Designing,
Manufacturing
and Supporting
Innovative
Approaches to Clean
Water Since 1863

Eliminator Reverse Osmosis Systems
Operations & Maintenance Manual

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Introduction

Reverse osmosis systems from Crane Environmental are designed to produce high quality permeate water from municipal and well water. The highest quality components and the latest technology are used in the production and design of our reverse osmosis systems.

What is Reverse Osmosis?

While ordinary filters use a screen to separate particles from water streams, a reverse osmosis system uses a semi-permeable membrane to reject a high percentage of dissolved molecules. Only certain types of molecules, like water, can pass through the membrane. Other molecules, like salts, do not pass through the membrane and are left behind.

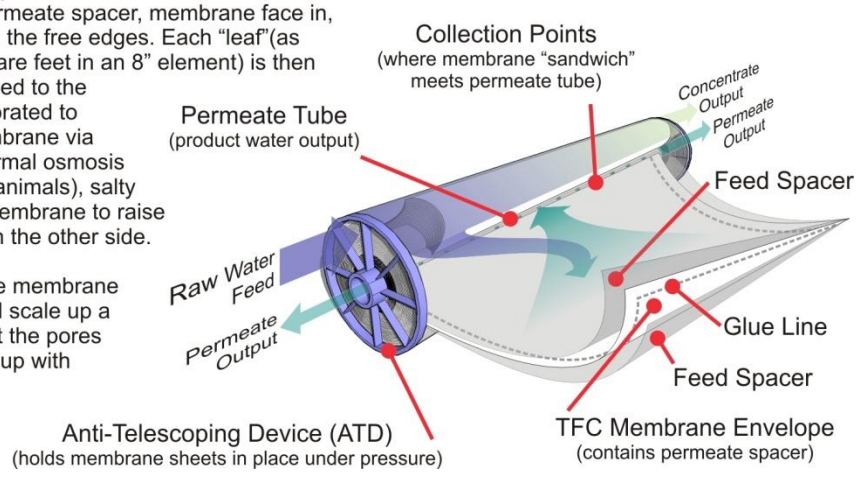
What is a Semi-Permeable Membrane?

A semi-permeable membrane is very similar to your skin. The membrane is made of thin, multi-layered sheets with microscopic pores that let water pass through while acting as a barrier to stop dissolved particles like salt.

Figure 1

A semipermeable thin-film composite (TFC) membrane flat sheet is laminated to a porous carrier and folded around a permeate spacer, membrane face in, to create an envelope which is glued along the free edges. Each "leaf"(as many as 30 - yielding as much as 400 square feet in an 8" element) is then sandwiched between feed spacers and glued to the permeate tube. The permeate tube is perforated to collect water that migrates across the membrane via reverse osmosis, so-called because, in normal osmosis (demonstrated in living cells of plants and animals), salty water migrates across a semipermeable membrane to raise the salt concentration of less salty water on the other side. Under pressure, this process is reversed.

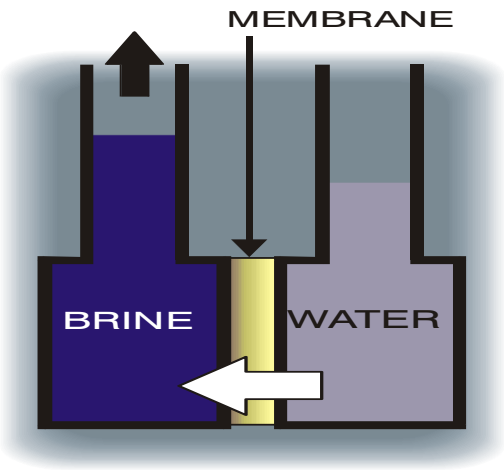
The channels, or pores of the polyamide membrane are around 0.001 micrometers. If you could scale up a one foot square piece of membrane so that the pores were the size of pin holes, you would wind up with 635,000 square feet; that is 14.6 acres, or more than 11 football fields!



How Does Osmosis and Reverse Osmosis Work?

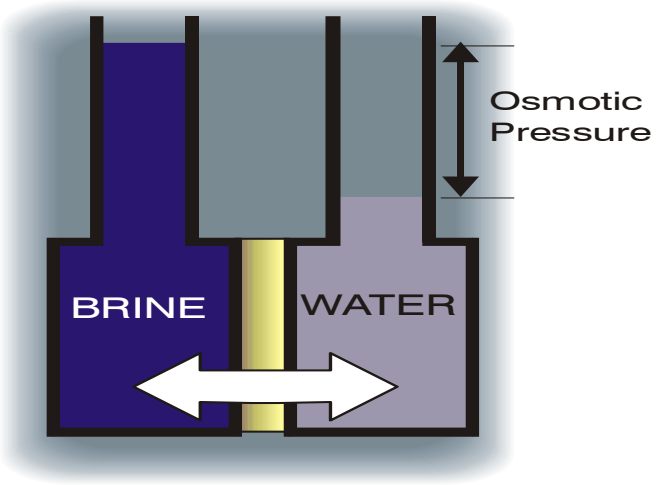
As shown in Figure 2, under normal pressure water will pass from the side of the membrane with lower concentration to the side with the higher concentration to reach equilibrium.

FIGURE 2: OSMOSIS



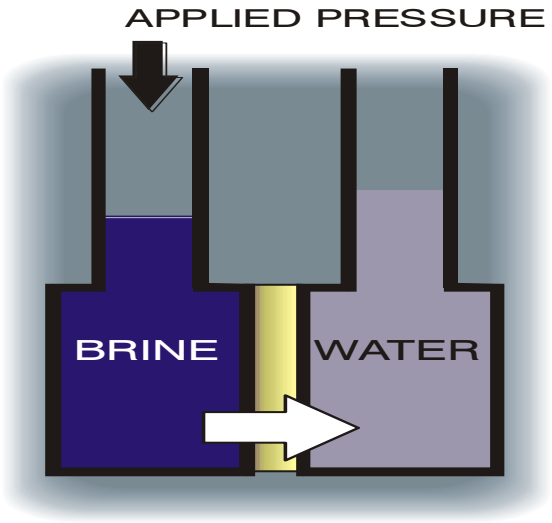
The water flow stops when the applied pressure equals the osmotic pressure. The osmotic pressure is the pressure required to stop water flow and reach equilibrium.
See Figure 3.

Figure 3: Equilibrium



When the applied pressure exceeds the osmotic pressure, reverse osmosis will take place. In reverse osmosis, water passes through the membrane to the dilute solution, leaving behind dissolved particles. This results in purified water in the permeate stream, often reducing the total dissolved solids over 99 percent. See Figure 4

Figure 4: Reverse Osmosis



Crane Environmental systems use semi-permeable spiral wound, thin film composite membranes to separate and remove dissolved solids, organic material, pyrogens, sub-micron colloidal matter, viruses, and bacteria from water. Feed water is delivered under pressure to the membranes, where reverse osmosis takes place. Water permeates the minute pores of the membrane and is delivered as purified product water. The impurities in the water do not pass through the membrane, and are instead concentrated in the reject stream that is flushed to the drain.

System Operating Pressure

The system operating pressure is defined as the pressure required to produce the quantity of permeate water (product water) recommended for the specific application. This pressure is measured at the feed of the first membrane. It is important to understand the following basic characteristics of all reverse osmosis systems. The system operating pressure is determined by three factors: the temperature of the feed water, the TDS of the feed water, and the type of membrane(s) installed in the system. As the feed water temperature decreases, and/or the feed water TDS increases, the pressure required to produce a specific quantity of permeate water increases. Therefore, both the temperature and TDS of the feed water have a major impact on the design and membrane selection of each reverse osmosis system.

Specifications

The standard Eliminators available are Eliminator I through VI, the Eliminator Dual IV, and the Eliminator Dual VI. Under recommended conditions, an Eliminator will produce 1440 gpd (1 gpm) @ a flux of 18.5 for each membrane. Lower feed water temperatures and/or higher feed water TDS will result in a reeducation of feed water quantity. Cold water membranes are available to compensate for colder feed water temperatures.

Standard features available include:

- Automatic backwashing, activated carbon filter
- 5 micron prefilter
- Automatic inlet solenoid
- Stainless steel multi-stage centrifugal pump
- 230v/1ph/60hz ODP motor (three phase option is available)
- Aluminum wall mount frame (aluminum floor frame is optional)
- Stainless steel pump throttle value
- Physical water conditioner
- Fiberglass or stainless steel pressure vessels
- Standard or cold water, high rejection, TFC membranes
- Acrylic block permeate and concentrate flow meters
- Liquid filled pressure gauges for prefilter out, 1st array feed and concentrate
- UL listed, programmable electronic control with an automatic low flow protection system, a digital water quality meter, dry contacts for liquid level controls and pretreatment lockout, and function LED's.

Membrane Rejection

Membrane rejection refers to the amount of total dissolved solids (TDS) rejected by the membrane, (expressed as a percentage). Membrane rejection is calculated using the following formula:

$$\% \text{ of Rejection} = \frac{\text{Feed TDS (ppm)} - \text{Permeate TDS (ppm)} \times 100}{\text{Feed TDS (ppm)}}$$

System Recovery

System recovery is a ration between the amount of permeate water produced by the system and the amount of feed water supplied to the system, (expressed as a percentage). System recovery is calculated using the following formula:

$$\% \text{ of Recovery} = \frac{\text{Permeate Water Flow Rate (gpm)} \times 100}{\text{Feed Water Flow Rate (gpm)}}$$

Membrane Flux

Membrane flux is a relationship between the permeate production from a membrane, and the surface area of that membrane.

$$\text{Membrane Flux} = \frac{\text{Permeate Production (gpd)}}{\text{Membrane Surface Area (sq ft)}}$$

TABLE 1
Eliminator-I through Eliminator-IV

Common Part Numbers with Descriptions

Part	Part #	Description
Prefilter Housing	HPO01S	23”L X 5”D
Prefilter Cartridge	PFC02A	20”L X 2.75”D / 5 Micron
Inlet Solenoid – 115v Inlet Solenoid – 220v	GCV075B GCV075C	Normally Closed, .75 In/Out, Brass
Pump/Motor Assembly 60hz Standard 60hz Low Pressure System 60hz Three Phase * 50hz Single Phase * 50hz Three Phase *	 DPM16 DPM14 DPM52 DPM04 DPM11	Multi-Stage Centrifugal, S/S 115-230v /1ph / 60hz / 1.5hp 115-230v / 1ph / 60hz / 1.0hp 230-460v / 3ph / 60hz / 1.5hp 220v / 1ph / 50hz / 1.5hp 380-415v / 3ph / 50hz / 1.5hp
Pump Throttle Valve	VGS01	Globe Valve, .75 In/Out, 316 S/S
Physical Water Conditioner	RT-750-KSPL	To Reduce Membrane Scaling Due To Hardness
Concentrate Control Valve	VGS01	Globe Valve, .75 In/Out, 316 S/S
Concentrate Pressure Gauge	DGO02S	0-300 Psi, 2.5”D, Brass Internals
Concentrate Recycle Valve *	BLV14	Needle Valve, .5 In/Out, 316 S/S
Flush Solenoid *	-	Same As Inlet Solenoid

Additional Parts

Part	Part#	ELIM-I	ELIM-II	ELIM-III	ELIM-IV
Pressure Vessel, 4”X40”, F/G Pressure Vessel, 4”X40”, S/S	HEF64WC HES19	(1)	(2)	(3)	(4)
Pressure Vessel Clamps, F/G Pressure Vessel Clamps, S/S	CH-9PW HEA40	(2)	(4)	(6)	(8)
Membrane, 4”X40”, Standard Membrane, 4”X40”, Cold Water Membrane, Extra Low Pressure *	ETT11 ETT74 ETT47	(1)	(2)	(3)	(4)
Concentrate Flow Meter	→	DFO06A	DFO06A	DFO06A	DFO06A
Permeate Flow Meter	→	DFO05A	DFO05A	DFO06A	DFO06A
Activated Carbon Filter	FAW2510-	AC12	AC12	AC14	AC14

Specifications

	ELIM-I	ELIM-II	ELIM-III	ELIM-IV
Permeate Production @ A Flux Of 18.5	O1.0 GPM	2.0 GPM	3.0 GPM	4.0 GPM
Average Rejection	99.0 %	99.0 %	99.0 %	99.0 %
Recovery (Without Recycle)	20.0 %	33.3 %	42.9 %	50.0 %
Minimum Feed Flow Required	5.0 GPM	6.0 GPM	7.0 GPM	8.0 GPM
Length – Wall Frame / Floor Frame	35” / 35”	35” / 35”	35” / 35”	35” / 35”
Width – Wall Frame / Floor Frame	15” / 32”	15” / 32”	15” / 32”	15” / 32”
Height – Wall Frame / Floor Frame	55” / 65”	55” / 65”	55” / 65”	55” / 65”
Weight – Wall Frame (without ACF)	150 LBS	170 LBS	190 LBS	210 LBS
Weight – Floor Frame (with ACF)	280 LBS	300 LBS	360 LBS	380 LBS

* Optional Feature

Table 2
Eliminator-V and Eliminator-VI

Common Part Numbers with Descriptions

Part	Part #	Description
Prefilter Housing	HPO05	12.75" X 7.25" (Big Blue)
Prefilter Cartridge	PFC03	10"L X 4.5"D / 5 Micron
Inlet Solenoid – 220v	GCV100C	Norm Closed, 1.0 In/Out, Brass
Pump/Motor Assembly		Multi-Stage Centrifugal, S/S
60hz Standard	DPM120	230v /1ph / 60hz / 3.0hp
60hz Three Phase *	DPM150	230-460v / 3ph / 60hz / 3.0hp
50hz Single Phase *	DPM	220v / 1ph / 50hz / 3.0hp
50hz Three Phase *	DPM	380-415v / 3ph / 50hz / 3.0hp
Pump Throttle Valve	VGS03	Globe Valve, 1.0 In/Out, 316 S/S
Physical Water Conditioner	RT-1000-KSPL	Reduces Membrane Scaling Due To Hardness
Concentrate Control Valve	VGS03	Globe Valve, 1.0 In/Out, 316 S/S
Concentrate Pressure Gauge	DGO02S	0-300 Psi, 2.5"D, Brass Internals
Concentrate Recycle Valve *	BLV12	Needle Valve, .75 In/Out, 316 S/S
Flush Solenoid *	GCV075C	Norm Closed, .75 In/Out, Brass

Additional Parts

Part	Part#	Eliminator-V	Eliminator-VI
Pressure Vessel, 4"X40", F/G Pressure Vessel, 4"X40", S/S	HEF64WC HES19	(5)	(6)
Pressure Vessel Clamps, F/G Pressure Vessel Clamps, S/S	CH-9PW HEA40	(10)	(12)
Membrane, 4"X40", Standard Membrane, 4"X40", Cold Water Membrane, Extra Low Pressure *	ETT11 ETT74 ETT47	(5)	(6)
Concentrate Flow Meter	→	DFO06A	DFO06A
Permeate Flow Meter	→	DFO06A	DFO06A
Activated Carbon Filter	FAW2510-	AC16	AC16

Specifications

	Eliminator-V	Eliminator-VI
Permeate Production @ A Flux Of 18.5	5.0 GPM	6.0 GPM
Average Rejection	99.0 %	99.0 %
Recovery (Without Recycle)	41.7%	42.9 %
Minimum Feed Flow Required	12.0 GPM	14.0 GPM
Length – Wall Frame / Floor Frame	35" / 46"	35" / 46"
Width – Wall Frame / Floor Frame	15" / 32"	15" / 32"
Height – Wall Frame / Floor Frame	55" / 65"	55" / 65"
Weight – Wall Frame (without ACF)	240 LBS	260 LBS
Weight – Floor Frame (with ACF)	410 LBS	430 LBS

* Optional Feature

Table 3
Eliminator Dual IV

Common Part Numbers with Descriptions

Part	Part #	Description
Prefilter Housing (2)	HPO01S	23" X 5"
Prefilter Cartridge (2)	PFC02A	20"L X 2.75"D / 5 Micron
Inlet Solenoid – 220v (2)	GCV075C	Norm Closed, .75 In/Out, Brass
Pump/Motor Assembly (2) 60hz Standard 60hz Three Phase * 50hz Single Phase * 50hz Three Phase *	 DPM16 DPM52 DPM04 DPM11	Multi-Stage Centrifugal, S/S 230v /1ph / 60hz / 1.5hp 230-460v / 3ph / 60hz / 1.5hp 220v / 1ph / 50hz / 1.5hp 380-415v / 3ph / 50hz / 1.5hp
Pump Throttle Valve (2)	VGS01	Globe Valve, .75 In/Out, 316 S/S
Physical Water Conditioner (2)	RT-750-KSPL	Reduces Membrane Scaling Due To Hardness
Concentrate Control Valve (2)	VGS01	Globe Valve, .75 In/Out, 316 S/S
Concentrate Pressure Gauge (2)	DGO02S	0-300 Psi, 2.5"D, Brass Internals
Concentrate Recycle Valve	BLV14	Needle Valve, .5 In/Out, 316 S/S
Flush Solenoid	GCV075C	Norm Closed, .75 In/Out, Brass

Additional Parts

Part	Part#	Eliminator Dual IV
Pressure Vessel, 4"X40", F/G Pressure Vessel, 4"X40", S/S	HEF64WC HES19	(8)
Pressure Vessel Clamps, F/G Pressure Vessel Clamps, S/S	CH-9PW HEA40	(16)
Membrane, 4"X40", Standard Membrane, 4"X40", Cold Water Membrane, Extra Low Pressure *	ETT11 ETT74 ETT47	(8))
Concentrate Flow Meter (2)	→	Dfo06a
Permeate Flow Meter (2)	→	Dfo06a
Activated Carbon Filter (2)	FAW2510-	Ac14

Specifications

	Eliminator Dual IV
Permeate Production @ A Flux Of 18.5	4.0 Gpm Each Side
Average Rejection	99.0 %
Recovery Each (Without Recycle)	42.9 %
Minimum Feed Flow Required	8.0 Gpm Each Side
Length – Floor Frame	46"
Width – Floor Frame	32"
Height – Floor Frame	65"
Weight – Floor Frame (With Two ACF's)	750 LBS

* OPTIONAL FEATURE

Table 4
Eliminator Dual VI

Common Part Numbers with Descriptions

Part	Part #	Description
Prefilter Housing (2)	HPO05	12.75" X 7.25" (BIG BLUE)
Prefilter Cartridge (2)	PFC03	10"L X 4.5"D / 5 MICRON
Inlet Solenoid – 220v (2)	GCV100C	NORM CLOSED, 1.0 IN/OUT, BRASS
Pump/Motor Assembly (2) 60hz Standard 60hz Three Phase * 50hz Single Phase * 50hz Three Phase *	 DPM120 DPM150 - -	MULTI-STAGE CENTRIFUGAL, S/S 230V /1PH / 60HZ / 3.0HP 230-460V / 3PH / 60HZ / 3.0HP 220V / 1PH / 50HZ / 3.0HP 380-415V / 3PH / 50HZ / 3.0HP
Pump Throttle Valve (2)	VGS03	GLOBE VALVE, 1.0 IN/OUT, 316 S/S
Physical Water Conditioner (2)	RT-1000-KSPL	REDUCES MEMBRANE SCALING DUE TO HARDNESS
Concentrate Control Valve (2)	VGS03	GLOBE VALVE, 1.0 IN/OUT, 316 S/S
Concentrate Pressure Gauge (2)	DGO02S	0-300 PSI, 2.5"D, BRASS INTERNALS
Concentrate Recycle Valve	BLV12	NEEDLE VALVE, .75 IN/OUT, 316 S/S
Flush Solenoid	GCV075C	NORM CLOSED, .75 IN/OUT, BRASS

Additional Parts

Part	Part#	Eliminator Dual VI
Pressure Vessel, 4"X40", F/G Pressure Vessel, 4"X40", S/S	HEF64WC HES19	(12)
Pressure Vessel Clamps, F/G Pressure Vessel Clamps, S/S	CH-9PW HEA40	(24)
Membrane, 4"X40", Standard Membrane, 4"X40", Cold Water Membrane, Xtra Low Press *	ETT11 ETT74 ETT47	(12)
Concentrate Flow Meter (2)	→	DFO06A
Permeate Flow Meter (2)	→	DFO06A
Activated Carbon Filter (2)	FAW2510-	AC16

Specifications

	Eliminator Dual VI
Permeate Production @ A Flux Of 18.5	6.0 GPM EACH SIDE
Average Rejection	99.0 %
Recovery Each (Without Recycle)	42.9 %
Minimum Feed Flow Required	14.0 GPM EACH SIDE
Length – Floor Frame	46"
Width – Floor Frame	32"
Height – Floor Frame	65"
Weight – Floor Frame (With Two ACF's)	800 LBS

* Optional Feature

General Overview of Components

Activated Carbon Filter

All Eliminator models are equipped with an automatic backwashing activated carbon filter (ACF) designed to remove oxidizing agents such as chlorine or chloramines from the feed water. Exposure to oxidizing agents will cause a continual degradation of the membrane, which will result in poor permeate quality. It is recommended that the feed water after the ACF be tested once per week for residual oxidizing agents. The carbon in the ACF must be replaced if any residual oxidizing agents are detected. Refer to Appendix B for information about the control valve on your ACF.

Prefilter

The 5 micron prefilter located in the feed of your Eliminator is designed to remove small amounts of suspended solids from the feed water. It is recommended that the feed water cartridge be replaced on a regular basis, depending on the feed water quality, (usually once per month). A multimedia filter may be required for feed water containing higher levels of suspended solids.

Inlet Solenoid

Your Eliminator is equipped with an automatic inlet solenoid which will open when there is a demand for permeate (product) water. The inlet solenoid will be closed when there is no demand for permeate water, which will prevent flow through the system when your Eliminator is not in operation.

High Pressure Booster Pump

The high pressure booster pump is a stainless steel, multi-stage centrifugal pump/motor assembly designed to provide the pressure and flow required for your Eliminator to produce the amount of permeate listed in Tables1, 2, 3, and 4 (pages 7-10).

Pump Throttle Valve

The system operating pressure is the sum of the feed pressure and the booster pump pressure. The operating pressure of your Eliminator will decrease as the feed water temperature increases, which will result in an increase in pump flow due to the properties of the multi-stage centrifugal pump. The pump throttle valve is used to adjust the pump flow to compensate for differences in feed water temperature. To understand this concept, refer to Table 5. Note that with a centrifugal pump, the pump flow will decrease as the operating pressure increased.

The pump throttle valve should never be closed completely

Table 5
Centrifugal Pump Performance Chart

Pump Pressure	1.0HP	1.5 HP	3.0 HP
120 PSI	10.5 GPM	12.0 GPM	25.2 GPM
150 PSI	7.0 GPM	9.0 GPM	20.5 GPM
180 PSI	3.0 GPM	6.5 GPM	10.0 PSI

Physical Water Conditioner

The patented physical water conditioner uses multiple reversing polarity magnetic fields to alter the natural scale forming characteristics of hard water borne minerals. These dissolved minerals consist of both positively and negatively charged ions, which, under normal conditions, will bond together and form scale. If these altered minerals precipitate due to excess concentration, they will not combine to cause scaling. The conditioner is located in the plumbing just prior to the first membrane.

Concentrate Control Valve

The concentrate control valve is located in the plumbing after the last membrane. Its function is to increase the permeate production by raising the system back pressure.

The concentrate control valve should never be closed completely

Concentrate Recycle Valve (optional)

The concentrate recycle valve is plumbed from the feed side of the concentrate control valve to the suction side of the booster pump. Opening the recycle valve allows a portion of the concentrate water to go back through the system, increasing system recovery. This will also decrease permeate quality.

Pressure Gauges

All eliminators are equipped with a prefilter out pressure gauge, a first array feed pressure gauge (operating pressure), and a concentrate pressure gauge. These gauges are required for proper set up, and effective troubleshooting.

Permeate Flow meter

The permeate flow meter is an acrylic block flow meter that reads out in gallons per minute and liters per minute. The permeate flow meter is used to monitor the permeate production (good water) during system adjustment and during normal operation.

Concentrate Flow meter

The concentrate flow meter is an acrylic block flow meter that reads out in gallons per minute and liters per minute. The concentrate flow meter is used to monitor the concentrate flow (drain water) during system adjustment and during normal operation.

Automatic Economy Permeate Flush (optional)

Automatic Economy Permeate Flush is controlled by the CE2 control, and provides a permeate flush of the membranes on each system shut down. The economy permeate flush requires an on site connection from a pressurized permeate source. A carbon filter must be included in the installation if an oxidizing agent is present in the permeate stream.

Automatic Forward Fast Flush (optional)

Automatic Forward Fast Flush is controlled by the CE2 control, which can be programmed to flush the membranes on a preset interval or upon each system shut down.

CE2 Electronic Control

The CE2 is a UL listed, programmable control with an automatic low flow protection system, a digital water quality meter, dry contacts for pretreatment lock out and liquid level controls, an on/off switch, and function LED's. Forward fast flush or permeate flush are optional.

System Low Flow Switch

All Eliminators are equipped with Low Flow Protection, which consists of a flow switch and the CE2 Electronic Control. The flow switch is located at the bottom (feed end) of the concentrate flow meter, (See Figure 5 below), and provides an on/off signal to the CE2 control. The two leads from the flow switch are connected to the low flow pair of control contacts (fourth pair from top) on the upper right, side of the PC board located inside the CE2 Electronic Control, (See Figure 6 below). During normal operation, when there is a demand for product water, the inlet solenoid will open allowing water to flow through the system. When the concentrate flow exceeds the minimum 1.5 gpm the flow switch will close which will signal the control to introduce electrical power to the pump/motor assembly. The control provides a one minute delay before electrical power is applied to the pump/motor. After the delay the system will start. If the concentrate flow drops below 1.5 gpm, the flow switch will open signaling the control to interrupt the electrical power to the pump/motor assembly, the system will shut down and the inlet solenoid will close. The control will automatically open the solenoid every five minutes as long as the demand for product water is not satisfied, allowing water to flow through the system. The flow switch will close when the concentrate flow exceeds the required 1.5 gpm, which will signal the control to apply electrical power to the pump/motor assembly.

Figure 5
Flow Switch

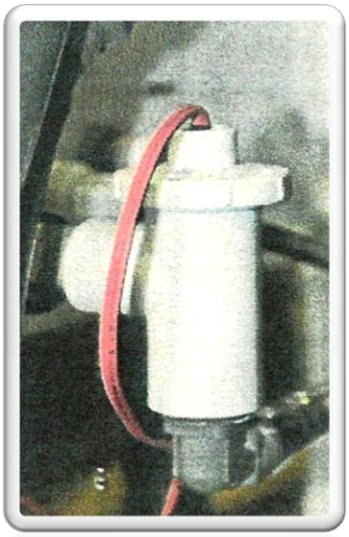
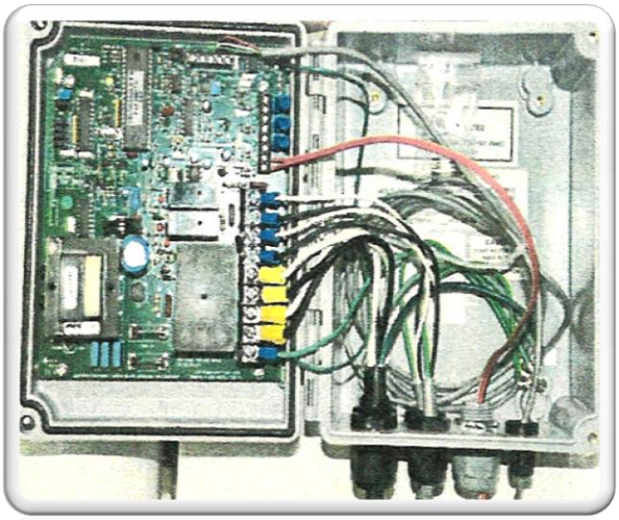


Figure 6
Flow Switch Connection



Feed Water Requirements

Nothing has a greater effect on a reverse osmosis system than feed water quality. For lasting performance it is important to supply the reverse osmosis system with the feed water quality consistent with the recommended feed water quality shown in Table 5 below. It is also important to feed the system the required amount of feed water, listed in Tables 1,2,3, and 4 (pages 7-10).

Table 6
Recommended Feed Water Quality

Hardness	< 1 grain	Iron	<0.01 ppm
Free Chlorine	0.0 ppm	Manganese	< 0.05 ppm
TDS	< 1000 ppm	Silica	< 1.0 ppm
pH	2 - 11	Organics	< 1 ppm
Maximum Turbidity	1.0 NTU	Temperature	35°F - 100°F
Maximum SDI	5.0		

The Eliminator Systems' projected output is based on feed water with a TDS of 1000 ppm or less and 77ºF (25ºC). Higher TDS and/or lower temperature will reduce system production. The projected output can usually be reached by configuring the system with cold water membranes, when feed water is colder than 77°F (25ºC). It is very important to meet feed water requirements. Failure to do so will cause membranes to foul or scale. Providing the proper pre-treatment and setting up the system correctly will extend the life of the membrane(s).

Reverse osmosis causes the concentration of impurities to collect in the concentrate stream. These impurities may precipitate (come out of solution) when their concentration reaches saturation. Precipitation can cause scaling and/or fouling of the membranes and must be prevented. Check your feed water chemistry. Provide the necessary pretreatment, and/or reduce the system recovery as required. Consult with your Crane Environmental service representative for pre-treatment recommendations.

Fouled or scaled membranes are not covered by warranty

Figure 7
Eliminator VI System Layout

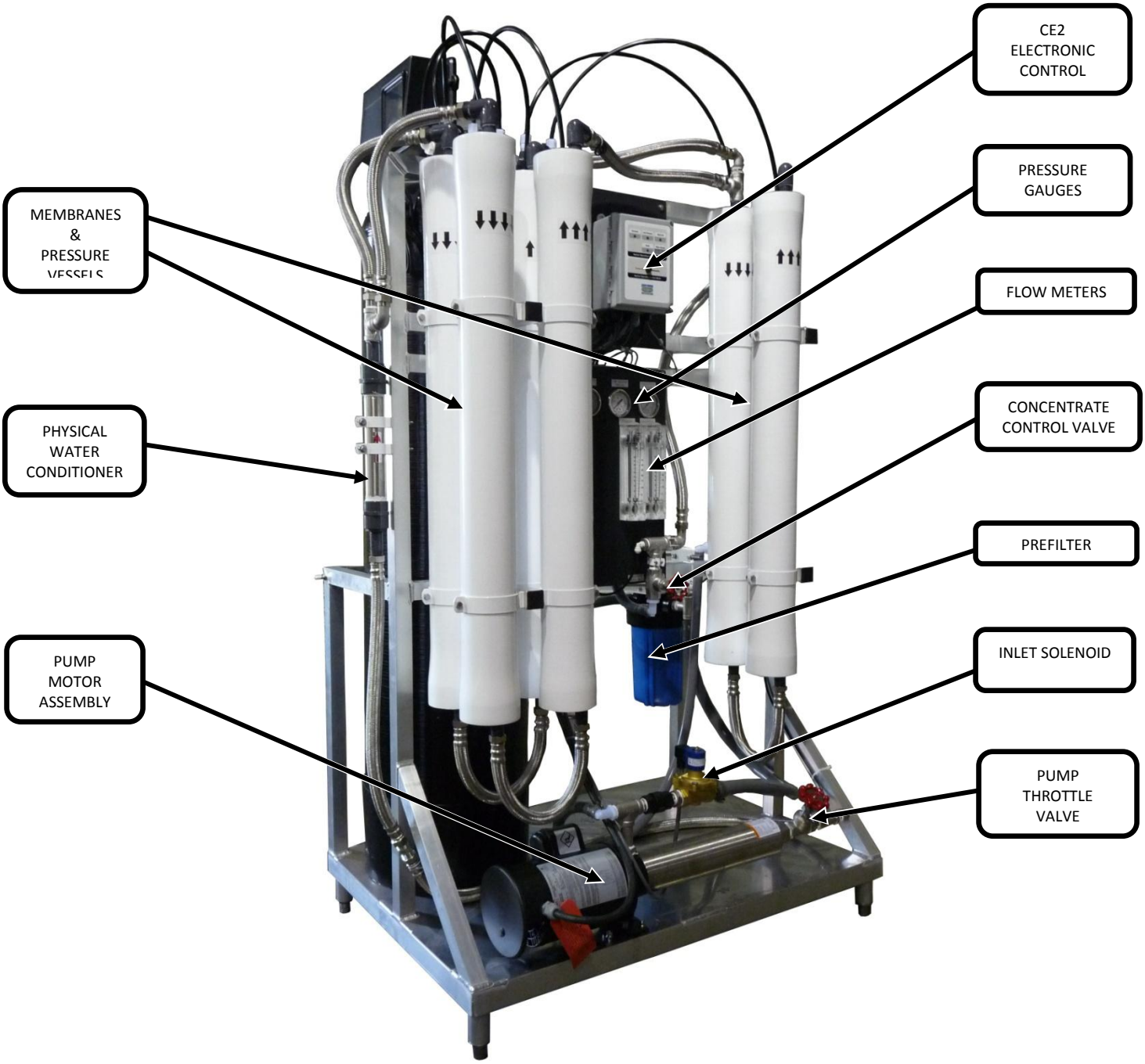
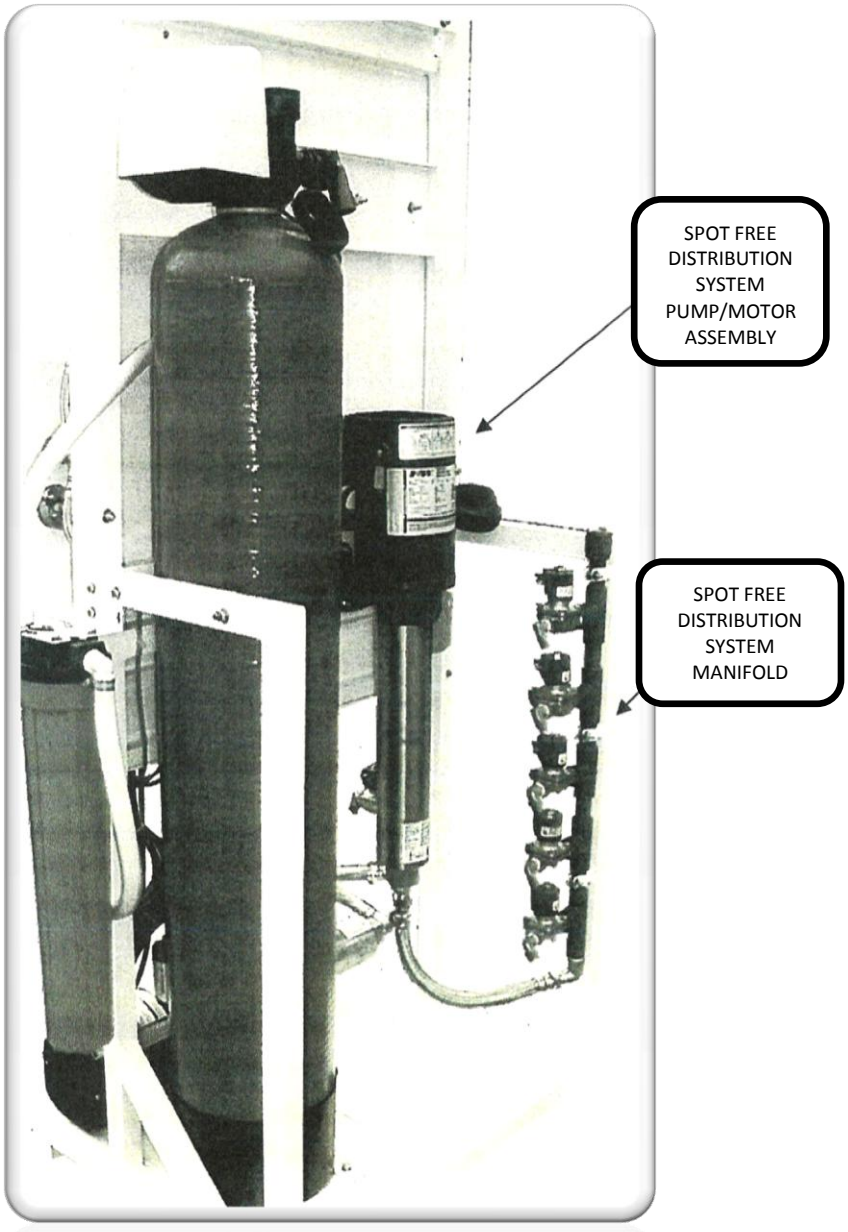


FIGURE 8
SPOT FREE DISTRIBUTION SYSTEM LAYOUT



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System P&ID

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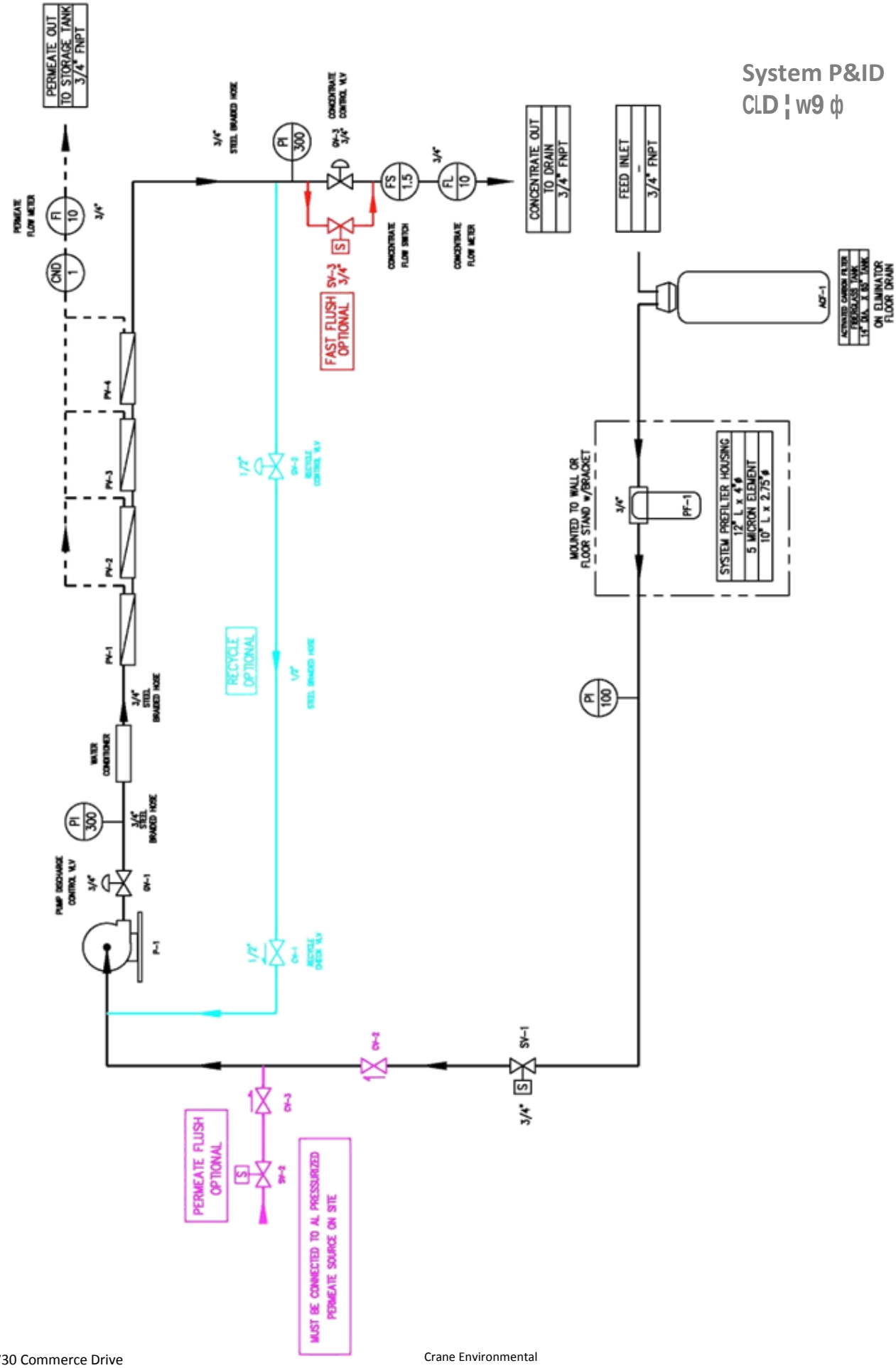

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System Installation

Site Requirements

1. For best performance and reliability, your Eliminator should be located in a climate controlled room. Freezing temperatures will cause damage to the unit.
2. Wall mount systems must be installed on a wall that can support the weight of the unit. The system must be level.
3. Floor mount systems must be installed on a level pad. A vibration isolator is recommended.

We recommend that a licensed electrician install your unit in accordance with all local and national codes.
Always verify the correct rotation of three phase motors. Reversal of any two power leads will result in the reversal of the motor rotation.

Electrical Requirements

General power requirements for all standard Eliminators are listed below. Single phase units come equipped with the required power plugs. Three phase units require special hard connections.

1. The standard pump/motor assembly installed on the Eliminator-I, Eliminator-II, Eliminator-III, or Eliminator-IV is a 230V/1ph/60hz/1.5hp. The minimum requirement for these systems is 230v/1ph/60hz, **20 amp service.** The activated carbon filter requires a separate 115v/1ph/60hz, 15 amp receptacle.
2. The standard pump/motor assembly installed on the Eliminator-V or Eliminator-VI is a 230v/1ph/60hz/3.0hp. The minimum requirement for these systems is a 230v/ph/60hz, **30 amp service.** The activated carbon filter requires a separate 115v/ph/60hz, 15 amp receptacle.
3. The Eliminator Dual IV is configured with two, 230,V1ph/60hz/1.5hp pump/motor assemblies, and two activated carbon filters. The minimum requirement for these systems is a 230v/1ph/60hz, **40 amp service.** The activated carbon filters each require a separate 115v/1ph/60hz, 15 amp receptacle.
4. The Eliminator Dual VI is configured with two, 230v/1ph/60hz/3.0hp pump/motor assemblies, and two activated carbon filters. The minimum requirement for these systems is a 230v/1ph/60hz, **60 amp service.** The activated carbon filters each require a separate 115v/1ph/60hz, 15 amp receptacle.
5. Your Eliminator will require an additional service if it is equipped with a Spot Free Distribution System. The size of the service will have to be determined individually, because the horsepower and number of pump/motor assemblies supplied on the system will vary based on each application.

We recommend that a licensed plumber install your Eliminator in accordance with all local and national codes.

Plumbing Requirements

General plumbing information for all standard Eliminators is listed below.

1. The feed supply to your Eliminator must meet or exceed the feed requirements listed in Tables 1, 2, 3, and 4 (pages 7-10). These requirements must be met in the dynamic state, (system running).
2. The feed line size must be equal to or larger than the input of the activated carbon filter.
3. The drain line size must be equal to or larger than the concentrate output line. Any backpressure in the drain line must be overcome during operation by the booster pump. A check valve must be installed on all drain lines plumbed in a vertical configuration to prevent siphoning and excessive back pressure after the unit turns off.

The drain line must be plumbed with an air gap. Do not feed the drain line down inside the drain.

4. The permeate line size must be equal to or larger than the system permeate output line. Any backpressure in the permeate line must be overcome during operation by the booster pump. A check valve must be installed on all permeate lines plumbed in a vertical configuration to prevent siphoning and excessive back pressure after the unit turns off.

The permeate line must be plumbed with an air gap. Do not feed the permeate line down inside the permeate tank.

Connections

All Eliminators come from the factory pre-wired and pre-plumbed where ever possible. However, there will be some field connections required that cannot be avoided. All wall mount units will be shipped with the activated carbon filter and prefilter housing packaged separately; therefore, they will require on site connections. Refer to the P&ID (Page 17) to determine the correct sequence of components. Floor mount units will be configured with the activated carbon filter and prefilter housing installed on the frame. The following plumbing connections will have to be made on site.

Activated carbon filter inlet - 1" male NPT
Activated carbon filter outlet (wall mount only) - 1" male NPT
Activated carbon filter drain line - *5/8"* ID flexible tube
RO permeate (Eliminator I and II) - *1/2"* male NPT
RO permeate (Eliminator III, VI, Dual IV & Dual VI) - 3/4" male NPT
RO concentrate (all Eliminators) - 3/4' male NPT

Permeate Atmospheric Storage Tank Connections

To ease on site installation, Crane Environmental's atmospheric storage tank selections may be ordered with the required upper and lower bulkhead fittings, and liquid level controls already installed. It will be necessary to adjust the level controls for the desired operation based on the required start and stop levels and differentials. Connect the permeate line to one of the upper bulkhead fittings. An additional upper bulkhead fitting is recommended to serve as an overflow to drain. The lower bulkhead fitting is used to supply the distribution system.

Level control Connections

Red level controls (on when down) are used to control the Eliminator. One red level control is supplied with each Eliminator I, II, III, IV, V, and VI. For these Eliminators, the two wires from the level control are connected to the "Tank Full High" pair of control contacts located on the upper right side of the PC board inside of the CE2 electronic control. Refer to Appendix "A", CE2 Electronic Control Manual, for additional information. Two red liquid level controls are supplied with each Eliminator Dual IV and Eliminator Dual VI. Refer to the schematic supplied with each dual system for the proper connections. The blue level controls (off when down) are used to protect the distribution pump. Refer to the schematic supplied with each spot free distribution system for the proper connections.

Eliminator Dual IV and Eliminator VI Operation

Both Eliminator Dual systems consist of two reverse osmosis systems. The Eliminator Dual IV includes two Eliminator IV systems, and the Eliminator Dual VI includes two Eliminator VI systems. Each side of the dual system is configured with an independent activated carbon filter, prefilter, inlet solenoid, pump/motor assembly; throttle valve, physical water conditioner, set of pressure vessels and membranes, concentrate control valve, pressure gauges and flow meters. They share one concentrate output and one permeate output. The two RO systems are controlled by one UL listed CE2 electronic control, which will alternate the RO systems on start up, and will utilize signals from two liquid level controls to initiate single or dual operation based on permeate water demand. The two level controls are installed at different levels in the atmospheric storage tank, (upper and lower). The positions of the level controls are determined by the unique requirements of each application. The upper level control is connected to the pair of contacts in the CE2 electronic control labeled "Tank Full High". A jumper should be connected across the pair of contacts labeled "Tank Full Low". The lower level control is connected to the contacts labeled #8 and #4 on the separate terminal board in the CE2 electronic control. On initial start up, (empty atmospheric storage tank condition), the CE2 electronic control will start both RO systems. Both RO systems will run until the atmospheric storage tank is full. The upper level control will signal the RO systems to shut down on each tank full condition. The CE2 electronic control will initiate a timed permeate flush after each tank full shut down. As the atmospheric storage tank empties, the upper level control will signal the CE2 electronic control to start one RO system, (the RO systems are started alternately). If one RO system can satisfy the demand, the upper level control will signal the RO system to shut down on tank full condition, and the timed permeate flush will follow the tank full shut down. The other RO system will start up on the next demand for permeate water. If one RO system cannot satisfy the demand, the second RO system will be activated by a signal from the lower level control, and both RO systems will run until the atmospheric storage tank is full. The timed permeate flush will follow the tank full shut down.

System Start-Up Procedures

The activated carbon filter must be hydrated for 12 to 24 hours prior to installation. Additionally, you must backwash and flush the carbon filter until the discharge is clear and free of carbon fines. Carbon fines will foul the membranes.

1. Inspect your Eliminator carefully, paying close attention to all electrical and plumbing connections. Your Eliminator is inspected and operationally tested prior to shipment; however, some connections may loosen during shipping.
2. Insure that your feed, concentrate and permeate plumbing connections are connected correctly.
3. Insure that your feed water supply is turned on.
4. Insure that your electrical connections are correct.
5. Open the throttle valve and concentrate control valve completely counterclockwise. If the system is equipped with recycle, adjust the recycle valve completely closed (clockwise).
6. Switch the On/Off switch on your CE2 electronic control to the "On" position. If there is a demand for permeate water (red level control down), the inlet solenoid will open, your concentrate flow meter should indicate concentrate flow, and your concentrate pressure gauge should display a pressure slightly lower than the feed pressure. After approximately eight seconds, the booster pump/motor will start. If the system fails to start, or it turns off prematurely, refer t the trouble shooting section of this manual on page 26.
7. Check for leaks. Generally, tightening fittings is not recommended. Remove, retape and reinstall the leaking fittings. **Do not over tighten fittings.**
8. Allow the system to continue to run without any adjustment for twenty to thirty minutes, to flush membrane preservative and air from the system.
9. Proceed with the following steps to adjust the system to the predetermined permeate production. The predetermined permeate production is dependent on the number of membranes on the system, the feed water conditions, and the requirements of the application. Always make slow, small adjustments. Never exceed the pressure rating of the system components.
   a) Adjust the concentrate control valve clockwise, monitoring the permeate flow meter and first array feed pressure gauge, until the correct permeate production is attained.
   b) If the concentrate flow is too high (excessive waste), adjust the pump throttle valve clockwise to reduce the system flow and then readjust the concentrate control valve for the proper permeate flow. This procedure may need to be repeated several times to reach the desired permeate and concentrate flows. Good design dictates that a minimum flow rate of 4-5 gpm be maintained across each 4" diameter membrane.

Note: Adjustment of any valve will change the operating pressure which will in turn change the permeate flow. It is recommended to make slow, small adjustments to reach the desired permeate and concentrate flows.

Scheduled Maintenance

Generally, reverse osmosis systems require very little scheduled maintenance. It is extremely important to provide and maintain the required pretreatment, and to set up the system properly. Following these simple requirements will result in extended membrane life.

Scaled or fouled membranes are not covered by warranty

Table 7
Scheduled Maintenance

Function	Frequency
Perform a thorough visual inspection of the system. Check for leaks and physical damage.	Daily
Perform a thorough operational inspection of the system. Record the pressures and flows on your system log sheet, (See the example in figure 10, page 23). The information on the log sheet will be valuable for future troubleshooting	Daily
Perform a test for residual oxidizing agents (chlorine) in the feed after the activated carbon filter. (for applications with oxidizing agents in the feed) Residual oxidizing agents will degrade the membranes and will result in poor permeate quality.	Weekly
Check all pretreatment for proper operation	Weekly
Replace the prefilter cartridge	Monthly

Figure 10
Operation Log

COMPANY:			DATE OF START-UP				
LOCATION:			DATE OF LAST CLEANING:				
WEEK OF:			CLEANING FORMULATION:				
MACHINE SERIAL #:							
DATE							
TIME							
HOURS OF OPERATION							
CARTRIDGE FILTER INLET PRESSURE (psi)							
DIFFERENTIAL PRESSURE (psi)							
PERMEATE PRESSURE (psi)							
FEED PRESSURE (psi)							
CONCENTRATE PRESSURE (psi)							
DIFFERENTIAL PRESSURE (psi)							
PUMP DISCHARGE PRESSURE (psi)							
PERMEATE FLOW (GPM)							
CONCENTRATE FLOW (GPM)							
FEED FLOW (GPM)							
RECOVERY (%)							
FEED TEMPERATURE (^{o}F)							
FEED CONDUCTIVITY (mg/L)							
PERMEATE CONDUCTIVITY (mg/L)							
REJECTION (%)							
FEED pH							
PERMEATE pH							
SCALE INHIBITOR FEED (PPM)							
ACID FEED (PPM)							
SODIUM BISULFITE FEED (PPM)							
FEED WATER: IRON (mg/L)							
FREE CHLORINE (mg/L)							
HARDNESS (PPM CaCO3)							
TURBIDITY (NTU)							

Membrane Removal and Replacement

In most applications, providing and maintaining the proper pretreatment and keeping your reverse osmosis system adjusted correctly will extend the life of your membrane(s) for three to five years or longer. However, it will be necessary to replace membranes during the life of your Eliminator because of the gradual membrane degradation during normal use. Membrane degradation will be evidenced by a slow reduction in permeate quantity and/or quality over time, which can be addressed initially by increasing the system operating pressure. This compensation will be limited to the centrifugal pump curve, the extent of the membrane degradation, and the permeate quantity and quality required by the application.

It is recommended that the membranes be removed and reinstalled in the direction that water flows through the pressure vessel

Membrane Removal and Replacement

There is a "v" shaped brine seal installed on the feed end of the each membrane which serves to block the feed water from flowing around the membrane, forcing all of the feed water to flow through the membrane. Installing the membrane in the opposite direction may result in damaging the brine seal, which will allow feed water to bypass the membrane. This will significantly reduce permeate production.

1. Disconnect the electrical power and turn off the water supply prior to starting the membrane removal process.
2. Remove all hoses and fittings from the end caps. Remember to note the location of the fittings.
3. Remove the two clamps that secure the pressure vessel to the frame. Remove the pressure vessel from the frame and place it on a clean work surface. It would be difficult to remove and replace the membrane in the direction of water flow, if the pressure vessel is left on the frame. It is important to note the direction of water flow indicated by the arrows on the outside of the pressure vessel. The pressure vessels must be reinstalled in the same orientation.
4. Clean and lubricate the inner wall of both ends of the pressure vessel with a water based lubricant.
5. Remove both end caps from the pressure vessel. Remember to note the orientation of the end caps.
    a) Stainless Steel Pressure Vessel – remove the "C" clamps from both ends of the pressure vessel. The end caps can be removed by hand.
    b) Fiberglass Pressure Vessel – remove the retaining plates from both ends of the pressure vessel using the correct size Allen wrench. It will be necessary to pull the end caps from each end using a puller. It is also possible to push the end caps out of the ends of the pressure vessel. Be careful not to damage the end caps or the rims of the pressure vessel.
6. Remove the membrane from the pressure vessel in the direction of water flow, as indicated by the arrows on the outside of the pressure vessel.

7. Prepare the components for the membrane installation. Clean the pressure vessel and end caps. Inspect the inner and outer o'rings on both end caps. Replace the o'rings as required. Lubricate both ends of the inner wall of the pressure vessel and the inner and outer o'rings on both end caps.

Failure of an inner o'ring will result in poor quality permeate. Failure of an outer o'ring will cause an external leak.

8. Install one end cap into the discharge end of the pressure vessel using the appropriate retainer, ("C" clamp or retainer plates). It may be necessary to tap the end cap in with a rubber mallet. With the pressure vessel in a vertical orientation and the discharge end down, carefully insert the new membrane into the feed end of the pressure vessel. The end of the membrane with the brine seal should be the last to enter the vessel. The brine seal is always installed on the feed end of the membrane with the open part of the brine seal (V) facing the feed end. Insert the membrane slowly until the product tube of the membrane seats into the product tube o'ring. Take care not to drop the membrane into the pressure vessel. This may damage the o'ring.
9. Install the remaining end cap into the feed end of the pressure vessel using the appropriate retainer.
10. Reinstall the pressure vessel on the frame. Be sure to follow the original direction of water flow.
11. Clean the fittings and apply new pipe tape to each fitting. Install the fittings and hoses being sure to follow the original configuration. **Do not over tighten.**
12. Open the pump throttle valve and concentrate control valve. Start the system and check for leaks.

New membranes often contain a preservative solution. Allow system to flush for at least thirty minutes to flush the preservative and air from the system.

13. Readjust the system in accordance with the Start Up section on page 21 of this manual.

Table 8
Troubleshooting Matrix

Symptom	Probable Cause	Corrective Action
CE2 electronic control function LED's do not light	1. No power to system 2. Blown fuses in CE2 control	1. Restore electrical power to system 2. Replace blown fuses in CE2 control
System cannot achieve the recommended operating pressure (1st array feed pressure) and concentrate pressure	1. System improperly adjusted 2. Pump/motor assembly damaged 3. Product tube o'rings damaged or missing causing feed flow to bypass to the permeate stream 4. Membrane(s) failed internally causing flow to bypass to the permeate stream	1. Readjust system in accordance with the System Start Up section on page 21 of this manual 2. Replace pump/motor assembly 3. Replace the product tube o'rings 4. Replace failed membrane(s)
System cannot achieve the recommended concentrate pressure. (recommended operating pressure can be achieved)	1. System improperly adjusted 2. Membrane(s) are scaled and/or fouled	1. Readjust system in accordance with the System Start Up section on page 21 of this manual 2. Replace membrane(s)
System shut down with low flow **LED lit on CE2 control**	1. System improperly adjusted 2. Prefilter cartridge restricted 3. Insufficient feed 4. Drain line restricted 5. Inlet solenoid failed to open	1. Insure that the pump throttle valve and/or the concentrate control valve are not completely closed 2. Replace prefilter cartridge 3. Restore feed 4. Clear drain line. The drain line must have an air gap 5. Replace inlet solenoid
Insufficient permeate production	1. System improperly adjusted 2. Membrane(s) installed incorrectly 3. Membrane(s) brine seal(s) defective causing feed flow to bypass the membrane(s) 4. Membrane(s) fouled and/or scaled	1. Readjust system in accordance with the System Start Up section of this manual 2. Insure that membranes are installed with the brine seals on the feed end 3. Replace defective brine seal(s) 4. Replace membranes
Poor permeate quality	1. System improperly adjusted 2. Product tube o'ring(s) leaking 3. Membrane(s) are fouled and/or scaled	1. Readjust system in accordance with the System Start Up section on page 21of this manual 2. Replace product tube o'ring(s) 3. Replace Membrane(s)
Excessive permeate production, **and poor permeate quality**	1. Product tube o'ring(s) leaking or missing causing feed flow to bypass to the permeate stream 2. Membranes failed internally causing flow to bypass to permeate stream	1. Replace Product tube o'ring(s) 2. Replace Membrane(s)

Appendix A:
CE2 Electronic Control Manual

CRANE

CRANE ENVIRONMENTAL

PURE *Water* MADE SIMPLE™

CE2 CONTROLLER W/FLUSH & TDS

CRANE ENVIRONMENTAL CE2 TECHNICAL DATA

SPECIFICATIONS

Controller:	UL/CUL listed Industrial Control Panel
Enclosure:	8 x 6 x 4 NEMA 4X fiberglass
Electrical requirement:	120/240VAC 50/60Hz 6 Watts
Environment:	-22°F(-30°C) to 140°F(60°C), 0-95% RH, non-condensing
Inputs:	Low Pressure - Closed to run Pretreat - Closed to run Tank Full High - Closed to run Tank Full Low - Closed to run
TDS:	199PPM and 999PPM as NaCl, temperature compensated
Outputs:	RO Pump - 120V/1HP, 240V/3HP Inlet Solenoid - 120/240V, 5A Flush Solenoid - 120/240V, 5A
Time delay:	RO Start - 8 seconds Tank Full - 5 seconds Tank Full Restart - 2 seconds Low Pressure - 4 seconds Pretreat - 4 seconds Auto Reset - 5 minutes Flush Interval - 10 hours Flush Time - 5 minutes TDS Shutdown Delay - 10 minutes

INSTALLATION/WIRING

The controller is shipped from the factory preset for 240VAC operation with cables for power, RO pump motor and inlet solenoid installed. If the unit is equipped with flush, a flush solenoid cable is also installed.

Power/Output Wiring

Verify that the controller is jumpered correctly for the operating voltage. The voltage jumpers are located in the lower left corner of the control board. For 240VAC operation, one jumper is installed between J4 and J5. For 120VAC operation, one jumper is installed between J3 and J4 and a second jumper is installed between J5 and J6. Connect the pump and solenoid cables to the end devices and install the correct plug on the power cable for the selected voltage.

> **NOTE:** The pump and solenoid outputs will be the same voltage as the controller.

Input Wiring

The TDS cell connects to P3 and the wiring is color-coded. Connect the low pressure, pretreat and level switches to the corresponding terminals of P2. The unit is configured for normally closed inputs. All inputs must be closed for the controller to run. If any input is unused, a jumper wire must be installed for that input before the unit will run.

> **NOTE:** These inputs are for dry contact switches only. Applying voltage to these inputs will damage the controller.

OPERATION

The controller has a two-position power switch to control the operating mode of the controller. With the switch in the left position, ‘POWER OFF’, the controller and all outputs are off. If the switch is moved to the right position, ‘AUTOMATIC’, the controller is in the automatic mode. In this mode, the controller operation is automatic and is controlled by the input signals.

Auto Mode

When the switch is placed in the ‘AUTOMATIC’ position, the inlet solenoid will operate and the controller will monitor the low pressure switch until a tank full condition exists. The RO pump will start after the RO start delay if no shutdown condition is present.

Low Pressure

If a low pressure condition occurs and the low pressure switch input opens for the low pressure delay time, the controller will turn off the pump due to a low pressure fault. The red Low Pressure lamp will light. If the auto reset jumper (J9) is in the A position, the controller will remain in the low pressure until reset. The controller is reset by placing the power switch in the “POWER OFF’ position for several seconds and then returning it to the ‘AUTOMATIC’ position.

Auto Reset

If the auto reset jumper (J9) is in the B position when a low pressure shut down occurs, the unit will attempt to restart after the auto reset delay. If the low pressure condition has cleared, the unit will continue to run normally. Otherwise, the unit will again shut down and the auto restart cycle will continue as long as the low pressure condition is active.

Pretreat

If the pretreat lockout switch opens for the pretreat delay time ,the unit will shut down for a pretreat condition. The amber Pre-treat lamp will light. The unit will remain shut down until the pretreat switch closes. The unit will then restart and continue to run normally.

Tank Full

The controller is designed to operate with either 1 or 2 tank level switches. When a tank full condition occurs, the unit will shut down and the amber Tank Full lamp will light. When the tank full condition clears, the unit will restart after the tank full restart delay.
If the unit is operated with only 1 level switch, the Tank Full Low input must remain jumpered. In this mode, when the tank full high switch opens for the tank full delay time the unit will shutdown. When the tank full condition clears, the unit will restart.
If the unit is operated with 2 level switches, the controller will run when both switches are closed. When the water level rises and the tank full low switch opens, the unit will continue to run. When the water level rises and the tank full high switch opens, after the tank full delay, the unit will shut down for tank full. As the tank level drops and the tank full high switch closes, the unit will remain shut down. When the level drops and the tank full low switch closes, the unit will restart.

NOTE: For both 1 and 2 tank level switch configurations, the float ball or level control switch contacts MUST BE NORMALLY CLOSED when no water is present in the tank.

Flush

If the flush option is installed, either of two modes of flush may be selected using jumper J11. If J11 is in the A position, the unit will enter a flush mode every 10 hours. This flush will occur whether the unit is running or not. When the flush occurs, the inlet and flush solenoids will open and the RO pump will start. The amber Flush lamp will light. The flush will last for 5 minutes.

> **NOTE:** A low pressure or pretreat condition will cancel the flush operation.
>
> **NOTE:** If the unit is shutdown for long periods of time due to a tank full condition, there is the possibility of tank overflow because of water produced during the flush cycle.

If J11 is in the B position, the unit will enter a 5 minute flush each time a tank full condition occurs. After the flush time has expired, the unit will shutdown for the tank full condition.

TDS

The 3 digit LED TDS display can be configured for either 0-199 or 0-999PPM. Two pin jumper S2 is used to select the proper range. Both jumpers must be in either the LO or HI position for proper operation.

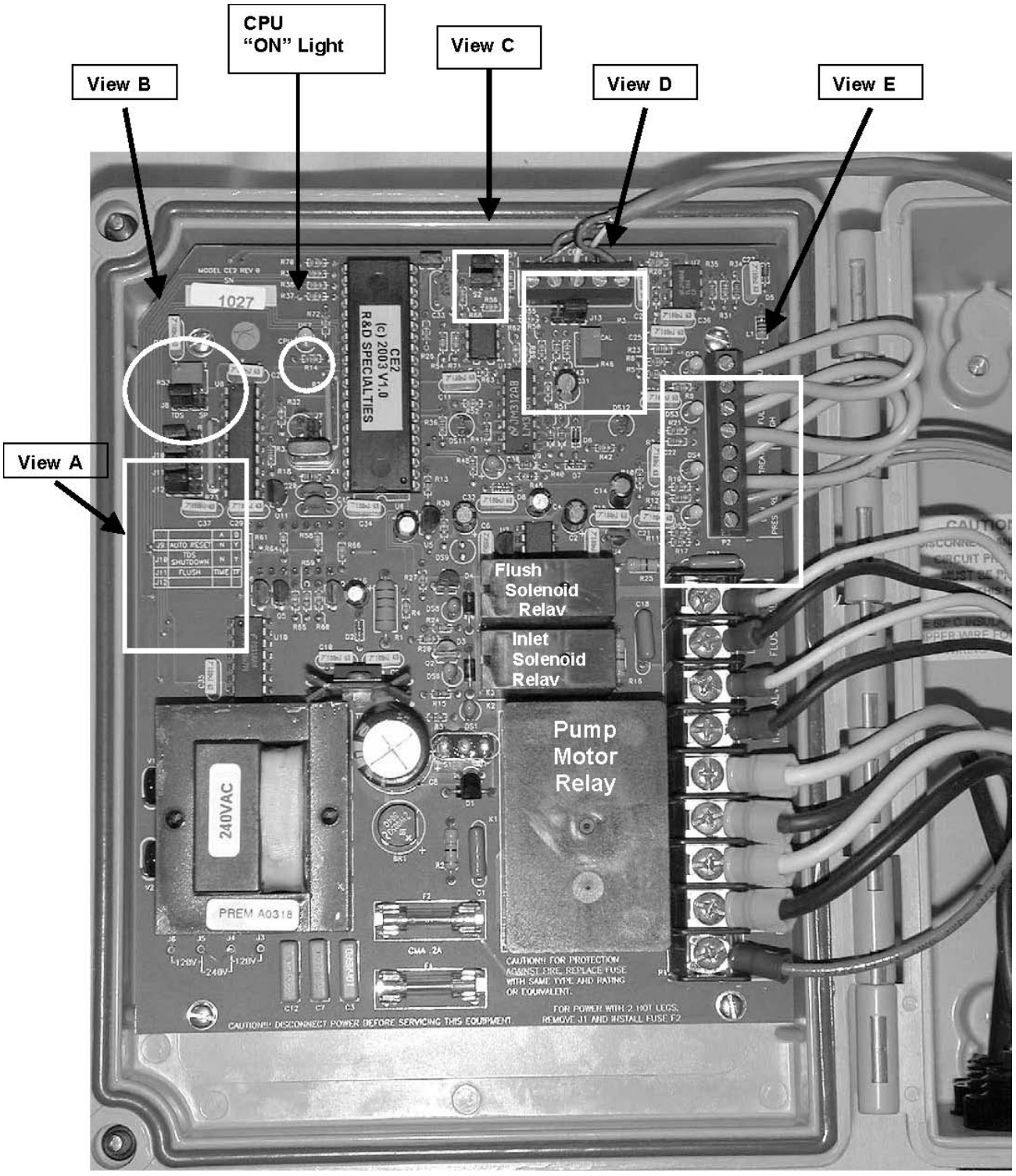
> **NOTE:** The unit is shipped calibrated for the low range. If the range is changed in the field, the unit must be recalibrated.

If the TDS reading exceeds the selected range, the display will show ‘uuu’ to indicate an overrange condition.

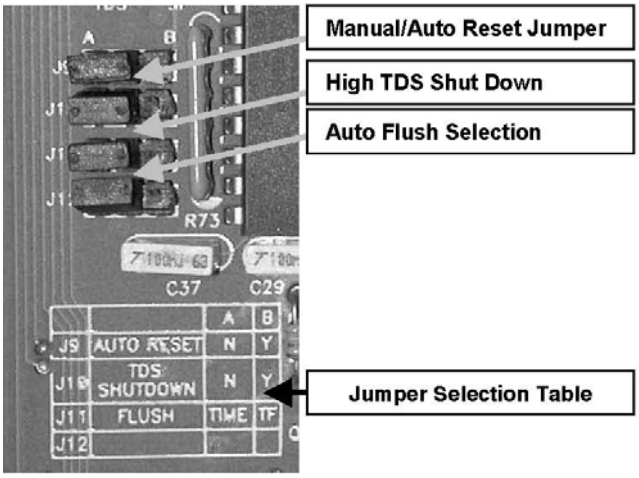
The unit may be calibrated with an on board calibration resistor or using standard solutions. To calibrate using the calibration resistor, disconnect the white wire from P3. Move jumper J13 to the A position. For the low range, adjust the CAL adjustment, R46 for a reading of 148. For the high range, adjust the CAL adjustment, R46 for a reading of 225. Move jumper J13 to the B position and reconnect the white wire to P3. To calibrate with a standard solution, place the cell in the standard and adjust the CAL adjustment for the correct reading.

A TDS limit can be enabled using the SETPOINT adjustment, R53. To set the limit, move jumper J8 to the B position. The display will now show the current setting for the setpoint adjustment. While J8 is in the B position, the display will briefly show ‘ccc’ to indicate that the display is showing the setpoint calibration value. Turn R53 to get the desired setpoint value. If the adjustment is turned to a value of 999, the setpoint limit is disabled. Move J8 to the A position to display the current TDS value. If the TDS value exceeds the setpoint, the TDS display will slowly blink to indicate a high TDS condition.

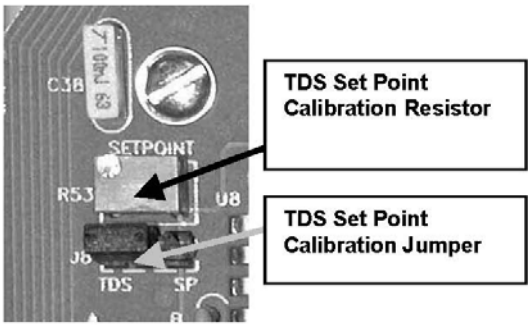
A high TDS shutdown can be enabled by moving J10 to the B position. When the shutdown is enabled and the TDS exceeds the limit, a 10 minute delay is started. If the TDS remains above the setpoint for this delay, the unit will shutdown. The TDS display will rapidly blink to indicate the cause of the shutdown. The unit will remain shutdown even if the TDS drops below the limit. The shutdown can be reset by moving the power switch to the off position for several seconds and then back to Auto.


CPU
"ON" Light
View B
View C
View D
View E
View A
Flush
Solenoid
Relay
Inlet
Solenoid
Relay
Pump
Motor
Relay
240VAC
1027
CE2
(c) 2003 V1.0
R&D SPECIALTIES
PREM A0318
CAUTION!! DISCONNECT POWER BEFORE SERVICING THIS EQUIPMENT
FOR POWER WITH 2 HOT LEGS,
REMOVE J1 AND INSTALL FUSE F2

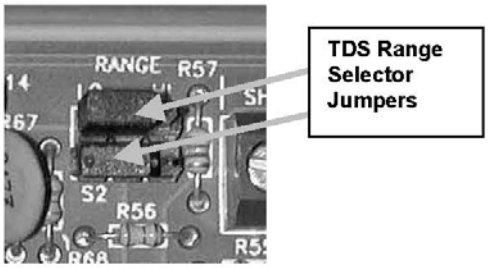
View A



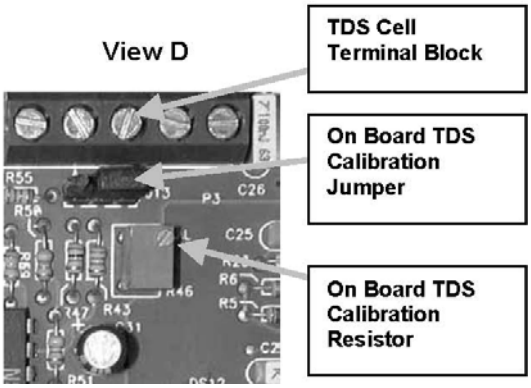
View B



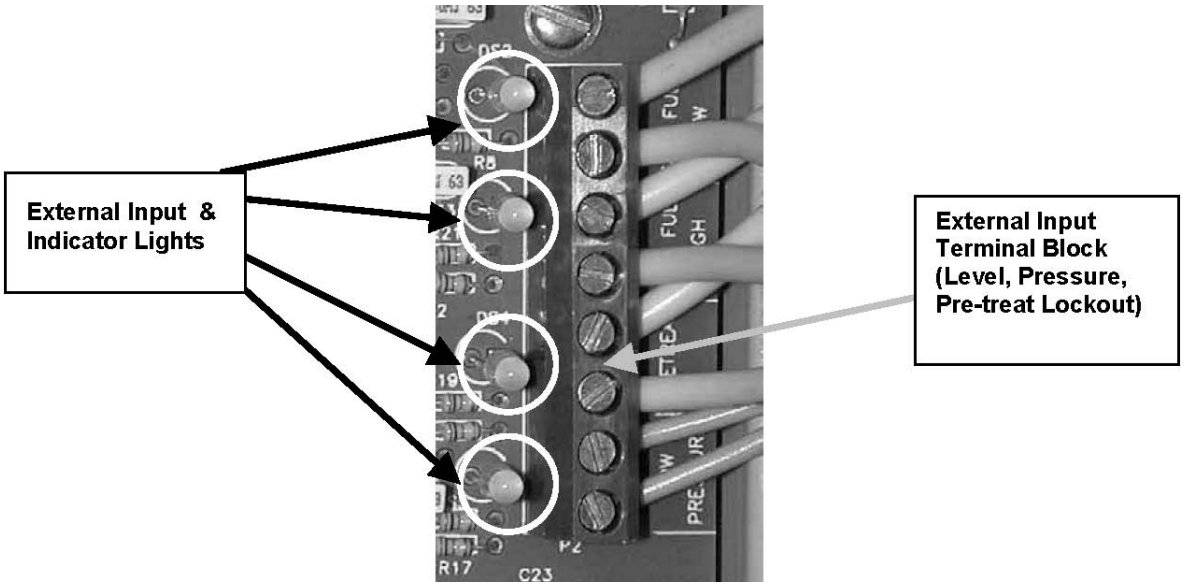
View C



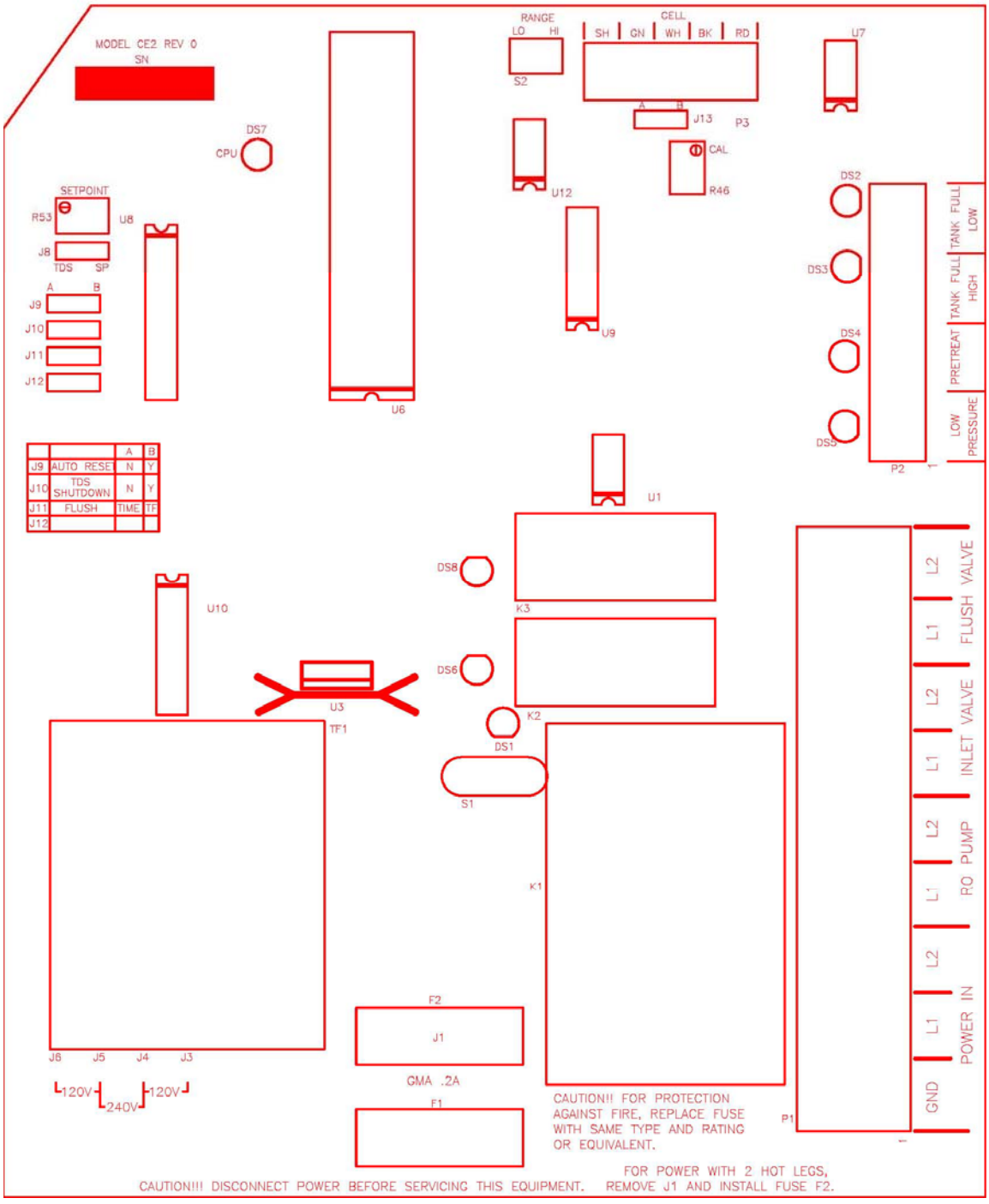
View D



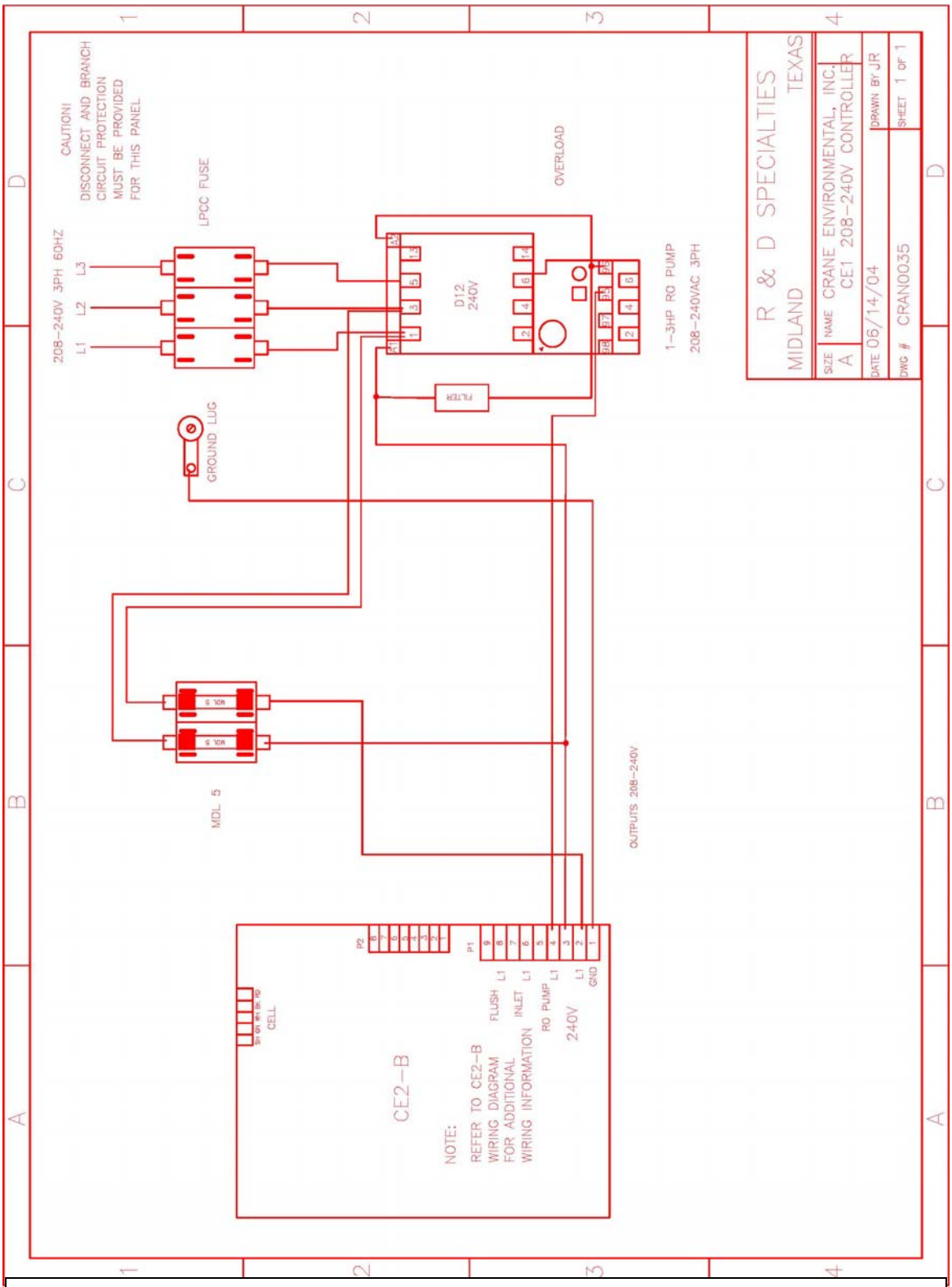
View E



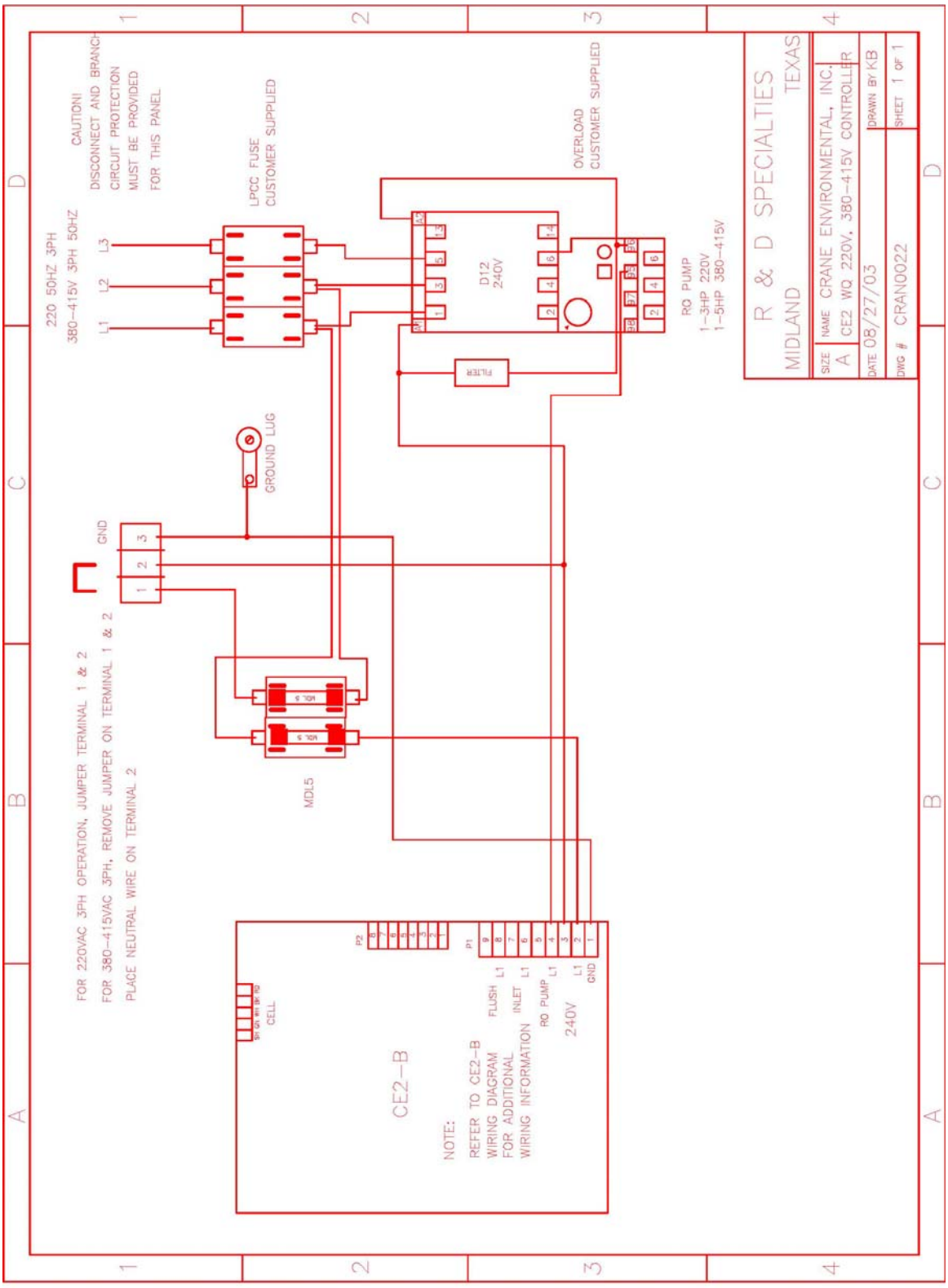
CE2 CONTROLLER W/FLUSH & TDS



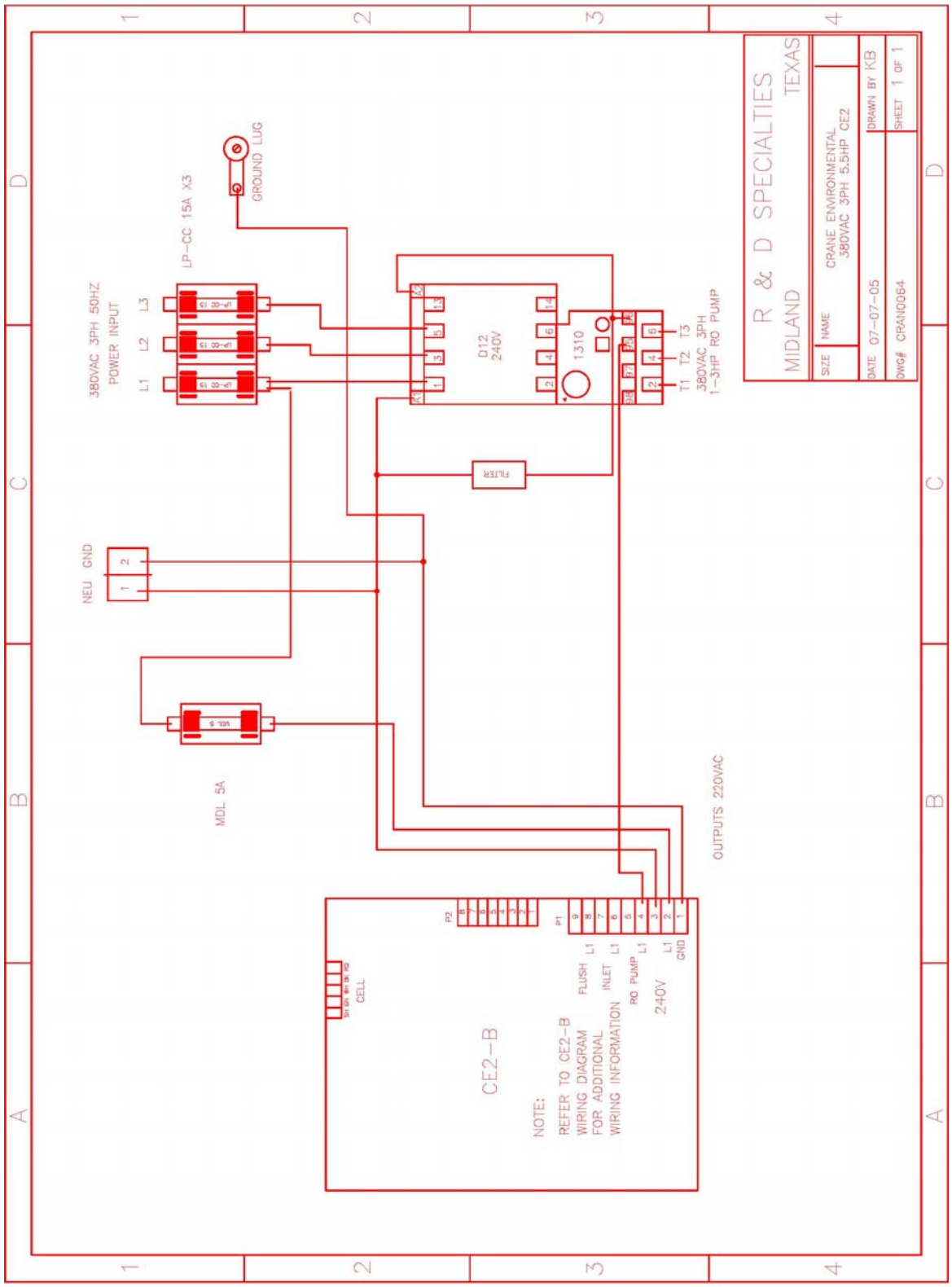
		A	B
J9	AUTO RESET	N	Y
J10	TDS SHUTDOWN	N	Y
J11	FLUSH	TIME	TF
J12			



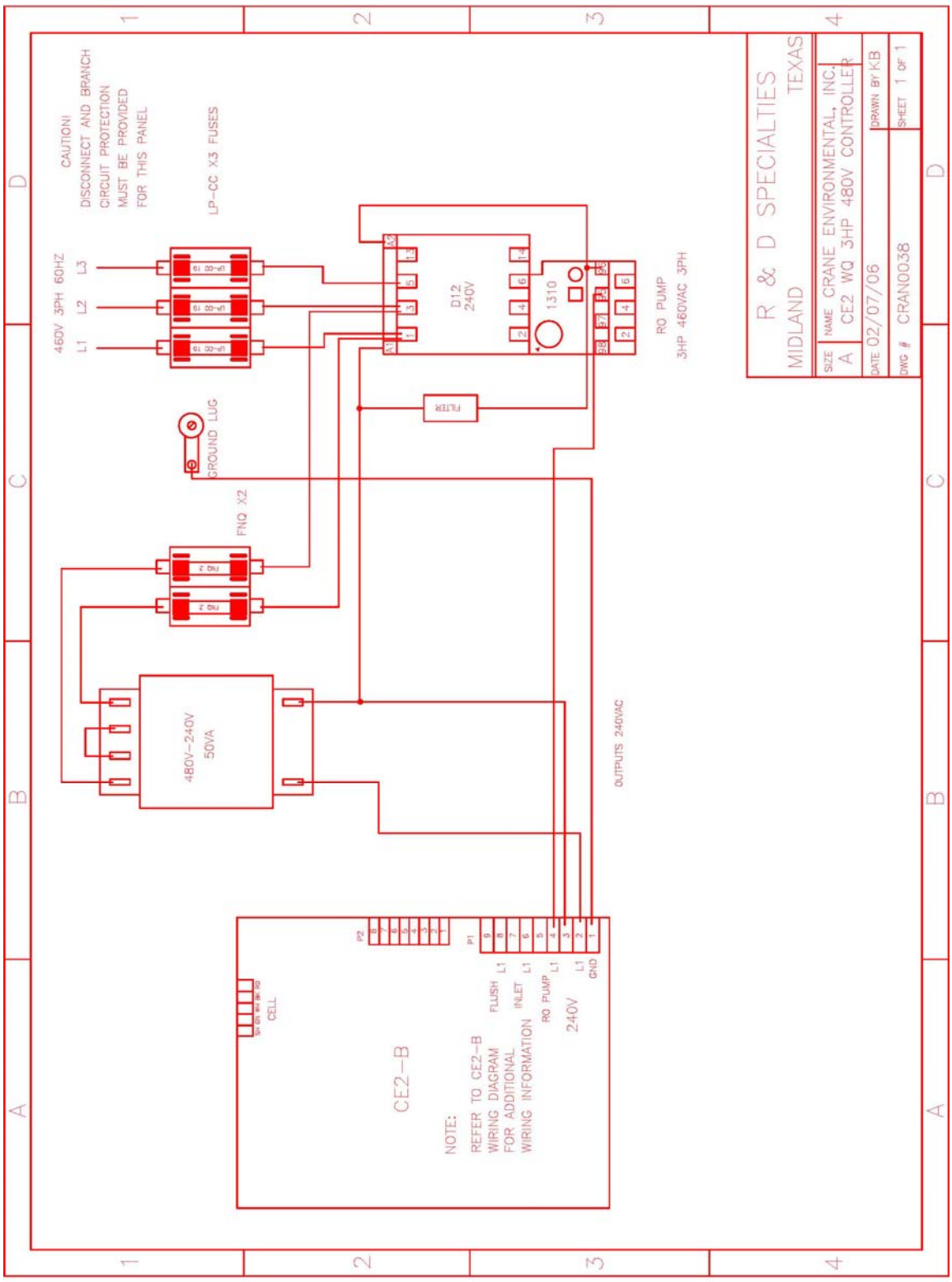
CE2 CONTROLLER W/FLUSH & TDS
208-230VAC, 3PH, 60HZ
1 – 3 HP



CE2 CONTROLLER W/FLUSH & TDS
380-415VAC, 3PH, 50HZ, 1-5HP
220V, 3PH, 50HZ, 1-3HP



CE2 CONTROLLER W/FLUSH & TDS
380VAC, 3PH, 50HZ
1 - 3HP



CE2 CONTROLLER W/FLUSH & TDS
460VAC, 3PH, 60HZ
3HP

Appendix B:
Booster Pump Operation & Maintenance Manual

Please read and save these instructions. Read carefully before attempting to assemble, install, operate or maintain the product described. Protect yourself and others by observing all safety information. Failure to comply with instructions could result in personal injury and/or property damage! Retain instructions for future reference.

Pressure Booster Pumps

Description

Pressure booster pumps increase water pressure from city mains or private water systems. Applications include providing high water pressure for washing buildings, dairy walls or floors, hog parlors, poultry houses, rinsing or spray cooling equipment, lawn sprinkling and insecticide spraying. Stainless steel models can handle salt-water and contaminated water in reverse osmosis filter and other aggressive water applications.

Single-phase models are equipped with a capacitor start, thermal protected motor. Three-phase models require separate overload protection.

Unpacking

When unpacking the unit, inspect carefully for any damage that may have occurred during transit.

⚠CAUTION ***Use pump with clear water only.***

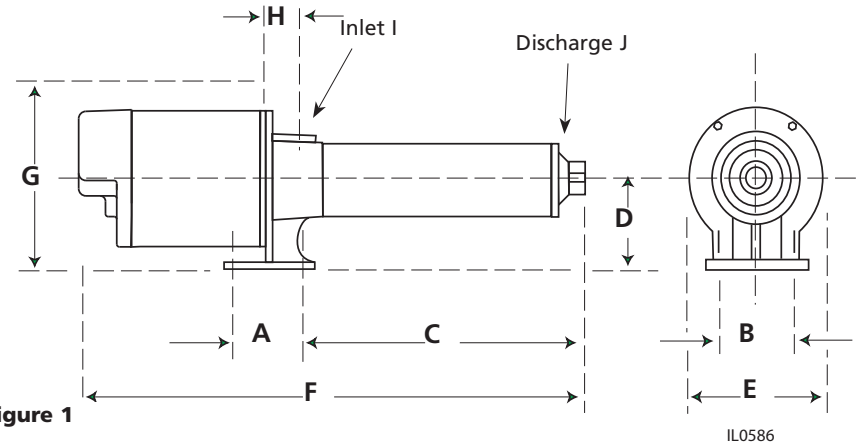


Figure 1

60 Hz Motor Driven Pump Dimensions (See Figure 1) •												Chart A
Stainless Steel Fitted	Stainless Steel 3 Phase	Dimensions In Inches										Lbs. Ship Wt.
		A	B	C	D	E	F	G	H	I	J	
DPM02	-	3-1/4	3-3/4	13-3/8	3-7/8	6-1/2	23-7/8	7-1/2	1-7/16	3/4	3/4	42
DPM14	DPM121	3-1/4	3-3/4	16-5/16	3-7/8	6-1/2	27-3/16	7-1/2	1-7/16	3/4	3/4	48
DPM16	DPM52	3-1/4	3-3/4	18-1/8	3-7/8	6-1/2	29-5/8	7-1/2	1-7/16	3/4	3/4	51
DPM120	DPM150	3-1/4	3-3/4	18-1/2	3-7/8	6-1/2	30-1/2	7-1/2	1-7/16	1	1	54
50 Hz Motor Driven Pump Dimensions (See Figure 1) •												
DPM05	DPM03	3-1/4	3-3/4	23-1/2	3-7/8	6-1/2	35	7-1/2	1-7/16	3/4	3/4	54
DPM04	-	3-1/4	3-3/4	24-1/16	3-7/8	6-1/2	36-1/16	7-1/2	1-7/16	3/4	3/4	56

(*) NOTE: Figure 1, holes in mounting base are open slotted 3/8" wide x 1/2" long; dimension A & B are centerline from these open slotted holes. These holes are suitable for 1/4 to 3/8" bolts.

Dimensions also apply to three phase models.

PERFORMANCE SPECIFICATIONS

PRESSURE ADDED - PSI†				10	20	40	60	80	100	120	140	160	180	200	Max. Press. PSI	Suction Pipe Tap NPT	Disch. Pipe Tap NPT
Stainless Steel Fitted	Powder-Coated Cast Iron Fitted	HP	Stage	Output - Gallons per Minute													
DPM02	-	3/4	12	14.0	13.4	12.2	10.9	9.5	7.9	6.0	3.6				152	3/4"	3/4"
DPM14/DPM121	-	1	14	*	*	14.5	13.4	12.3	11.2	9.8	8.3	6.3	3.3		185	3/4"	3/4"
DPM16/DPM52	-	1-1/2	16	*	*	14.7	13.8	12.9	11.9	10.8	9.7	8.2	6.6	4.3	211		
DPM120	DPM150	3	14	*	*	32.2	30.6	28.9	27.0	24.8	22.0	18.4	12.2		190	1"	1"

† Example: If DPM02 pump is connected to supply line of sufficient capacity, carrying water at 40 PSI, and the output of the pump is held to 12.2 GPM by a gate valve, the pump will add 40 PSI to line pressure for a total output pressure of 80 PSI.

* Operation of pump in this range may result in reduced pump life and/or motor damage.

To keep pump and seal lubricated, a minimum flow of 1.5 GPM must always be maintained through the pump.

Motor voltage: Single Phase 1/3 - 2 HP - 115/230; 3 HP - 230V 60 Hz.

Three Phase 1/2 - 2 HP - 208-230/460, 50/60Hz.

Three Phase 3 HP - 208-230/460, 60 HZ

Single Phase Motor Data 60HZ — Chart C

Single Phase† 60 Hz 3450 RPM Capacitor Start

HP	Motor Voltage	Factory Connected Motor Voltage	Service Factor Motor Amps		Locked Rotor Motor Amps		Code Letter
			115V	230V	115V	230V	
3/4	115/230	230V	14.0	7.0	52.0	26.0	K
1	115/230	230V	18.0	9.0	78.0	39.0	L
1-1/2	115/230	230V	21.0	10.5	98.0	49.0	J
2	115/230	230V	25.0	12.5	116.0	58.0	H
3	230	230V	-	13.5	-	53.0	D

Single Phase Motor Data 50HZ

Single Phase† 50 Hz 2850 RPM Capacitor Start

1	115/230	230V	16.4	8.2	72.0	36.0	K
1-1/2	115/230	230V	23.6	11.8	104.0	52.0	K
2	230	230V	-	13.2	-	55.0	H

†Thermal overload protector - automatic reset

Three Phase Motor Data							Chart D
Three Phase† 60/50 Hz 3450/2850 RPM Capacitor Start							
HP	Motor Voltage	Factory Connected Motor Voltage	Service Factor Motor Amps		Locked Rotor Motor Amps		Code Letter
			230V	460V	230V	460V	
1	208-230/460	230V	4.5	2.25	26.9	13.5	K
1-1/2	208-230/460	230V	5.7	2.85	33.5	16.8	K
2	208-230/460	230V	7.4	3.70	44.0	22.0	K
3††	208-230/460	230V	9.8	4.90	48.0	24.0	D

††3 HP, 3 Phase motor operable on 60Hz only.

Material Construction	Chart E
Component	Stainless Steel Models
Motor	Rear access - Nema 56J face
Bearings	Ball-ball, permanently lubricated
Impellers	Noryl with 304 stainless steel bearing insert
Diffuser	Noryl
Diffuser plates	Delrin
Pump shaft	303 Stainless steel
Pump shaft coupling	316 Stainless steel
Pump shell	304 Stainless steel
Discharge & inlet casting	304 Stainless steel
O-Rings	Viton
Seal composition	Carbon-ceramic, stainless steel spring and Viton

Minimum Wire Size Chart (Gauge)								Chart F
Motor HP	Volts	Phase	Distance In Feet From Motor To Service Panel					Breaker Size (Amps)
			0-50	50-100	100-150	150-200	200-300	
			Wire Size					
3/4	115/230	1	12/14	12/14	10/14	10/12	8/12	20/15
1	115/230	1	10/14	10/14	10/12	8/12	6/10	30/15
1 1/2	115/230	1	10/12	8/12	6/12	*/10	*/10	30/20
2	115/230	1	10/12	8/12	6/12	*/10	*/10	30/20
3	230	1	10	10	10	10	8	30
3/4	230/460	3	14/14	14/14	14/14	14/14	14/14	15/15
1	230/460	3	14/14	14/14	14/14	14/14	12/14	15/15
1 1/2	230/460	3	14/14	14/14	14/14	12/14	12/14	15/15
2	230/460	3	14/14	14/14	14/14	12/14	10/12	15/15
3	230/460	3	14/14	14/14	14/14	12/14	10/12	15/15

(*) Not economical to run in 115V, use 230V.

General Safety Information

Carefully read and follow all safety instructions in this manual and on pump. Keep safety labels in good condition. Replace missing or damaged safety labels.

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 if ignored.***

⚠WARNING ***Warns of hazards that CAN cause serious personal injury or death, if ignored.***

⚠CAUTION ***Warns of hazards that MAY cause minor personal injury, product or property damage if ignored.***

IMPORTANT: Indicates factors concerned with operation, installation, assembly or maintenance which could result in damage to the machine or equipment if ignored.

NOTE: Indicates special instructions which are important but are not related to hazards.

⚠WARNING

Hazardous voltage. Can shock, burn or cause death. Ground pump before connecting to power supply.

Wire motor for correct voltage. See "Electrical" section and Motor Data Charts C&D of this manual, and motor nameplate.

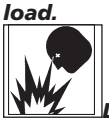
Ground motor before connecting to power supply.

Meet United States National Electrical Code and local codes for all wiring.

Do not handle a pump or pump motor with wet hands or when standing on a wet or damp surface or in water.

Follow wiring instructions in this manual when connecting to power lines.

⚠WARNING ***Always disconnect power source before performing any work on or near the motor or its connected load.***



Do not use to pump flammable or explosive fluids such as gasoline, fuel oil, kerosene, etc. Do not use in flammable and/or explosive atmospheres.

Hazardous pressure! Install pressure relief valve in discharge pipe. Release all pressure on system before working on any component.

1. Make workshop child proof - use padlocks, master switches; remove starter keys.
2. Wear safety glasses when working with pumps.
3. Wear a face shield and proper apparel when pumping hazardous chemicals.
4. Keep work area clean, uncluttered and properly lighted; replace all unused tools and equipment.
5. Provide guarding around moving parts.
6. Keep visitors at a safe distance from the work area.
7. Periodically inspect pump and system components.
8. Protect electrical cord. Replace or repair damaged or worn cords immediately.
9. Do not insert finger or any object into pump or motor openings.
10. Secure the discharge line before starting the pump. An unsecured discharge line will whip, possibly causing personal injury and/or property damage or puncture.

⚠CAUTION ***Do not touch an operating motor or engine. They are designed to operate at high temperatures.***

⚠WARNING ***This product contains chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.***

⚠WARNING ***Risk of Electric Shock. This pump has not been investigated for use in swimming pool areas.***
NOTE: Pumps with the "CSA-CUS" mark are tested to UL standard UL778 and certified to CSA standard C22.2 No. 108.

Pre-Installation

HANDLING

Avoid impact on pump or motor. In particular, avoid impact on discharge end of pump or rear motor access cover.

LOCATION

⚠WARNING ***In any installation where property damage and/or personal injury might result from an inoperative or leaking pump due to power outages, discharge line blockage, or any other reason, a backup system(s) should be used.***

1. Locate pump as close to the fluid source as possible, keeping the inlet pipe short as possible.
2. Place unit where the pump and piping are protected from the weather and extremes of heat, humidity and below freezing temperatures.
3. Mount unit in a dry location that is easily accessible for inspection and maintenance. If a dry location is not available, mount it on a foundation well above the wet floor.
4. Allow ample clearance around unit for free air circulation.

SUCTION LIMITATIONS

1. Units are non self-priming.
2. Pressure booster pumps are not recommended for suction lift applications.

PIPING

1. Use galvanized piping, rigid plastic or other suitable pipe that will not collapse under suction or rupture due to pressure.

⚠CAUTION ***If hose is used, make sure it is the reinforced industrial type that is rated higher than the shutoff pressure of the system. Ordinary garden hose will collapse and starve the pump of water.***

2. The diameter of the inlet and discharge pipe should be no smaller than the corresponding ports of the pump (See Figure 1). Smaller pipe will reduce the capacity of the pump. Increase pipe size on long runs.
3. Avoid air pockets in inlet piping or air will accumulate at high points, making priming difficult.
4. Use pipe compound on all joints and connections. Use Teflon tape or plastic joint stik, on plastic pipe. Draw all pipe up tightly.

IMPORTANT: The entire system must be air and water tight for efficient/proper operation.

Installation

PUMP INSTALLATION

IMPORTANT: Pump is built to handle clear water only; it is not designed to handle water containing sand, silt or other abrasives.

1.Refer to Figures 6, 7, and 8 for typical installations.

⚠CAUTION ***Support pump and piping when assembling and when installed. Failure to do so may cause piping to break, pump to fail, motor bearing failures, etc.***

2. If the pump is used as part of a permanent installation, bolt to a rigid foundation.

⚠WARNING ***Use only components that are rated for maximum pressure pump can produce when used in boosting system or any other system. Do not exceed the total maximum pressure boost as listed per model in Performance Charts B.***

PRESSURE BOOST SYSTEMS

1. On pressure boost systems, locate the pump so that there will always be a positive supply of water to the pump (See Figures 6, 7 and 8).
2. For service convenience, install a gate valve and union in the inlet and discharge line.

⚠CAUTION ***Do not use a globe valve or other restricting type of valve that will seriously restrict the pumps discharge capacity.***

3. Install a check valve as shown in Figure 6. Be sure check valve flow arrows point in the direction of water flow.
4. Whenever dirt, sand or debris is present in the supply water, install a strainer or filter on the inlet side of the pump (See Figure 7).

NOTE: For heavy amounts of sediment, install a trap filter on the inlet side of the pump (See Figure 5).

NOTE: Pressure gauges installed before and after the filter will show pressure differential indicating the need for filter replacement or cleaning.

Figure 2 - No Air Pockets in Inlet Pipe

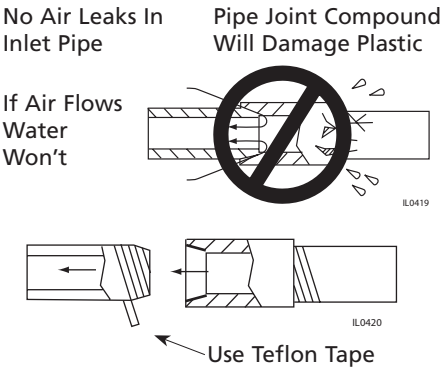


Figure 3 - Inlet Pipe Must Not Leak

⚠CAUTION ***Mount pump in correct position or pump failure will result.***

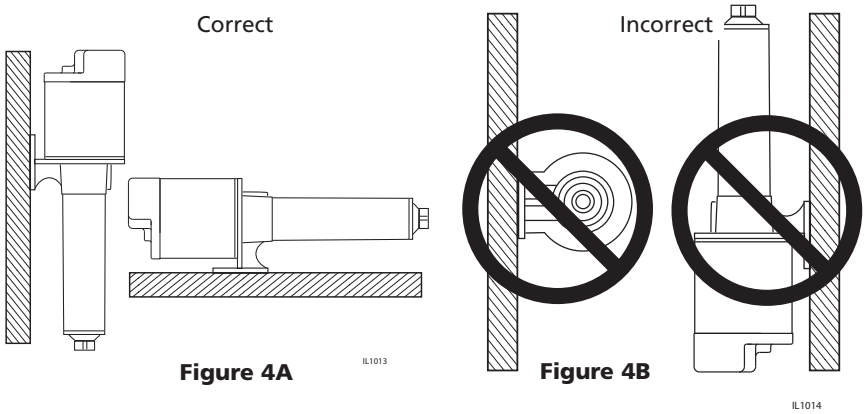


Figure 4A **Figure 4B**

SAND AND SEDIMENT TRAP FILTER

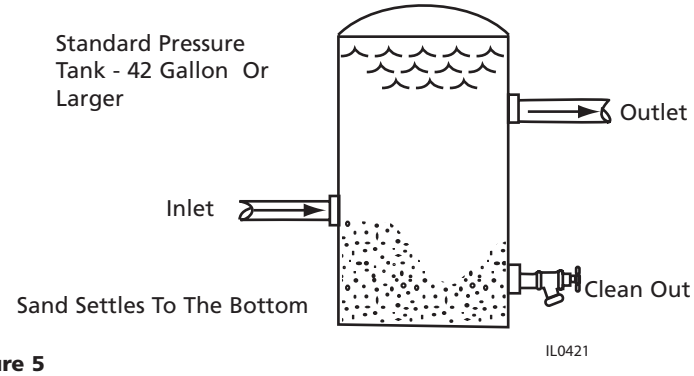


Figure 5

IMPORTANT: Clean all filters and strainers on a regular schedule.

Installation (Continued)

5.A pressure gauge installed in the inlet pipe close to the inlet port, (See Figure 6) will show if enough water is being supplied to the pump. See Operation Section - Priming, Pressure Boost Installations.

6. On installations that are using nozzles for mist spraying, install a filter in the discharge plumbing to prevent the nozzles from becoming plugged. Multiple filters should be plumbed in parallel.

⚠WARNING ***Install a pressure relief valve on any installation where pump pressure can exceed the pressure tank's maximum working pressure or on systems where the discharge line can be shut off or obstructed. Extreme over pressure can result in personal injury or property damage.***

⚠CAUTION ***This unit is not waterproof and is not intended to be used in showers, saunas or other potentially wet locations. The motor is designed to be used in a clean dry location with access to an adequate supply of cooling air. Ambient temperature around the motor should not exceed 104°F (40°C). For outdoor installations, motor must be protected by a cover that does not block airflow to and around the motor. This unit is not weatherproof nor is it able to be submersed in water or any other liquid.***

⚠ ***To avoid dangerous or fatal electrical shock, turn off power to motor before working on electrical connections.***

⚠ ***Supply voltage must be within ± 10% of nameplate voltage. Incorrect voltage can cause fire or seriously damage motor and voids warranty. If in doubt, consult a licensed electrician.***

⚠ ***Use wire size specified in wiring Chart F. If possible, connect pump to a separate branch circuit with no other appliances on it. If motor wiring diagram differs from diagram shown below, follow diagram on motor.***

Pump used to boost incoming city pressure (automatic operation).

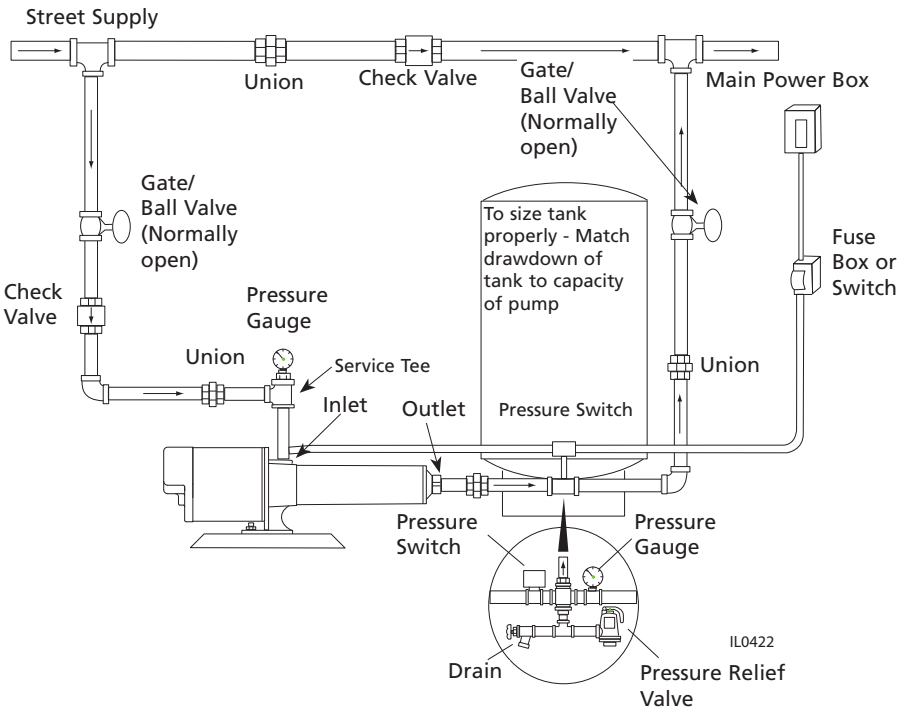


Figure 6

IMPORTANT: A contained air pressure tank and pressure switch is required to keep the pump from rapid cycling and prevent the motor from over heating. Install the tank and switch on the house side of system.

Pump used to boost water pressure in mist spray applications (automatic operation).

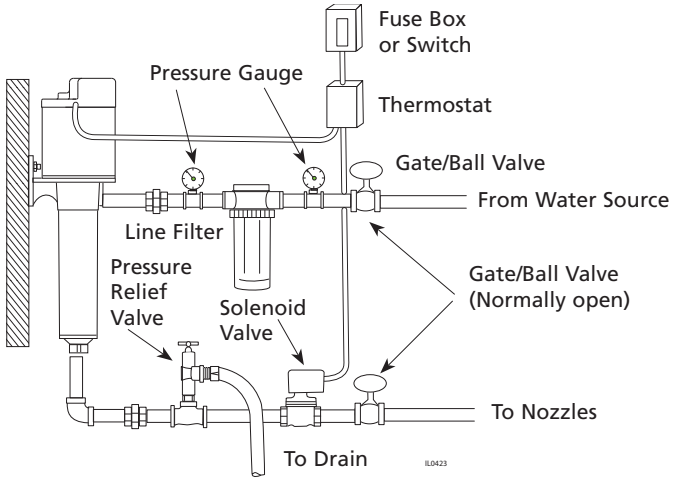


Figure 7

NOTE: Install solenoid valve on discharge side of pump.
IMPORTANT: Clean all filters and strainers on a regular schedule.

Installation (Continued)

⚠WARNING

Hazardous voltage. Can shock, burn or cause death. Ground pump before connecting to power supply.

⚠ ***Ground motor before connecting to electrical power supply.***

⚠ ***Failure to ground motor can cause severe or fatal electrical shock hazard.***

⚠ ***Do not ground to a gas supply line.***

⚠CAUTION ***Proper rotation of pump impeller is critical on three phase motors. See Motor Rotation under Operation section and Figure 12.***

WIRING

1. Install, ground, wire and maintain this pump in accordance with your local electrical code and all other codes and ordinances that apply. Consult your local building inspector for local code information.
2. Ground the pump permanently using a wire of size and type specified by local or United States National Electrical Code. **Do not ground to a gas supply line.**

3.Connect ground wire first. Connect to ground first, then to green grounding terminal provided on the motor frame, identified as GRD. Ground connection MUST be made to this terminal. Do not connect motor to electrical power supply until unit is permanently grounded; otherwise serious or fatal electrical shock hazard may be caused.

4. Connect the other end of the ground wire to a properly grounded service panel or to a control panel ground bar if it is connected to the power supply ground.

IMPORTANT: Check local and/or United States National Electric Codes for proper grounding information.

⚠CAUTION ***Make certain that the power supply conforms to the electrical specifications of the motor supplied. See Motor Data Charts.***

Pump used to boost incoming pressure from a wall hydrant (manual operation).

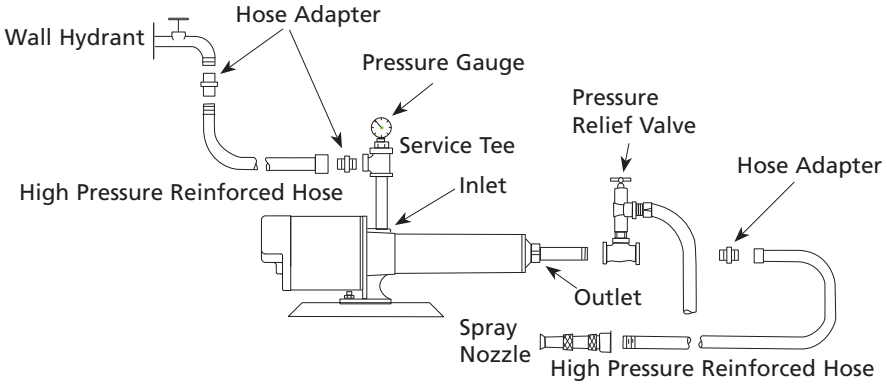
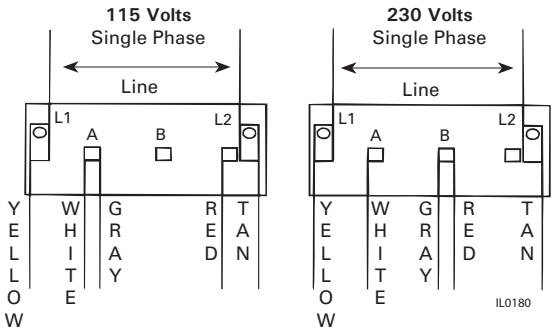
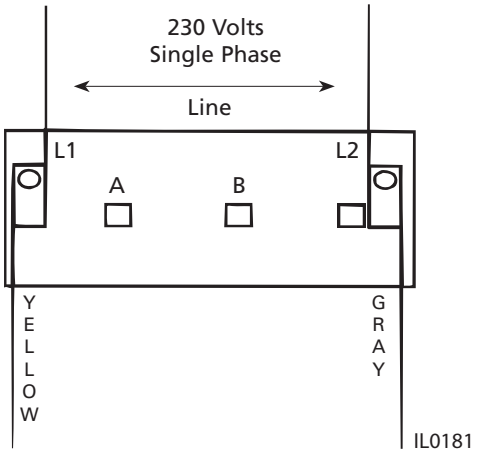


Figure 8



NOTE: Dual voltage motors, change the red and gray wire to the voltage required.

Figure 9 - Wiring Diagram for Single Phase 1/3 - 2 HP Motors



NOTE: Single voltage (230V) motor, and can not be connected to 115V.

Figure 10 - Wiring Diagram for Single Phase 3 HP Motors

Installation (Continued)

5.**Specific Wiring Procedure** (Refer to Figures 9, 10, & 11 and Minimum Wire Size Chart).

a. Select the voltage you are to use, either 115V or 230V single phase, 230V or 460V three phase.
b. The 1/3, 1/2 and 3/4 HP single phase pumps are factory connected for 115V at the motor. The 1, 1½, 2 and 3 HP pumps are factory connected for 230V at the motor. Three phase models are factory connected for 230V at the motor.
c. If the motor wiring must be changed to conform to your specific voltage requirements then the motor, pressure switch or other controls should be rewired to conform to one of the wiring diagrams (either 115V or 230V, single phase; 230V or 460V, three phase). Single phase 3 HP motors are 230V only and cannot be wired for 115V service.
d. The motor wiring diagrams are Figures 9, 10, & 11 and also are located on the motor label of the pump.

6. Remove the rear access cover of the motor.
7. Make the wiring change and replace the rear access cover.

⚠WARNING ***Replace rear access cover before starting or operating pump. Failure to do so can result in personal injury.***

IMPORTANT: Do not use an extension cord or splice wires. Joints should be made in an approved junction box. If the above information or the following wiring diagrams are confusing, consult a licensed electrician.

8. All units are **not supplied** with pressure switches, float devices, on/off switches, or the like (control devices). Controls should be wired in at this time, utilizing whatever instructions come with the controls. All units supplied with cords, will run whenever cord is plugged into power and will turn off whenever cord is disconnected from power.

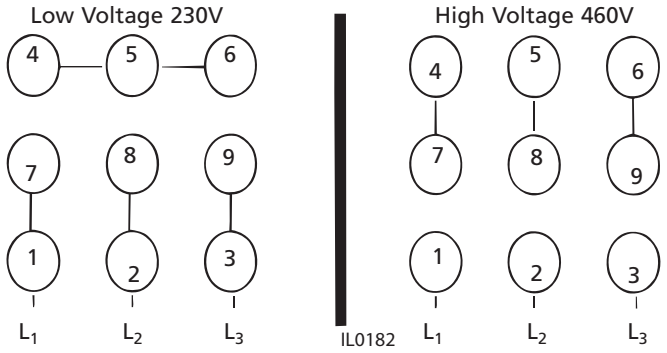
MOTOR PROTECTION

All single phase motors have built in thermal protection for all voltages. The overload protects the motor against burnout from overload of low voltage, high voltage and other causes. The device is automatic and resets itself once the temperature has dropped to a safe point. Frequent tripping of the device indicates trouble in the motor or power lines and immediate attention is needed.

⚠WARNING ***Never examine, make wiring changes or touch the motor before disconnecting the main electrical supply switch. The thermal device may have opened the electrical circuit.***

Three phase motors do not have a built in thermal protection. It is recommended that a properly sized magnetic or manual starter (both with properly sized heaters) be used with all three phase motors. Install starters following instructions of the starter manufacturer. See Motor Rotation under Operation Section for changing rotation on three phase motors.

All motors (single and three phase) should be equipped with a correctly fused disconnect switch to provide protection. Consult local or United States National Electric Codes for proper fuse protection based on motor data chart (See Charts C, D and Wire chart F).



1 - Tan	4 - Yellow	7 - Purple
2 - Red	5 - Black	8 - Gray
3 - Orange	6 - Blue	9 - White

CONNECTION FOR 3 PHASE, 9 LEADS. IF YOUR 3 PHASE LEADS ARE COLOR CODED, MATCH NUMBER ABOVE TO THE CORRESPONDING COLOR.

NOTE: To reverse rotation, interchange any two incoming lines (Power) leads.

Figure 11 - Wiring Diagram for Three Phase Motors

Operation

⚠CAUTION ***Unit must be full of fluid before operating. Do not run dry, or against a closed discharge. Do not pump dirty water or abrasive liquids. To do so will cause pump failure and will void the warranty.***

VALVES

The inlet valve should be in the full open position and the discharge valve should be partially open, permitting some back pressure to be exerted against the pump when starting up. Open valve after start up is completed.

PRIMING

NOTE: Before starting the pump it is absolutely necessary that **both the pump and the inlet pipe be completely filled with water.**

PRESSURE BOOST INSTALLATIONS

Priming is automatic when pump is connected to a pressure source such as a hydrant or city main (See Figures 6, 7 & 8).

1. Open valves or nozzle on inlet and discharge side of pump

2. To relieve trapped air, allow water supply to run a minimum of 30 seconds before starting the pump.

IMPORTANT: An adequate flow of water going into the pump is required so that the pumps impellers and shaft seal do not run dry and fail.

3. If you installed a pressure gauge at the pump inlet, a reading of 2 psi minimum should show whenever the pump is in operation (See Figures 6, 7 & 8).

This reading insures that there is an ample supply of water into the pump inlet housing.

Operation (Continued)

MOTOR/PUMP ROTATION

1. Single phase models are one (1) rotation only (counter-clockwise when facing the pump end) and cannot be reversed.
2. Proper rotation of pump impeller is critical for three phase pumps. Pump motor should turn counterclockwise (CCW) when facing pump end. Momentarily "bump" (apply power for less than a second) the motor to check for proper rotation. To change rotation on three phase units, interchange any two (2) incoming line (power) leads.

⚠CAUTION ***Do not go over recommended maximum operating pressure (see Specifications), while maintaining minimum flow of 1.5 GPM thru the pump. Do not restrict the inlet line to the pump.***
If driver (electric motor) is overloaded, a valve can be installed in the discharge line to increase the back pressure and reduce driver loading.

START - UP PROCEDURE

Once the preceding instructions have been completed, the pump can be started.

1. During the first few hours of operation, inspect the pump, piping and any auxiliary equipment used in connection with the unit.
2. Check for leaks, excessive vibration or unusual noises.

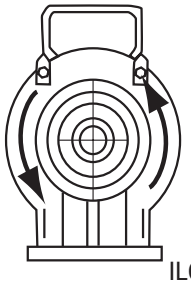


Figure 12 - Correct Motor/Pump Rotation (all units)

NOTE: See rotation arrow on inlet casting.

Maintenance

⚠CAUTION ***Disconnect power supply and depressurize system before servicing pump or removing any component.***

ROUTINE

Pump should be checked routinely for proper operation. Replace or clean all filters and line strainers on a regular basis.

DRAINING

This pump cannot be completely drained because of internal design. Most of the liquid can be drained by tilting the discharge forward after removing discharge casting; or, the liquid can be drained through the inlet port. Store in heated areas.

CLEANING

If used for spraying insecticides, pump should be thoroughly flushed with clean water after using.

LUBRICATION

The motor has prelubricated bearings. No lubrication is required.

SERVICING THREE-PHASE UNITS

Loctite (thread sealer) is used on the threads between the motor shaft and the pump shaft coupling. When reassembling, reapply thread sealer.

PUMP DISASSEMBLY

To disassemble the pump, refer to the exploded parts view, Figures 17 & 18 Tools Required

- Block of wood (2" x 4" x 12")
  Piece of 3/4" pipe (12" to 24" long)
- Pipe wrench
- Strap wrench
- 1/4" Dowel rod (about 24" long)
- 9/16" Open end wrench
- 3/8" Open end wrench or 3/8" deep well socket

1. To stabilize pump during disassembly, place block of wood underneath pump barrel.
2. Thread pipe into pump inlet port. This acts as a handle.
3. Using the pipe wrench, remove the discharge head, turning CCW (counter clockwise).
4. With the strap wrench, loosen the barrel, turning CCW (counter clockwise). DO NOT use pipe wrench on pump barrel.
5. Holding the impeller stack in place, position pump in upright position, standing unit on the motor end cover.
6. Use the 1/4" dowel rod to hold the stages down and in place on the pump shaft. Remove pump barrel.
7. With the pump set in the vertical position, remove the top stage and carefully set aside. **WARNING: Do not remove the pump shaft from the cartridge for any reason! If the shaft is removed from cartridge, consult factory customer service at number listed below.**
8. Through the side opening of the mounting frame, hold the motor shaft with 9/16" wrench. Remove the shaft and coupling from the motor using the 3/8" wrench or deep well socket on the hex shaped pump shaft.

NOTE: If the hex shaft comes free, leaving the coupling attached to the motor, use vise grips to free the coupling.

MECHANICAL SEAL REPLACEMENT

1. Follow instructions under "Pump Disassembly".
2. Remove the mechanical seal assembly.
   a. The rotary portion of the seal assembly (carbon ring, Viton gasket and spring will slide easily off the end of shaft).
   b. Using two (2) screwdrivers, pry the ceramic seal and rubber gasket from the recess of the mounting ring (See Figure 14).

⚠CAUTION ***The precision lapped faces of the mechanical seal are easily damaged. Handle the replacement seal carefully. Short seal life will result if seal faces (ceramic & carbon) are nicked, scratched or dirty.***

3. Clean the seal cavity of the mounting ring and the motor thoroughly.
4. Wet outer edge of rubber cup on ceramic seat with liquid soap solution. Use sparingly (one drop only).

Maintenance (Continued)

NOTE: Liquid soap solution - one drop of liquid soap combined with one teaspoonful of water.

5. With thumb pressure, press ceramic seal half firmly and squarely into seal cavity. Polished face of ceramic seat is up. If seal will not seat correctly, remove, placing seal face up on bench. Reclean cavity. Seal should now seat correctly (See Figure 14).
6. If seal does not seat correctly after recleaning cavity, place a cardboard washer over polished seal face and carefully press into place using a piece of standard clean 3/4" pipe as a press (See Figure 15).

IMPORTANT: Do not scratch seal face.

7. Dispose of cardboard washer and recheck seal face to be sure it is free of dirt, foreign particles, scratches and grease.
8. Inspect shaft to be sure it is free of nicks and scratches.
9. Apply liquid soap solution sparingly (one drop is sufficient) to inside diameter of rubber rotating member.
10. Slide rotating seal member (carbon face down toward ceramic face) and spring over the shaft.

IMPORTANT: Do not nick or scratch carbon face of seal when handling.

MOTOR REPLACEMENT

The motor can be replaced with any standard Nema 56J jet pump motor (of proper HP for each pump) by referring to the following instructions.

1. Follow steps as outlined under Rotary Seal Replacement and Pump Disassembly.
2. Remove cap screws that connect the motor to the mounting ring and pull motor away.
3. Replace motor with standard Nema 56J jet pump motor by positioning motor against the mounting frame and assembling with four (4) cap screws.

IMPORTANT: Because damage to the shaft seal can occur in disassembly, a new seal will be necessary.

PUMP REASSEMBLY

Before reassembling the pump, carefully inspect the component parts of the cartridge (stage) assembly, looking for damage, wear or heat distortion. Pay careful attention to spacing direction of components, and location of shims. Refer to Figure 16 for proper facing and parts arrangement. If damage to Stage components is evident, a complete cartridge assembly or individual stage assemblies are available for replacement (See Replacement Parts List).

1. Reassembly should follow the reverse order of the disassembly procedure with special care given to replacement of the rotary seal. Tighten pump shaft to 8-10 Ft. lbs. torque.
2. Check top and bottom of o-rings for damage. It is recommended that new o-rings be used.
3. Do not use pipe compound of Teflon tape on barrel threads. The o-rings will prevent pump from leaking.
4. After pump is reassembled, tighten the discharge head to a torque of 45-50 ft/lbs. If torque wrench is not available, tighten firmly but avoid distortion or damage to plastic internal parts.
5. After reassembly, apply power momentarily to unit (15 to 30 seconds). The pump and motor should rotate freely or with a light rubbing.

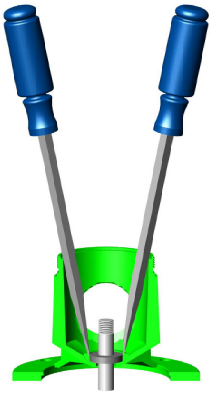


Figure 13 - Remove Mechanical Seal

Figure 14 - Press In Seal

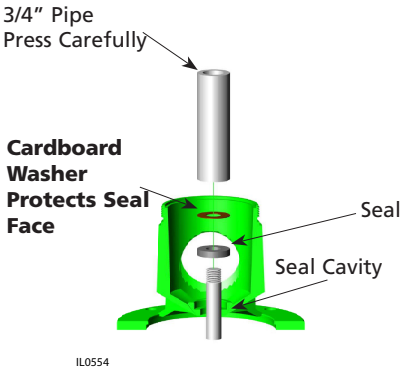
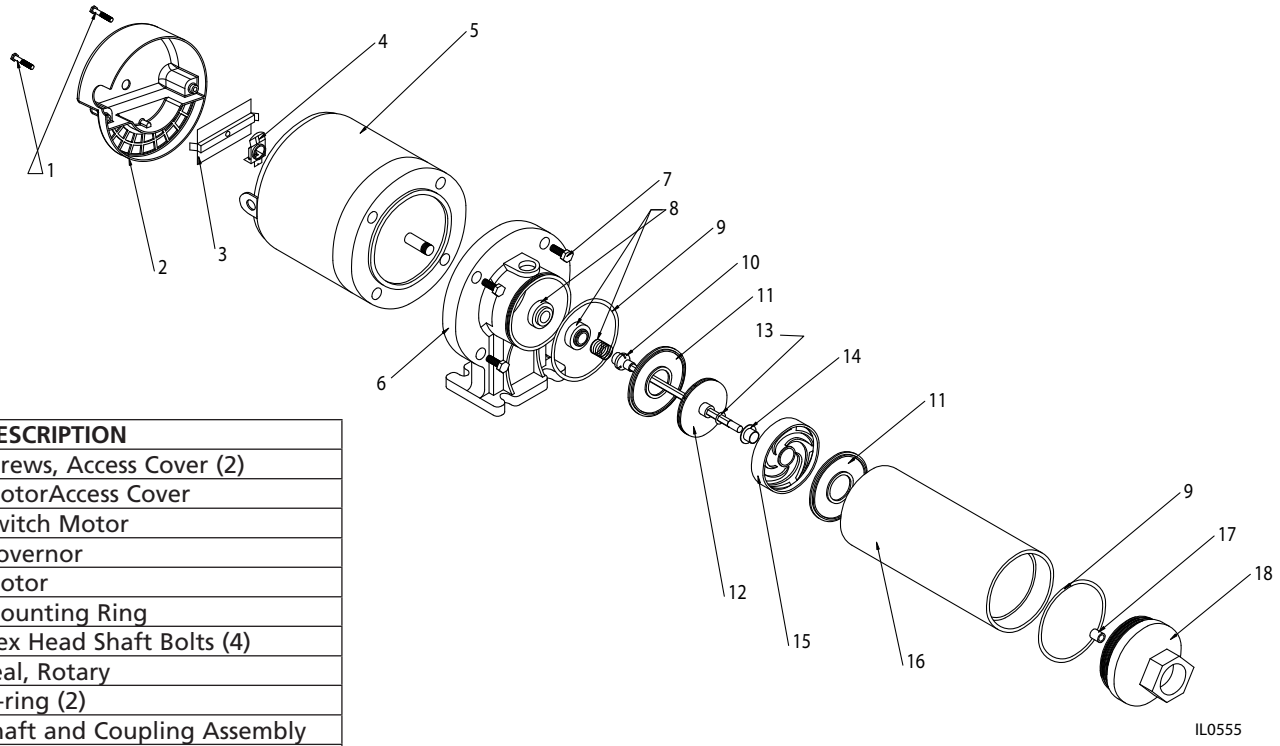


Figure 15 - If Necessary, Press With Cardboard And Pipe

Troubleshooting Chart

Symptom	Possible Cause(s)	Corrective Action
Pump won't start or run at full speed	1. Blown fuse or open circuit breaker	1. Replace fuse or close circuit breaker. See wire size chart for proper break/fuse size
	2. Power supply in OFF position	2. Turn power on
	3. Incorrect voltage at motor (check voltage with motor running)	3. Low voltage a. Voltage must be within ± 10% of motor rated voltage. Check incoming voltage. Contact power company b. Make certain that voltage of motor matches voltage of power supply. See motor name plate and motor wiring diagrams c. Check wire size from main switch to pump. See wire size chart for correct wire size
	4. Loose, broken or incorrect wiring	4. Rewire any incorrect circuits. Tighten connections, replace defective wires
	5. Defective motor	5. Replace motor
	6. Pump hydraulic components clogged/ worn/damaged	6. Replace worn parts or entire pump. Clean parts if required
Pump operates, but delivers little or no water	1. Manual or solenoid valves plumbed into system restricting flow	1. a Check all valves on pump inlet and discharge sides of system to be sure they are opened properly to allow flow to and from the pump b. Bleed trapped air in pump which keeps water from reaching the pump. (Normally due to closed valve in discharge plumbing)
	2. In-line filter restricting flow	2. Check all in-line filters to be sure they are not plugged or restricted
	3. Low line voltage	3. See low line voltage corrective action (above)
	4. Inadequate water supply to booster pump	4. Check pressure on inlet side of booster to be sure positive pressure is maintained to the booster pump
	5. Undersized piping	5. Replace undersized piping
	6. Leak on inlet side of system	6. Make sure connections are tight. Repair leaks as necessary
	7. Inadequate, defective or plugged foot valve and/or strainer	7. Clean, repair or replace as needed
	8. Worn or defective pump parts or pump.	8. Replace worn parts or entire plugged impeller Clean parts if
	9. Suction lift too great	9. Pump should be operated under flooded suction only
	10. Pump not primed	10. Prime pump - Make certain inlet pipe is drawn up tight and pump and pipe are full of water
	11. Incorrect rotation, motor running backwards	11. Reverse motor rotation can occur on three phase units. To correct, interchange any two incoming power leads.
Excessive noise while pump in	1. Pump not secured to firm foundation	1. Secure properly
	2. Piping not supported	2. Make necessary adjustments
	3. Restricted inlet line	3. Clean or correct
	4. Cavitation (noise like marbles in pump)	4. a. Reduce speed on direct drive b. Increase inlet pipe size c. Too viscous (material being pumped too thick
	5. Worn motor bearings	5. Replace bearings or motor
Pump leaks	1. Worn mechanical seal (leaks at shaft)	1. Replace shaft (rotary) seal
	2. Worn o-ring seals	2. Replace o-ring seals, located inside both ends of the stainless steel shell

Booster Pump Parts Drawing



ITEM NO.	DESCRIPTION
1	Screws, Access Cover (2)
2	MotorAccess Cover
3	Switch Motor
4	Governor
5	Motor
6	Mounting Ring
7	Hex Head Shaft Bolts (4)
8	Seal, Rotary
9	O-ring (2)
10	Shaft and Coupling Assembly
11	Plate, Diffuser
12	Impeller
13	Shim as Required
14	Diffuser Bearing
15	Diffuser
16	Barrel
17	Discharge Bearing
18	Discharge Head

*See note below parts included in cartridge assembly.

Internal Parts Detail

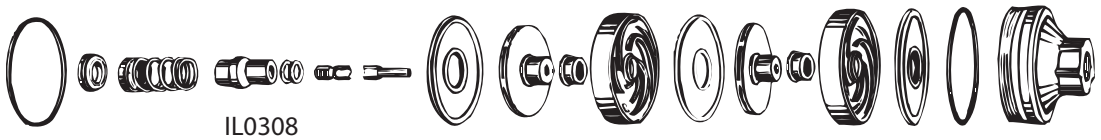
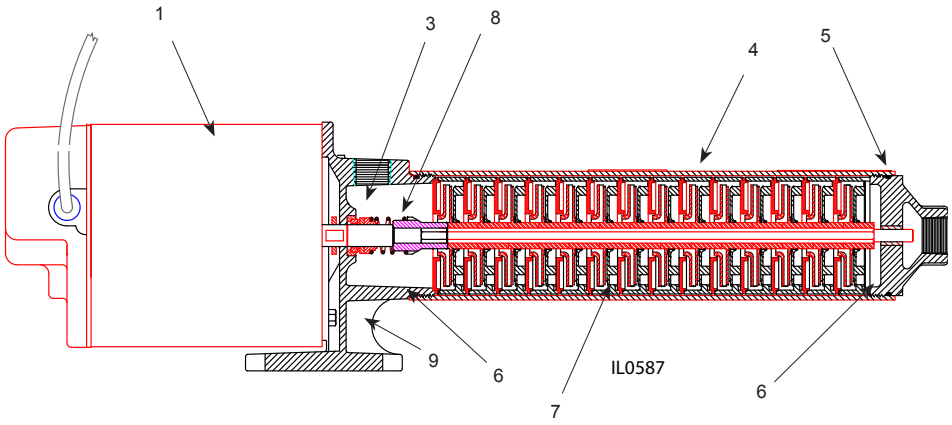


Figure 16 - Cartridge Assembly Includes Discharge Bearing, Shaft & Coupling Assembly, Diffuser Plate, Impellers, Diffuser Bearings and Diffusers

NOTE: Illustration shows only two stages. Pump has multiple stages. Individual parts are not available separately.

PRESSURE BOOSTER PUMP REPAIR PARTS
STAINLESS STEEL BOOSTER PUMP — 60 Hz
(For Pricing Refer To Repair Parts Price List)



ITEM	STAINLESS STEEL	HORSEPOWER		3/4	1	1-1/2
		SINGLE PHASE	MODEL NO.	DPM02	DPM14	DPM16
		THREE PHASE		-	DPM121	DPM52
	DESCRIPTION		PART NO.			
1	Motor, 1 PH Nema J			98S107	98S110	98S115
1	Motor, 3 PH Nema J			-	98S310	98S315
	Motor Access Cover		021301R	1	1	1
•	Screws, Access Cover		021302	2	2	2
3	Seal, Rotary w/Spring - Viton		136682	1	1	1
4	Barrel			132003	134997	135815
5	Discharge Head - Stainless Steel		136640	1	1	1
6	O-Ring, Viton		136607	2	2	2
7	Cartridge Assembly †			136684	136685	136686
8	Shaft & Coupling Assembly			136636	136637	136638
9	Mounting Ring - Stainless Steel		136639	1	1	1
•	Hex Hd. Cap Screws 3/8 x 3/4”		*	4	4	4
•	Rain Cover		023109	1	1	1

ITEM	STAINLESS STEEL	HORSEPOWER		3
		SINGLE PHASE	MODEL NO.	DPM120
		THREE PHASE		DPM150
	DESCRIPTION		PART NO.	QUANTITY
1	Motor, 1 PH Nema J			98S630
1	Motor, 3 PH Nema J			98S330
	Motor Access Cover		021302R	1
•	Screws, Access Cover		021302	2
p	Hex Hd. Cap Screws 3/8 x 1”		*	2
3	Seal, Rotary w/Spring - Viton		136682	1
4	Barrel			136630
5	Discharge Head - Stainless Steel			139166
6	O-Ring, Viton		136607	2
7	Cartridge Assembly †			021658
8	Shaft & Coupling Assembly			021530
9	Mounting Ring - Stainless Steel		136639	139100
•	Hex Hd. Cap Screws 3/8 x 3/4”		*	4
•	Rain Cover		023109	1

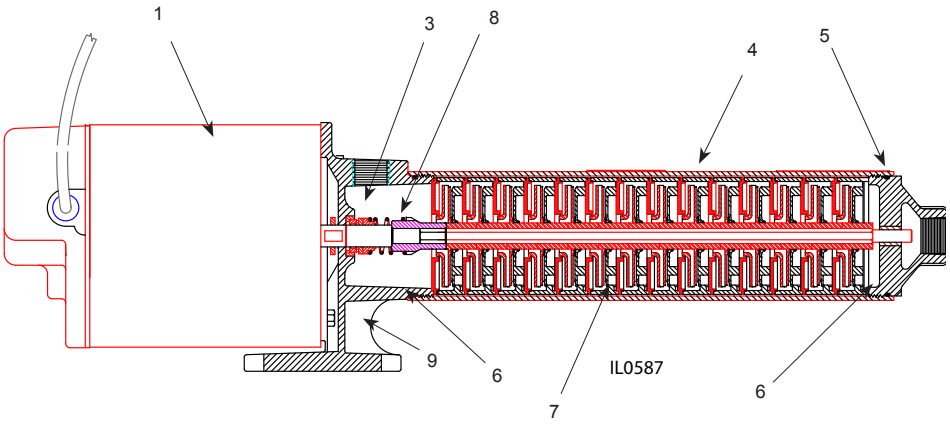
(*) Standard hardware item

(•) Not shown

(†) Cartridge assembly includes: Impeller, Diffusers, Shaft and Coupling Assembly. Components not available individually. Sold as assembly only.

(2) 132079 Handle available as an option

PRESSURE BOOSTER PUMP REPAIR PARTS
STAINLESS STEEL BOOSTER PUMP — 50 Hz
(For Pricing Refer To Repair Parts Price List)



STAINLESS STEEL BOOSTER PUMP — 50 Hz				
HORSEPOWER			1	1-1/2
STAINLESS STEEL	SINGLE PHASE	MODEL NO.	DPM05	DPM04
ITEM	DESCRIPTION	PART NO.	QUANTITY	
1	Motor, 1 PH Nema J		98S010	98S015
•	Motor Access Cover	021301R	1	1
•	Screws, Access Cover	021302	2	2
3	Seal, Rotary w/Spring - Viton	136682	1	1
4	Barrel		020279	020094
5	Discharge Head - Stainless Steel		136640	136640
6	O-Ring - Viton	136607	2	2
7	Cartridge Assembly †		020280	020095
8	Shaft & Coupling Assembly		020278	020093
9	Mounting Ring - S.S.		136639	136639
•	Hex Hd. Cap Screws 3/8 x 3/4"	121106	4	4
•	Rain Cover	023109	1	1

(*) Consult factory
(†) Cartridge assembly includes: Impeller, Diffusers, Shaft & Coupling Assembly. Components not available individually. Sold as assembly only.
(•) Not shown
(2) 132079 Handle available as an option

WARRANTY

This product is warranted for one year from the date of purchase or two years from the date of manufacture, whichever occurs first. Subject to the conditions hereinafter set forth, the manufacturer will repair or replace to the original consumer, any portion of the product which proves defective due to defective materials or workmanship. To obtain warranty service, contact the dealer from whom the product was purchased. The manufacturer retains the sole right and option to determine whether to repair or replace defective equipment, parts or components. Damage due to conditions beyond the control of the manufacturer is not covered by this warranty.

THIS WARRANTY WILL NOT APPLY: (a) To defects or malfunctions resulting from failure to properly install, operate or maintain the unit in accordance with printed instructions provided; (b) to failures resulting from abuse, accident or negligence or use of inappropriate chemicals or additives in the water; (c) to normal maintenance services and the parts used in connection with such service; (d) to units which are not installed in accordance with normal applicable local codes, ordinances and good trade practices; and (e) the unit is used for purposes other than for what it was designed and manufactured.

RETURN OF WARRANTED COMPONENTS: Any item to be repaired or replaced under this warranty must be returned to the manufacturer at Kendallville, Indiana or such other place as the manufacturer may designate, freight prepaid.

THE WARRANTY PROVIDED HEREIN IS IN LIEU OF ALL OTHER EXPRESS WARRANTIES, AND MAY NOT BE EXTENDED OR MODIFIED BY ANYONE. ANY IMPLIED WARRANTIES SHALL BE LIMITED TO THE PERIOD OF THE LIMITED WARRANTY AND THEREAFTER ALL SUCH IMPLIED WARRANTIES ARE DISCLAIMED AND EXCLUDED. THE MANUFACTURER SHALL NOT, UNDER ANY CIRCUMSTANCES, BE LIABLE FOR INCIDENTAL, CONSEQUENTIAL OR SPECIAL DAMAGES, SUCH AS, BUT NOT LIMITED TO DAMAGE TO, OR LOSS OF, OTHER PROPERTY OR EQUIPMENT, LOSS OF PROFITS, INCONVENIENCE, OR OTHER INCIDENTAL OR CONSEQUENTIAL DAMAGES OF ANY TYPE OR NATURE. THE LIABILITY OF THE MANUFACTURER SHALL NOT EXCEED THE PRICE OF THE PRODUCT UPON WHICH SUCH LIABILITY IS BASED.

This warranty gives you specific legal rights, and you may have other rights which vary from state to state. Some states do not allow limitations on duration of implied warranties or exclusion of incidental or consequential damages, so the above limitations may not apply to you.

WARRANTY VALID IN CANADA AND MEXICO.

Appendix C:
Activated Carbon Filter Manual

Model 2510

FRONT WITHOUT COVER

BACK

Product Features

- Fully adjustable 5-cycle top mount control delivers controlled upflow backwash, downflow brining and slow rinse, rapid rinse, brine refill and downflow service
- Time-tested hydraulically balanced piston, seal and spacer concept to control service flow and regeneration
- Non-corrosive, high-tech material construction
- Excellent flow rates – 19 GPM continuous, 24 GPM peak
- Backwash capacity handles tanks up to 16″ diameter for softener applications, 16″ diameter for filter applications
- Choice of 7 or 12 day clock, manual or meter initiated regeneration, mechanical or electronic control

Options

- Corrosion-free bypass valve
- Backwash filter
- Meter initiated regeneration
- Manual operation
- Environmental cover
- No hard water bypass piston
- Auxiliary switches

Valve Specifications	
Valve material	Fiber reinforced polymer
Inlet/Outlet	3/4″, 1″ or 1-1/4″
Cycles	5

Flow Rates (50 psi Inlet) - Valve Alone	
Continuous (15 psi drop)	19 GPM
Peak (25 psi drop)	24 GPM
CV (flow at 1 psi drop)	4.8
Max. backwash (25 psi drop)	17 GPM

Regeneration	
Downflow/Upflow	Downflow only
Adjustable cycles	Yes
Time available	Electromechanical: 164 minutes SE: 0 - 99 minutes ET: 0 - 999.9 minutes

Meter Information	
Meter accuracy range	.25 - 15 GPM +/- 5%
Meter capacity range (gal.)	Standard: 125 - 2,125 Extended: 625 - 10,625 SE: 1 - 9,999 ET: 1 - 9,999,999

Dimensions	
Distributor pilot	1.05″ O.D.
Drain line	1/2″ O.D.
Brine line	1600 - 3/8″, 1650 - 3/8″
Mounting base	2-1/2″ - 8 NPSM
Height from top of tank	7-1/2″

Typical Applications	
Water softener	6″-16″ diameter (limited by maximum injector size)
Iron filter	8″-16″ diameter (based on 10 GPM per sq. ft.)
Sediment filter	8″-16″ diameter (based on 10 GPM per sq. ft.)
Carbon filter	8″-16″ diameter (based on 10 GPM per sq. ft.)
Neutralizing filter	8″-16″ diameter (based on 10 GPM per sq. ft.)

Additional Information	
Injector brine system	1600
Electrical rating	24 v, 110 v, 220 v - 50 Hz, 60 Hz
Max. VA	72
Estimated shipping weight	Time clock: 7 lbs. Metered valve: 10 lbs.
Pressure	Hydrostatic: 300 psi Working: 20 - 125 psi
Temperature	34° - 110° F

Appendix D:
Activated Carbon Filter Start Up Procedures

CRANE

CRANE ENVIRONMENTAL

PURE *Water* MADE SIMPLE

ACTIVATED CARBON FILTER

START-UP PROCEDURES

(AUTOMATIC or MANUAL)

The Carbon Filter is shipped with **DRY** activated Carbon media that **MUST BE HYDRATED** with water for **24 hours (12 hours minimum)** before placing the unit into service mode. Failure to properly **HYDRATE** the activated Carbon media and perform the following backwashing procedures may allow Carbon ash or fines to enter into the RO system causing premature fouling of the RO membranes.
(Damage to membranes due to Carbon fines, sediment fouling or scaling is not covered under warranty for replacement.)

If the Carbon filter has been shipped preloaded with activated Carbon media, install the controller valve head per the manufacturer's instruction manual and proceed to step #1.
If the Carbon filter has been shipped with loose activated Carbon media, load the activated Carbon media on site into the filter vessels per the manufacturer's instruction manual, install the controller valve head and proceed to step #1. **NOTE:** FILL the filter vessel approximately 1/3 full with clean water before loading the under-bed gravel or Carbon media to avoid possible breakage of the lower distributor.

1. Connect the feedwater, backwash drain and service lines to the filter's controller unit per the manufacturer's instruction manual included with the unit. Allow a 6-8" air gap on the drain line connection to the main drain.
2. Connect the proper electrical power connections for automatic control units, per the manufacturer's instruction manual included with the unit.
3. Direct the service outlet line from the Carbon filter to the drain during the initial startup backwashing procedures. (DO NOT direct water from the new service outlet side of the Carbon filter into the RO unit until the Carbon filter backwash procedure has been completed.)
4. Manually place the controller valve into the backwash position or electrically advance the control valve to the backwash mode and then unplug the control valve. Close off the service outlet line with an isolation ball valve. Direct the feedwater supply slowly into the control valve until all air has been vented out of the Carbon tank. After the air has been vented off and a steady flow of water is observed into the drain, you may open the feedwater supply fully to pressurize the tank and establish full backwash flow.
5. Allow the Carbon media to backwash and sample the drain water with a clean WHITE cup. You may observe that the water is partially black with some Carbon ash or fines settling to the bottom of the cup. Continue backwashing until the water becomes clear as sampled with the WHITE cup. This may initially take 30-60 minutes or longer depending on the amount of Carbon media loaded into the tank.

CAUTION: IF EXCESSIVE AMOUNTS OF CARBON MEDIA CONTINUES TO DISCHARGE TO THE DRAIN DURING BACKWASH—STOP! (1) The backwash flow controller orifice maybe installed incorrectly (2) The flow during backwash is too high. (3) The lower lateral screen may be cracked. Remove the control valve and inspect and/or repair.

6. Manually place the unit into the RINSE/SETTLE position and allow the media to settle for the next 15-20 minutes.
7. Manually place the unit into the SERVICE position. Open the isolation valve on the service outlet line and observe the water out of the service line directed to the drain. Perform the WHITE cup sample tests until the water is clear. Stop the water flow into the Activated Carbon Filter and close the feedwater inlet ball valve and the outlet service line ball valve. Allow the Activated Carbon media to HYDRATE for 24 hours (12 hours minimum).
8. After HYDRATION of the media, perform steps 1 through 7 at least 3-4 more times to remove all loose Carbon ash and fines throughout the media bed.
9. Perform a Chlorine test before the Carbon filter and record the PPM level of Chlorine residual.
10. Perform a Chlorine test after the Carbon filter and record the PPM level of Chlorine residual. (CHLORINE RESIDUAL MUST BE ZERO for feedwater supply to the RO unit.) Perform the WHITE cup test again; the water should be clear with NO Carbon ash or fines present.
11. If Chlorine is still present, check the installation of the controller valve. The upper o-rings in the control valve may not be seated properly to the distributor pipe or the distributor pipe is cut too short. Verify proper flow design through the Carbon filter to prevent channeling due to low flow or high flow conditions. It may be possible that the Chlorine residual level is too high at your site and you do not have enough Carbon media for proper contact time to absorb the Chlorine residual.

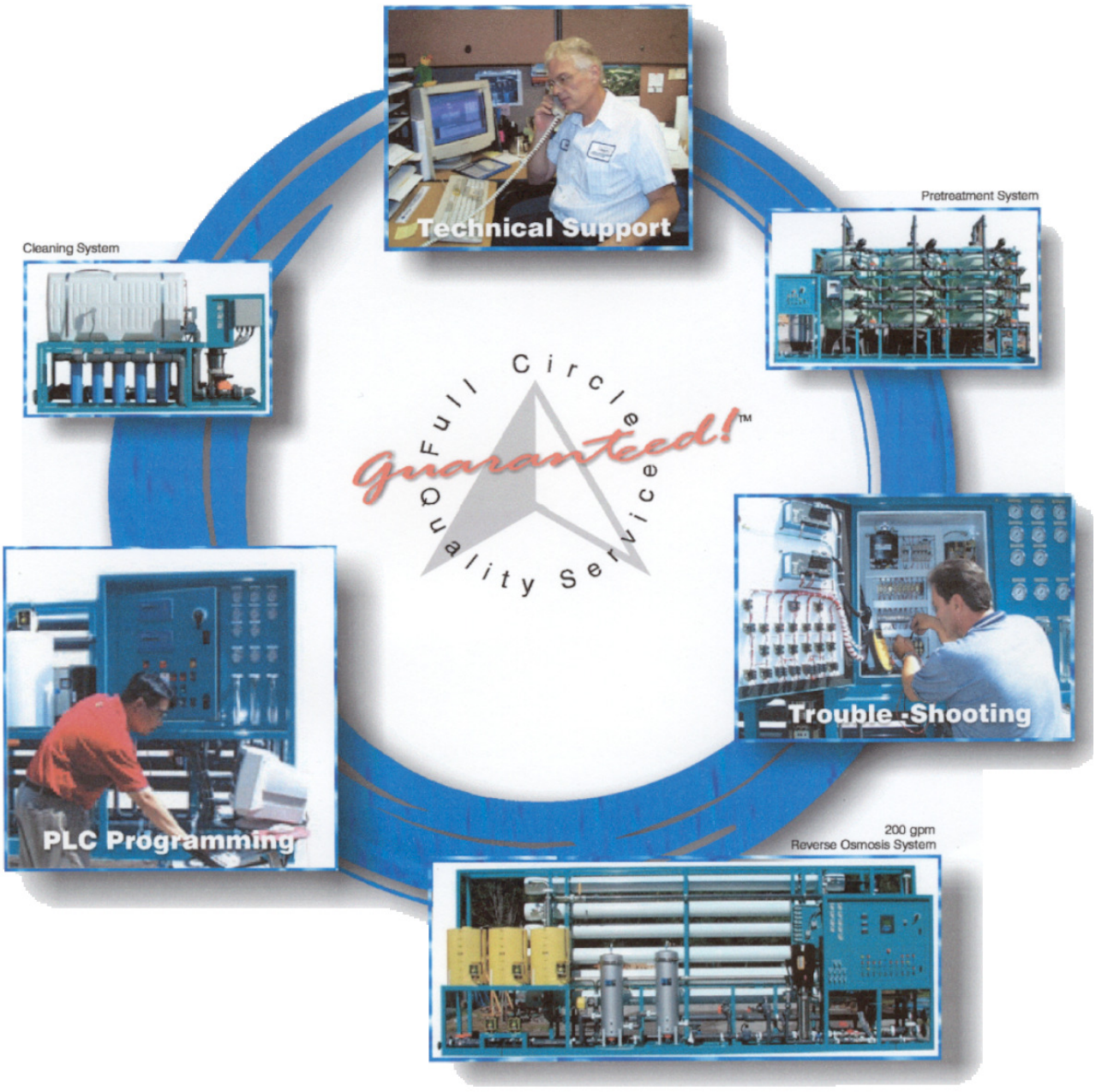
    NOTE: If the feedwater supply has Chloramines used for disinfection, it will require 4-6 times more Carbon media to remove the Chloramines residual from the feedwater supply.

Should you have any problems or require additional assistance, please call your Crane Environmental Representative or Dealer for assistance.

Appendix E:
Technical Field Service Information

Technical Field Services

Complete product-line field-service support worldwide...



CRANE

CRANE ENVIRONMENTAL
PURE Water MADE SIMPLE

COCHRANE CHICAGO BELCO FORCE FILTRATION WESTINGHOUSE CONDENSER

THE ORIGINAL NAMES IN WATER TREATMENT

Customer Technical Services

Crane Environmental is continually expanding our service capabilities to provide our customers with the assistance that is needed and therefore, we have added outside field service engineers (FSE) in addition to our in-house customer call center service technicians. Our highly trained team of professionals assure system performance by providing the highest level of customer service support throughout the life of your equipment. This level of service availability continues to separate Crane Environmental from the competition.

ON-SITE FIELD SERVICES

Service of equipment or related systems:

- Inspections/Evaluations
- Repair Assistance
- Trouble-shooting
- Installation Supervision
- Start-up Assistance
- Operator Training
- Maintenance Agreements
- Technical Support

SYSTEMS SERVICED INCLUDE

- Aerators
- Chemical Feeders
- Deaerators
- Dealkalizer
- Degasifier
- Demineralizer
- Filters: Carbon, Iron, Media
- Softeners
- Reverse Osmosis

CALL-IN TECHNICAL SERVICES

- Situation Analysis
- Trouble-shooting
- Operator Assistance
- Repair Parts
- Technical Support

NEW! ONE YEAR SERVICE AGREEMENTS - PLANNED MAINTENANCE SERVICES (PMS)

One Year Service Agreement Includes:

- Discounted Service Rates
- Minimum of 4 Quarterly Scheduled Site Inspections
- Assigned Field Service Engineer (FSE)
- Operational Log Sheet Reviews via fax or email
- Emergency Technical Support - 24/7
- Trouble-shooting - phone support or field services
- Extended Operator Training
- Discount on Service Maintenance Parts

**Our service engineers do not perform the equipment installation involving piping, rigging, etc. However, we will provide a field service engineer to supervise or assist your personnel or contractor to install, modify or repair a system.*

PRICING

Please call a Service Technician for a competitive quote for your service needs. Special discount service rates are available with system orders.

730 Commerce Drive • Venice, FL 34292 • Tel: 941.480.9101 • Fax: 941.480.9201
Toll free: 1.866.CRANENV or 1.800.828.2447 • E-mail: info@CRANENV.com • Web: www.CRANENV.com

J5/02

Appendix F:
Terms & Conditions / Limited Warranty

CRANE

CRANE ENVIRONMENTAL

PURE *Water* MADE SIMPLE

Terms and Conditions

1. **APPLICABILITY / SCOPE:** All goods and services provided shall be governed by the terms and conditions set forth herein. Any modifications to these terms or to the scope of any order or project hereunder, shall be mutually agreed upon and set forth in an appropriate writing executed by both parties. Such writing shall clearly set forth the nature and extent of the change, and, if applicable, any adjustment in price associated with such change.

2. **PRICING / PAYMENT**: The price to be paid by Buyer shall be mutually agreed upon by the parties and set forth in an appropriate writing. Unless otherwise agreed to, prices quoted do not include any state or local sales or use tax, special fees, duties or custom fees, freight and handling charges, or export crating costs that may be added to the price at invoicing. Crane reserves the right to change prices without notice.

Method of Payment. All orders shall be shipped C.O.D. or require payment in advance until credit has been established. A complete credit check is required prior to shipping on a Net-30 or "C.O.D. - CUSTOMER CHECK ACCEPTABLE" basis. Upon credit approval on open account terms, payment shall be made in U.S. Dollars without discount, payable within 30 days of the date of invoice. Minimum billing amount is $100. Shipments outside of the U.S.A. shall be prepaid (by credit card, wire transfer, or U.S. cashier's check), or by irrevocable Letter of Credit. Processing fees may be assessed for additional costs incurred for credit card charges, returned checks, Letters of Credit, or other bank charges.

Payment. All payments shall be remitted as follows: (a) If by Check: Crane Environmental, Inc. P.O. Box 535052 Atlanta GA 30353-5052 (b) If by wire transfer: Wells Fargo Bank N.A. 425 Montgomery Street San Francisco CA 94104 Swift Code: WFBIUS6S, Routing Number: 121000248, Account Name: Crane Environmental, Inc., Account Number 4121222574. Wire transfers should be initiated with all bank charges paid from the account of the applicant. Crane reserves the right to specify the method and/or timing of payment (including prior to shipment) if Crane, in good faith, believes that the prospect of payment by Buyer has been impaired. Crane shall be entitled to a liquidated late charge calculated at a rate of 1.5% per month (18% per annum) or if lower, at the maximum rate permitted by law, for any payment not made within 10 days following the date due. If the Buyer disputes any portion of an invoice, they shall notify Seller in writing with specific details and pay the undisputed portion within 30 days. Buyer shall reimburse all costs incurred in collection of past due amounts including but not limited to attorney's fees, court costs and collection fees incurred by Seller.

Letters Of Credit. Letters of Credit will be accepted by Crane only when compliant with the following: The Letter of Credit must (a) Be IRREVOCABLE and CONFIRMED by a US bank; (b) Be in favor of Crane; (c) State payment is by site draft payable AT SIGHT; (d) State that ALL bank charges, including those outside the country of origin, are to be applied to BUYER'S account; (e) Must state Ex-Works, point as factory unless terms of Pro Forma Invoice specify otherwise, (f) Be advised through a class A U.S. bank; (g) Show buyer as applicant for the Letter of Credit.

3. **DELIVERY**: Once Crane has confirmed acceptance of an order from Buyer, unless otherwise mutually agreed upon: (a) all goods to be supplied hereunder and delivered within the United States shall be shipped Ex-Works, point as factory; (b) all goods to be supplied hereunder and delivered outside the United States shall be shipped in accordance with the applicable provisions of the Incoterms); and (c) title and risk of loss shall pass to Buyer upon Crane's delivery of the goods to the carrier unless otherwise specified. Crane shall not be bound by any delivery requirements unless and until mutually agreed upon by the parties in writing.

Export preparation is not included in the total price and all shipments are Ex-Works, point as factory. Seller reserves the right to choose the location of manufacture. When the total price indicated includes a freight allowance, it is understood that all rail freight charges are included to rail depot nearest to job site and all motor freight charges are included to the job site. All freight charges should be "Prepaid and "Add". If Purchaser indicates equipment is to be shipped "Prepaid", such transportation charges plus processing fee will be added to the invoice as a separate item. All parcel post shipments will be prepaid, the cost of which shall be added to the invoice. Parcel post shipments will be uninsured unless otherwise requested. Equipment requiring the use of large traveling cranes for erection and shipment cannot be held after completion without incurring additional charges.

4. **ACCEPTANCE**: (a) Buyer shall inspect all shipments of equipment or other goods within 10 days of receipt, and shall promptly notify Crane of any defects or non-conforming goods. The parties acknowledge that acceptance of any goods supplied hereunder shall be deemed to have occurred if Buyer fails to notify Crane of any such defects or non-conforming goods within 30 days of the date of receipt. The parties acknowledge that acceptance of any services provided hereunder shall be deemed to have occurred if Buyer fails to notify Crane of any defects or non-conformance in such services within 30 days of the date the services were completed; (b) For any order hereunder which requires Crane's involvement in the installation, start-up, check-out and/or commissioning of any Crane equipment or system, the parties acknowledge that system acceptance shall be deemed to have occurred upon completion of the startup and checkout of the system, or upon operational use of the system by Buyer, whichever occurs first.

5. **WARRANTY**: (See WARRANTY document)

6. **OPERATIONAL AND MAINTENANCE PROCEDURES**: Buyer acknowledges that any improper use, maintenance, or modification of the equipment provided hereunder, or use of unqualified maintenance or service technicians will severely impair the operational effectiveness of the entire system. Buyer hereby agrees to indemnify, defend and hold harmless Crane from and against any and all third party claims arising, in any manner, out of: (a) Buyer's neglect of the equipment; (b) Buyer's use of technicians not authorized by Crane to service the equipment; or (c) Buyer's improper use or modification of the equipment or failure to follow the operational and maintenance procedures provided with the equipment.

7. **LIMITATION OF LIABILITY / DAMAGES**: In no event (even should circumstances cause the exclusive warranties and remedies set forth in the Warranty section to fail their essential purpose) shall either party be liable for any indirect, incidental, special or consequential damages (including, but not limited to, loss of use, loss of anticipated profits, or damages arising from delay) whether such claims are alleged to have arisen out of breach of warranty, breach of contract, strict or absolute liability in tort, or other act, error or omission, or from any other cause whatsoever, or any combination of the foregoing.

8. **CUSTOM EQUIPMENT OR SYSTEMS**: Buyer acknowledges that any approvals and/or listings specified in Crane's proposal are limited to the specific scope and application set forth in the proposal, and may not cover or apply to any custom or special equipment or services which are outside the scope of Crane's proposal. Crane shall retain all proprietary rights in any and all technical data, designs, or other information developed by Crane (and not provided by Buyer) in the course of designing, developing and/or manufacturing custom equipment or systems.

9. **BREACH**: In addition to any failure to comply with any other terms as set forth herein, the occurrence of any of the following events shall constitute a breach on the part of Buyer: (a) If Buyer shall become insolvent or make a general assignment for the benefit of creditors; (b) If a petition under the Bankruptcy Act is filed by or against Buyer; (c) If, at any time Buyer fails to fulfill its obligations under the terms and conditions hereof, or acts in such a manner as to endanger performance of such obligations; (d) If Crane shall reasonably believe that Buyer will not timely fulfill its obligations or otherwise perform hereunder, and Buyer is unable to provide reasonable assurances that such timely performance will occur. Upon breach by Buyer, Crane may terminate the contract or agreement by giving notice to the Buyer. Such termination shall be effective immediately. In the event of a breach and contract termination, Buyer is still responsible for costs incurred by Crane.

10. **INDEMNIFICATION**: Each party shall defend, indemnify and hold each other's officers, directors and employees, harmless from and against any third party claims, damages or losses, including reasonable attorney's fees and costs (whether based on negligence, contract or any other legal theory), to the extent such claims, damages or losses are attributable to the negligence of each party or each party's failure to perform in accordance with the terms and conditions set forth herein.

11. **CONFIDENTIAL & PROPRIETARY INFORMATION**: Buyer acknowledges that the information and processes utilized by Crane in the manufacture and supply of its products and systems are confidential and proprietary to Crane. Buyer agrees to treat as confidential and proprietary any such information or processes, including, but not limited to, design information or data, proposals, software, schematics, drawings, operational and maintenance manuals, testing procedures or other similar technical information ("Confidential Information") provided by Crane in connection with the supply or installation of products or systems hereunder, and will, at a minimum, protect any such

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confidential Information in a manner commensurate with the measures taken to protect Buyer's own confidential or proprietary information. Crane retains all rights, titles and interests in all such Confidential Information and Buyer shall not use or otherwise disclose to any third party any such Confidential Information except to the extent authorized by Crane in writing.

12. **INTELLECTUAL PROPERTY RIGHTS**: Crane retains any and all intellectual property rights in and to the equipment, services, and/or information supplied hereunder (including, but not limited to, patents, copyrights, trademarks and trade secrets) ("Intellectual Property"). Buyer is not granted any interest, right, or license with respect to any such Intellectual Property, except to use the equipment, services and/or information for the purposes for which it is specifically provided to Buyer in accordance with the terms and conditions hereof. Crane shall indemnify and hold Buyer harmless from and against all third party claims of infringement or alleged infringement arising out of Buyer's use of any equipment, services, or information supplied by Crane hereunder. Provided, however, that Crane's indemnity obligation hereunder shall not apply to, and Crane shall not be responsible for, any claims to the extent arising out of Buyer's modification of Crane's equipment, services or information, or use of such equipment, services or information: (a) in combination with equipment, services or information not supplied by Crane, or (b) in the operation of any process or in any other manner inconsistent with the purpose for which Crane's equipment, services or information were intended.

13. **INSURANCE**: Each party shall provide and maintain at its own expense, such policies of insurance in such amounts as are appropriate and commercially reasonable for parties engaging in the type of activities contemplated by the projects entered into hereunder. Upon request, each party shall furnish the other with certificates evidencing the required insurance coverage.

14. **LIENS**: Crane shall promptly pay for all materials, supplies and labor employed by it in providing the goods and/or services hereunder, such that any equipment or system supplied to Buyer remains free of materialmen's, warehousemen's, mechanics', and any other similar liens. Crane shall promptly discharge any such liens arising out of its performance hereunder.

15. **COMPLIANCE WITH LAWS**: In providing the goods and/or services hereunder, Crane shall comply with all applicable federal, state, and local laws and all rules and regulations issued thereunder. Any provisions required to be included by any such law; rule or regulation shall be deemed to be included by reference herein.

16. **ASSIGNMENT**: The rights and responsibilities of Buyer as set forth herein, are personal to Buyer and may not be assigned or delegated without the prior written consent of Crane.

17. **NON-WAIVER**: The parties' failure to demand strict performance or to otherwise enforce any rights hereunder shall not constitute a waiver of any rights hereunder. No claim arising out of a breach hereof may be discharged in whole or in part by a waiver of the claim unless supported by consideration and set forth in a writing signed by the waiving party. Any such waiver shall apply to the specifically identified claim only, and shall in no way constitute a waiver or discharge of any other prior or subsequent claim.

18. **SUSPENSION BY BUYER**: If any project or order, for which Crane is to supply goods and/or services hereunder, is suspended by Buyer, for any reason other than a breach by Crane, Crane shall take all reasonable measures to cooperate with Buyer in rescheduling any planned or ongoing work, and in otherwise complying with the suspension instructions. Provided, however, that in the event of any such suspension which continues for a period of 90 days, Crane shall be entitled to terminate that order, without any further liability or obligation thereunder. Provided, further, that Crane shall be entitled to prompt reimbursement from Buyer IAW Provision 24 below.

19. **CANCELLATION/TERMINATION**: This contract is not subject to cancellation except by mutual consent and on terms that will indemnify Crane against loss. If any project or order, for which Crane is to supply goods and/or services hereunder, is terminated IAW the provisions of these terms and conditions, Crane shall be entitled to charge 25% of selling price to the Buyer who placed the order for standard equipment. As it relates to any specially-designed, non-standard equipment ordered, a 25% charge will be levied if canceled prior to incurring related engineering, drafting, and production time. If engineering, drafting, and production time has been incurred, 100% of the selling price plus additional costs incurred will be charged to the Buyer who placed the order. Additional costs incurred as a direct result of termination may include, but are not limited to, freight and storage charges, costs of labor, transportation, travel and living expenses for support.

20. **APPLICABLE LAW / DISPUTES**: It is the expectation of the parties that any disputes arising hereunder will be amicably resolved by mutual agreement of the parties. Any dispute, involving the supply of goods or services within the United States, which cannot be amicably resolved by the parties, shall be submitted to binding arbitration in accordance with the applicable rules and regulations of the American Arbitration Association. The substantive law of Pennsylvania shall apply to any such arbitration, which shall be conducted in Philadelphia, Pennsylvania. Any dispute, involving the supply of goods or services outside the United States, which cannot be amicably resolved by the parties, shall be submitted to binding arbitration in accordance with the applicable rules and regulations of the International Chamber of Commerce. Unless otherwise agreed upon by the parties, the applicable substantive law, language and the location for any such arbitration shall be determined by the arbitrator(s) in accordance with the applicable rules.

21. **FORCE MAJEURE**: Neither party shall be liable for any failure or delay in its performance resulting from any cause beyond its reasonable control including, but not limited to, acts of God; acts or omissions of civil or military authority; fires; floods; unusually severe weather; strikes or other labor disputes; embargoes; wars; political strife; riots; delays in transportation; sabotage; or fuel, power, material or labor shortages.

22. **INTEGRATION / MODIFICATION**: Except as otherwise specifically set forth herein, these terms and conditions are intended by both Buyer and Crane as the final integrated expression of their agreement with respect to any projects or orders subject hereto. No additions to or modifications of any of the terms or conditions herein shall be effective unless set forth in a writing duly executed by both parties.

23. **CONSTRUCTION**: If these terms and conditions have been provided in response to an invitation to bid or other solicitation from Buyer, and the provisions set forth herein differ in any way from the provisions (if any) of Buyer's invitation or solicitation, these terms and conditions shall constitute Crane's counteroffer and shall not be effective as an acceptance unless Buyer assents to the provisions herein. If these terms and conditions constitute a counteroffer, acceptance hereof must be on the exact terms contained herein. Any additional, conflicting or different terms proposed by Buyer shall constitute a counteroffer by Buyer, and shall not be effective unless set forth in a mutually agreed upon writing executed by both parties.

24. **RETURNED GOODS**: No equipment shall be returned to Seller without its prior written authorization. All returns due to unwanted products or customer error will be assessed a 25% restocking charge, based on the original invoice amount (shipping charges will be borne by the Buyer). The Buyer will be credited the full invoice amount, including return shipping charges, if the original shipment was Crane's error. To obtain specific performance under this warranty, the defective product must be returned to Crane together with proof of purchase, installation date, failure date, supporting technical data, and documentation supporting the warranty claim. Any defective product to be returned to the factory or service center must be sent Freight Prepaid. Buyers desiring to return product should contact our Customer Service Department at 1-800-828-2447 to obtain a Return Authorization (RA) number and a Return Material tag (RMT). Each carton must be visibly marked with the RA number and have the RMT tag (RMT) in the packing list pouch and shipped via ground transport to: The Crane facility indicated on the Return Authorization form. The following applies to returns: (a) Cartons that are not marked with the RA number or do not have the RMT tag in the packing list pouch will be returned to the sender, unopened; (b) The appropriate credit will be issued upon verification of the age and condition of the product returned; (c) Customized products cannot be returned for credit unless it is identified that Crane shipped the order in error; (d) Return of products not manufactured by Crane will be subject to the original manufacturer's return to stock policy; (e) Crane will not accept C.O.D. return shipments; (f) A return authorization will become null and void if equipment is not received by Crane within 30 days of the date of issue. Claims for error in quantity or condition must be made within 10 days of receipt of the material. Crane will not be responsible for any claimed shortages not reported within 10 days.

CRANE

CRANE ENVIRONMENTAL

PURE *Water* MADE SIMPLE

Limited Warranty

Crane Environmental (C.E.) warrants, for a period of twelve months from the date of shipment, that any equipment it manufactures shall be free of defects in material and workmanship, shall comply with the then-current product specifications and product literature, and if applicable, shall be fit for the purpose specified in the agreed upon quotation or proposal document, but only when said products are operated at all times in accordance with Seller's written instructions.

Products which are sold but not manufactured by C.E. are subject to the warranty provided by the manufacturer of said products and not by C.E.'s warranty. Seller shall assign to Purchaser manufacturer's warranties of equipment or material purchased from others to the extent they are assignable, and Buyer's sole recourse shall be against the manufacturer. Crane will determine the applicability of any such third-party warranties.

This warranty applies only to the original purchaser. C.E.'s liability under this warranty shall be limited to repairing or replacing at C.E.'s option, without charge, F.O.B. C.E.'s factory, any product manufactured by C.E. Crane Environmental will not be liable for any cost of removal, installation, transportation, or any other charges which may arise in connection with a warranty claim. Buyer shall provide Seller with reasonable opportunity to make inspections, tests, and repairs using the most cost-effective methods available. If Seller is not responsible under the terms of this agreement, the Buyer shall pay the Seller for such inspections, tests, and repairs at the Seller's prevailing rates.

Repair or replacement shall be Buyer's sole and exclusive remedy, and the warranty period on any repaired or replacement equipment shall be 1 year from the original equipment ship date. In no event shall Crane's warranty obligations with respect to equipment exceed 100% of the total cost of the equipment supplied hereunder. No allowance will be made for repairs or alterations made without Seller's written consent or approval. C.E. 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 C.E.'s printed installation and operating instructions.

C.E. 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 extends beyond those warranties described or referred to above.

Returned of Defective Goods:

No equipment shall be returned to Seller without Seller's prior written authorization. To obtain specific performance under this warranty, the defective product must be returned to C.E. together with proof of purchase, installation date, failure date, and supporting technical data including serial number of the item or the item's parent component. This information must be provided at the time a request is made for a Returned Material Authorization (RMA).

Any defective product to be returned to the factory or manufacturers service center must be authorized in advance and sent Freight Prepaid. The RMA number must be clearly marked on the return shipping documents and any Documentation supporting the warranty claim shall be attached. Contact your C.E. sales engineer or customer service for details on obtaining an RMA number.

Services:

Any services Crane provides hereunder, whether directly or through subcontractors, shall be performed in accordance with the standard of care with which such services are normally provided in the industry. If the services fail to meet the applicable industry standard, Crane will, for a period of 1 year from the date of completion of said services, re-perform such services at no cost to Buyer. Re-performance of services shall be Buyer's sole and exclusive remedy, and in no event shall Crane's warranty obligations with respect to services exceed 100% of the total cost of services provided hereunder.

Limitations / Exclusions:

C.E. warrants its pumps and membrane elements for one year from ship date, providing that loss of performance was not caused by fouling or neglect. C.E. will, on confirmation of loss of performance during the warranty period, credit one-twelfth of the original invoice price of the pump or membrane element for each month remaining in the warranty period, toward the purchase of the replacement pump or membrane.

Components and materials of the type that need periodic replacement due to normal wear and tear, such as membranes, electrodes, frames, gaskets, o-rings, filters, pump seals, spray nozzles, trays and fuses, are warranted against defects only as of the shipment date, unless expressly stated otherwise.

The warranties herein shall not apply to, and Crane shall not be responsible for, any damage to the goods or failure of the services supplied hereunder, to the extent caused by Buyer's neglect, failure to follow operational and maintenance procedures, or the use of technicians not specifically authorized by Crane to maintain or service the equipment. Crane 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 Crane's printed installation and operating instructions. The warranties and remedies contained herein are in lieu of and exclude all other warranties and remedies, whether expressed or implied by operation of law or otherwise, including any warranties of merchantability or fitness for a particular purpose.

Seller reserves the right to utilize the most compact and feasible design compatible with sound engineering practices, and to make changes in details of design, construction and arrangement of goods unless precluded by limitations specified by Buyer in writing in the purchase order or contract at the time the order is placed. If no such limitations are specified, Seller accepts no responsibility for incompatibility of prepared goods with actual space or design limitations, which may become apparent at a later date. 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 have other rights, which vary from jurisdiction to jurisdiction. Unless stated specifically on a formal, official "Performance Warranty Document" signed by an officer of the Seller and an employee of the Buyer who is authorized to make such representations, there is no performance warranty on products or systems or warranty on process results. Any performance warranties shall apply only if equipment is operated in accordance with Seller's instructions when operated on water or other liquids having the characteristics specified in the proposal or purchase order. Any costs incurred by C.E. customers, mechanical contractors or end-users related to C.E. products or accessories will not be reimbursed by C.E. without prior approval in writing by the C.E. Operations Manager or a Crane Co. Corporate Officer. C.E. has a "No Backcharge" and "No Short-Payment" policy. In addition, C.E. will not be responsible for consequential damages. C.E. will fully support its products and correct any unlikely deficiencies in a timely manner.