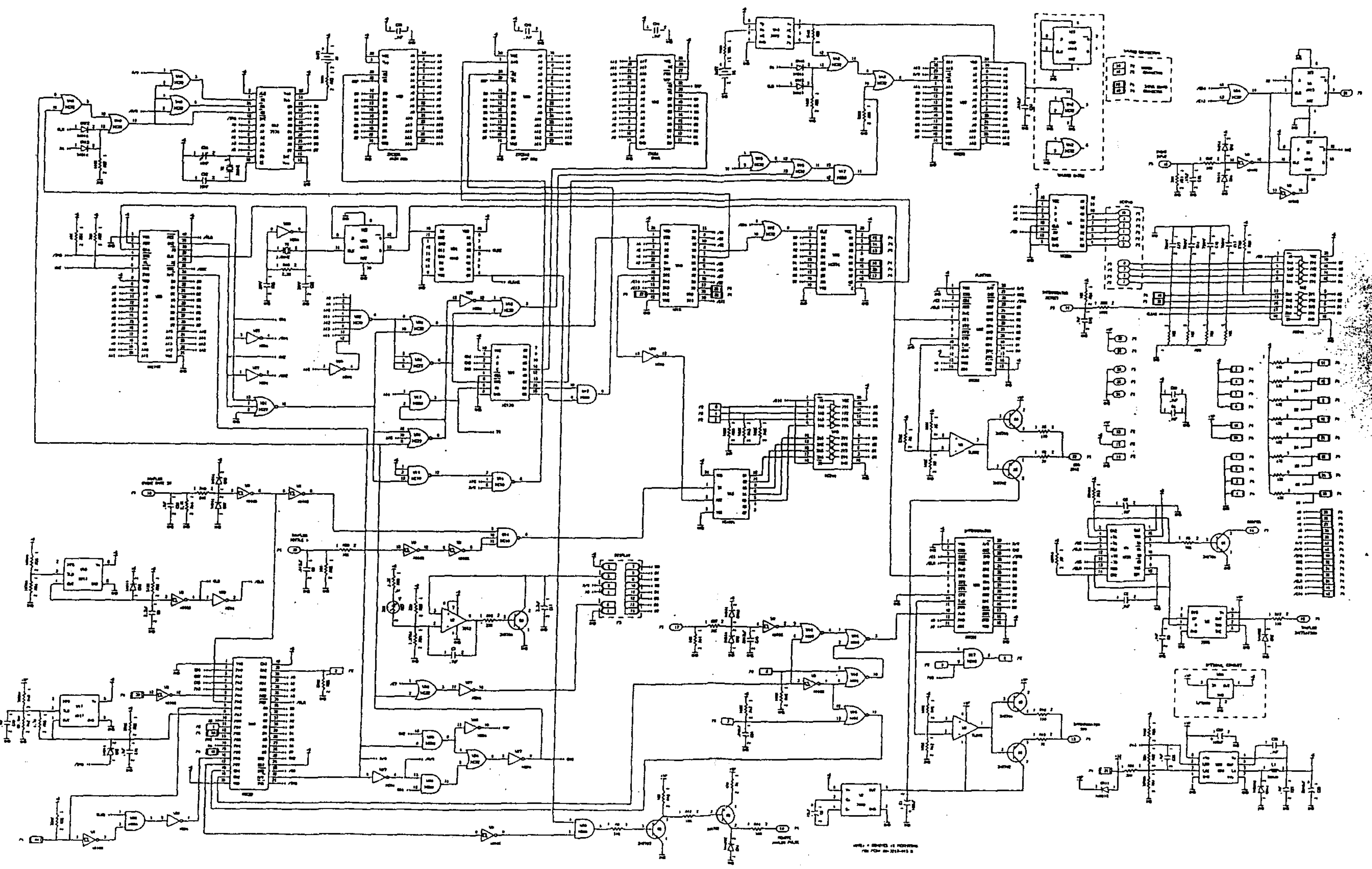


Figure 5.5-4 Schematic Diagram for the CPU Printed Circuit Board



'gure 5.5-5 Component Layout for the Plotter Printed Circuit Board

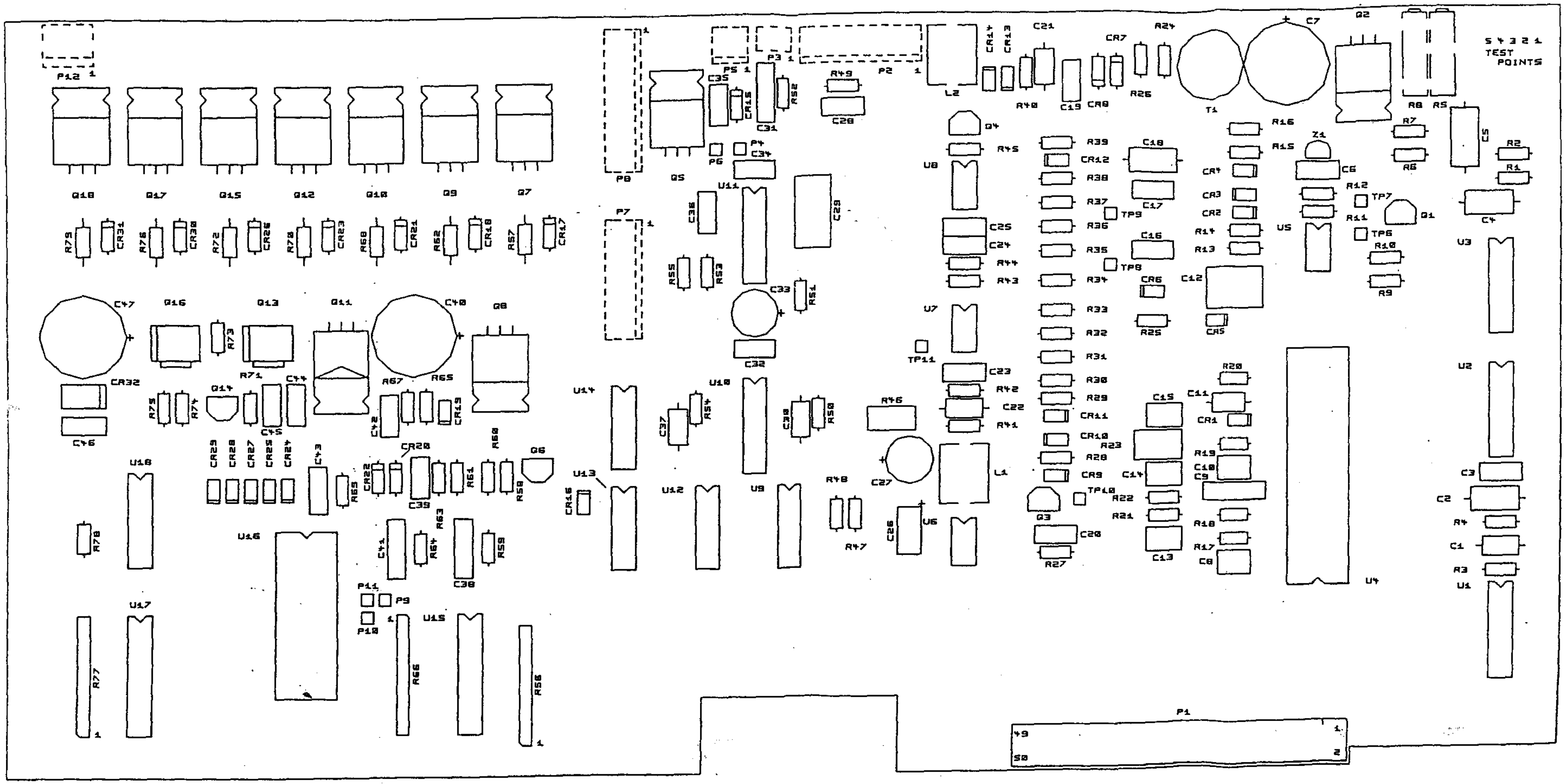
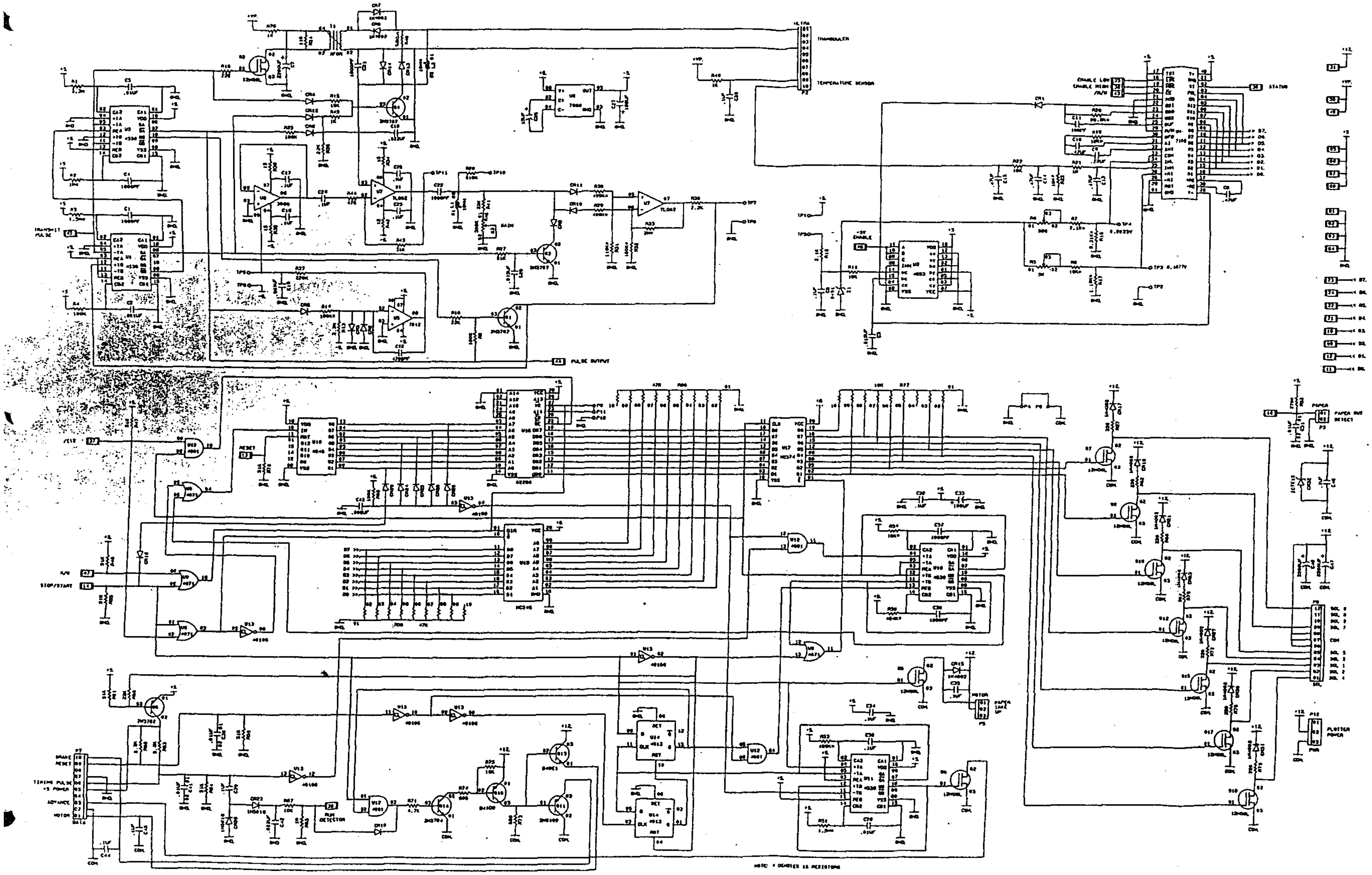
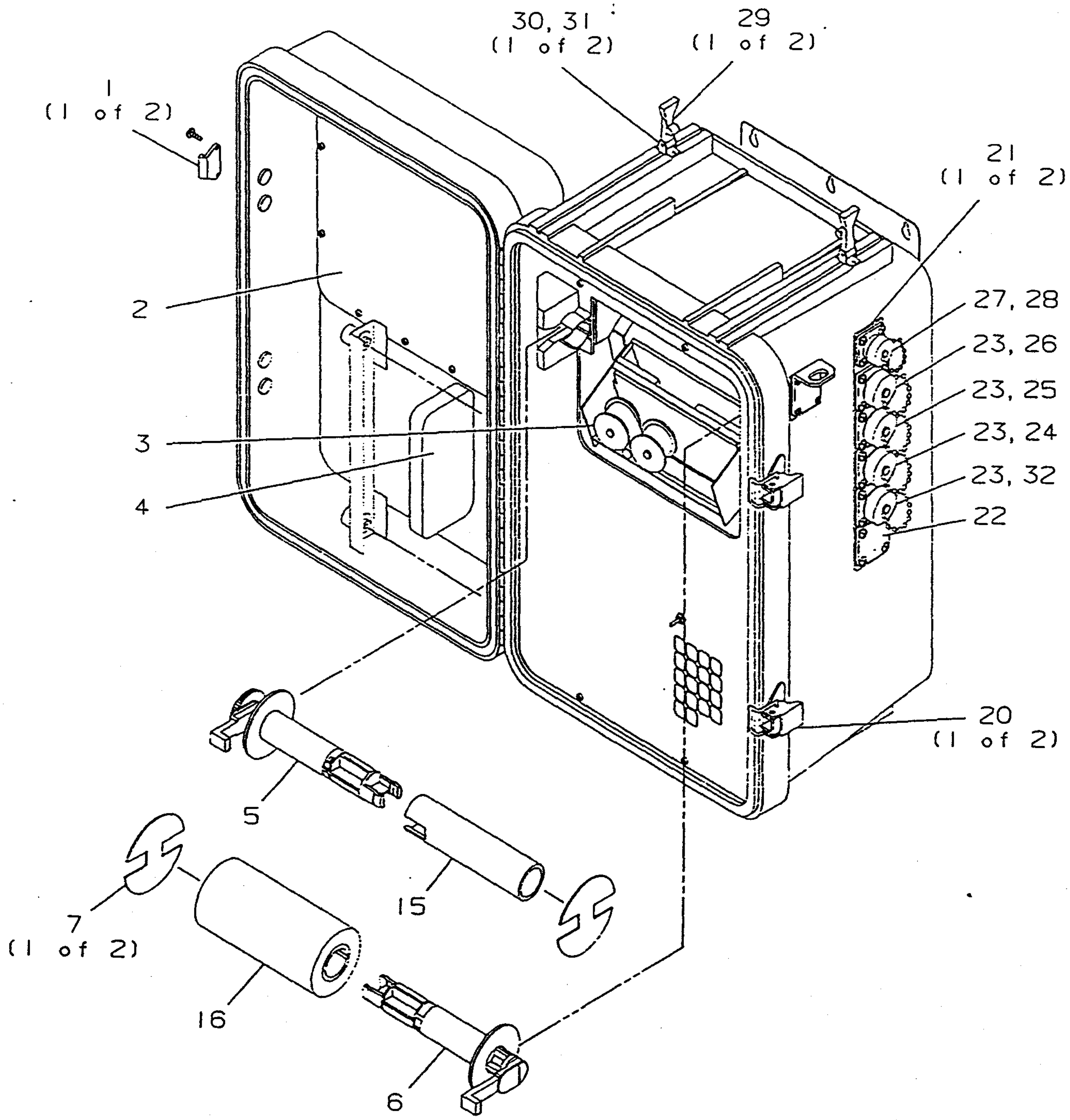


Figure 5.5-6 Schematic Diagram for the Plotter Printed Circuit Board



MODEL 3210



30, 31
(1 of 2)
29
(1 of 2)
1
(1 of 2)
21
(1 of 2)
27, 28
23, 26
23, 25
23, 24
23, 32
22
2
3
4
20
(1 of 2)
5
15
7
(1 of 2)
16
6

ITEM NO.	COMPLETE ASSEMBLY	INDIVIDUAL PARTS	DESCRIPTION
1		109-0607-01	SST Strike
2		60-3213-032	Window
3		250-0200-00	Dot Matrix Printer Ribbon-Black
4		099-0012-00	Dri-Can Desiccant Canister
5	60-3234-023		Reroll Spool Assembly
6	60-3234-022		Supply Spool Assembly
7		60-3213-229	Spool End Cap
15		60-2313-005	Model 2310 Printer Paper Core
16		60-2313-019	2310/2312 Plotter Paper Roll
20		109-0607-00	SST Latch
21		60-3213-035	Gasket Amphenol Conn.
22		60-3213-025	Amphenol Hole Cover
23		149-1001-00	Amp Dust Cover MS9760-14
24		60-3214-038	Ultrasonic Wiring Harness Assy
25		60-3214-037	Interrogator Wiring Harness Assy
26		60-3214-036	Sampler Wiring Harness Assy
27		149-1000-00	Amp Dust Cover 9760-10

*Not Shown

ITEM NO.	COMPLETE ASSEMBLY	INDIVIDUAL PARTS	DESCRIPTION
53		60-2903-083	Keyboard Button - Molded
54		60-3214-034	LCD Module Assy Before S/N 08109-001
54		60-3214-058	LCD Module Assy B/L Starting with 08109-001
55		410-5100-05	Toggle Switch Boot

*Not Shown

MODEL 3210
PROGRAMMING WORKSHEET   REV. 6-92

The following is a worksheet for the user to select desired entries for each step of the Model 3210 program. It is suggested that the user circle selected entries with a pencil; where numeric values are required, they may be written in. The Flow Meter may then be programmed by entering the values selected on the worksheet.

NOTE: Programs will not require entries for every line shown below; choosing some entries will make other steps unnecessary. Study the explanations given for each program step in Section 2.3.4 before attempting to fill out the worksheet. Refer to the *Simplified Flowchart Diagram*, Figure 2.3-1 for an overview of the Programming sequence. The Model 3210 Flow Meter will reject invalid entries.

The main program steps:

1. SELECT MODE OF OPERATION
2. SELECT SAMPLER INITIATION
3. SELECT PLOTTER MODE OF OPERATION
4. ENTER PLOTTER FULL-SCALE READING
5. SELECT PLOTTER CHART SPEED
6. SET CALENDAR/CLOCK
7. SITE IDENTIFICATION NUMBER
8. ADJUST LEVEL
9. RESET FLOW TOTALIZER
10. REPORT GENERATION
11. ENABLE LOCK

Full Programming Sequence:

1.0 SELECT MODE OF OPERATION:
1. NORMAL 2. LEVEL ONLY

1.1 SELECT FLOW CONVERSION TYPE:
1. STD 2. EQN 3. MANN 4. DATA 5. PROM

1.2 SELECT UNITS OF LEVEL MEASUREMENT:
1. FEET 2. METERS

1.3 SELECT FLOW RATE UNITS:
1. GPM 2. GPS 3. MGD 4. CFS 5. OTHER
1. CMS 2. CMH 3. CMD 4. LPS 5. OTHER
1. CFD 2. GPH 3. AFD 4. CFH 5. OTHER

1.4 SELECT TOTALIZED VOLUME UNITS:
1. CF 2.GAL 3.M 4. AF 5. L 6. MGAL

1.5 SELECT TYPE OF STANDARD DEVICE:
1. WEIR 2. FLUME

1.6 SELECT TYPE OF WEIR: 1. V-NOTCH
2. RECTANGULAR 3. CIPOLETTI

1.7 SELECT V-NOTCH WEIR ANGLE (IN DEGREES):
1. 90 2. 60 3. 45 4. 30 5. 22.5

1.8 SELECT RECTANGULAR WEIR TYPE:
END CONTRACTIONS: 1. YES 2. NO

1.9 RECTANGULAR WEIR WITH END CONTRACTIONS:
ENTER CREST LENGTH ___.___FT.

1.10 RECTANGULAR WEIR WITHOUT END CONTRACTION
ENTER CREST LENGTH:___.____FT.

1.11 CIPOLETTI WEIR:
ENTER CREST LENGTH:___.____ FT.

1.12 SELECT TYPE OF FLUME:
PAL-BOW 2. PARS 3. TRAP 4. H

1.13 (Palmer-Bowlus only) SELECT SIZE: 1. 6" 2. 8"
3. 10" 4. 12" 5. 15" 6. 18" 7. 24" 8. 30" 9. 48"

1.14 (Parshall only) SELECT SIZE: 1. 1" 2. 2" 3. 3"
4. 6" 5. 9" 6. 12" 7. 18" 8. 24" 9. 36"

1.15 (Trapezoidal only) SELECT TYPE:
1. LG 60 V 2. 2" 45 WSC 3. 12" 45 SRCRC

1.16 ("H" flume only) SELECT TYPE: 1. .5' 2. .75'
3. 1.0' 4. 1.5' 5. 2.0' 6. 2.5' 7. 3.0 8. 4.5'

1.17 (Use only if "EQN" selected at 1.1)
ENTER EQUATION:
*(GPM) = ___.__H^_._ ±_._H^_._
(*Note: the units displayed will depend on the units selected at 1.3.)

1.18 (Use only if "MANN" selected at 1.1)
SELECT MANNING: 1. ROUND PIPE
2. U-CHANNEL 3. RECTANGULAR

1.19 (Use only if "ROUND PIPE" selected at 1.18)
ROUND PIPE: SLOPE = 0.____
ROUGHNESS = 0.___

1.20 (Use only if "ROUND PIPE" selected at 1.18) ROUND PIPE: DIAMETER _.__ FT

INDEX

FCC NOTICE
MODEL 3210 FLOW METER

We are required by the Federal Communications Commission to include the following statement in this instruction manual:

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at his own expense.

FURTHER NOTE: Changes or modifications made to this product by the user that are not expressly approved by the party responsible for compliance (Isco) could void the user's authority to operate the equipment.

August 27, 1992

one year, limited

Warranty

Please read before instrument setup.

ISCO INSTRUMENTS HAVE A ONE YEAR LIMITED WARRANTY COVERING BOTH PARTS AND LABOR. Should any instrument become defective due to faulty parts or workmanship within the guarantee period, it will be repaired at the factory at no charge to the customer. Isco will pay SURFACE transportation charges both ways within the contiguous United States if the instrument proves to be defective WITHIN 30 DAYS from the date of shipment. Throughout the remainder of the guarantee period, the customer will pay transportation charges to return the defective instrument to Isco, and Isco will pay SURFACE transportation charges to return the repaired instrument to the customer. Isco will not pay air freight or packing and crating charges. The warranty period begins with the shipping date of the instrument to the original purchaser. All requests for warranty service must be received within the warranty period.

At the convenience of Isco, Isco may reimburse the customer to have the repairs performed by a qualified technician in the customer's locality. Authorization must be granted prior to the time any repair is performed.

Isco's liability is limited to repair or replacement of defective instruments. UNDER NO CIRCUMSTANCES IS ISCO LIABLE FOR CONSEQUENTIAL DAMAGES. The following are not covered by this warranty: Expendable items such as charts, pens, suction and pump tubing, and glassware; damage due to corrosion, abuse, accident, or alteration; and suitability for any specific purpose. This warranty is expressly in lieu of other warranties and obligations, and no person has authority to change it.

OUTSIDE THE WARRANTY PERIOD, REPLACEMENT PARTS AND REPAIR LABOR ARE GUARANTEED FOR 90 DAYS.

The warrantor is Isco, Inc., Lincoln, Nebraska.

Instructions for returning instruments for repair.

Before returning any instrument for repair, call or write our service department for instructions. Simple difficulties can often be diagnosed over the phone.

Pack the instruments carefully, preferably in its original carton, and ship to the attention of the service department. U.P.S. or motor freight is generally the best method except for very small, non-fragile items which can be sent by insured parcel post. BE SURE TO ENCLOSE A NOTE EXPLAINING THE DEFECT AND A PURCHASE ORDER AUTHORIZING THE REPAIR.

Return equipment to:
Isco Environmental Division
531 Westgate Blvd.
Lincoln, NE 68528-1586, U.S.A.
Mailing Address: P.O. Box 82531, Lincoln, NE 68501-2531, U.S.A.
Phone: (402) 474-2233 or (800) 228-4373 (U.S.A.)
FAX: (402) 474-6685

ISCO®

January, 1992

Isco 3200 Series Open Channel Flow Meters

THE ONLY CHOICE FOR MAXIMUM ACCURACY

- Four Measurement Technologies
- Exclusive Built-in Printer
- Advanced Data Management
- Variety of Power Sources

ISCO

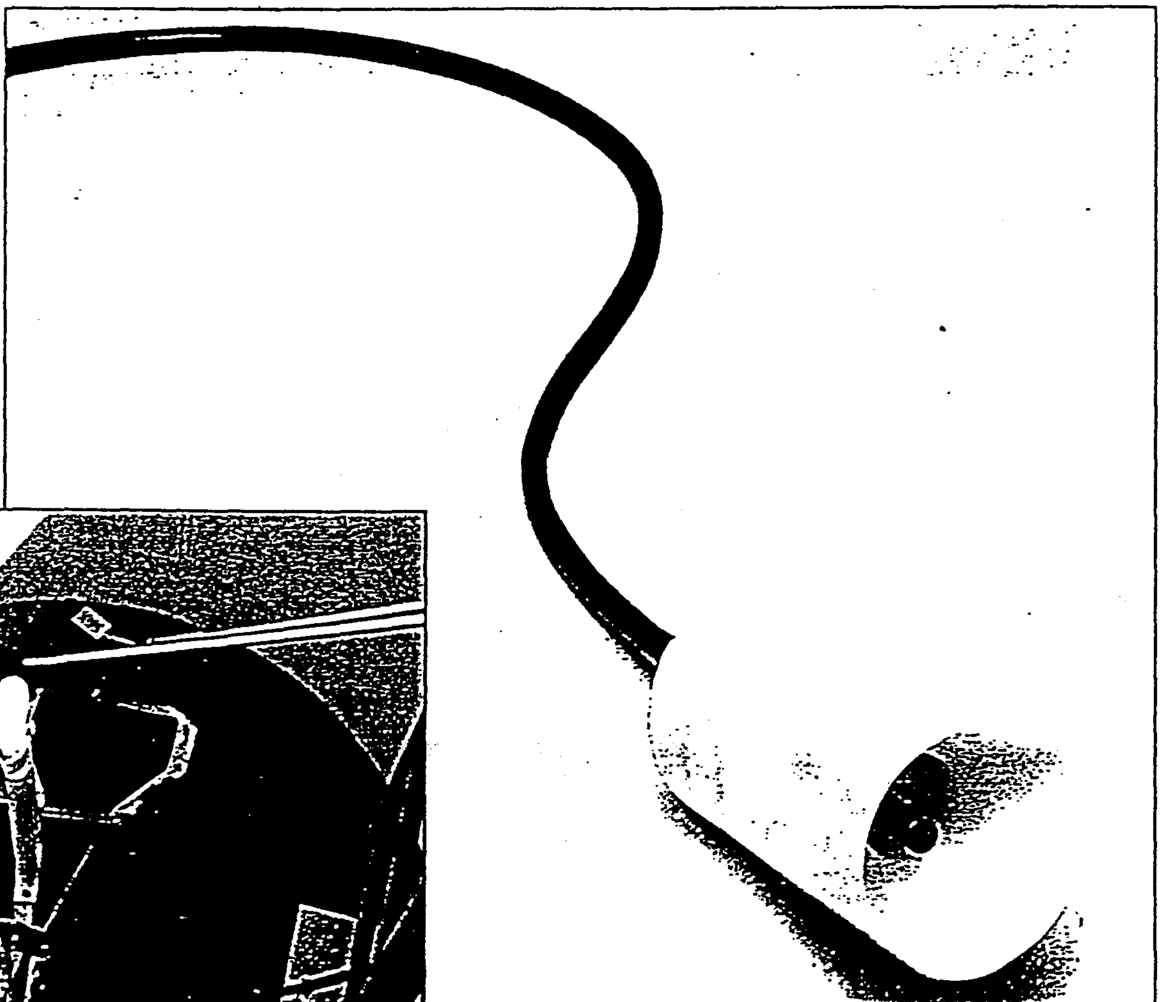
3210 Ultrasonic Flow Meter

Maintenance-free, non-contacting flow measurement.

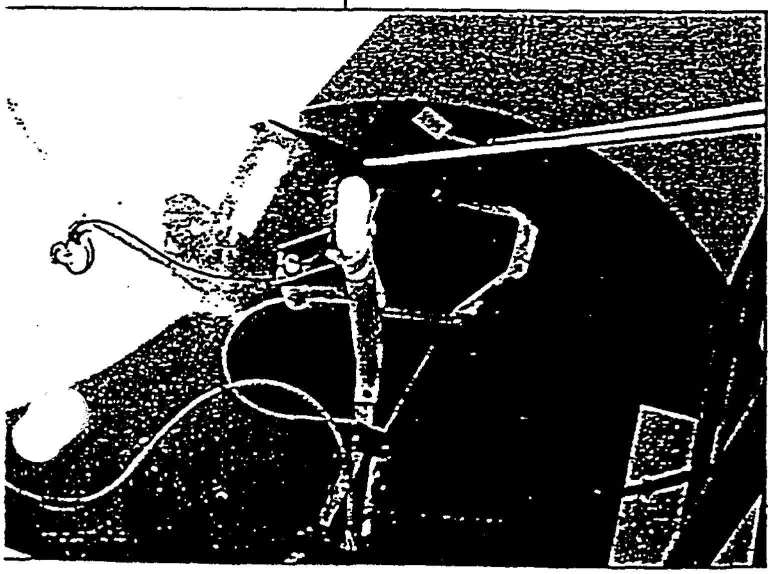
The Isco 3210 Flow Meter features an ultrasonic sensor that does not contact the liquid. This gives you long-term dependability with no scheduled maintenance. Because ultrasonic sensors are installed above the flow stream, they are easy to mount and are not affected by chemicals. The 3210 is ideal for applications with high concentrations of grease, suspended solids or silt.

Dependable, Non-Contacting Sensor

For long-term dependability, the 3210 uses a single-head sensor sealed in a rugged, corrosion resistant, acetal plastic housing. The sensor transmits a sound pulse which is reflected from the surface of the flow stream. The elapsed time between sending a pulse and receiving an echo determines the level in the flow stream. A built-in temperature probe automatically compensates for changes in air temperature and ensures maximum accuracy.



Non-contact sensing of the level in the stilling well of a Parshall flume.



Isco 3210 Specifications

Flow Meter

Height *(with power source)*	18.0 in.	45.7 cm
(without power source)	15.13 in.	38.4 cm
Width	11.5 in.	29.2 cm
Depth	10.75 in.	27.3 cm
Weight *(with power source)*	20.4 lbs.	9.2 kg
Enclosure	NEMA 4X *(self-certified)*	
Power requirements		
Flow Meter	Less than 24 mA average at 12 volts DC	
Power Pack	120 or 240 volts AC. 50/60 Hz	
Rechargeable battery life	7 to 10 days typical with plotter, 14 days typical without plotter *(fully charged)*	
Display type	LCD. 2 lines, 40 characters per line (5.5 mm high x 3.2 mm wide)	
Totalizer	8 digit floating decimal, resettable	
Time base accuracy	±1 second per day	
Plotter chart speed	OFF. 0.5, 1, 2. or 4 inches per hour	OFF, 1.25, 2.5, 5, and 10 cm/hr
Plotter recording modes	Level vs. time, flow rate vs. time, both modes include totalized flow, sampler event marks *(bottle, time)* and hourly rainfall	
Plotter reports generated	Setup parameters, flow interval reports, optional PROM information	
Plotter flow interval report contents	Site number, report interval *(programmable)*, maximum and minimum level and flow rate and time of occurrence, average flow rate, interval flow volume, total flow volume, number of sampling events, total rainfall	
Plotter recording span	Programmable with one over-range	
Built-in conversion equations		
Weirs	V-notch. rectangular with and without end contractions. Cipolletti	
Flumes	Palmer-Bowlus. Parshall. trapezoidal. H	
Manning formula	Round. U-channel. rectangular	
Data points	Four sets of 50 level-flow rate points	
Units of measurement		
Level	ft.. m	
Flow rate	GPS. GPM. GPH. MGD. CMS. CMH. CMD. LPS. CFS. CFH. CFD. AFD	
Totalized flow	CF. CM. GAL. MGAL. AF. L	
Data storage		
Capacity	11.600 level readings divided in up to 3 memory partitions	
Resolution	0.000328 ft. (0.00394 in.)	0.0001 m
Operating temperature range	0° to 140°F	-18° to 60°C
Storage temperature range	-40° to 140°F	-40° to 60°C

Ultrasonic Sensor

Length	6 in.		15.2 cm	
Diameter	2.25 in.		5.7 cm	
Weight	1 lb.		0.45 kg	
Range				
Minimum distance from sensor to liquid	1 ft.		0.3 m	
Maximum distance from sensor to liquid	11 ft.		3.3 m	
Span	0 to 10 ft.		0 to 3 m	
Level Measurement Accuracy	**Head Change***	**Maximum Error**	**Head Change***	**Maximum Error**
At 22°C, still air, and 40 to 70% relative humidity	1.0 ft. or less	±0.02 ft.	0.31 m or less	±0.006 m
	1.0 ft. to 10 ft.	±0.03 ft.	0.31 m to 3.05 m	±0.009 m
Ambient operating temperature range	-13° to 140°F		-25° to 60°C	
Compensated temperature range	-13° to 140°F		-25° to 60°C	
Temperature error	±0.000047 x D per °F		±0.000085 x D per °C	
Maximum error within compensated temperature range *(per degree of temperature change)*	Where D is the distance from the transducer to the liquid surface			
Materials				
Sensor housing	Acetal plastic with a Teflon® coated stainless steel temperature sensor, and a Teflon covered transducer			
Cable	5 conductor cable with an integral stainless steel mounting cable, 0.3 inch (0.1 cm) diameter, with a polyvinyl chloride (PVC) jacket			

* *Actual vertical distance between the ultrasonic sensor and the liquid surface.*

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Engineering Specifications for Isco 3210 Ultrasonic Flow Meter

Refer to brochure # 60-3213-108

There shall be furnished a recording, totalizing open channel flow meter suitable for portable use or fixed site monitoring. The flow meter shall require 12 volt DC power for operation. Power shall be supplied from a [(rechargeable nickel cadmium battery) (rechargeable lead acid battery) (rechargeable lead acid battery with solar panel battery charger) (120 volt AC, 50/60 Hz power converter/ battery charger) (240 volt AC, 50/60 Hz power converter/battery charger) (companion Isco sampler)[1] (external user-supplied 12 volt DC source)[2]].[3]

An ultrasonic level sensor shall be utilized to measure liquid level. The sensor shall consist of a single Teflon® covered ultrasonic transducer, housed in a corrosion resistant acetal plastic enclosure. The sensor shall be capable of being mounted within 1 foot (0.3 m) of the maximum liquid level. The measurement span shall be from 0 to 10 feet (0 to 3.3 m). The level shall be measured with a maximum error of ±0.02 feet (±0.006 m) over a head change of 0 to 1 foot (0 to 0.31 m), and ±0.03 feet (±0.009 m) over a head change of 1 to 10 feet (0.31 to 3.05 m).

The sensor shall also include a Teflon covered stainless steel temperature probe to measure air temperature at the probe and automatically compensate for air temperature changes. The maximum error due to temperature change shall be ±0.000047 per °F (±0.000085 per °C) x distance from the transducer to the liquid surface in stable, constant air ranging from -13° to 140°F (-25° to 60°C). (An optional sunshade for the sensor shall be supplied to shade the sensor from direct sunlight.)[4] The sensor shall be supplied with a standard 25 foot (7.62 m) 4 conductor connect cable for connection to the flow meter. (Optional [(25 ft. - 7.62 m)(50 ft. - 15.2 m)(100 ft. - 30.5 m) (250 ft. - 76.2 m)], 4 conductor extension cables shall be included to increase the separation distance between the sensor and the flow meter.)[5] All cables shall be 0.3 inch (0.8 cm) diameter, and shall include a polyvinyl chloride (PVC) jacket and internal 1/16 inch (0.16 cm) diameter stainless steel wire rope to allow the transducer to be suspended using only the cable. (An optional cable straightening bracket shall be supplied to ensure that the sensor is perpendicular to the flow stream when the sensor is suspended by the cable.)[6] (An optional stainless steel mounting bracket shall be supplied for rigid mounting of the sensor.)[7] (An optional floor mount for the sensor shall be supplied. It shall be adjustable from 12 to 24 inches (0.3 to 0.6 m) vertically above the mounting surface and from 16 to 24 inches (0.4 to 0.6 m) horizontally from its mounting point.)[8]

Measured liquid level readings shall be converted into corresponding flow rate readings using internal conversion algorithms. The flow meter shall contain conversion information for use with the following: Palmer-Bowlus flumes, 6", 8", 10", 12", 15", 18", 24", 30", and 48"; Parshall flumes, 1", 2", 3", 6", 9", 12", 18", 24", and 36"; Trapezoidal flumes, large 60° V, 2" 45° WSC, and 12" 45° SRCRC; H flumes, 0.5', 0.75', 1.0', 1.5', 2.0', 2.5', 3.0', and 4.5'; V-notch weirs, 22.5°, 30°, 45°, 60°, and 90°; all sizes of rectangular weirs with or without end contractions; and Cipolletti weirs up to 10 feet (3 m). The flow meter shall be capable of accepting a manually entered two component equation of the form $k_1H^{P_1} \pm k_2H^{P_2}$. For monitoring in applications using the Manning equation for round pipes, U-channels, and rectangular channels, the flow meter shall accept manually entered information for channel configuration and size, and slope and roughness coefficient. The flow meter shall also be capable of accepting up to four sets of 50 manually entered level-flow rate data points. The flow meter shall then calculate a least squares fit equation for the entered data points. (The flow meter shall be supplied with an optional characterization PROM programmed at the factory for the following devices:

____

____

____

____

specify up to eight different primary devices or open channel flow situations).[9]

Programming the flow meter shall be accomplished using a tactile keypad and 2 line, 80 character alphanumeric liquid crystal display. The LCD shall visually prompt the user through the programming sequence. As values are entered on the keypad, they shall be simultaneously displayed on the LCD.

Level, flow rate, and totalized flow shall be displayed and recorded in units selected by the user. The flow meter shall be capable of measuring level in feet or meters. Flow rate information shall be indicated in gallons per second, gallons per minute, gallons per hour, million gallons per day, cubic meters per second, cubic meters per hour, cubic meters per day, liters per second, cubic feet per second, cubic feet per hour, cubic feet per day, or acre feet per day. Totalized flow shall be in cubic feet, cubic meters, gallons, million gallons, acre feet, or liters, as selected. The total flow and flow rate shall be directly displayed in engineering units; no conversions, exponents, or multiplying factors shall be required.

A built-in digital plotting device shall record the level or flow rate and totalized flow as measured by the flow meter. An impact dot matrix ribbon printing mechanism shall be used to produce this record. Level or flow rate, total flow, time of day, date, site ID number, flow conversion, and full-scale span shall be recorded simultaneously on a 4-1/2 inch (11.4 cm) wide plain paper tape. The plotter shall automatically print a graduated chart background for the chart record. When the 3210 flow meter is connected to a compatible Isco sampler, the plotter shall record a sampling event mark, corresponding sample bottle number, and time. An automatic over-ranging feature shall extend the level or flow rate span by a factor of two in the event of an over-range condition. The plotter shall have selectable chart speeds ranging from 0.5 to 4 inches per hour. An automatic chart paper reroll mechanism shall allow long-term, unattended collection of data, for a period of up to 65 days. The chart paper supply and reroll shall be readily accessible to facilitate chart paper changing.

Internal programming shall allow the plotter to generate flow summary reports on command, or selected time intervals. The flow summary report shall contain the site ID number, report interval, maximum and minimum level, maximum and minimum flow rate, and the time of their occurrence, average flow rate, interval flow volume, totalized flow volume, and the number of sampling events. Flow meter setup parameters shall be printed directly on the chart paper on command. The flow meter shall also be capable of printing optional PROM programming information on the chart.

The flow meter shall be connected to a tipping bucket rain gauge which tips every 0.01 inch of rainfall. Rainfall shall be automatically printed on the chart hourly. Total accumulations of rainfall shall also be included on the summary report for the report interval. Printed rainfall amounts shall be in 0.01 inch increments.

The flow meter shall be capable of initiating the operation of an attached sampler at a user specified level (sampler enable/disable feature).[1] The flow meter's internal strip chart may also be enabled or disabled with this feature. The level shall be programmable from the flow meter keypad. There shall be two modes for enabling the sampler. The first mode is the "Toggle" mode. Selection of the "Toggle" mode will cause the sampler to be turned on when the liquid level reaches or exceeds the value selected, and turned off again when the level drops below this value. Selection of the "Latch" mode will also cause the sampler to be enabled when the liquid level reaches the specified value, but will continue to operate when the liquid level drops below the level specified.

The internal data storage memory shall have a capacity of more than 10,000 level or rainfall readings or sample events divided in up to three user-defined memory partitions. Timing for the data storage shall be selectable in 1, 2, 5, 10, 15, 30, 60, or 120 minute intervals. Internal memory shall be accessible by using an optional modem and dial-up phone line for telemetry[10], or an optional laptop computer for on-site data collection.

The flow meter shall be housed in a rugged, watertight, dust-tight, corrosion resistant (self-certified NEMA 4X), 1/4 inch (0.64 cm) thick, high-impact strength, structural foam enclosure. The enclosure shall include a carrying handle, integral wall mounting bracket, and a large polycarbonate viewing window to allow the total flow, chart record, and LCD readings to be viewed without opening the enclosure. All exterior parts shall be stainless steel or anodized aluminum. An internal, easily replaceable, rechargeable desiccant canister shall keep the interior of the flow meter moisture-free.

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OPTIONS

Modem

An optional built-in, full duplex, auto-answer modem circuit board shall be supplied to provide an interface between the 3210 and voice grade telephone lines. The modem shall operate at 1200 baud. This baud rate corresponds to the baud rate required by the telemetry software. The modem shall have 212A capability. It shall include a connection to the telephone line.[10]

Liquid Level Actuator

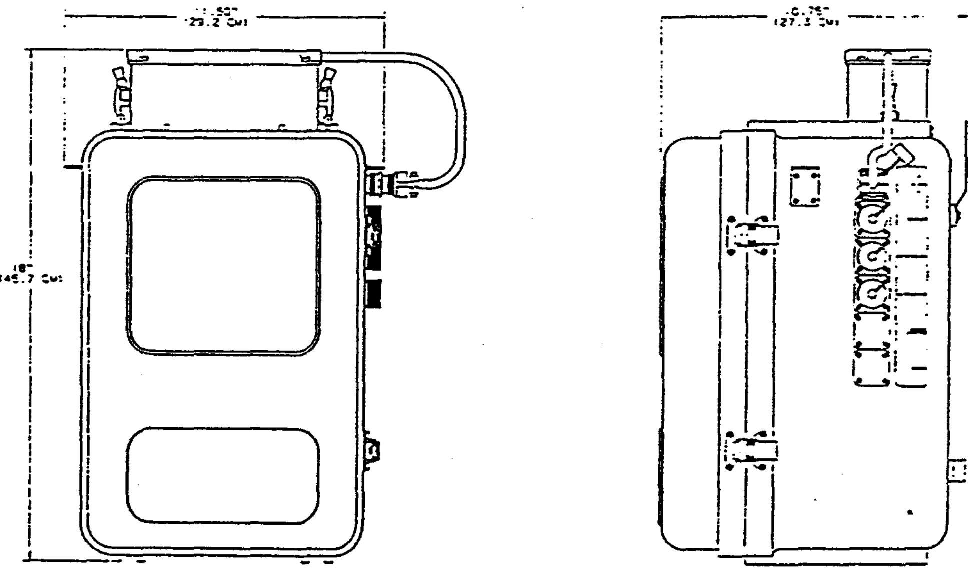
The flow meter shall include factory modification to allow direct connection to an Isco Model 1640 Liquid Level Actuator, to provide flow meter activation only when a predetermined flow stream level has been reached.[11]

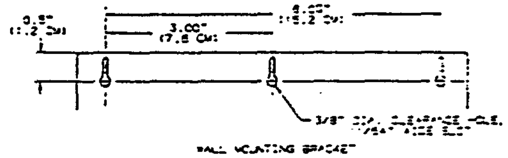
4 to 20 ma Output Converter

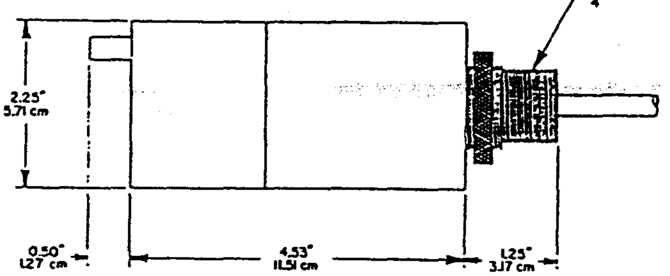
The flow meter shall be supplied with a 4 to 20 milliamp interface unit to allow connection to external non-Isco processing equipment. It will also connect to the 2410 Circular Chart Recorder. The interface shall convert digital pulse information supplied by the flow meter into a variable analog output current which ranges from 4 to 20 milliamps. The interface shall require 120V, AC line power for operation.[12]

1 Specify optional sampler to flow meter connect cable.
2 Specify optional external 12 volt DC source connect cable.
3 Specify one or more power sources as desired.
4 Specify optional sunshade.
5 Specify length of optional ultrasonic sensor extension cable.
6 Specify optional cable straightening bracket.
7 Specify optional stainless steel mounting bracket.
8 Specify optional floor mount.
9 Specify programming information for optional PROM.
10 Specify optional modem and factory modification.
11 Specify optional liquid level actuator modification.
12 Specify optional 4 to 20 ma output interface.

Isco 3210 Ultrasonic Flow Meter







Ultrasonic Level Sensor

ISCO

Isco, Inc. • Environmental Division
P.O. Box 82531
Lincoln, NE 68501-2531
Phone: (402) 474-2233 • USA: (800) 228-4373
FAX: (402) 474-6685

Isco Instruments Europa AG
Brueschstrasse 17
CH - 8708 Maennedorf, Switzerland
Phone: 41 1 920 2425
FAX: 41 1 920 6208

one year, limited

Warranty

Please read before instrument setup.

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Return equipment to:
Isco Environmental Division
531 Westgate Blvd.
Lincoln, NE 68528-1586, U.S.A.
Mailing Address: P.O. Box 82531, Lincoln, NE 68501-2531, U.S.A.
Phone: (402) 474-2233 or (800) 228-4373 (U.S.A.)
FAX: (402) 474-6685

ISCO

January. 1992

12-3: Parshall Flume Discharge Table *(Continued)*

Formulas: $CFS = 0.9920H^{1.547}$ GPS = CFS x 7.481
GPM = CFS x 448.8   MGD = CFS x 0.6463

Head Feet	CFS	GPS	GPM	MGD	Head Feet	CFS	GPS	GPM	MGD
2.01	2.921	21.85	1311	1.888	2.51	4.119	30.82	1849	2.662
2.02	2.944	22.02	1321	1.902	2.52	4.145	31.01	1860	2.679
2.03	2.966	22.19	1331	1.917	2.53	4.170	31.20	1872	2.695
2.04	2.989	22.36	1341	1.932	2.54	4.196	31.39	1883	2.712
2.05	3.012	22.53	1352	1.946	2.55	4.221	31.58	1894	2.728
2.06	3.034	22.70	1362	1.961	2.56	4.247	31.77	1906	2.745
2.07	3.057	22.87	1372	1.976	2.57	4.272	31.96	1917	2.761
2.08	3.080	23.04	1382	1.991	2.58	4.298	32.15	1929	2.778
2.09	3.103	23.21	1393	2.005	2.59	4.324	32.35	1941	2.795
2.10	3.126	23.39	1403	2.020	2.60	4.350	32.54	1952	2.811
2.11	3.149	23.56	1413	2.035	2.61	4.376	32.74	1964	2.828
2.12	3.172	23.73	1424	2.050	2.62	4.402	32.93	1975	2.845
2.13	3.195	23.90	1434	2.065	2.63	4.428	33.12	1987	2.862
2.14	3.219	24.08	1444	2.080	2.64	4.454	33.32	1999	2.879
2.15	3.242	24.25	1455	2.095	2.65	4.480	33.51	2011	2.895
2.16	3.265	24.43	1465	2.110	2.66	4.506	33.71	2022	2.912
2.17	3.289	24.60	1476	2.125	2.67	4.532	33.91	2034	2.929
2.18	3.312	24.78	1486	2.141	2.68	4.559	34.10	2046	2.946
2.19	3.336	24.95	1497	2.156	2.69	4.585	34.30	2058	2.963
2.20	3.359	25.13	1508	2.171	2.70	4.611	34.50	2070	2.980
2.21	3.383	25.31	1518	2.186	2.71	4.638	34.70	2081	2.997
2.22	3.407	25.48	1529	2.202	2.72	4.664	34.89	2093	3.015
2.23	3.430	25.66	1540	2.217	2.73	4.691	35.09	2105	3.032
2.24	3.454	25.84	1550	2.232	2.74	4.717	35.29	2117	3.049
2.25	3.478	26.02	1561	2.248	2.75	4.744	35.49	2129	3.066
2.26	3.502	26.20	1572	2.263	2.76	4.771	35.69	2141	3.083
2.27	3.526	26.38	1582	2.278	2.77	4.798	35.89	2153	3.101
2.28	3.550	26.56	1593	2.294	2.78	4.824	36.09	2165	3.118
2.29	3.574	26.74	1604	2.310	2.79	4.851	36.29	2177	3.135
2.30	3.598	26.92	1615	2.326	2.80	4.878	36.49	2189	3.153
2.31	3.623	27.10	1626	2.341	2.81	4.905	36.70	2201	3.170
2.32	3.647	27.28	1637	2.357	2.82	4.932	36.90	2214	3.188
2.33	3.671	27.46	1648	2.373	2.83	4.959	37.10	2226	3.205
2.34	3.696	27.65	1659	2.388	2.84	4.986	37.30	2238	3.223
2.35	3.720	27.83	1670	2.404	2.85	5.014	37.51	2250	3.240
2.36	3.745	28.01	1681	2.420	2.86	5.041	37.71	2262	3.258
2.37	3.769	28.20	1692	2.436	2.87	5.068	37.92	2275	3.276
2.38	3.794	28.38	1703	2.452	2.88	5.096	38.12	2287	3.293
2.39	3.819	28.57	1714	2.468	2.89	5.123	38.32	2299	3.311
2.40	3.843	28.75	1725	2.484	2.90	5.150	38.53	2312	3.329
2.41	3.868	28.94	1736	2.500	2.91	5.178	38.74	2324	3.346
2.42	3.893	29.12	1747	2.516	2.92	5.205	38.94	2336	3.364
2.43	3.918	29.31	1758	2.532	2.93	5.233	39.15	2349	3.382
2.44	3.943	29.50	1770	2.548	2.94	5.261	39.36	2361	3.400
2.45	3.968	29.68	1781	2.564	2.95	5.288	39.56	2373	3.418
2.46	3.993	29.87	1792	2.581	2.96	5.316	39.77	2386	3.436
2.47	4.018	30.06	1803	2.597	2.97	5.344	39.98	2398	3.454
2.48	4.043	30.25	1815	2.613	2.98	5.372	40.19	2411	3.472
2.49	4.068	30.44	1826	2.629	2.99	5.400	40.40	2423	3.490
2.50	4.094	30.63	1837	2.646	3.00	5.428	40.60	2436	3.508

12-4: 6 in. Parshall Flume Discharge Table

Formulas: $CFS = 2.060H^{1.580}$ GPS = CFS x 7.481
GPM = CFS x 448.8   MGD = CFS x 0.6463

Head Feet	CFS	GPS	GPM	MGD	Head Feet	CFS	GPS	GPM	MGD
0.01	0.0014	0.0107	0.6396	0.0009	0.51	0.7109	5.318	319.1	0.4595
0.02	0.0043	0.0319	1.912	0.0028	0.52	0.7331	5.484	329.0	0.4738
0.03	0.0081	0.0605	3.629	0.0052	0.53	0.7555	5.652	339.1	0.4883
0.04	0.0127	0.0953	5.717	0.0082	0.54	0.7781	5.821	349.2	0.5029
0.05	0.0181	0.1356	8.134	0.0117	0.55	0.8010	5.992	359.5	0.5177
0.06	0.0242	0.1808	10.85	0.0156	0.56	0.8241	6.165	369.9	0.5326
0.07	0.0308	0.2307	13.84	0.0199	0.57	0.8475	6.340	380.4	0.5478
0.08	0.0381	0.2849	17.09	0.0246	0.58	0.8711	6.517	391.0	0.5630
0.09	0.0459	0.3432	20.59	0.0296	0.59	0.8950	6.695	401.7	0.5784
0.10	0.0542	0.4053	24.32	0.0350	0.60	0.9191	6.876	412.5	0.5940
0.11	0.0630	0.4712	28.27	0.0407	0.61	0.9434	7.057	423.4	0.6097
0.12	0.0723	0.5407	32.44	0.0467	0.62	0.9679	7.241	434.4	0.6256
0.13	0.0820	0.6136	36.81	0.0530	0.63	0.9927	7.427	445.5	0.6416
0.14	0.0922	0.6898	41.38	0.0596	0.64	1.018	7.614	456.8	0.6578
0.15	0.1028	0.7692	46.15	0.0665	0.65	1.043	7.802	468.1	0.6741
0.16	0.1139	0.8518	51.10	0.0736	0.66	1.068	7.993	479.5	0.6905
0.17	0.1253	0.9374	56.24	0.0810	0.67	1.094	8.185	491.0	0.7071
0.18	0.1372	1.026	61.55	0.0886	0.68	1.120	8.379	502.7	0.7239
0.19	0.1494	1.118	67.04	0.0965	0.69	1.146	8.574	514.4	0.7408
0.20	0.1620	1.212	72.70	0.1047	0.70	1.173	8.772	526.2	0.7578
0.21	0.1750	1.309	78.53	0.1131	0.71	1.199	8.970	538.2	0.7750
0.22	0.1883	1.409	84.52	0.1217	0.72	1.226	9.171	550.2	0.7923
0.23	0.2020	1.511	90.67	0.1306	0.73	1.253	9.373	562.3	0.8098
0.24	0.2161	1.616	96.97	0.1396	0.74	1.280	9.577	574.5	0.8273
0.25	0.2305	1.724	103.4	0.1490	0.75	1.308	9.782	586.8	0.8451
0.26	0.2452	1.834	110.0	0.1585	0.76	1.335	9.989	599.2	0.8630
0.27	0.2603	1.947	116.8	0.1682	0.77	1.363	10.20	611.8	0.8810
0.28	0.2757	2.062	123.7	0.1782	0.78	1.391	10.41	624.4	0.8991
0.29	0.2914	2.180	130.8	0.1883	0.79	1.419	10.62	637.0	0.9174
0.30	0.3074	2.300	138.0	0.1987	0.80	1.448	10.83	649.8	0.9358
0.31	0.3238	2.422	145.3	0.2092	0.81	1.477	11.05	662.7	0.9544
0.32	0.3404	2.547	152.8	0.2200	0.82	1.506	11.26	675.7	0.9730
0.33	0.3574	2.673	160.4	0.2310	0.83	1.535	11.48	688.8	0.9918
0.34	0.3746	2.803	168.1	0.2421	0.84	1.564	11.70	701.9	1.011
0.35	0.3922	2.934	176.0	0.2535	0.85	1.593	11.92	715.2	1.030
0.36	0.4100	3.068	184.0	0.2650	0.86	1.623	12.14	728.5	1.049
0.37	0.4282	3.203	192.2	0.2767	0.87	1.653	12.37	741.9	1.068
0.38	0.4466	3.341	200.4	0.2886	0.88	1.683	12.59	755.4	1.088
0.39	0.4653	3.481	208.8	0.3007	0.89	1.714	12.82	769.1	1.107
0.40	0.4843	3.623	217.4	0.3130	0.90	1.744	13.05	782.8	1.127
0.41	0.5036	3.767	226.0	0.3255	0.91	1.775	13.28	796.5	1.147
0.42	0.5231	3.913	234.8	0.3381	0.92	1.806	13.51	810.4	1.167
0.43	0.5429	4,062	243.7	0.3509	0.93	1.837	13.74	824.4	1.187
0.44	0.5630	4.212	252.7	0.3639	0.94	1.868	13.98	838.4	1.207
0.45	0.5834	4.364	261.8	0.3770	0.95	1.900	14.21	852.6	1.228
0.46	0.6040	4.518	271.1	0.3904	0.96	1.931	14.45	866.8	1.248
0.47	0.6249	4.675	280.4	0.4038	0.97	1.963	14.69	881.1	1.269
0.48	0.6460	4.833	289.9	0.4175	0.98	1.995	14.93	895.5	1.290
0.49	0.6674	4.993	299.5	0.4313	0.99	2.028	15.17	910.0	1.310
0.50	0.6890	5.155	309.2	0.4453	1.00	2.060	15.41	924.5	1.331

...ulas: $CFS = 2.060H^{1.580}$ $GPS = CFS \times 7.481$
$GPM = CFS \times 448.8$ $MGD = CFS \times 0.6463$

Head Feet	CFS	GPS	GPM	MGD	Head Feet	CFS	GPS	GPM	MGD
1.01	2.093	15.66	939.2	1.352	1.51	3.950	29.55	1773	2.553
1.02	2.125	15.90	953.9	1.374	1.52	3.992	29.86	1792	2.580
1.03	2.158	16.15	968.7	1.395	1.53	4.033	30.17	1810	2.607
1.04	2.192	16.40	983.6	1.416	1.54	4.075	30.49	1829	2.634
1.05	2.225	16.65	998.6	1.438	1.55	4.117	30.80	1848	2.661
1.06	2.259	16.90	1014	1.460	1.56	4.159	31.11	1867	2.688
1.07	2.292	17.15	1029	1.482	1.57	4.201	31.43	1886	2.715
1.08	2.326	17.40	1044	1.504	1.58	4.244	31.75	1905	2.743
1.09	2.360	17.66	1059	1.526	1.59	4.286	32.07	1924	2.770
1.10	2.395	17.92	1075	1.548	1.60	4.329	32.38	1943	2.798
1.11	2.429	18.17	1090	1.570	1.61	4.372	32.70	1962	2.825
1.12	2.464	18.43	1106	1.592	1.62	4.415	33.03	1981	2.853
1.13	2.499	18.69	1121	1.615	1.63	4.458	33.35	2001	2.881
1.14	2.534	18.96	1137	1.638	1.64	4.501	33.67	2020	2.909
1.15	2.569	19.22	1153	1.660	1.65	4.545	34.00	2040	2.937
1.16	2.604	19.48	1169	1.683	1.66	4.588	34.32	2059	2.965
1.17	2.640	19.75	1185	1.706	1.67	4.632	34.65	2079	2.994
1.18	2.676	20.02	1201	1.729	1.68	4.676	34.98	2098	3.022
1.19	2.712	20.29	1217	1.753	1.69	4.720	35.31	2118	3.050
1.20	2.748	20.56	1233	1.776	1.70	4.764	35.64	2138	3.079
1.21	2.784	20.83	1249	1.799	1.71	4.808	35.97	2158	3.108
1.22	2.820	21.10	1266	1.823	1.72	4.853	36.30	2178	3.136
1.23	2.857	21.37	1282	1.847	1.73	4.898	36.64	2198	3.165
1.24	2.894	21.65	1299	1.870	1.74	4.942	36.97	2218	3.194
1.25	2.931	21.93	1315	1.894	1.75	4.987	37.31	2238	3.223
1.26	2.968	22.20	1332	1.918	1.76	5.032	37.65	2259	3.252
1.27	3.005	22.48	1349	1.942	1.77	5.078	37.99	2279	3.282
1.28	3.043	22.76	1366	1.966	1.78	5.123	38.33	2299	3.311
1.29	3.080	23.04	1382	1.991	1.79	5.169	38.67	2320	3.340
1.30	3.118	23.33	1399	2.015	1.80	5.214	39.01	2340	3.370
1.31	3.156	23.61	1416	2.040	1.81	5.260	39.35	2361	3.400
1.32	3.194	23.90	1434	2.064	1.82	5.306	39.70	2381	3.429
1.33	3.233	24.18	1451	2.089	1.83	5.352	40.04	2402	3.459
1.34	3.271	24.47	1468	2.114	1.84	5.399	40.39	2423	3.489
1.35	3.310	24.76	1485	2.139	1.85	5.445	40.73	2444	3.519
1.36	3.349	25.05	1503	2.164	1.86	5.492	41.08	2465	3.549
1.37	3.388	25.34	1520	2.189	1.87	5.538	41.43	2486	3.579
1.38	3.427	25.64	1538	2.215	1.88	5.585	41.78	2507	3.610
1.39	3.466	25.93	1556	2.240	1.89	5.632	42.13	2528	3.640
1.40	3.505	26.22	1573	2.266	1.90	5.679	42.49	2549	3.671
1.41	3.545	26.52	1591	2.291	1.91	5.727	42.84	2570	3.701
1.42	3.585	26.82	1609	2.317	1.92	5.774	43.20	2591	3.732
1.43	3.625	27.12	1627	2.343	1.93	5.822	43.55	2613	3.763
1.44	3.665	27.42	1645	2.369	1.94	5.869	43.91	2634	3.793
1.45	3.705	27.72	1663	2.395	1.95	5.917	44.27	2656	3.824
1.46	3.746	28.02	1681	2.421	1.96	5.965	44.63	2677	3.855
1.47	3.786	28.33	1699	2.447	1.97	6.013	44.99	2699	3.886
1.48	3.827	28.63	1718	2.474	1.98	6.062	45.35	2721	3.918
1.49	3.868	28.94	1736	2.500	1.99	6.110	45.71	2742	3.949
1.50	3.909	29.24	1754	2.527	2.00	6.159	46.07	2764	3.980

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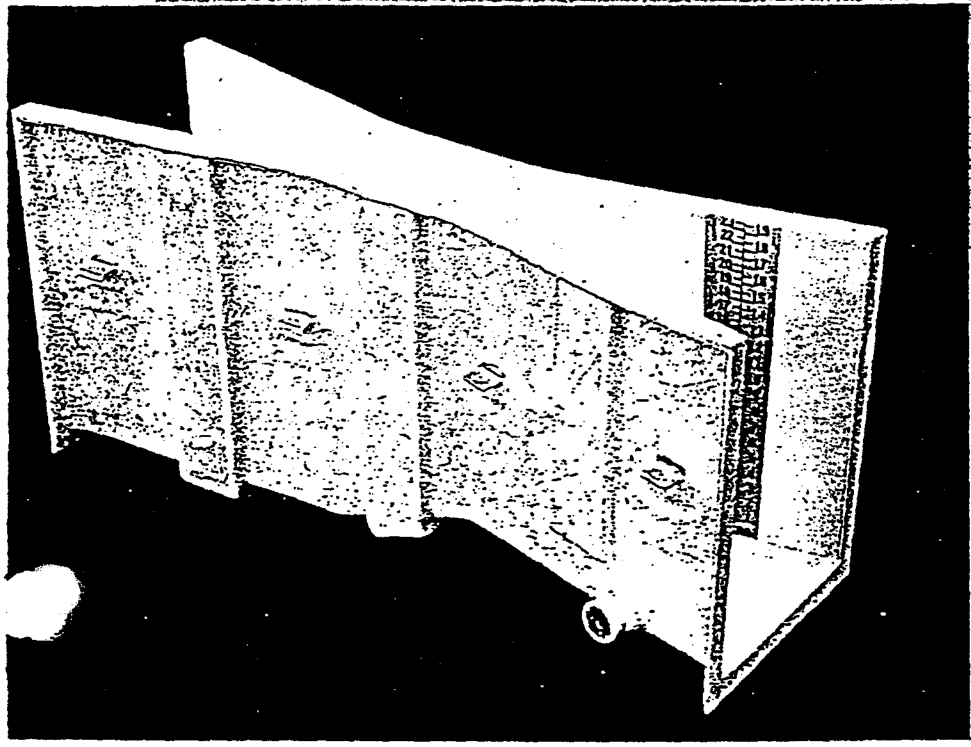
Formulas: $CFS = 2.060H^{1.580}$ $GPS = CFS \times 7.481$
$GPM = CFS \times 448.8$ $MGD = CFS \times 0.6463$

Head Feet	CFS	GPS	GPM	MGD	Head Feet	CFS	GPS	GPM	MGD
2.01	6.208	46.44	2786	4.012	2.51	8.818	65.96	3957	5.699
2.02	6.256	46.80	2808	4.043	2.52	8.873	66.38	3982	5.735
2.03	6.305	47.17	2830	4.075	2.53	8.929	66.80	4007	5.771
2.04	6.355	47.54	2852	4.107	2.54	8.985	67.21	4032	5.807
2.05	6.404	47.91	2874	4.139	2.55	9.041	67.63	4057	5.843
2.06	6.453	48.28	2896	4.171	2.56	9.097	68.05	4083	5.879
2.07	6.503	48.65	2918	4.203	2.57	9.153	68.47	4108	5.916
2.08	6.553	49.02	2941	4.235	2.58	9.209	68.89	4133	5.952
2.09	6.602	49.39	2963	4.267	2.59	9.266	69.32	4158	5.988
2.10	6.652	49.77	2986	4.299	2.60	9.322	69.74	4184	6.025
2.11	6.702	50.14	3008	4.332	2.61	9.379	70.16	4209	6.062
2.12	6.753	50.52	3031	4.364	2.62	9.436	70.59	4235	6.098
2.13	6.803	50.89	3053	4.397	2.63	9.493	71.02	4260	6.135
2.14	6.854	51.27	3076	4.430	2.64	9.550	71.44	4286	6.172
2.15	6.904	51.65	3099	4.462	2.65	9.607	71.87	4312	6.209
2.16	6.955	52.03	3121	4.495	2.66	9.665	72.30	4337	6.246
2.17	7.006	52.41	3144	4.528	2.67	9.722	72.73	4363	6.283
2.18	7.057	52.79	3167	4.561	2.68	9.780	73.16	4389	6.321
2.19	7.108	53.18	3190	4.594	2.69	9.837	73.59	4415	6.358
2.20	7.160	53.56	3213	4.627	2.70	9.895	74.03	4441	6.395
2.21	7.211	53.95	3236	4.661	2.71	9.953	74.46	4467	6.433
2.22	7.263	54.33	3260	4.694	2.72	10.01	74.89	4493	6.470
2.23	7.315	54.72	3283	4.727	2.73	10.07	75.33	4519	6.508
2.24	7.366	55.11	3306	4.761	2.74	10.13	75.77	4545	6.546
2.25	7.418	55.50	3329	4.795	2.75	10.19	76.20	4572	6.583
2.26	7.471	55.89	3353	4.828	2.76	10.24	76.64	4598	6.621
2.27	7.523	56.28	3376	4.862	2.77	10.30	77.08	4624	6.659
2.28	7.575	56.67	3400	4.896	2.78	10.36	77.52	4651	6.697
2.29	7.628	57.06	3423	4.930	2.79	10.42	77.96	4677	6.735
2.30	7.681	57.46	3447	4.964	2.80	10.48	78.40	4704	6.773
2.31	7.733	57.85	3471	4.998	2.81	10.54	78.85	4730	6.812
2.32	7.786	58.25	3495	5.032	2.82	10.60	79.29	4757	6.850
2.33	7.840	58.65	3518	5.067	2.83	10.66	79.74	4783	6.888
2.34	7.893	59.05	3542	5.101	2.84	10.72	80.18	4810	6.927
2.35	7.946	59.44	3566	5.136	2.85	10.78	80.63	4837	6.966
2.36	8.000	59.84	3590	5.170	2.86	10.84	81.07	4864	7.004
2.37	8.053	60.25	3614	5.205	2.87	10.90	81.52	4891	7.043
2.38	8.107	60.65	3638	5.240	2.88	10.96	81.97	4918	7.082
2.39	8.161	61.05	3663	5.274	2.89	11.02	82.42	4945	7.121
2.40	8.215	61.46	3687	5.309	2.90	11.08	82.87	4972	7.160
2.41	8.269	61.86	3711	5.344	2.91	11.14	83.33	4999	7.199
2.42	8.323	62.27	3735	5.379	2.92	11.20	83.78	5026	7.238
2.43	8.378	62.67	3760	5.415	2.93	11.26	84.23	5053	7.277
2.44	8.432	63.08	3784	5.450	2.94	11.32	84.69	5081	7.316
2.45	8.487	63.49	3809	5.485	2.95	11.38	85.14	5108	7.356
2.46	8.542	63.90	3834	5.521	2.96	11.44	85.60	5135	7.395
2.47	8.597	64.31	3858	5.556	2.97	11.50	86.06	5163	7.435
2.48	8.652	64.72	3883	5.592	2.98	11.56	86.51	5190	7.474
2.49	8.707	65.14	3908	5.627	2.99	11.63	86.97	5218	7.514
2.50	8.762	65.55	3932	5.663	3.00	11.69	87.43	5245	7.554

Plasti-Fab®

FIBERGLASS REINFORCED POLYESTER

PARSHALL FLUMES



- Maintenance free
- Dimensionally stable
- Easily installed
- Lightweight
- Accurate
- Economical

CORROSION RESISTANT
polyester affords protection from chemical attack by corrosive wastes.

DIMENSIONALLY STABLE
prefabricated Plasti-Fab Parshall flumes assure accurate dimensions.

EASY INSTALLATION
light weight – high strength. Plasti-Fab Parshall flumes are heavily ribbed for free standing installation. They may also be installed as liners in concrete.

CLEAN WHITE SMOOTH SURFACES
minimize any build-up of organisms.

RUGGED CONSTRUCTION
2" flanges on ends and top, with heavy angle bracing across top flanges.

LOWER COST
and more rugged than stainless.

MORE DURABLE
and more accurate than concrete.

2" THREADED CONNECTION
is available on either side for connection to a separate floatwell or bubbler system.

FLOATWELLS ATTACHED
to the side of the flume are 12"; 8" is also available. They can be mounted on either side.

REMOTE FLOATWELLS
are also available. A 2" threaded tap on the flume and the floatwell is provided for interconnecting piping. A 1" blow-out connection is also provided on the well.

HEAD GAUGES
are supplied on all Plasti-Fab Parshall flumes. The gage is molded in the side of the flume in the first stage of construction, retaining a smooth surface on the sidewall.

CONTACT

7070 Telephone Rd. — Pavilion, NY 14525
BURGH SCHOENENBERGER
Sales & Service 716-584-3768
FAX 716-584-3322

DIRECT TO . . .
PLASTI-FAB, INC.
P.O. Box 100
Tualatin, Oregon 97062
Phone (503) 692-5460

STANDARD DEPTH FLUMES & SPECIAL DEPTH FLUMES

All Plasti-Fab Parshall flumes are supplied to the dimensions shown unless specified otherwise. We do supply flumes having more or less depth when quired at extra cost.

SHORT SECTION FLUMES

(Space Savers). The diverging section (the section downstream from the throat) may be omitted without affecting a Parshall flume's accuracy. These "short section flumes" as we call them, are available at no extra cost. Short section flumes have been found to be helpful space savers to many engineers. As a matter of explanation, the diverging or exit sections of a Parshall flume serves two functions. neither of which has to do with flow measurement. It reduces the head loss through the flume and reduces downstream erosion (as when installed in irrigation systems).

FREE FLOW DISCHARGE

The discharge graph is for free flow conditions and does not apply in cases of submerged flow. Free flow conditions exist when the level at the downstream gaging point does not exceed more than approximately 2/3 of the level of the upstream gage, both of which are measured above the crest of the flume.

FREE FLOW vs SUBMERGED FLOW

In the free flow condition, the downstream water level does not affect the level of the water upstream. Technically speaking, the flow of water passes through itical depth, usually near the flume crest (the trance to the throat), in the free flow condition.

In the submerged flow condition the tailwater depth is sufficiently high that it affects the upstream depth and it is necessary to measure head at two places in the flume to determine flow (H_a and H_b).

The point at which the flow changes from free flow to submerged flow is called the transition submergence and is expressed as a percentage, which is the ratio of H_b/H_a. This varies from size to size being as low as 55% and as high as 78% through the range of sizes from 8 foot to 1". In all the larger sizes, i.e., 10 ft. and larger, transition submergence is 80%.

Recent work has produced easy to use free and submerged flow calibration curves for each of the standard sizes of flumes. (Source: Utah Water Lab.)

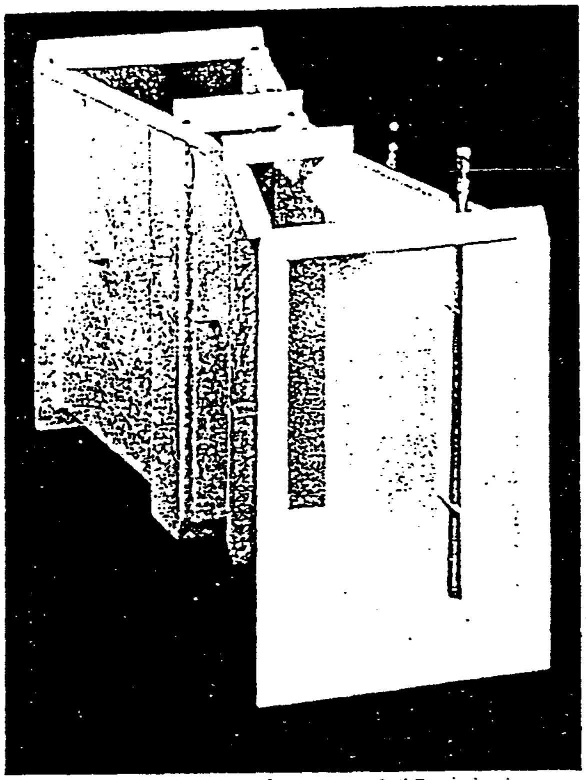
Instrumentation is available to record and totalize submerged flow (electronically), however we at Plasti-Fab encourage you to design for free flow whenever possible.

SETTING FLUMES

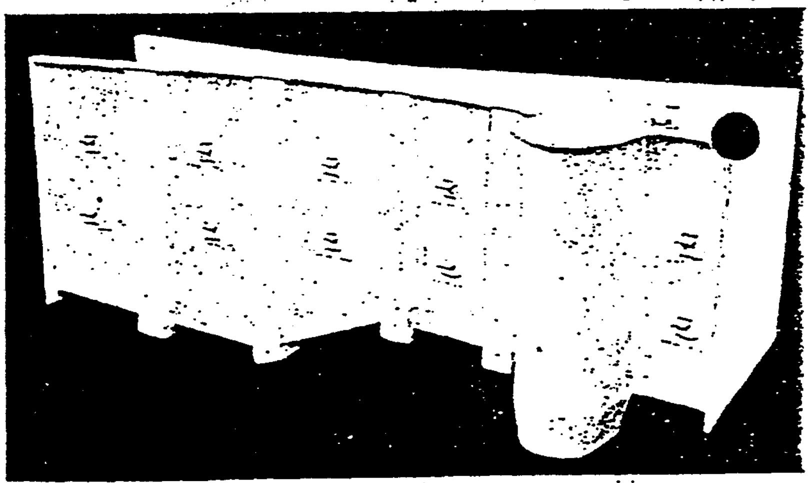
Proper setting and size is necessary for successful operation. Frequently the elevation of the crest of the flume is governed by the maximum allowable head. Where the crest of the flume is more than 6" above the channel bottom, a short sloping approach to the inlet end of the flume should be provided. All flumes must be set with the inlet tion level.

HANDY FACTS TO REMEMBER

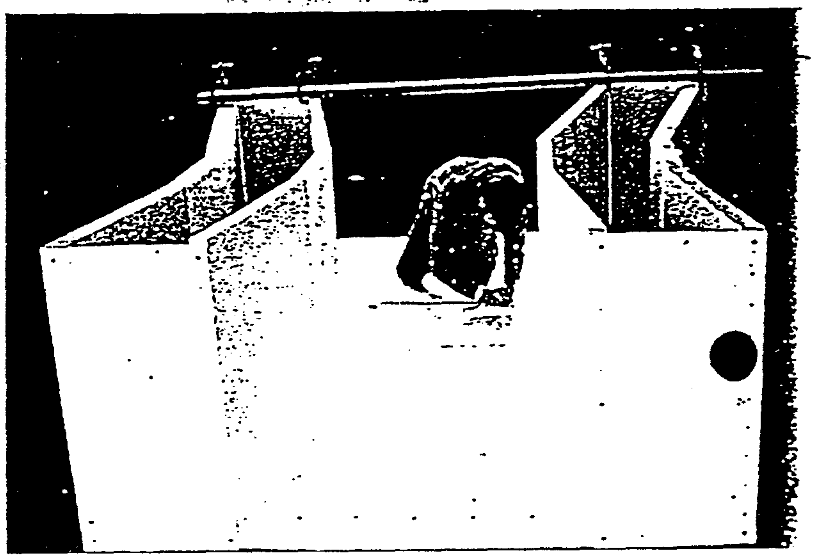
1 cu. ft. = 7.48 gals
1 mgd = 694.4 gpm
1 mgd = 1.55 cfs
1 cfs = 449 gpm
1 cfs = 0.646 mgd



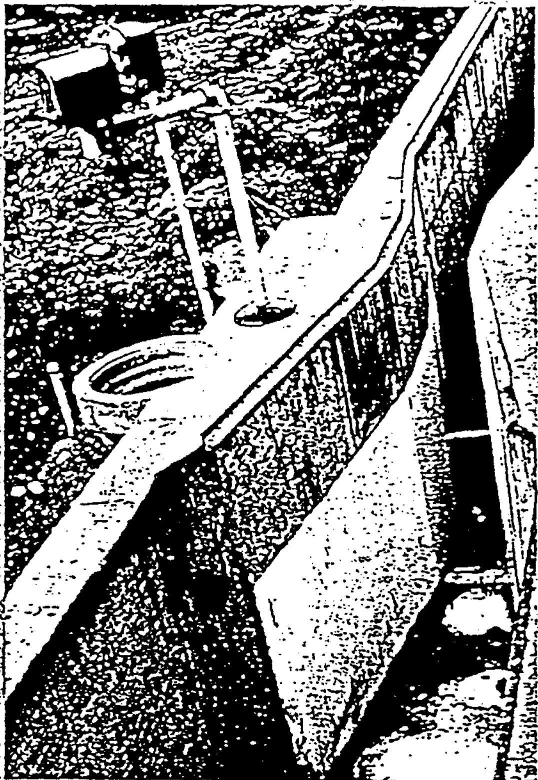
Removable stainless steel bubble tubes are popular.



12" Parshall with 12" dia. attached floatwell.

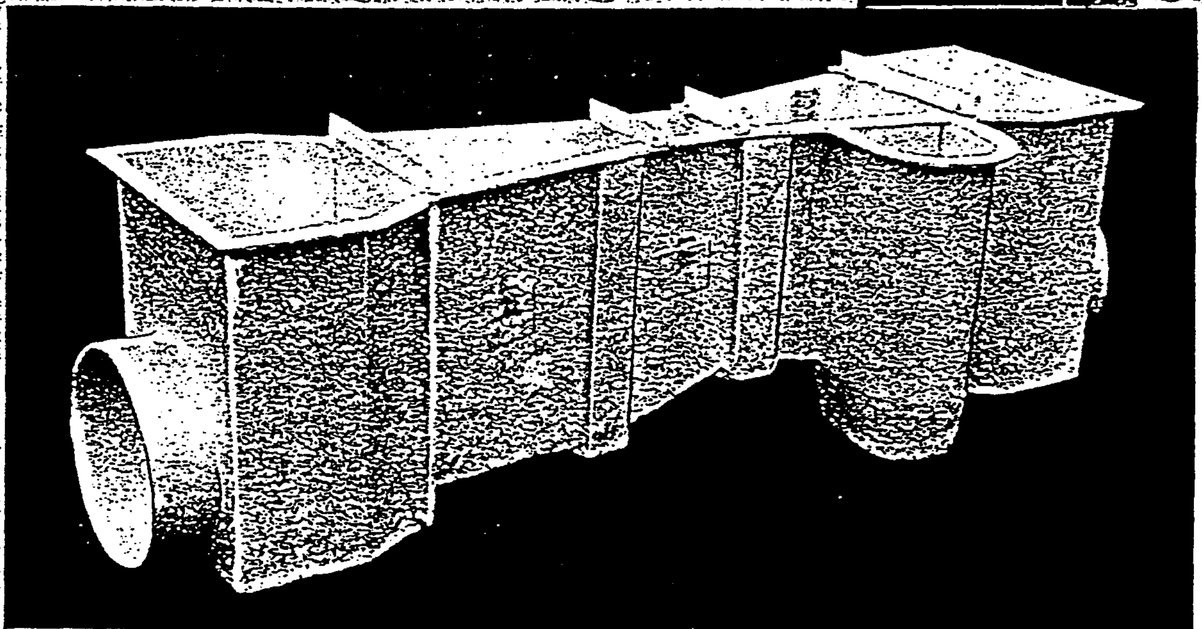


A 3-foot flume mounted

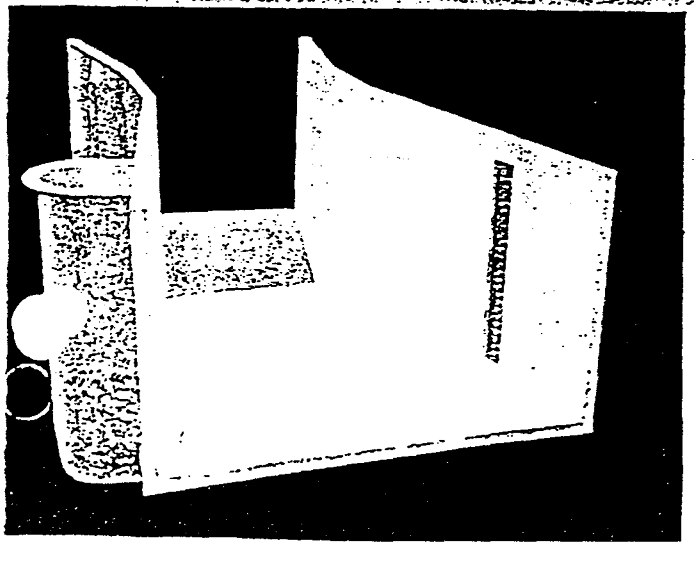


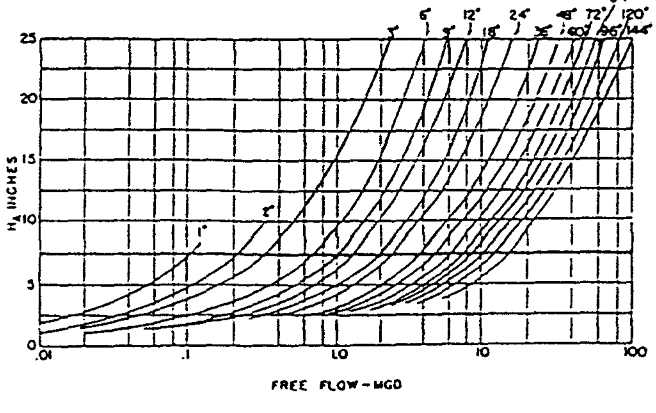
A 6" flume with a separate floatwell in a municipal treatment plant.

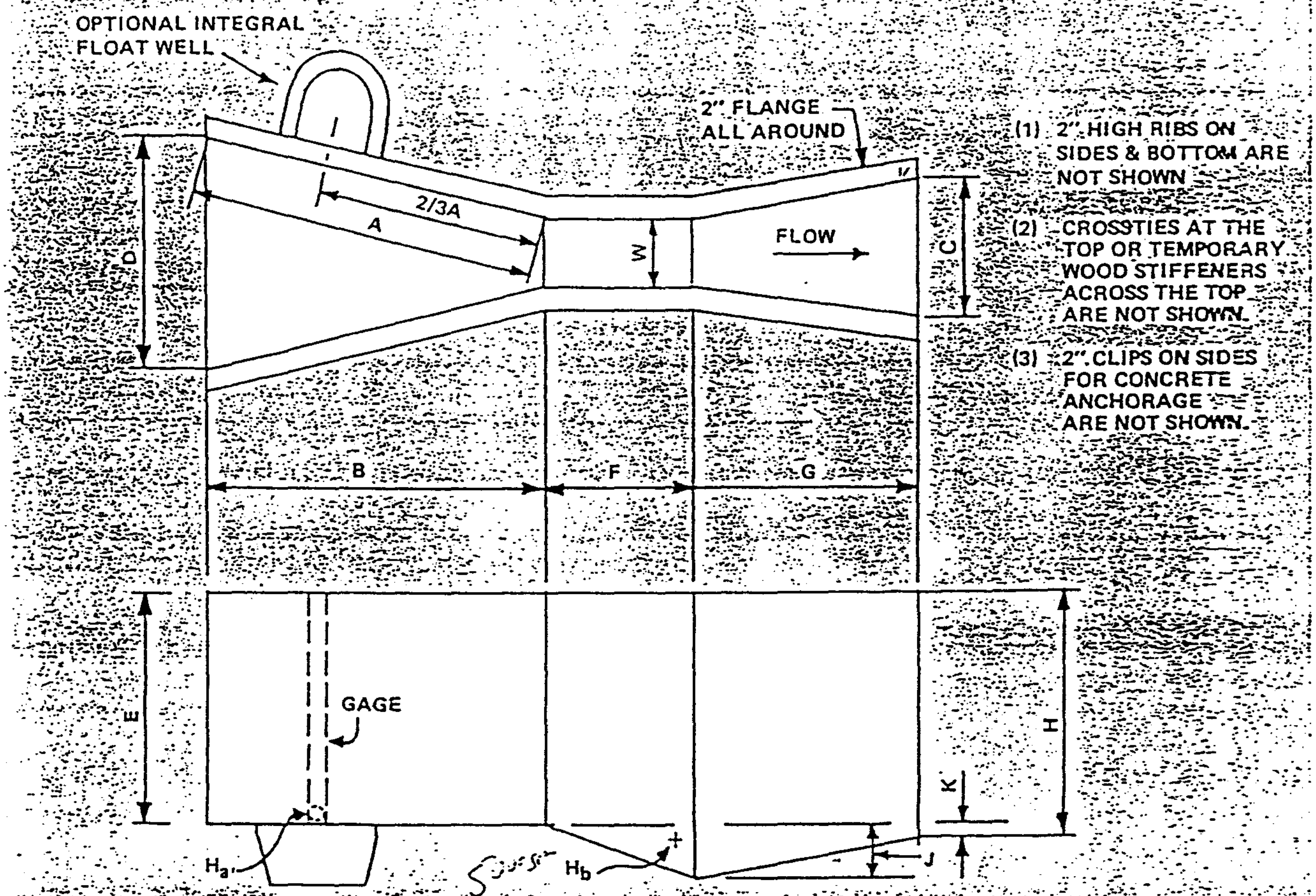
This 1" flume is small enough that an 8 year old girl can handle it.



A Parshall Flume equipped with standard Plasti-Fab end adapters for installation in a pipeline.





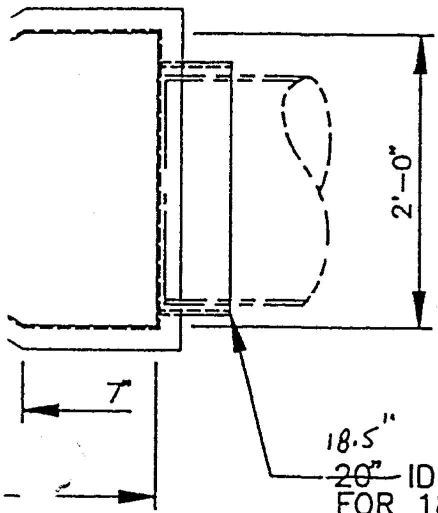


W	A	2/3 A or 2/3 (W/2+4)	B	C	D	E	F	G	H	J	K
1"	1'-2-9/32"	0'-9-17/32"	1'-2"	0'-3-21/32"	0'-6-19/32"	0'-9"	0'-3"	0'-8"	0'-9-3/4"	1-1/8"	3/4"
2"	1'-4-5/16"	0'-10-7/8"	1'-4"	0'-5-5/16"	0'-8-13/32"	0'-9"	0'-4-1/2"	0'-10"	0'-9-7/8"	1-11/16"	7/8"
3"	1'-6-3/8"	1'-0-1/4"	1'-6"	0'-7"	0'-10-3/16"	2'-0"	0'-6"	1'-0"	2'-1"	2-1/4"	1"
6"	2'-0-7/16"	1'-4-5/16"	2'-0"	1'-3-1/2"	1'-3-5/8"	2'-0"	1'-0"	2'-0"	2'-3"	4-1/2"	3"
9"	2'-10-5/8"	1'-11-1/8"	2'-10"	1'-3"	1'-10-5/8"	2'-6"	1'-0"	1'-6"	2'-9"	4-1/2"	3"
12"	4'-6"	3'-0"	4'-4-7/8"	2'-0"	2-9-1/4"	3'-0"	2'-0"	3'-0"	3'-3"	9"	3"
18"	4'-9"	3'-2"	4'-7-7/8"	2'-6"	3'-4-3/8"	3'-0"	2'-0"	3'-0"	3'-3"	9"	3"
24"	5'-0"	3'-4"	4'-10-7/8"	3'-0"	3'-11-1/2"	3'-0"	2'-0"	3'-0"	3'-3"	9"	3"
30"	5'-4-1/4"	3'-6-3/4"	5'-3"	3'-6"	4'-6-3/4"	3'-0"	2'-0"	3'-0"	3'-3"	9"	3"
36"	5'-6"	3'-8"	5'-4-3/4"	4'-0"	5'-1-7/8"	3'-0"	2'-0"	3'-0"	3'-3"	9"	3"
48"	6'-0"	4"-0"	5'-10-5/8"	5'-0"	6'-4-1/4"	3'-0"	2'-0"	3'-0"	3'-3"	9"	3"
60"	6'-6"	4'-4"	6'-4-1/2"	6'-0"	7'-6-5/8"	3'-0"	2'-0"	3'-0"	3'-3"	9"	3"
72"	7'-0"	4'-8"	6'-10-3/8"	7'-0"	8'-9"	3'-0"	2'-0"	3'-0"	3'-3"	9"	3"
84"	7'-6"	5'-0"	7'-4-1/4"	8'-0"	9'-11-3/8"	3'-0"	2'-0"	3'-0"	3'-3"	9"	3"
96"	8'-0"	5'-4"	7'-10-1/8"	9'-0"	11'-1-3/4"	3'-0"	2'-0"	3'-0"	3'-3"	9"	3"
120"	14'-3-1/4"	6'-0"	14'-0"	12'-0"	15'-7-1/4"	4'-0"	3'-0"	6'-0"	4'-6"	1'-1-1/2"	6"
144"	16'-3-3/4"	6'-8"	16'-0"	14'-8"	18'-4-3/4"	5'-0"	3'-0"	8'-0"	5'-6"	1'-1-1/2"	6"

Plasti-Fab Also Builds Fiberglass

- Palmer-Bowlus Flumes
- Overflow Gates
- Slide Gates
- Filter Backwash Troughs
- V-Notch Weirs for Clarifiers
- Launders

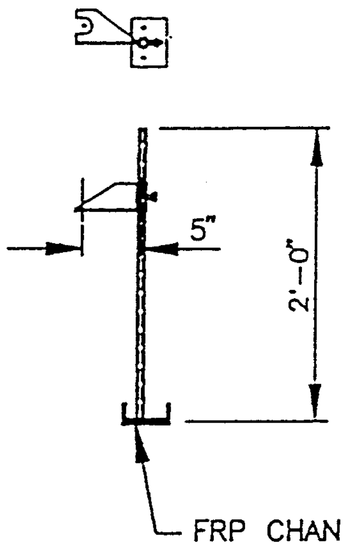
STIFFENERS ACROSS THE TOP OF THE FLUME ARE NOT SHOWN.
) WASHERS ARE TYPE 304 STAINLESS STEEL.
(I...CHES & TENTHS OF A FOOT) IS MOLDED INTO THE SIDE OF THE FLUME AT H_A.
SS CONTENT IS 30%, EXCLUSIVE OF THE RESIN RICH SURFACES.
ACE IS SMOOTH WHITE GEL COAT.
CKNESS IS 1/4" FRP (FIBERGLASS REINFORCED POLYESTER) PLUS THE RIB OVERLAY.



PLEASE ADVISE PIPE OD

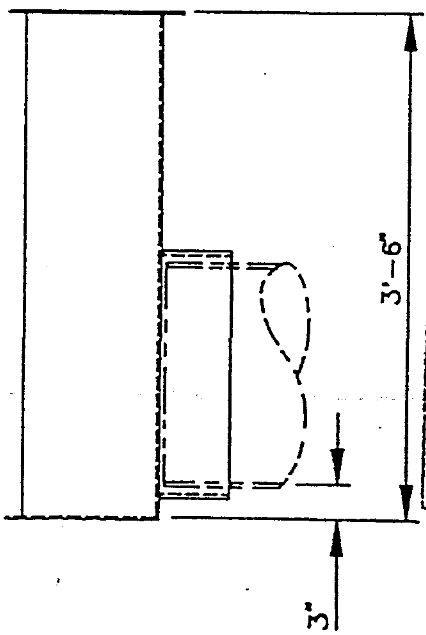
18.5"
~~20"~~ ID FRP CAULKING COLLAR
FOR 18" ID X OD PIPE

PIPE O.D. 18"
I.D. 15.8"



FRP CHANNEL TO BE DRILLED AND MTD AT REQUIRED LOCATION

SONIC BRKT DETAIL



ALL NOTATIONS MUST BE MARKED IN RED

CUSTOMER: B.P. OIL
JOB:
P.O. NO.: 424–9255–0015
ENGINEER:
REP.: BURGH & SCHEONBERGER
PLASTI–FAB JOB NO.: 18352

REVISIONS

Plasti-Fab INC.
TUALATIN, OREGON

6" PARSHALL FLUME
WITH END ADAPTERS

DR.BY: PDP CHK.BY:	14518–B
DATE: 3–23–94	
SCALE: 3/4"=1'–0"	

☐ ~~REVIEWED~~ ☐ ~~REVISE AND RESUBMIT~~

☒ REVIEWED AS NOTED ☐

☐ REVIEWED AS NOTED RESUB[illegible]SION REQUIRED

Reviewed [illegible] general concept and arrangement with the under- standing that it is the Contractor's submission of his proposed design and method to construct the work as specified in the Contract Documents and that the Contractor is responsible for [illegible] and successful construction of the work and [illegible] requirements of the Contract Documents.

H&A OF NEW YORK

BY JFD DATE 3/25/94

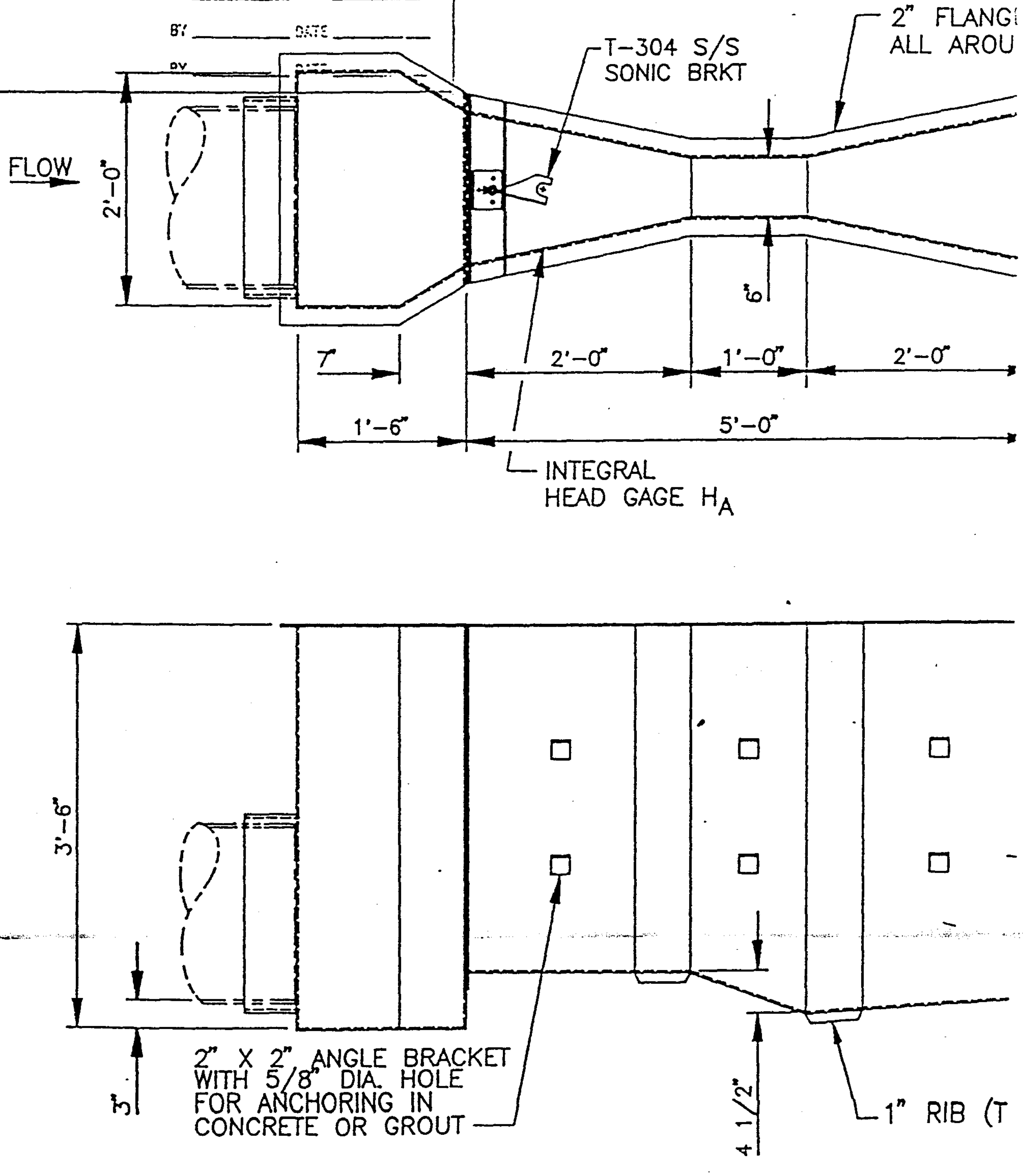
BY ______ DATE ______

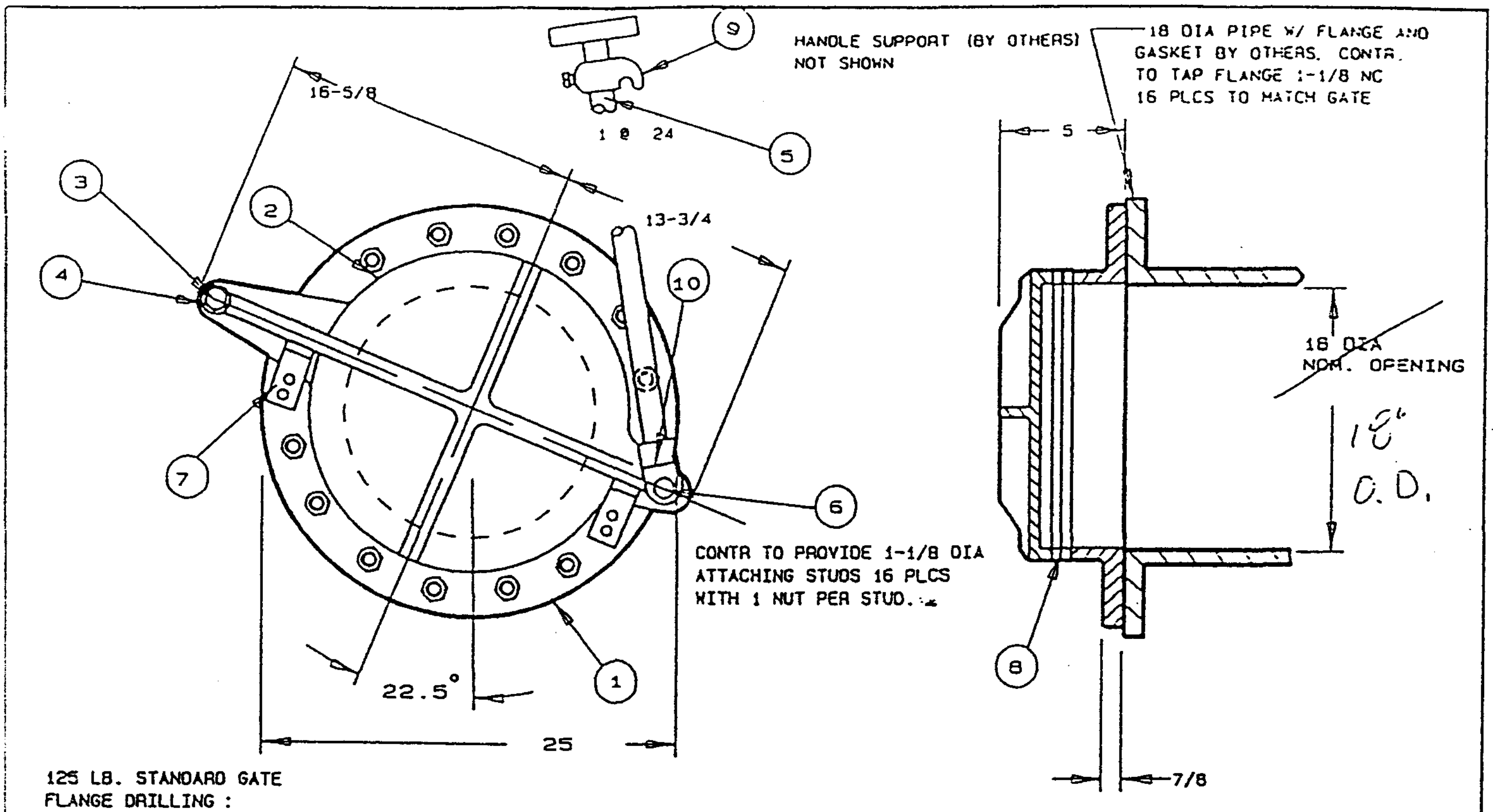
BY ______ DATE ______

BY ______ DATE ______

NOTES:

6. THE FRP A
5. ALL BOLTS,
4. THE HEAD
3. THE MINIMU
2. THE INSIDE
1. THE MINIMU





125 LB. STANDARD GATE
FLANGE DRILLING :
DRILL 1-1/4 DIA HOLE 16 PLCS
EQUALLY SPACED STRADDLE CENTER
LINE ON A 22-3/4 DIA BOLT CIRCLE

NOTE 20 QTY OF (2) GATES

DESCRIPTION	PART #/SIZE	MATERIAL	FIN	QTY	TOT
1. FRAME	W-1242	CAST IRON : ASTM A-126 CL. B	6	1	1
2. COVER	W-1241	CAST IRON : ASTM A-126 CL. B	6	1	1
3. HINGE BOLT	1/2 NC X 3-1/2 LG	COMMERCIAL BRONZE	2, 3	1	1
4. BUSHING	17/32 I.D.	COMMERCIAL BRONZE	2, 3	1	1
5. LIFT ROD	3/8 DIA PIPE	STL PIPE : ASTM A-53 TY. E GR. A	4	1	1
6. LIFT BOLT & NUT	3/8 NC X 2 LG	COMMERCIAL BRONZE	2, 3	1	1
7. WEDGE BLOCK	W-536	COMP. BRZ. : ASTM B-584 AL. 844	2, 3	2	2
a. WEDGE BOLT & NUT	1/2 NC X 3-1/2 LG	COMMERCIAL BRONZE	2, 3	2	2
8. SEATS		COMP. BRZ. : ASTM B-584 AL. 844	3	-	-
9. ADJ. LUG	W-1246	CAST IRON : ASTM A-126 CL. B	6	1	1
10. LIFT LUG	W-1209	CAST IRON : ASTM A-126 CL. B	6	1	1

REVIEWED
☒ REVIEWED
☐ REVISE AND RESUBMIT
H&A CHECKED
JTD 3/25/94
BY ______ DATE ____
BY ______ DATE ____

FINISH KEY
1. AS CAST 2. MILL
3. MACHINED
4. GALVANIZE ASTM A-123
5. GALVANIZE ASTM A-153
6. PAINT -
STANDARD SHOPCOAT

NOTES
1. ALL DIMENSIONS IN INCHES UNLESS OTHERWISE NOTED.
2. DESIGNED FOR 20 FT. SEATING HEAD.

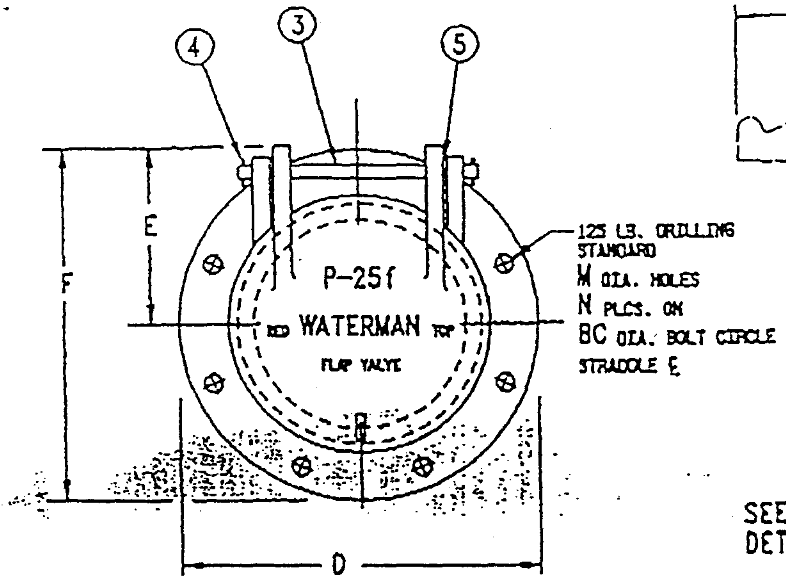
(1) GATE REQ'D

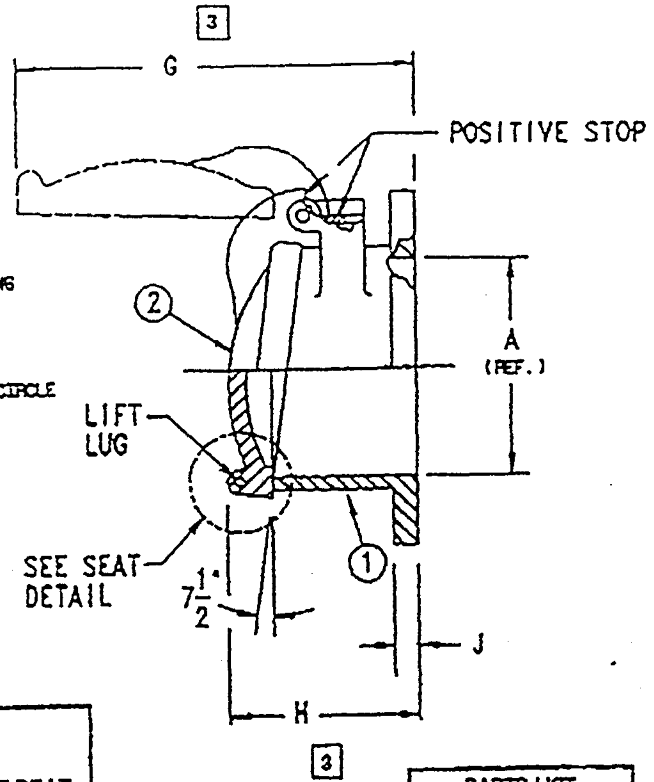
JOB REF. H & A OF NEW YORK SANBORN NEW YORK	FOR: B.P. OIL COMPANY 200 PUBLIC SQUARE 7-I CLEVELAND, OH 44114	JOB NO. 8-5283-8 / PROJECT MANAGER DF QUOTE NO. SQ94-DA-023 / QUOTE ITEM 2 DRAWN BY JM / CHECKED BY GM
18 DIA WATERMAN MODEL C-16f CAST IRON SHEAR GATE	P.O. NO. 424-9255-0016	SCALE NONE / DATE 03-22-1994

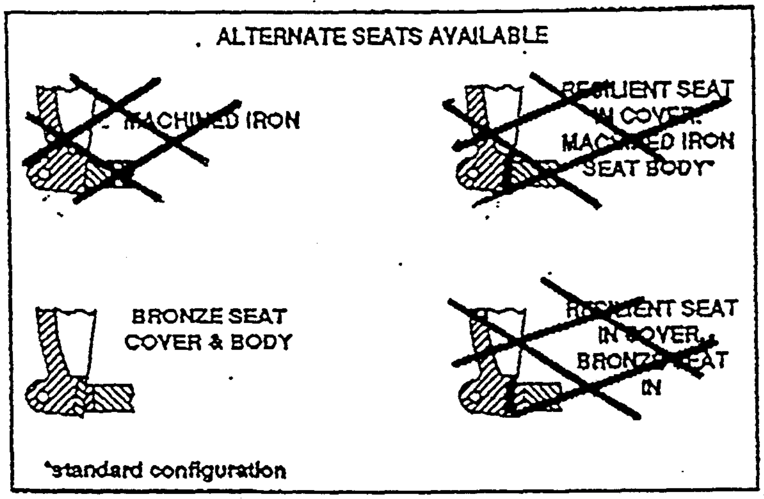
WATERMAN INDUSTRIES INC. EXETER, CA. 93221 — DRAWING NO. RA-94-0428

CODE # : 8- 16520- 64

PF-251 FLAP VALVE







PARTS LIST	
No.	Name
1	BODY(flanged)
2	COVER
3	HINGE PIN
4	SPRING PIN
5	WASHER

1. Designed for use on pump discharge lines.
2. 25 Lb. drilling available on request.
3. If grout pad mounting is used, add grout thickness to dimensions.

GATE DIMENSIONS IN INCHES										
GATE SIZE A	4	6	8	10	12	14	16	18	20	24
BC	7 1/2	9 1/8	11 3/4	14 1/4	17	18 3/4	21 1/4	22 3/4	25	29 1/2
D	9	11	13 1/2	16	19	21	23 1/2	25	27 1/2	32
E	4 5/8	5 11/16	6 7/8	8 1/8	9 3/8	10 7/16	11 5/8	12 1/4	13 3/8	15 1/2
F	9 1/8	11 3/16	13 5/8	16 1/8	18 7/8	20 15/16	23 3/8	24 3/4	27 1/8	31 1/2
G	8 1/4	11 7/8	14 1/4	16 1/4	18 3/8	22 1/4	24 1/4	26 1/4	28 3/4	32 3/4
H	6 1/4	7 5/8	8	8	8 1/2	10 1/2	10 1/2	10 1/2	11	11
J	1	1	1	1	1	1	1	1 1/8	1 1/8	1 1/4
M	3/4	7/8	7/8	1	1	1 1/8	1 1/8	1 1/4	1 1/4	1 3/8
N	8	8	8	12	12	12	16	16	20	20

waterman® INDUSTRIES, INC.

NOTE: FOR PRELIMINARY DESIGN PURPOSES ONLY
DO NOT USE FOR INSTALLATION
UNLESS PART OF CERTIFIED & APPROVED SUBMITTAL