
GARDNER DENVER®

13-11-604
1st Edition
June, 1997

TWISTAIR®
OIL-FREE ROTARY SCREW
COMPRESSORS

MODELS

AIR COOLED

EWFQ_A – 100 to 150 HP (75 to 112 KW)

WATER COOLED

EWFS_A – 100 to 150 HP (75 to 112 KW)

**OPERATING AND
SERVICE MANUAL**

Gardner

Denver

MAINTAIN COMPRESSOR RELIABILITY AND PERFORMANCE WITH GENUINE GARDNER DENVER COMPRESSOR PARTS AND SUPPORT SERVICES

Gardner Denver Compressor genuine parts, engineered to original tolerances, are designed for optimum dependability — specifically for Gardner Denver compressor systems. Design and material innovations are the result of years of experience with hundreds of different compressor applications. Reliability in materials and quality assurance are incorporated in our genuine replacement parts.

Your authorized Gardner Denver Compressor distributor offers all the backup you'll need. A worldwide network of authorized distributors provides the finest product support in the air compressor industry. Your local authorized distributor maintains a large inventory of genuine parts and he is backed up for emergency parts by direct access to the Gardner Denver Machinery Inc. Master Distribution Center (MDC) in Memphis, Tennessee.

Your authorized distributor can support your Gardner

Denver air compressor with these services:

1. Trained parts specialists to assist you in selecting the correct replacement parts.
2. Factory warranted new and remanufactured rotary screw air ends. Most popular model remanufactured air ends are maintained in stock at MDC for purchase on an exchange basis with liberal core credit available for the replacement unit.
3. A full line of factory tested AEON™ compressor lubricants specifically formulated for use in Gardner Denver compressors.
4. Repair and maintenance kits designed with the necessary parts to simplify servicing your compressor.

Authorized distributor service technicians are factory-trained and skilled in compressor maintenance and repair. They are ready to respond and assist you by providing fast, expert maintenance and repair services.

For the location of your local authorized Gardner Denver Air Compressor distributor refer to the yellow pages of your phone directory or contact:

Distribution Center:
Gardner Denver Machinery Inc.
Master Distribution Center
5585 East Shelby Drive
Memphis, TN 38141
Phone: (901) 542-6100
(800) 245-4946
Fax: (901) 542-6159

Factory:
Gardner Denver Machinery Inc.
1800 Gardner Expressway
Quincy, IL 62301
Phone: (217) 222-5400
Fax: (217) 224-7814

REMANUFACTURED AIR ENDS

Whenever an air end requires replacement or repair, Gardner Denver offers an industry unique, factory remanufactured air end exchange program. From its modern Remanufacturing Center in Indianapolis, IN, Gardner Denver is committed to supplying you with the highest quality, factory remanufactured air ends that are guaranteed to save you time, aggravation and money.

Immediately Available

Repair downtime costs you money, which is why there are over 200 remanufactured units in inventory at all times, ready for immediate delivery.

Skilled Craftsmen

Our Remanufacturing assembly technicians average over 20 years experience with air compression products.

Precision Remanufacturing

All potentially usable parts are thoroughly cleaned, inspected and analyzed. Only those parts that can be brought back to original factory specifications are remanufactured. Every remanufactured air end receives

a new overhaul kit: bearings, gears, seals, sleeves and gaskets.

Extensive Testing

Gardner Denver performs testing that repair houses just don't do. Magnaflux and ultrasonic inspection spot cracked or stressed castings, monochromatic light analysis exposes oil leaks, and coordinate measurement machine inspects to $\pm .0001$ ", insuring that all remanufactured air ends meet factory performance specifications.

Warranty

Gardner Denver backs up every remanufactured air end with a new warranty . . . 18 months from purchase, 12 months from service.

Gardner Denver remanufactured air ends deliver *quality without question . . . year in and year out.*

Call Gardner Denver for information on the air end exchange program and the name of your authorized distributor.

Phone Number: 800-245-4946 or
FAX: 901-542-6159

FOREWORD

Gardner Denver Rotary Screw compressors are the result of advanced engineering and skilled manufacturing. To be assured of receiving maximum service from this machine the owner must exercise care in its operation and maintenance. This book is written to give the operator and maintenance department essential information for day-to-day operation, maintenance and adjustment. Careful adherence to these instructions will result in economical operation and minimum downtime.

DANGER

Danger is used to indicate the presence of a hazard which will cause severe personal injury, death, or substantial property damage if the warning is ignored.

WARNING

Warning is used to indicate the presence of a hazard which can cause severe personal injury, death, or substantial property damage if the warning is ignored.

CAUTION

Caution is used to indicate the presence of a hazard which will or can cause minor personal injury or property damage if the warning is ignored.

NOTICE

Notice is used to notify people of installation, operation or maintenance information which is important but not hazard-related.

This book covers the following models:

HP (KW)	Air Cooled	Water Cooled	Parts List
100 (75)	EWQMA	EWFSMA	13-11-506
125 (93)	EWQNA	EWFSNA	13-11-506
150 (112)	EWQOA	EWFSOA	13-11-506

INSTRUCTIONS FOR ORDERING REPAIR PARTS

When ordering parts, specify Compressor MODEL, Method of Cooling, HORSEPOWER and SERIAL NUMBER (see nameplate on unit). The Serial Number is also stamped on top of the cylinder flange to the right of the inlet housing.

All orders for Parts should be placed with the nearest authorized distributor.

Where NOT specified, quantity of parts required per compressor or unit is one (1); where more than one is

required per unit, quantity is indicated in parenthesis. SPECIFY EXACTLY THE NUMBER OF PARTS REQUIRED.

DO NOT ORDER BY SETS OR GROUPS.

To determine the Right Hand and Left Hand side of a compressor, stand at the drive side of the package and look toward the compressor. Right Hand and Left Hand are indicated in parenthesis following the part name, i.e. (RH) & (LH).

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SECTION 1 GENERAL INFORMATION

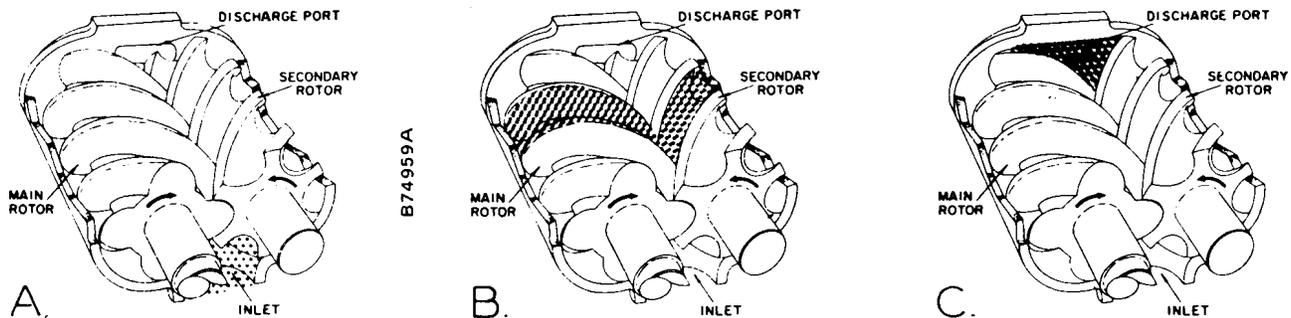


FIGURE 1-1 – TYPICAL COMPRESSION CYCLE

COMPRESSOR – The Gardner Denver® Rotary Screw compressor is a single stage, positive displacement rotary machine using meshing helical rotors to effect compression. Both rotors are supported between high capacity roller bearings located outside the compression chamber. Tapered roller bearings positioned at each rotor suction end and at the secondary rotor discharge end locate the rotors axially and carry all thrust loads and a portion of the radial loads. Single width cylindrical roller bearings are used at the discharge end of the rotors to carry the majority of the radial loads.

COMPRESSION PRINCIPLE (FIGURE 1-1) – Compression is accomplished by the main and secondary rotors synchronously meshing in a one-piece cylinder. The main rotor has four (4) helical lobes 90° apart. The secondary rotor has six (6) matching helical grooves 60° apart to allow meshing with main rotor lobes.

The air inlet port is located on top of the compressor cylinder near the suction end. The discharge port is at the bottom on the opposite end of the compressor cylinder. FIGURE 1-1 is an inverted view to show inlet and discharge ports. The compression cycle begins as rotors unmesh at the inlet port and air is drawn into the cavity between the main rotor lobes and secondary rotor grooves (A). When the rotors pass the inlet port cutoff, air is trapped in the interlobe cavity and flows axially with the meshing rotors (B). As meshing continues, more of the main rotor lobe enters the secondary rotor groove, normal volume is reduced and pressure increases.

Water is injected into the cylinder to remove the heat of compression and seal internal clearances. Volume re-

duction and pressure increase continues until the air/water mixture trapped in the interlobe cavity by the rotors passes the discharge port and is released to the air/water reservoir (C). Each rotor cavity follows the same “fill–compress–discharge” cycle in rapid succession to produce a discharge air flow that is continuous, smooth, and shock free.

AIR FLOW IN THE COMPRESSOR SYSTEM (FIGURE 1-4, page 3) – Air enters the air filter and passes through the inlet unloader valve to the compressor. After compression, the air/water mixture flows to the separator/reservoir tank where most of the water is removed by velocity change and impingement. The air flows to the aftercooler, then to the moisture separator where the water that has condensed is removed from the air stream. The air then flows through the package discharge check valve and to the plant compressed air system.

WATER SYSTEM (FIGURE 1-6, page 4) – Water is forced by air pressure from the separator/reservoir tank through the heat exchanger, the system water filters, and into the compression chamber injection ports. The water removes the heat of compression and seals internal clearances. Seals minimize water leakage out of the compression chamber.

LUBRICATION – Oil in the oil reservoir is drawn through the mechanical oil pump driven by the input shaft to the air end. The oil is pumped through the oil filter and into both the gear/discharge end bearing housing and the suction end where it lubricates the gears and bearings. The oils drains out of the bottom of the housings and flows back into the reservoir.

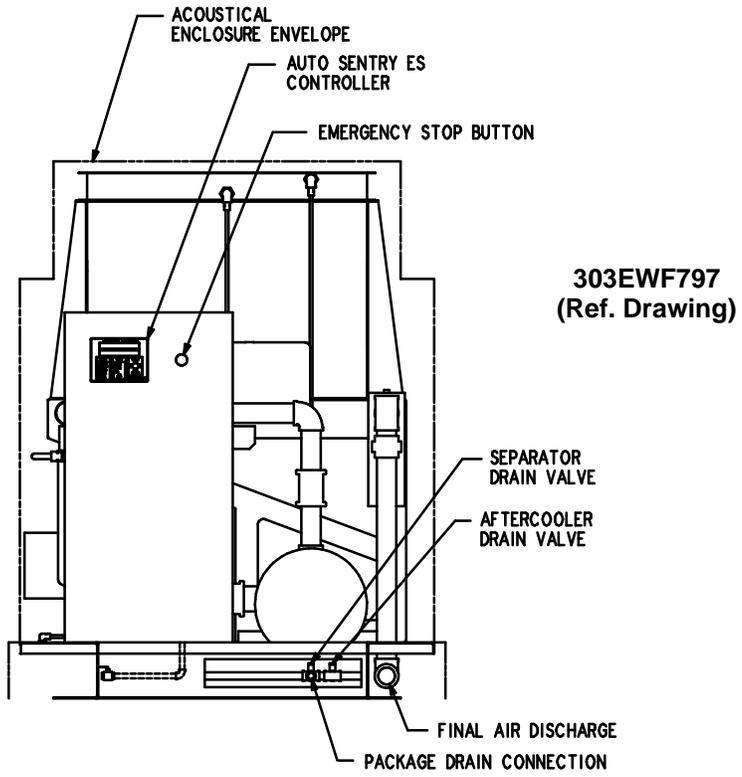


FIGURE 1-2 – CONTROL BOX END

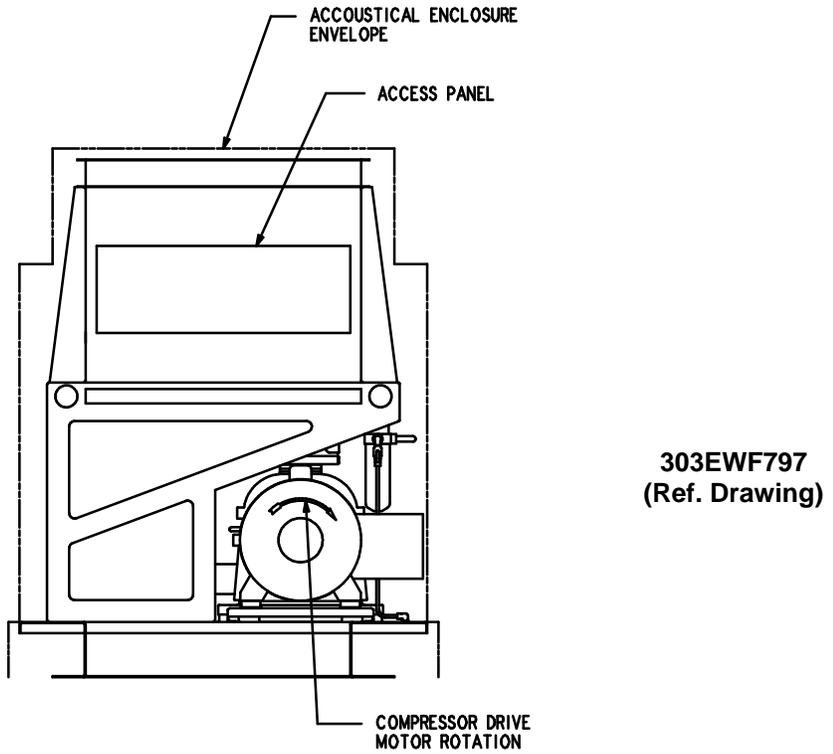


FIGURE 1-3 – MOTOR END

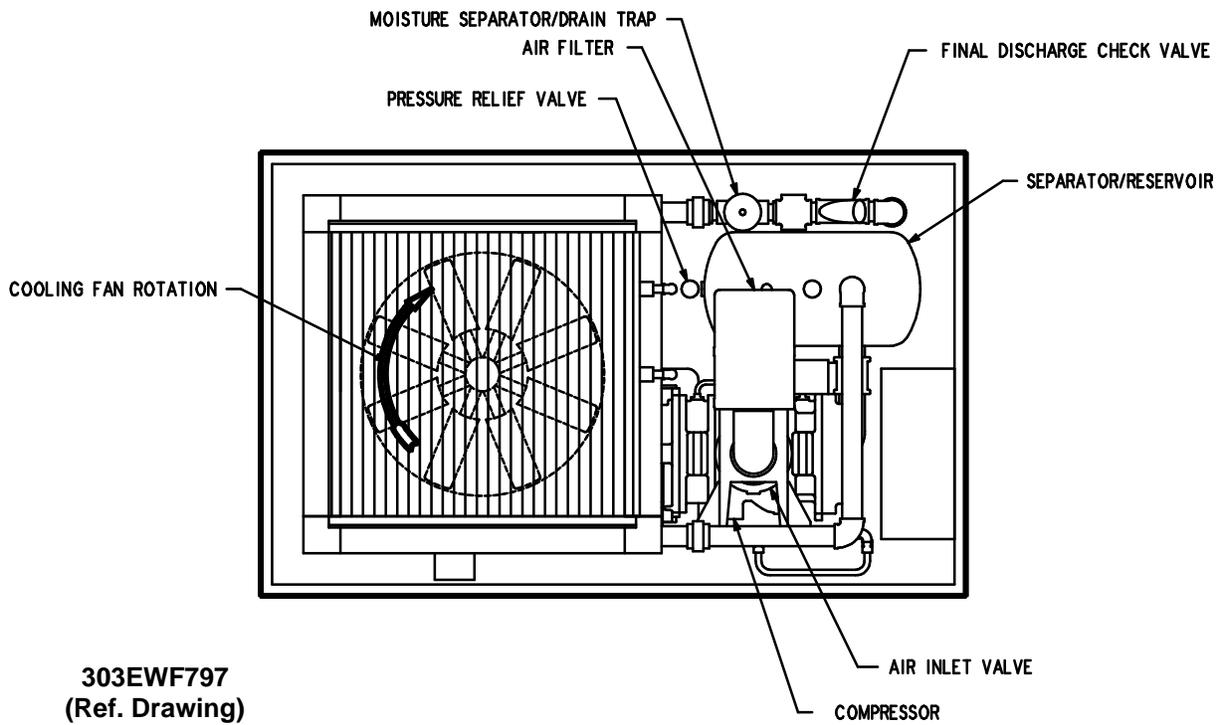


FIGURE 1-4 - TOP VIEW

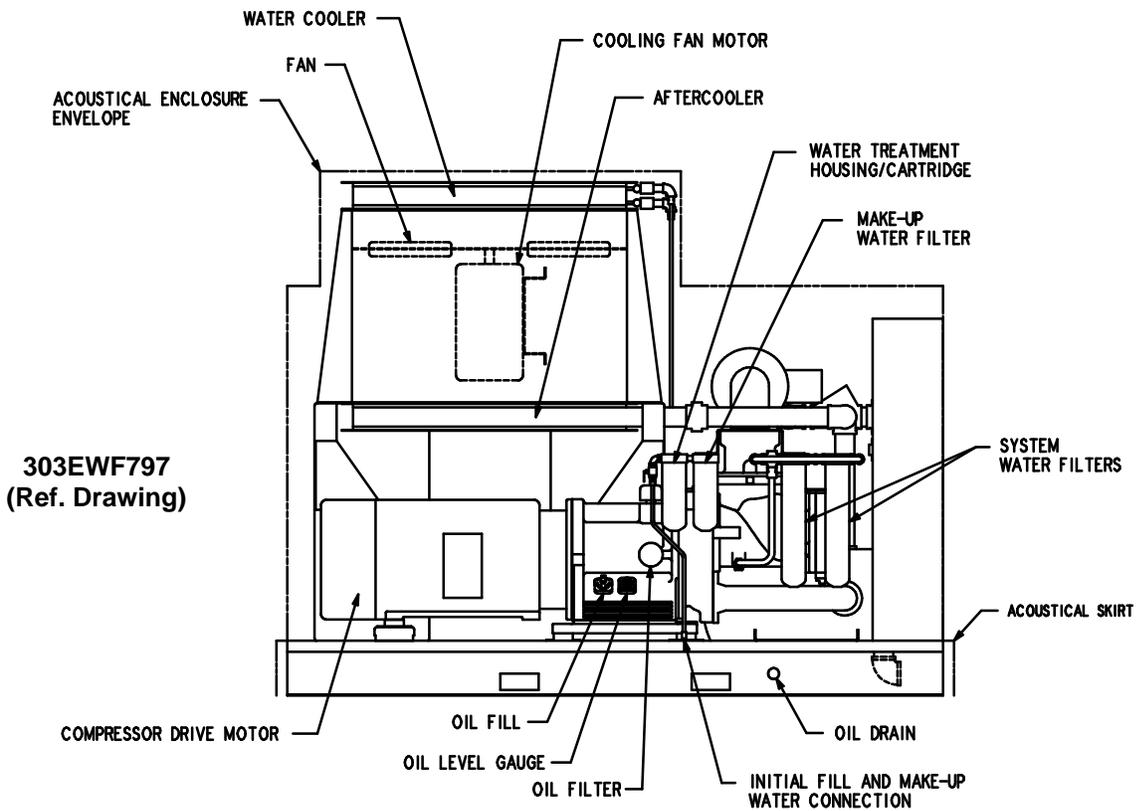
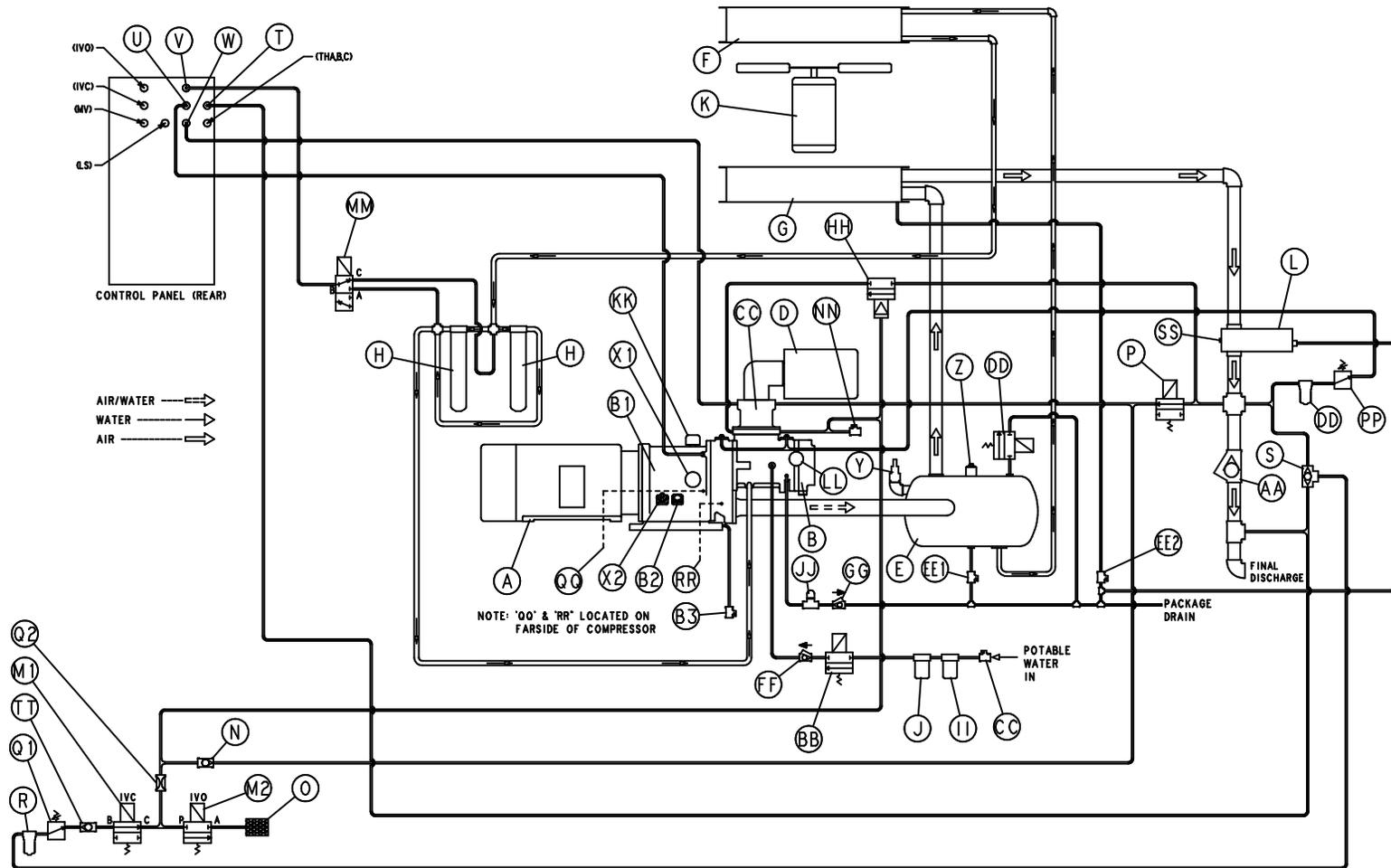


FIGURE 1-5 - COMPRESSOR/MOTOR SIDE VIEWS



- | | | | |
|--------------------------------|--|--|---|
| A - DRIVE MOTOR | L - MOISTURE SEPARATOR/
CONDENSATE DRAIN TRAP | V - WATER PRESSURE TRANSDUCER (XDB) | HH - PURGE VALVE |
| B - COMPRESSOR | M1 - INLET VALVE CLOSE (IVC) SOLENOID VALVE | W - AIR FILTER VACUUM SWITCH | II - WATER TREATMENT HOUSING
& CARTRIDGE |
| B1 - ADAPTOR/OIL RESERVOIR | M2 - INLET VALVE OPEN (IVO) SOLENOID VALVE | X1 - OIL FILTER | JJ - DRAIN BREATHER |
| B2 - OIL LEVEL GAUGE | N - CONTROL CHECK VALVE | X2 - OIL FILLER CAP | KK - CRANKCASE BREATHER |
| B3 - OIL RESERVOIR DRAIN VALVE | O - MUFFLER | Y - PRESSURE RELIEF VALVE | LL - HOUSING BREATHER |
| C - AIR INLET VALVE | P - BLOWDOWN SOLENOID VALVE | Z - SEPARATOR WARE LEVEL SWITCH (LS) | MM - WATER METERING VALVE (MV) |
| D - AIR FILTER | Q1 - PRESSURE REGULATOR | AA - DISCHARGE CHECK VALVE | NN - INLET CONTROL DRAIN |
| E - SEPARATOR RESERVOIR | Q2 - ORIFICE | BB - WATER INLET SOLENOID VALVE | OO - BUFFERING AIR LINE FILTER |
| F - HEAT EXCHANGER | R - AIR LINE FILTER | CC - GLOBE VALVE | PP - BUFFERING AIR PRESSURE REGULATOR |
| G - AFTERCOOLER | S - SHUTTLE VALVE | DD - AUTO DRAIN SOLENOID VALVE | QQ - OIL TEMPERATURE THERMISTOR (THB) |
| H - MAKE-UP WATER FILTER/S | T - SYSTEM PRESSURE TRANSDUCER (XDA) | EE1 - MANUAL DRAIN GLOBE VALVE (SEPARATOR) | RR - COMPRESSOR DISCHARGE THERMISTOR (THA) |
| J - MAKE-UP WATER FILTER | U - OIL PRESSURE TRANSDUCER (XDC) | EE2 - MANUAL DRAIN GLOBE VALVE (AFTERCOOLER) | SS - FINAL DISCHARGE THERMISTOR (THC) |
| K - FAN MOTOR | | FF - BACKFLOW CHECK VALVE | TT - CHECK VALVE |
| | | GG - DRAIN CHECK VALVE | |

300EWF797
(Ref. Drawing)

FIGURE 1-6 - AIR/WATER SCHEMATIC

SAFETY PRECAUTIONS

Safety is everybody's business and is based on your use of good common sense. All situations or circumstances cannot always be predicted and covered by established rules. Therefore, use your past experience, watch out for safety hazards and be cautious.

Some general safety precautions are given below:

DANGER

Failure to observe these notices could result in injury to or death of personnel.

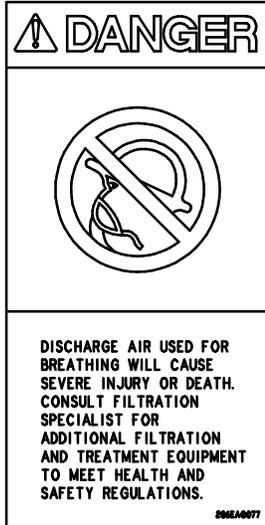
- **Keep fingers and clothing away from revolving fan, drive belts, etc.**
- **Do not use the air discharge from this unit for breathing – not suitable for human consumption.**
- **Do not loosen or remove the oil filler plug, drain plugs, covers, or break any connections, etc., in the compressor air or oil system until the unit is shut down and the air pressure has been relieved.**
- **Electrical shock can and may be fatal.**
- **Compressor unit must be grounded in accordance with the National Electrical Code. A ground jumper equal to the size of the equipment ground conductor must be used to connect the compressor motor base to the unit base.**
- **Fan motors must remain grounded to the main base through the starter mounting panel in accordance with the National Electrical Code.**
- **Open main disconnect switch, tag and lockout before working on the control.**
- **Disconnect the compressor unit from its power source, tag and lockout before working on the unit – this machine is automatically controlled and may start at any time.**

 **WARNING**

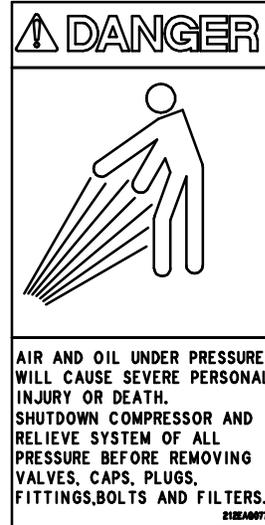
Failure to observe these notices could result in damage to equipment.

- **Stop the unit** if any repairs or adjustments on or around the compressor are required.
- **Disconnect the compressor** unit from its power source, tag and lockout before working on the unit – this machine is automatically controlled and may start at any time.
- **An Excess Flow Valve** should be on all compressed air supply hoses exceeding 1/2 inch inside diameter. (OSHA Regulation, Section 1926.302)
- **Do not exceed the rated maximum pressure values** shown on the nameplate.
- **Do not operate unit** if safety devices are not operating properly. Check periodically. Never bypass safety devices.

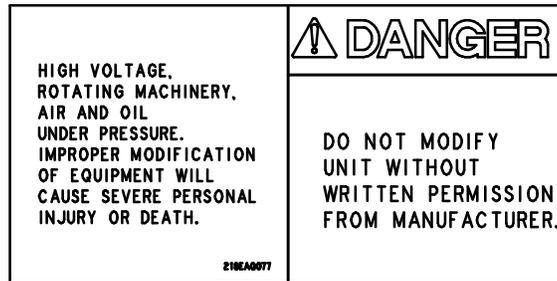
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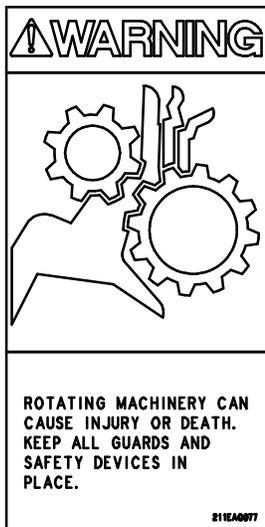
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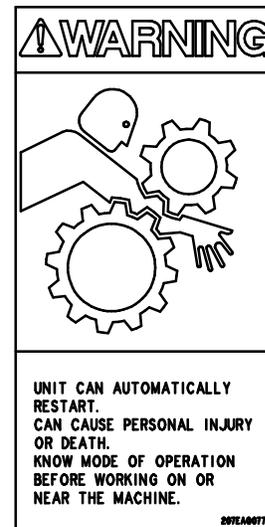
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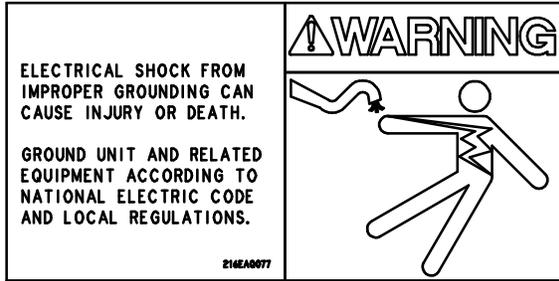


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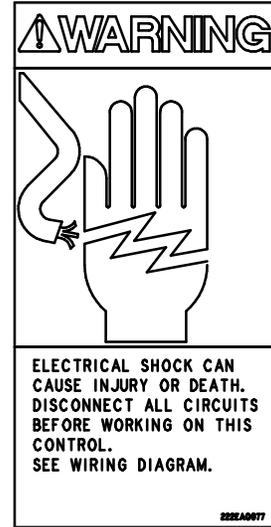


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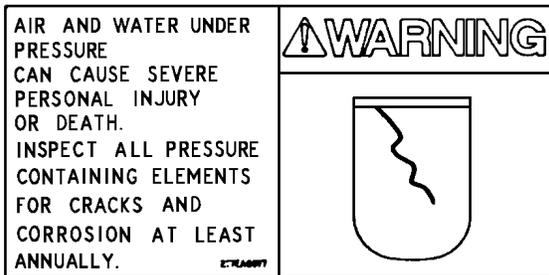
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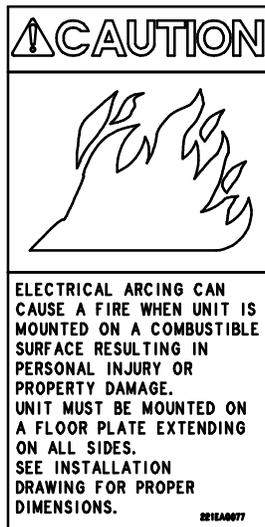
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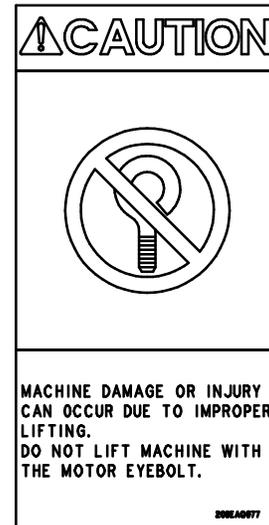
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206EWD077



221EAQ077



208EAQ077

SECTION 2 INSTALLATION, COOLERS AND WATER SYSTEMS

GENERAL – On receipt of the unit, check for any damage that may have occurred during transit or handling. Report any damage or missing parts as soon as possible.

CAUTION

Do not electric weld on the compressor or base; bearings can be damaged by passage of current.

LIFTING UNIT – Proper lifting and/or transporting methods must be used to prevent damage. Lifting slots are provided in the base for towmotor use. The unit may also be moved into location by rolling on bars.

CAUTION

Lift compressor unit by base only. Do not use other places such as motor, compressor or discharge manifold piping as lifting points.

DANGER

The eyebolts or lugs provided on the motor are for lifting the motor only and should not be used to lift any additional weight. All eyebolts must be securely tightened. When lifting the motor the lifting angle must not exceed 15 degrees. Failure to observe this warning may result in damage to equipment or personal injury.

LOCATION – The compressor should be installed in a clean, well-lighted, and ventilated area with ample space all around the unit for maintenance. Select a location that provides a cool, clean, and dry source of air. In some cases it may be necessary to install the air filter at some distance from the compressor to obtain proper air supply.

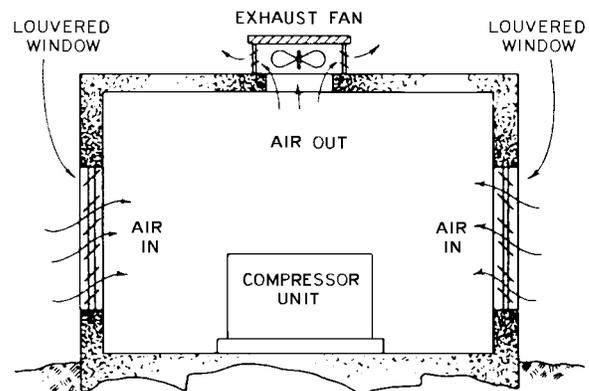
WARNING

Do not install this compressor in a location that may be subject to temperatures below 32° F. (0° C.).

Below freezing temperatures will cause damage to the compressor.

The air-cooled unit requires cooling air as well as air to the compressor inlet. Proper ventilation **MUST** be provided; hot air must be exhausted from the compressor operating area. A typical inlet-outlet air flow arrangement is shown in FIGURE 2-1.

Air-Cooled Units – An air cooled heat exchanger and aftercooler is supplied as standard equipment on all air-cooled units. The air cooled motor and fan are mounted within the cooling module. Cooling air is



A75119

FIGURE 2-1 – TYPICAL COMPRESSOR ROOM

Minimum Air Flow* For Compression And Cooling – Cubic Feet/Minute (Cubic Meters/Minute)		
HP (KW)	Air Cooled	Water Cooled
100–150 (75–112)	22,500 (637)	4000 (113)

* 80° F (27° C) Inlet Air

FIGURE 2-2 – AIR FLOW CHART

drawn into the package through the top of the enclosure at the control box end. It passes through the after-cooler and is exhausted through the heat exchanger mounted in the cooling shroud located at the top-rear of the enclosure. The air-cooled unit with the standard enclosure requires sufficient air flow, FIGURE 2-2, page 9, for the compressor water/aftercooling system and for electric motor cooling. Do not block the air flow to and from the unit. Allow three and one-half (3-1/2) feet (1.1 M) to the nearest obstruction on the control box end of the unit. Allow six (6) feet (1.8 M) to the nearest obstruction above and three (3) feet (.9 M) to the nearest obstruction on remaining sides of the unit. For continuous efficiency, the heat exchanger and after-cooler cores must be periodically cleaned with either vacuum or compressed air. If wet cleaning is required, shield the motor and spray on a mild soap solution, then flush with clean water.

 **WARNING**

For copper water coolers, do not use any cleaning solution that is not compatible with copper. Use of improper solution may result in damage to the cooler.

Water-cooled Units – The water-cooled unit with the standard enclosure requires sufficient air flow, FIGURE 2-2, page 9, for electric motor cooling. Air is drawn into the unit at the top of the enclosure on the motor end and is exhausted through the top of the enclosure above the control box. Do not block air flow to and from the unit. Allow three and one half (3-1/2) feet (1.1 M) to the nearest obstruction on the control box end of the unit. Allow three (3) feet (.9 M) to the nearest obstruction above and on other sides of the unit. For additional information and requirements for water-cooled units, see pages 12 through 15.

FOUNDATION – The Gardner Denver Rotary Screw compressor requires no special foundation, but should be mounted on a smooth, solid surface. Whenever possible, install the unit near level. Temporary installation may be made at a maximum 10° angle lengthwise or 10° sidewise.

Mounting bolts are not normally required. However, installation conditions such as piping rigidity, angle of tilt, or danger of shifting from outside vibration or moving vehicles may require the use of mounting bolts and shims to provide uniform support for the base.

OIL BREATHER – To prevent oil leakage during ship-

ment, the breather vents normally located in the top of the motor adapter/oil reservoir and suction end housing have been removed and replaced by plugs. Before operating unit, remove the plugs and install the breathers.

Potential contamination of air inlet supply due to minute traces of vapors from the oil sump vents can be avoided by piping the vents to the outside.

OIL RESERVOIR DRAIN – The oil drain is piped from the bottom of the motor adapter/oil reservoir through the side of the base. This drain is approximately 4 inches (100 MM) above the floor level. If this is not sufficient to conveniently drain the oil, some other methods of providing drainage are:

1. Elevate the compressor unit on blocks to obtain the desired drain height.
2. Construct an oil sump or trough below the floor level and pump or bail the drained oil.
3. Pump oil from reservoir filler opening or drain to a container.

ENCLOSURE – The compressor, electric motor, heat exchanger and aftercooler are mounted within the enclosure.

Service doors are provided for maintenance access. Allow enough space around the unit for the doors to be opened and removed as necessary for service procedures. Any enclosure door may be removed by opening the door and lifting it up slightly to disengage the hinges. The air filter, oil filter, water filters, and water treatment cartridge are easily accessed through a side door.

 **DANGER**

Do not operate the compressor with the coupling guard removed. Exposed rotating components may cause injury to personnel.

COMPRESSOR WATER SPECIFICATION – The compressor initial fill and make-up water must meet the United States Environmental Protection Agency National Primary Drinking Water Regulation (See Table, page 18.) By requiring potable water fit for human consumption, a quality level is defined which is most generally readily available.

In addition to the requirements of the National Primary Drinking Water Regulations, the limits listed in FIGURE 2-3, page 11, must not be exceeded.

	Maximum Limit
1) Total Hardness as CaCO ₃	120 parts per million
2) Either Total Dissolved Solids or Specific Conductance	500 parts per million 800 Micromhos/cm
3) pH	7.5 to 9.0

FIGURE 2-3 – ADDITIONAL WATER LIMITATIONS

Total Hardness in Mg/L* as CaCO ₃	Water Classification
0 – 60	Soft
61 – 120	Moderately Hard
120 – 180	Hard
Greater than 180	Very Hard

* 1 Mg/L = Approx. 1 ppm

FIGURE 2-4 – USGS CLASSIFICATION OF WATER

 **WARNING**

Backflow Preventers must be installed on the potable water supply line to the compressor to prevent high pressure air from blowing into the water supply.

 **WARNING**

Use of compressor initial fill and make-up water exceeding these limits could result in excessive scale formation which can facilitate corrosive activity and equipment damage or malfunction.

 **WARNING**

Use of compressor initial fill and make-up water not meeting all water specification standards noted may result in contamination of the discharge air stream.

 **WARNING**

Compressor water seal leakage may occur. You must have potable make-up water available.

NOTICE

Water may no longer be potable after use in the compressor.

In addition to the requirements of the National Drinking Water Regulations, the limits listed in FIGURE 2-3 shall not be exceeded.

This unit is equipped with a food-grade hexameta-phosphate feeder cartridge which dissolves slowly in water to prevent scale and inhibit corrosive activity. The use of a water considered to be “hard” or “very hard” by the U.S. Geological Survey (See FIGURE 2-4 for the U.S.G.S. classification of water) will result in increased frequency of required water filter and cartridge replacements and lead to scale build-up which can cause equipment malfunction and/or damage. If the quality of a proposed water supply is questionable, the water should be analyzed. If the water does not comply with these specifications, a water treatment service can recommend a treatment program to satisfy the specifications. Hardness can often be reduced by using a sodium ion exchange water softener.

AUXILIARY AIR RECEIVER – An auxiliary air receiver is not required if the piping system is large and provides sufficient storage capacity to prevent rapid cycling. When used, an air receiver should be of adequate size, provided with a relief valve of proper setting, a pressure gauge and a means of draining condensate.

MOISTURE SEPARATOR/TRAP – Since the unit is equipped with a built-in aftercooler, a combination moisture separator and drain trap is furnished with the unit. The moisture from the trap is piped to the unit drain line.

CONTROL PIPING – External control piping is not necessary since the unit is factory wired and piped for the control system specified.

INLET LINE – Where an inlet line is used between the air filter and the compressor, it must be thoroughly

Length of Inlet Line	Diameter of Pipe Size
0 to 10 Feet (0 to 3 Meters)	Same as Compressor Inlet Opening
10 to 17 Feet (3 to 5 Meters)	One Size Larger Than Inlet Opening
17 to 38 Feet (5 to 11.5 Meters)	Two Sizes Larger Than Inlet Opening

FIGURE 2-5 – INLET LINE LENGTHS

cleaned on the inside to prevent dirt or scale from entering the compressor. **If welded construction is used, the line must be shot blasted and cleaned to remove welding scale.** In either case, the inlet line must be coated internally by galvanizing or painting with a moisture and oil-proof sealing lacquer. Up to ten (10) feet in length, the inlet line should be the full size of the inlet opening on the compressor. If an extra-long line is necessary, the pipe size should be increased according to Inlet Line Chart, FIGURE 2-5.

Accessibility for inlet air filter servicing must be considered when relocating the filters from the unit to a remote location.

DISCHARGE SERVICE LINE – The discharge service line connection on the unit is located at base level on the right side of the control box end of the package. When manifolding two or more rotary screw units on the same line, each unit is isolated by the check valve

in the unit discharge line. If a rotary screw unit is manifolded to another compressor, be sure the other compressor has a check valve in the line between the machine and the manifold. If a rotary screw and reciprocating compressor are manifolded together, an air receiver must be located between the two units.

 DANGER
Discharge air used for breathing will cause severe injury or death. Consult filtration specialists for additional filtration and treatment equipment to meet health and safety standards.

The oil-free air discharging from the EWF package is

HEAT EXCHANGER							
HP (KW)	Model	Water Temperature to Heat Exchanger GPM (LPS)				Maximum Water Flow GPM* (LPS)	Approximate Water Pressure Drop @ 90° F (32° C) Water Temp. PSID (Bar)
		60° F. (16° C.)	70° F. (21° C.)	80° F. (27° C.)	90° F. (32° F.)		
100 HP (75)	EWFSMA	9.5 (.60)	12.0 (.76)	16.0 (1.0)	23.8 (1.5)	55.0 (3.47)	2.5 (.17)
125 HP (93)	EWFSNA	12.0 (.76)	15.0 (.95)	20.0 (1.3)	30.0 (1.9)	55.0 (3.47)	3.8 (.26)
150 HP (112)	EWFSOA	14.2 (.90)	18.0 (1.1)	23.8 (1.5)	35.5 (2.2)	55.0 (3.47)	5.6 (.39)

* Flows exceeding “Maximum Water Flow” will cause severe erosion and will void unit warranty.

FIGURE 2-6 – HEAT EXCHANGER (OIL COOLER) APPROXIMATE WATER FLOW

AFTERCOOLER							
HP (KW)	Model	Water Temperature to Heat Exchanger Gallons/minute				Maximum Water Flow GPM* (LPS)	Approximate Water Pressure Drop @ 90° F (32° C.) Water Temp. PSID (Bar)
		60° F. (16° C.)	70° F. (21° C.)	80° F. (27° C.)	90° F. (32° F.)		
100 HP (75)	EWFSMA	1.5 (.09)	2.0 (.13)	2.5 (.16)	3.8 (.24)	26.0 (1.64)	Less than 1 PSI for any flow rate shown in the table.
125 HP (93)	EWFSNA	2.0 (.13)	2.4 (.15)	3.1 (.20)	4.7 (.30)	26.0 (1.64)	
150 HP (112)	EWFSOA	2.2 (.14)	3.0 (.19)	3.7 (.23)	5.6 (.35)	26.0 (1.64)	

* Flows exceeding "Maximum Water Flow" will cause severe erosion and will void unit warranty.

FIGURE 2-7 – AFTERCOOLER APPROXIMATE WATER FLOW

saturated with water vapor at discharge temperature. An air dryer may be required if the air is used in a moisture sensitive process. In addition, the compressed air has been mixed with contaminants that entered the intake of the compressor.

UNIT WATER DRAIN – The unit drain port should be connected to a floor drain. The drain line must slope downward away from the unit to allow excess condensate to flow by gravity. As necessary, the automatic water management system will open the drain solenoid valve to drain excess water. Since the drain solenoid valve may open at any point during compressor operation, high temperature water under pressure may be discharged from the unit. It is recommended that the compressor water drain port be hard piped to the floor drain.

 **DANGER**

Hot water under pressure will cause severe personal injury or death. Do not operate compressor until a water drain line is installed from compressor water drain port to a floor drain.

BLOWDOWN VALVE PIPING – The blowdown valve is piped into the air end at the inlet valve. The air filter acts as a muffler.

WATER PIPING (Water-Cooled Heat Exchanger Models Only) – On machines equipped with water-cooled heat exchangers, the water inlet and outlet connections are located in the unit base flange at the rear of the unit.

The water source should be capable of supplying up to the maximum flow shown in FIGURE 2-6, page 12, at a minimum pressure of 40 psig (2.8 bar); maximum allowable water pressure is 150 psig (10.3 bar). The water flow rates shown in FIGURE 2-6, page 12, are approximate and serve as a guide for piping and cooling tower sizing and other water system equipment.

The heat exchanger system is designed to operate with water inlet temperatures from 60° F to 90° F (16° to 32° C) and a water outlet temperature not to exceed 110° F (43° C). If water cooler than 60° F (16° C) is used, high water outlet temperatures (over 110° F – 43° C) will be experienced along with shortened heat exchanger life caused by tube fouling and corrosion. If water warmer than 90° F (32° C) is used, higher compressor injection water inlet temperatures and high water usage will result.

Most water systems will require control of impurities: filtration, softening or other treatment. See "Compressor Injection Water Cooler – Water-Cooled Heat Exchanger" for more information on the water system. The cooling water for the water cooled heat exchanger and aftercooler does not have to meet the compressor injection recirculating system potable requirement.

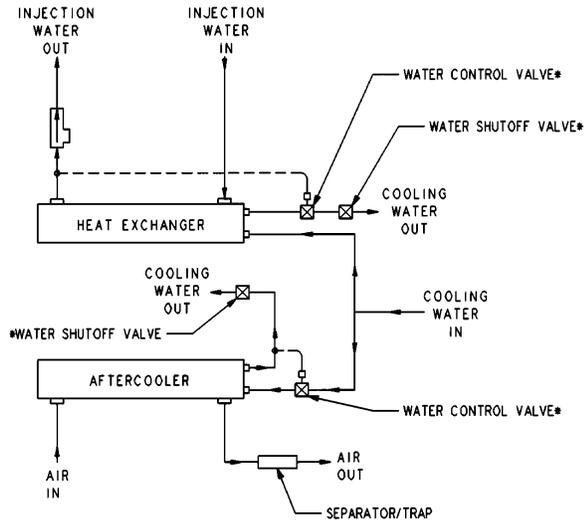


FIGURE 2-8 – PARALLEL PIPING

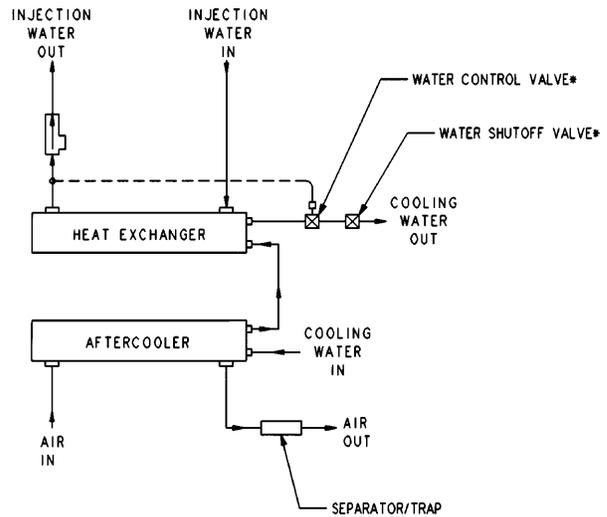


FIGURE 2-9 – SERIES PIPING

* (OPTIONAL) WATER CONTROL VALVE AND WATER SHUTOFF VALVE MUST BE ORDERED SEPARATELY.

SERIES PIPING (FIGURE 2-9) – Water flow must be through aftercooler first for effective cooling of discharge air and is so piped on the standard water-cooled unit.

PARALLEL PIPING (FIGURE 2-8) – A separate water control valve is required to control the discharge air temperature. If a remote (externally mounted) water-cooled aftercooler is piped in parallel with the heat exchanger, provide a separate water control valve for the aftercooler and pipe separate inlet water lines to both the aftercooler and heat exchanger.

The water control valve is to be adjusted to maintain water out of the heat exchanger within the 100° to 120° F (38° to 49° C) range regardless of inlet water flow or temperature as long as a minimum flow for a given temperature is met (FIGURE 2-6, page 12). See “Water Flow Control Valve For Heat Exchanger,” page 15, for adjustment instructions.

COMPRESSOR INJECTION WATER COOLER – WATER-COOLED HEAT EXCHANGER – (FIGURE 5-3, page 46) – The compressor injection water heat exchanger is a multiple pass type cooler with cooling water in the tubes and compressor injection water in the shell. The optional cooling water control valve may be used to conserve water.

Compressor injection water cooler malfunction may be traced by checking the pressure at the compressor injection water inlet and outlet. At normal operating air service pressure (65 – 125 psig – 4.5 to 8.6 bar) with the unit warm, a pressure drop of 3 to 5 psid (.2 to .3 bar) can be expected.

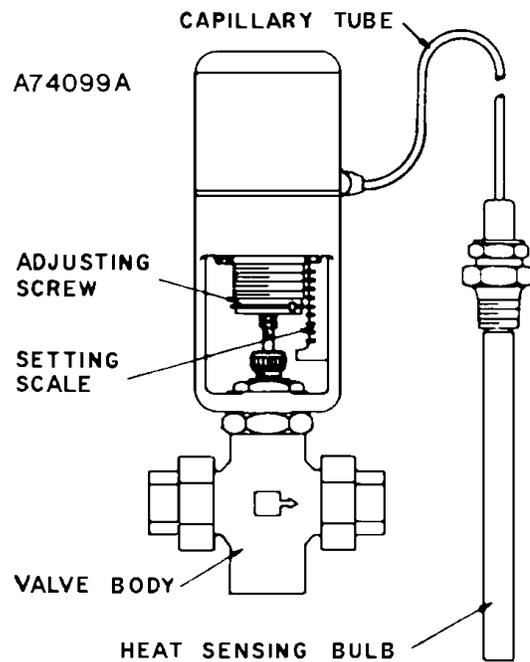


FIGURE 2-10 – WATER FLOW CONTROL VALVE

Cooling water pressure drop from inlet to outlet will vary with the inlet pressure and amount of cooling water flowing through the cooler. A normal pressure drop may range from 5 to 10 psid (.3 to .7 bar). Any change in the pressure drop may indicate tube leakage or fouling and should be investigated.

In many instances, the cooling water supply for the heat exchanger will contain impurities in solution and/or sus-

pension. These substances can cause scale formation, corrosion, and plugging of any water-cooled heat exchanger equipment. Increased maintenance and operation expense, reduced equipment life and emergency shutdowns can result from adverse cooling water conditions if left unchecked. It is strongly recommended that a reputable, local water treatment concern be contacted to establish the corrosive, scale forming, and fouling tendencies of the cooling water and take steps necessary to remedy the situation if a problem does exist. The need for water treatment may involve filtration (screening) to remove debris, sand, and/or salt in the cooling water supply. However, chemical treatment methods may be necessary in some instances to inhibit corrosion and/or remove dissolved solids, to alter the water's tendency to form scale deposits, or prevent the growth of microorganisms.

The normal maintenance program for the unit should also include periodic cleaning of the tubes (water side) of the heat exchanger to remove deposits which facilitate fouling and corrosion.

Hex head zinc anodes are used in the return bonnet (opposite end to the water pipe connections) of heat exchangers to provide internal water system corrosion protection. These anodes should be inspected periodically and replaced when the zinc has been reduced to about 1/2 inch in length.

WATER FLOW CONTROL VALVE FOR HEAT EXCHANGER (Optional Equipment) (FIGURE 2-10) – The cooling water flow control valve is adjustable to compensate for varying cooling water inlet temperatures and pressures and is to be mounted in the cooling water outlet line after the compressor injection water cooler (FIGURE 2-6 and FIGURE 2-7, pages 12 and 13). Use the compressor discharge air temperature gauge on the instrument panel in setting the flow control valve.

To decrease water flow (increase compressor discharge air temperature) turn the adjusting screw from left to right, increasing spring tension. **To increase water flow** (decrease compressor discharge air temperature) turn the adjusting screw in the opposite direction. The groove at the lower edge of the adjusting screw is an index line for use with the index scale 0 to 8 in obtaining a desired setting.

These valves must be handled with care and proper tools and techniques must be used when working on the valve.

Care must be used when handling the capillary tube; a kink or break in the tubing or connections will make the valve inoperative. Never attempt to change capillary length. Excess capillary tube should be carefully coiled and placed so that damage will not occur in normal maintenance or traffic past the unit.

If a leak develops through the packing, tighten the packing gland nut firmly with a wrench to reseal the packing around the valve stem, then back off the nut until loose, and finally retighten the nut finger tight. Over-tightening the packing nut may cause erratic operation. An occasional drop of oil on the valve stem at the packing nut will prolong packing life.

If the valve malfunctions, check the valve stem for bends, binding, paint, or corrosion. Foreign material in the valve, erosion, or thermal system (capillary) failure can also cause valve malfunction. If foreign material or scale is likely, the addition of a strainer in the inlet water line is recommended.

COOLING WATER SHUTOFF VALVE – WATER-COOLED HEAT EXCHANGER (Optional Equipment) (FIGURE 5-2, page 45) – A magnetic solenoid operated cooling water shutoff valve rated at 150 psig (10.3 bar) water pressure should be mounted in the cooling water outlet line after the compressor cooler. This inlet water valve should be wired into the compressor control circuit so that the valve opens to allow water to flow any time the compressor is running. When compressor stops under automatic control, or is shut off manually, the valve should close, stopping water flow through the system. See Wiring Diagrams, FIGURE 4-10 thru FIGURE 4-12, pages 39 thru 41.

AIR/WATER RESERVOIR – The air/water reservoir-separator combines multiple functions into one vessel. The lower half serves as the reservoir, providing water storage capacity for the system and the upper portion functions as the means for primary air/water separation. The reservoir also provides limited air storage for control and gauge actuation.

CHANGING THE SYSTEM WATER FILTER – When the injection water pressure differential through the filter reaches 30 psid (2.1 bar), an advisory will appear on the "AUTO SENTRY®-ES" control panel. Change both the system and make-up water filters when this occurs. To change the water filter:

1. Be sure the unit is completely off and that no air pressure is in the system.
2. Disconnect, tag and lockout the power supply to the starter.
3. Drain the water from the filter housing by either turning the petcock or removing the plug on the bottom of the filter assembly.
4. Remove the nut at the top of the filter assembly, while holding the filter housing to keep it from dropping. When the nut is removed, change the filter, and reassemble.
5. Repeat Steps 3 and 4 on the make-up water filter.
6. Reconnect the power supply to the starter, start the machine and check for leaks.

CHANGING THE MAKE-UP WATER FEEDER CARTRIDGE – The material in the feeder cartridge is slowly

dissolved as make-up water is added to the compressor system. If no material is observed inside of the cartridge by a periodic visual inspection, replace the empty cartridge. To replace the feeder cartridge:

1. Be sure the unit is completely off and that no air pressure is in the system.
2. Disconnect, tag and lockout the power supply to the starter.
3. Shut off the supply of make-up water to the cartridge housing.
4. Remove the clear housing and empty cartridge.
5. Remove the cap from the top and the seal from the bottom of the new cartridge and insert into the housing and reassemble.
6. Turn on water supply, reconnect the power supply, start the machine and check for leaks.

COMPRESSOR INJECTION WATER SYSTEM CHECK – The following readings are based on an ambient temperature of 80° F. (27° C) inlet cooling air on air-cooled units with the system in good condition. The compressor should be at operating temperature at the time of the checks. One-half hour of loaded operation is usually sufficient to reach typical operating temperatures.

Air and Water Discharge Temperature–145° to 170° F. (63° to 77° C) – Read on the “AUTO SENTRY®–ES” control panel.

Compressor Injection Water Inlet Temperature –105° to 120° F. (41° to 49° C) – Check anywhere on the line from the heat exchanger to the compressor inlet.

Water Injection Cooler Temperature Differential (Air Cooled Heat Exchanger) – The water temperature differential depends on the temperature of the air at the water injection cooler fan and the cleanliness of the core faces. As ambient temperatures and core restrictions increase, the injection water outlet temperature will increase. The injection water inlet temperature is approximately the same as the compressor discharge temperature – see the “AUTO SENTRY®–ES” control panel. The injection water outlet temperature is approximately the same as the package exhaust air temperature. The outlet temperature may also be checked by installing a tee in the water line between the cooler and the air end.

Water Injection Cooler Temperature Differential (Water Cooled Heat Exchanger) – The injection water temperature differential depends upon the inlet cooling water temperature and the cooling water flow rate permitted by the setting of the optional cooling water flow control valve. The injection water inlet temperature is approximately the same as the compressor discharge temperature – see the “AUTO SENTRY®–ES” control panel. The injection water outlet temperature is approximately the same as the cooling water outlet temperature. The outlet temperature may also be checked by installing a tee in the line between the cooler and the air end.

Water Injection Cooler Pressure Differential (Air Cooled Radiator) – 5 to 7 psid – Check injection water pressure differential in the same place as temperature. (See above.)

Water Injection Cooler Pressure Differential (Water Cooled Heat Exchanger) – 2 to 5 psid – Check injection water pressure differential in the same place as temperature. (See above.)

ELECTRICAL WIRING – Standard Units – The Twistair® compressor is factory wired for all starter to motor and control connections for the voltage specified on the order. It is necessary only to connect the unit starter to the correct power supply. The standard unit is supplied with an open drip-proof motor, a NEMA 12 starter and control enclosure. See “Location” paragraph, page 9, for distance to the nearest obstruction on starter and control box sides of the unit.

 WARNING
Electrical shock can cause injury or death. Open main disconnect switch, tag and lockout before working on starter/control box.

GROUNDING – Equipment must be grounded in accordance with Table 250–95 of the National Electrical Code.

 WARNING
Failure to properly ground the compressor package could result in controller malfunction.

MOTOR LUBRICATION – Long time satisfactory operation of an electric motor depends in large measure on proper lubrication of the bearings. The charts on the next page show recommended grease qualities and regreasing intervals for ball bearing motors. For additional information, refer to the motor manufacturer's instructions.

The following procedure should be used in regreasing:

1. Stop the unit.
2. Disconnect, tag and lockout the unit from the power supply.
3. Remove the relief plug and free hole of hardened grease.
4. Wipe lubrication fitting clean and add grease with a hand-operated grease gun.

5. Leave the relief plug temporarily off. Reconnect the unit and run for about 20 minutes to expel the excess grease.
6. Stop the unit. Replace the relief plug.
7. Restart the unit.

 WARNING
<p>Rotating machinery can cause injury or death. Open main disconnect, tag and lockout power supply to the starter before working on the electric motor.</p>

ELECTRIC MOTOR GREASE RECOMMENDATIONS (–30° to 50° C)

MANUFACTURER	TRADE NAME
CHEVRON	SRI #2
SHELL	DOLIUM R
EXXON	UNIREX #2
EXXON	POLYREX

ELECTRIC MOTOR REGREASING INTERVAL

Type of Service	Typical Examples	Rating	Relubrication Interval
Standard	One– or Two–Shift Operation	Up to 150 HP (112 KW)	18 Months
		Above 150 HP (112 KW)	12 Months
Severe	Continuous Operation	Up to 150 HP (112 KW)	9 Months
		Above 150 HP (112 KW)	6 Months
Very Severe	Dirty Locations, High Ambient Temperature	Up to 150 HP (112 KW)	4 Months
		Above 150 HP (112 KW)	2 Months

U.S. EPA National Drinking Water Regulations *

Primary ¹ Constituents	Secondary ² Constituents	Maximum Contaminant Level Parts Per Million
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Inorganic

Arsenic		0.05
Barium		1
Cadmium		0.01
Chromium		0.05
Fluoride		4
Lead		0.05
Mercury		0.002
Nitrate–Nitrogen		10
Selenium		0.01
Silver		0.05
	Chloride	250
	Copper	1
	Iron	0.3
	Manganese	0.05
	Sulfate	250
	Zinc	5

Organics

Dischlorophenoxy Acetic Acid (2,4–D)		0.1
Endrin		0.0002
Lindane		0.004
Methoxychlor		0.1
Trichloroxypropionic Acid (2,4,5–Tp Silvex)		0.01
Total Trihalomethanes		0.1
Toxaphene		0.005

Radionuclides

Radium 226 and 228 combined		5 pCi/L
Alpha Particle	15.0 pCi/l	
Beta Particle	4 mRem/year	

Biological

Coliform Bacteria	10/L monthly average	
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Physical Characteristics

Turbidity	5 NTU	
Color	15 Color Units	
Corrosivity	Noncorrosive	
Foaming Agents	0.5	
Odor	3 (threshold odor number)	
pH	6.5 to 8.5	
Total Dissolved Solids	500	

¹ Primary – Toxic health hazard, enforceable maximum.

² Secondary – Aesthetic characteristics, desirable goals not enforceable.

* For general information only – refer to the U.S. EPA for current requirements, additional regulations may be in effect.

SECTION 3 STARTING & OPERATING PROCEDURES

PRESTART–UP INSTRUCTIONS – A new unit as received from the factory has been tested and then prepared for shipping. Do not attempt to operate the unit until checked and serviced as follows:

1. **Compressor Oil** – Check reservoir oil level. The oil level must be within the “operating range” of the level gauge. Add or drain oil to correct level using the same type of oil.

REPLACE OIL FILTER EVERY 8000 HOURS

After the initial fill, or filling after a complete draining of the system, the level gauge may indicate an oil level in the “YELLOW” or “HI” range. The level will settle to the “GREEN” or normal operating range upon start–up as the lubrication system is filled. If necessary, add oil to bring the level to the top of the “GREEN” range as read when the unit is operating at full load and normal pressure.

After a shutdown, oil in the system will partially drain back into the reservoir which may cause the level gauge to read higher than during normal operation. **DO NOT DRAIN OIL TO CORRECT;** verify oil level during machine operation at fully loaded operation. See FIGURE 5–1, page 44.

The oil level must be maintained within the “GREEN” or normal operating range. Add or drain oil to correct the level using the same type of oil. Check to ensure that the breather vent/s are installed in their correct location and functioning properly.

DANGER

Air and water under pressure will cause severe personal injury or death. Shut down compressor, relieve system of all pressure, disconnect, tag and lockout power supply to the starter before removing valves, caps, plugs, fittings, bolts, and filters.

CAUTION

Use of improper lubricants will cause damage to equipment. Do not mix different types of lubricants or use inferior lubricants. See Section 5, page 43, for lubrication recommendations.

NOTICE

Regular maintenance and replacement at required intervals of the air and water filters are necessary to achieve maximum service of this screw compressor. Use only genuine Gardner Denver filters designed and specified for this compressor.

2. **Air Filter** – Inspect the air filter to be sure it is clean and tightly assembled. Refer to Section 6, “Air Filter,” page 47, for complete servicing instructions. Be sure the inlet line, if used, is tight and clean.
3. **Coupling** – Check all bolts and cap screws for tightness. See Section 7, page 49.
4. **Piping** – Refer to Section 2, “Installation,” page 9, and make sure piping meets all recommendations.
5. **Electrical** – Check the wiring diagrams furnished with the unit to be sure it is properly wired. See FIGURE 4–10 and FIGURE 4–11, pages 39 and 40, for general wiring diagrams and Section 2, page 9 for installation instructions.
6. **Grounding** – Equipment must be grounded in accordance with Table 250–95 of the National Electrical Code.

 **WARNING**

Failure to properly ground the compressor package could result in controller malfunction.

7. **Rotation** – Check for correct motor rotation using the “JOG MOTOR?” function in the “UNIT SET-UP” controller adjustment menu. An arrow cast on the compressor/motor adapter adjacent to the coupling guard indicates correct rotation. Compressor coupling rotation is clockwise when viewed from the motor end of the adapter.

 **WARNING**

Operation with incorrect motor rotation can damage equipment and cause water eruption from the compressor inlet. When checking motor rotation, induce minimum rotation (less than one revolution if possible). Never allow motor to reach full speed.

8. **System Pressure** – Set the controls to the desired unload and load pressures. DO NOT EXCEED THE MAXIMUM OPERATING PRESSURE ON THE COMPRESSOR NAMEPLATE. See Section 4, “Controls and Instruments,” for procedure.

 **WARNING**

Operation at excessive discharge air pressure can cause personal injury or damage to equipment. Do not adjust the full discharge air pressure above the maximum stamped on the unit nameplate.

9. **Operating Mode** – Refer to Section 4 for detailed information on the control system.
9. **Enclosure** – Check for damaged panels or doors. Check all screws and latches for tightness. Be sure doors are closed and latched.

STARTING THE UNIT – Observe the following starting procedures.

It is a good practice to prime the compressor air end and separator/reservoir prior to initial start-up following the installation of the compressor package and following a manual draining of the water reservoir. Pour 2 to 3 gallons of water in through the inlet valve to prime the unit.

Start the unit by pushing the [RUN] key. The unit will reach normal operating temperature in approximately 5 minutes. Check the package operating information by pressing the [<] or [>] keypad cursor keys at any time during operation.

DAILY CHECK – Refer to Section 8, “Maintenance Schedule,” page 50.

STOPPING THE UNIT – Press [STOP/RESET] key. The air/water reservoir will automatically blow down as the motor stops. If the unit is a water-cooled heat exchanger type, close any manual water inlet valves.

SECTION 4 CONTROLS & INSTRUMENTATION

GENERAL DESCRIPTION – The Gardner Denver® TWISTAIR® waterflooded rotary screw compressor is prewired with all controls, motor, and starter for the voltage and horsepower at the time of ordering. It is necessary only to connect the compressor unit to the correct power supply, to the shop air line, and to the appropriate water supply. A standard compressor unit consists of the compressor, water reservoir, water cooling system and filters, lubrication reservoir and pump, motor type as specified, NEMA 12 starter / control box, and control components as described in this section.

This compressor unit features the “AUTO SENTRY®–ES” controller, which integrates all the control functions under microprocessor control. Its functions include safety and shutdown, compressor regulation, operator control, and advisory / maintenance indicators. The keypad and display provide the operator with a logical and easily operated control of the compressor and indication of its condition.

The ES controller used on this compressor unit is similar to that used on other Gardner Denver screw compressors, but is designed specifically for the waterflooded compressor package. It is not interchangeable with controllers designed for oilflooded compressors.

AUTO SENTRY®–ES OPERATION

Operation of the “AUTO SENTRY®–ES” is dependent on selection of an operating mode (described below) from the controller keypad. Prior to starting, the [STOP/RESET] key must be pressed to place the controller into its “READY” state (as indicated on the display). Compressor operation may then be started by pressing an operating mode key. Once operating, the mode may be changed at any time by pressing a key, and the selected mode will be displayed in the lower right corner of the message window. The [STOP/RESET] key may be pressed at any time to stop the compressor under normal conditions. If the compressor has been running, the reservoir pressure is relieved before stopping the motor. The display will count down to zero during the normal stop.

An optional control may be wired into the “AUTO SENTRY®–ES” controller to interrupt and restart the unit based on controls by others. When stopped by these controls, the display indicates remote stop.

WARNING

Automatic restarting or electrical shock can cause injury or death. Open, tag and lockout main disconnect and any other circuits before servicing the unit.

In any mode, the compressor will start only if reservoir pressure is below 5 psig (.3 bars). The display will indicate if the control is waiting for a reservoir blowdown, along with the remaining pressure. The controls also delay initial loading of the compressor until a startup delay has been completed.

Constant Run Mode Operation – This mode is best used in applications where there are no long periods of unloaded operation, or for minimum response time to sudden demands. The compressor unit will start and run continuously, using its modulation controls to match delivery to demand.

As demand falls below the compressor capacity, the pressure will rise to the setpoint of the control. When the pressure reaches the setpoint, the “AUTO SENTRY®–ES” controller operates the solenoid valves IVO and IVC to pass pressure to the inlet valve piston, and the inlet valve will close enough to match it to the air system demand.

As demand increases, the controller will modulate the inlet valve by passing pressure with the solenoid valves as required to provide the most economical means of matching delivery to demand. Once the compressor has been first loaded, it will maintain pressure within a few psi of the setpoint pressure for any demand within its rated capacity.

When first starting, the controller will keep the compressor fully unloaded and blown down until the system pressure drops below the reset pressure. Once loaded, the reservoir will remain fully charged, regardless of demand. Responses to demand are thus immediate, as soon as system pressure drops below setpoint.

Low Demand Mode Operation – The low demand mode reduces power consumption by relieving pressure in the reservoir during unloaded operation. This mode is best used where there is moderate air storage and there are unloaded periods during the day, but fre-

quent motor starting and stopping is undesirable. During periods of moderate to high demands, this mode is identical to the constant-run mode described above.

During low demand periods, the controller will open the blowdown valve and fully close the inlet valve to minimize the motor load. A timer is reset when this occurs. While in this state, control air pressure is supplied from the plant air system (as are any plant loads). When the system air pressure drops to the reset pressure due to increased demand, the blowdown valve recloses and the controls resume their normal modulation sequence.

Subsequent blowdown periods are not allowed until the timer has completed its cycle. This cycle eliminates frequent blowdowns during moderate loads, and the energy required to repressurize the reservoir. The timer is adjustable from 5 to 20 minutes.

Automatic Mode Operation – This mode provides automatic start and timed stop, and is best used in applications with long unloaded periods and adequate storage to allow the compressor to be stopped for periods of light demands. Operations during periods of moderate to heavy demands is identical to the low demand mode described above.

The automatic time delay is adjustable from 5 to 20 minutes. If the controller operates unloaded for this period with no demand, the compressor drive motor is halted to eliminate its power consumption. The controls will remain in this state until demand is again indicated by a drop in pressure.

This is the most common selected mode of operation, as it automatically will operate the compressor unit in the most efficient manner for the demand of the air system.

Sequence Mode Operation – This mode provides for communication between controllers, operating only as many as are required for economical operation. This is best used on applications with large storage capacity and diverse loads. The lead unit will operate identically to the automatic mode; operation will be automatically staged for each lag unit (up to 8 total). For more information, refer to the sequencing instructions later in this chapter.

Communication between controllers is achieved by interconnection of a communications cable to circuit board connectors. A “unit number” must be assigned to each unit in this mode, but the display will indicate the unit’s actual operating ranking.

AUTO-SENTRY®-ES CONTROL DISPLAY

The display above the keypad is used to provide operating information to the user. If a shutdown has occurred, the display will indicate the cause.

During normal operation, the display will show the system pressure, compressor discharge temperature, total running hours, and operation mode. Alternate displays are available by pressing keypad cursor [<] [>] keys, and will be identified on the display. These include:

1. compressor discharge temperature
2. reservoir pressure
3. water filter differential pressure
4. system temperature
5. system pressure
6. oil temperature
7. oil pressure
8. total hours
9. loaded hours
10. remaining blowdown time
11. remaining auto time

Remaining blowdown and auto times are only available in Low Demand, Automatic, and Sequence modes, as appropriate.

If no keys are pressed for 5 seconds, the display will revert to its normal mode.

The display is also used as a service reminder for normal maintenance items. If service is recommended, the yellow “ADVISORY” light will come on, and a message will alternate with the normal lower line message. These messages are intended to advise of conditions which may lead to a shutdown.

If a protective shutdown occurs, the red shutdown light will be on and the top line of the display will indicate “SHUTDOWN.” The lower line will indicate the cause of the shutdown.

SERVICE ADVISORIES

The “AUTO-SENTRY® ES” controller turns on an advisory when it detects operation which needs service attention, but does not warrant shutting down the compressor. Some of these are normal maintenance procedures, and are intended to serve as a reminder to perform routine service. Others are conditions which can reduce the maximum compressor performance. It will remain in effect until reset. Check the display during routine inspections, and perform maintenance as suggested. Refer to the troubleshooting section for detailed information about each advisory.

Temperature advisories may be cleared while the unit is running by simply pressing the [ENTER] key. To reset the service advisories, press the [STOP/RESET] key to stop operation of the compressor. After it has stopped, disconnect power and service as required.

After servicing, restore power and reset the board as indicated in the programming / maintenance section below.

PROTECTIVE SHUTDOWNS

The "AUTO SENTRY®-ES" will shut down the unit following any fault detected in the following devices. Long-term problems will have a brief blowdown period before fully shutting down. Following a shutdown, a message will be displayed, with the top line indicating "SHUTDOWN" and the lower line indicating the cause. The shutdown light will be steadily lit if the cause still exists, or will flash if the cause has been cleared. Refer to the troubleshooting section for detailed information about each shutdown. To resume operation, the cause of the shutdown must be corrected and the controller reset by pressing the [STOP/RESET] key.

Motor Protective Devices – Overload heaters are furnished for the starter in the voltage range specified. There are three (3) overloads in the starter of proper size for the starter and its enclosure. Note that motor nameplate current must be multiplied by 0.577 for wye-delta starters. The display will indicate that an overload

relay has tripped. The overload relay is reset by pressing the button on the relay itself, then the controller may be reset. Motor current (amps) and voltage must be measured in the affected motor wiring to locate the cause for high current. Proper starter coil and contact action is also monitored and errors in operation will cause a shutdown with the cause displayed as a starter or contact error.

High Temperature – The compressor is protected from high discharge temperature by a thermistor probe located in the compressor discharge elbow. The "AUTO SENTRY®-ES" will shut the compressor down if temperature exceeds 190° F (88° C) (or lower per user adjustment) or if rapid temperature rise is detected. Oil injection temperature and final unit discharge temperatures are also monitored, and will provide high temp shutdowns. Shutdown will also occur if the temperature at any of these locations falls below freezing. The location of the temperature fault will be displayed. Thermistor probes are also checked for open or shorted circuits, and the display will indicate the location of the defective probe.



FIGURE 4-1 – AUTO SENTRY® -ES DISPLAY



CAUTION

Machine damage will occur if compressor is repeatedly restarted after high temperature stops operation. Find and correct the malfunction before resuming operation.

Water Filter Differential Pressure – The pressure drop across the water filter is continually monitored by the “AUTO SENTRY®–ES”. The unit will be shut down at a differential pressure of approximately 40 psid (2.8 bars). This becomes active only after the compressor has been running and pressures have had time to stabilize.

The pressure drop can be monitored at any time by selecting the alternate display “DIF PRES” (water filter differential pressure) with the cursor [<] [>] keys. This should be checked while the compressor is delivering at full capacity. A service advisory comes on to recommend maintenance prior to this shutdown.

High Water Level – If the water management controls are unable to maintain proper water levels, the compressor will be shutdown to prevent damage. Check wiring and piping of the drain and fill solenoid valves. If wiring errors are detected in the float switch, a shutdown will occur, and the display will indicate a bad float switch.

High Pressure – The “AUTO SENTRY®–ES” will first attempt to unload and blow down the unit if excessive pressures are detected in the reservoir or the plant system. If unsuccessful, a shutdown will occur. Shut down will also occur if a defective transducer is detected. The display will indicate the location of the high sensed pressure or transducer “XDUCER” error. Check that all adjustments have been properly made, and all connections are secure.

Oil Pressure – The “AUTO SENTRY®–ES” monitors oil pressure, and will shut down the unit if inadequate oil pressure is detected. If this occurs, check the piping to the oil pump.

The controller also checks for high oil pressure, indicating clogged lines or severely thickened oil.

Emergency Stop – Press the emergency stop button to shut down the unit and the controller. To restart, pull the button out to its normal position and reset the controller. This should be used for emergency purposes only – use the keypad [STOP/RESET] key for normal controlled stopping.

Power Failure – Following power interruptions, the controller will remain in a shutdown state (unless programmed for auto restart).

External Device – This input is provided for user- or dealer- installed devices needed by specific applications. Other shutdown field selectable messages include: high vibration, phase relay, low voltage relay, and water press.

Other Shutdowns – The controller runs continuous diagnostic checks of its own operation and the sensors to which it is connected. Refer to the service section for a complete listing of shutdowns and remedial actions.

PROGRAMMING AND SETUP FOR THE AUTO SENTRY®–ES CONTROLLER FOR EWF

Programming and setup is accomplished with the PROGRAM keys. See FIGURE 4–1, page 23. In all steps, the [ENTER] key will cause the controller to accept the displayed value into memory and advance to the next programming function. The plus [+] and minus [-] keys will increase and decrease displayed numeric values, or step through menu selections. During numeric adjustments, the right [→] and left [←] arrow keys, move the cursor (flashing digit) to the position desired. Use the [+] and [-] keys to change the number at the cursor. At any point in the programming and setup routine, the [STOP/RESET] key can be pressed to exit and return to the ready mode without altering the adjustment. In all steps of the programming routine, the top line of the display will give a description of the parameter to be programmed, while the bottom line shows the variable that is capable of being altered by programming.

The following is a step by step guide to programming the “AUTO SENTRY®–ES”. Remember, between each step, it is necessary to press the [ENTER] key to store the new value and advance to the next step.

Main Adjustments Menu

1. The compressor must be stopped prior to making any adjustments. If the unit is running, press the [STOP/RESET] key to place the control in the “READY” state.

Adjustments can also be performed while in the “SHUTDOWN” state. After the adjustments are completed, the ES controller returns to this state until the cause is repaired and the controller is manually reset.

2. Press the [ENTER] key to begin programming. This enters the adjustments menu. The adjustments are broken into five groups as shown in FIGURE 4–2, page 25. To select a group, press [+] or [-] until the desired group is shown on the bottom line of the display. Press [ENTER] to proceed to the group adjustments detailed below.

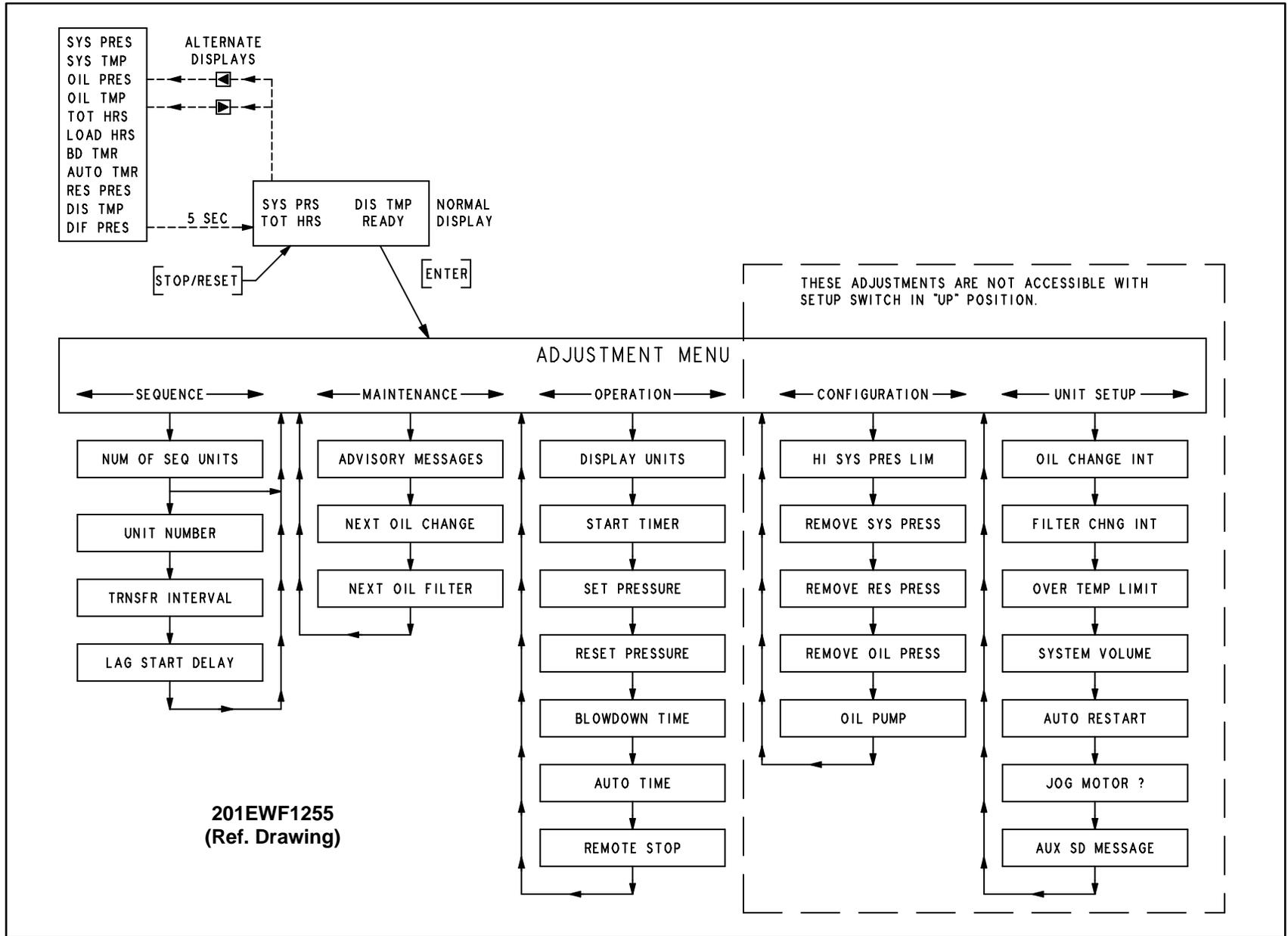


FIGURE 4-2 – FLOW CHART FOR SET-UP PROGRAMMING

NOTICE

Configuration adjustments are normally required only at the time of assembly or after parts have been replaced. Unit setup adjustments are normally required only at the time of unit installation. To prevent accidental access, these will not be available if the “SET” switch is in the up position. The “SET” switch is located beneath the power transformer mounting plate on the left edge of the main circuit board.

Operation Adjustments

1. In the top line, “**DISPLAY UNITS**” is indicated. The bottom line will indicate “**ENGLISH**” (PSIG, Fahrenheit) or “**METRIC**” (Bars, Celsius) units of measurement. Select the desired display units and press [ENTER] to proceed.
2. In the top line, “**START TIMER**” is displayed. The bottom line will indicate a time between 3 and 10 seconds. This is the time that the controller spends in the unloaded ‘start’ mode. If reduced-voltage starting is used, it should be set longer than the starter’s timer.
3. In the top line, “**SET PRESSURE**” is displayed. The bottom line will indicate a pressure value. It is to be set at the nameplate rating of the compressor for normal operation. **Under no circumstances**, is this adjustment to be set in excess of the compressor nameplate pressure.
4. In the top line, “**RESET PRESSURE**” is displayed. The bottom line will indicate a pressure value. This setting determines the point at which machine startup occurs in AUTO and SEQUENCE modes and when the compressor will load up from the blown down condition. Note that RESET PRESSURE cannot be set within 7 PSI of the SET PRESSURE. It is necessary that all machines to be sequenced have the same SET and RESET PRESSURE setpoints.
5. In the top line, “**BLOWDOWN TIME**” is displayed. The bottom line will indicate a time between 5 and 20 minutes. It is factory set at 10 minutes. This is the minimum time interval between blowdowns. A longer blowdown time minimizes wasteful dumping of compressed air when loading is likely to occur in a short time.
6. In the top line, “**AUTO TIME**” is displayed. The bottom line will indicate a time between 5 and 20 minutes. It too, is factory set at 10 minutes. Its function is to prevent too frequent motor starting, and to allow the motor a ‘cool-down’ period before stopping.
7. In the top line, “**REMOTE STOP**” is displayed. The bottom line indicates either “**TIMED**” or “**IMMEDIATE**”. Refer to the description of “Remote On/Off” later in this section for additional details. Select the desired response to the remote input and press [ENTER] to proceed.
8. This completes operational adjustments. The controller will return to the main adjustments menu.

Maintenance Adjustments

1. If any service advisories are in effect (yellow ADVISORY indicator is on), they will be displayed on the top line. The bottom line indicates “**LEAVE ADVISORY**” (do not reset) or “**CLEAR ADVISORY**” (turn it off). Select the desired action and press [ENTER] to proceed.
2. The top line displays “**NEXT OIL CHANGE**” and the hours remaining are displayed on the bottom line. Press the [+] or [-] keys to switch to the oil change interval (see UNIT SETUP) if service was performed early. Press [ENTER] to proceed.
3. The top line displays “**NEXT OIL FILTER**” and the hours remaining are displayed on the bottom line. Press the [+] or [-] keys to switch to the oil filter interval (see UNIT SETUP) if service was performed early. Press [ENTER] to proceed.
4. This completes maintenance adjustments. The controller will return to the main adjustments menu.

Sequence Adjustments

See “SEQUENCING COMPRESSORS WITH THE “**AUTO SENTRY®-ES**,” page 28, for more details on setting up and optimizing a sequenced compressor installation.

1. In the top line, “**NUM OF SEQ UNITS**” is displayed. The bottom line will indicate a number in the range of one through eight. This will be factory set at “1”. This should be set to a number corresponding to the number of compressors that are currently installed on this air system that also have “**AUTO SENTRY®-ES**” controllers. It should be noted that all “**AUTO SENTRY®-ES**” compressors on the system must have the same number programmed here to operate correctly in SEQUENCE mode. Adjust as required, and press [ENTER] to proceed.

NOTICE

Setting the value in step 1 to one indicates that no sequencing is to take place. Consequently, steps 2, 3 & 4, which relate to sequencing, are skipped by the “AUTO SENTRY®–ES;” the controller will return to the main adjustments menu.

2. In the top line, “**UNIT NUMBER**” is displayed. The bottom line will again indicate a number of one through eight and be factory set at “1”. Each “**AUTO SENTRY®–ES**” in a sequenced system must have a unique number here. The sequence mode will not function if two or more compressors have the same UNIT NUMBER. Most efficient machine-to-machine communications will occur when the lowest possible numbers are used. Example: 1, 2, and 3 for a three compressor installation.

This is the only setting which must be different for each unit in a sequenced system. All other settings should normally be the same for all units.

3. In the top line, “**TRANSFER INTERVAL**” is displayed. The bottom line will indicate a number of hours in the range of 1 to 5000. It is factory set at 24. This is the number of hours that this machine will stay in the role of “master” or “lead” compressor.

Normally it is desirable to set this to the same value on all sequenced units to equalize running hours. Different values may be programmed, if desired, to help equalize hours.

4. In the top line, “**LAG START DELAY**” is displayed. The bottom line will indicate a number in the range of 15 to 600 seconds. It is factory set at 30. This is the length of time this machine will wait before starting when the pressure drops below the reset point. This should be set to the same value for all sequenced units. Its setting will depend on the amount of air storage volume in the system. Too small a number will result in more compressors being started than is necessary to satisfy demand.
5. This completes sequence adjustments. The controller will return to the main adjustments menu.

Configuration Adjustments

1. In the top line, “**HI SYS PRES LIM**” is displayed. The bottom line will indicate a value that is factory set 20 – 25 PSI above name plate. This is the pressure that will cause a shutdown if exceeded

due to a malfunction such as a stuck inlet valve or broken control line. This should be set at or slightly below the rating of the pressure relief valve. The controller will attempt a number of actions as it approaches to prevent the pressure from reaching this limit.

2. In the top line, “**REMOVE SYS PRESS**” is displayed. The bottom line displays the current pressure being sensed at the package discharge. At this point steps must be taken to ensure that system pressure is, in fact, zero psig. Remove the line to the system pressure transducer. Pressing [ENTER] will now cause the “**AUTO SENTRY®–ES**” to calibrate the transducer output to zero PSIG. Obviously, pressure measurement errors will be encountered if ‘zeroing’ is done with pressure at the transducer. If large errors are detected, the controller will demand that the transducer be checked.
3. In the top line, “**REMOVE RES PRESS**” is displayed. The bottom line displays the current pressure being sensed in the reservoir. The reservoir pressure transducer may now be ‘zeroed’ by following the steps outlined in 2 above.
4. In the top line, “**REMOVE OIL PRESS**” is displayed. The bottom line displays the current pressure being sensed in the oil line. The oil pressure transducer may now be ‘zeroed’ by following the steps outlined in 2 above.
5. The top line displays “**OIL PUMP**”, and the bottom line displays the type of pump. Select “**MECHANICAL**” for EWF compressor packages.
6. This completes configuration adjustments. The controller will return to the main adjustments menu.

Unit Setup Adjustments

1. In the top line, “**OIL CHANGE INTERVAL**” is displayed. The bottom line will indicate a time interval of 1000 to 8000 hours. After the machine has run for the programmed setting, an advisory will be displayed, requesting an oil change. Adjust as desired and press [ENTER] to proceed.
2. In the top line, “**FILTER CHNG INTERVAL**” is displayed. The bottom line will indicate a time interval of 1000 to 8000 hours. After the machine has run for the programmed setting, an advisory will be displayed, requesting an oil filter change. Adjust as desired and press [ENTER] to proceed.
3. In the top line, “**HI TEMP LIMIT**” is displayed. The bottom line will indicate 190° F. This is the maximum (and proper) setting for compressor operation. It may be temporarily lowered to verify the function of the temperature shutdown system.
4. In the top line, “**SYSTEM VOLUME**” is displayed.

The bottom line may be selected as “SMALL”, “MEDIUM”, or “LARGE”. This tunes the response of the modulation control loops to optimize loop stability. It is factory set to MEDIUM. Set as follows:

SMALL if estimated volume is less than .25 gallon per CFM.

MEDIUM if estimated volume is between .25 and 1.0 gallon per CFM.

LARGE if estimated volume is greater than 1.0 gallon per CFM.

Note: The setting of this parameter is not critical. When set to the most appropriate value, the controller will maintain the discharge at the closest possible value. If not set correctly, pressure will vary from the desired setpoint to a somewhat greater degree, but the compressor and its components will not be adversely affected.

5. In the top line, “**AUTO RESTART**” is displayed. The bottom line will indicate either “OFF” or “ON” The factory setting is “OFF”, and the controller will display a power failure shutdown after power has been restored.

Set this feature to ON when it is necessary to have the compressor automatically restart after a power interruption. There will be a brief delay, then the control resumes the mode it was in prior to the interruption. This feature shall only be enabled when the owner determines that it is safe to do so. It is recommended that compressor access be limited to only trained service personnel when this feature is used.

6. This step is only encountered if the AUTO RESTART function was set to ON in the previous step. In the top line, “**RESTART TIME**” is displayed.

The bottom line will indicate a time between 5 and 60 seconds. It is factory set at 10 seconds. This is the amount of delay introduced before restarting after power has been restored. Set it as desired to allow for power to stabilize before starting compressors.

7. The display now reads “**JOG MOTOR?**” and indicates the amount of time to energize the starter. Adjust with the [+] or [-] key to the smallest value needed to bump the motor and check rotation. 0.1 to 0.2 seconds is normally adequate for factory-furnished full-voltage starters; wye-delta or remote starters may require a little more time. Set back to zero to proceed to the next step.

8. In the top line, “**AUX SD MESSAGE**” is displayed. The bottom line will display the message which will appear if power is removed from terminal 7. Se-

lect the most appropriate message for user-furnished shutdown devices, and press [ENTER] to proceed.

9. This completes unit setup adjustments. The controller will return to the main adjustments menu.

OTHER CONTROL FEATURES

Auto Restart After Power Failure – The “AUTO SENTRY®-ES” controller normally displays “**SHUT-DOWN – POWER FAILURE**” after power has been interrupted and restored. Press the [STOP/RESET] key and select an operating mode to restart the compressor.

If programmed for automatic restart, the controller pauses and begins counting down when power is restored. This time is adjustable in the programming steps noted above. This must be at least several seconds, but may be set longer to allow other plant loads to start up first. After the countdown is complete, the controller resumes the mode of operation prior to the power interruption.

SEQUENCING COMPRESSORS WITH THE AUTO SENTRY®-ES

Sequencing compressors with the “AUTO SENTRY®-ES” controller is as simple as plugging in a telephone to a wall jack. The only item required to make the system functional is a standard telephone cable identical to cables that connect nearly every telephone to its wall jack. One less cable than the number of compressors to be sequenced is required. For example, to sequence four compressors, three cables are required. A kit, 200EAP752, is available which contains all material needed to sequence up to five compressors. This kit contains 500 feet of cable, eight modular connectors, and a crimping tool to install the connectors.

In spite of the fact that it is a standard feature and its inherent installation simplicity, the sequencing function of a multi-compressor “AUTO SENTRY®-ES” system is the most fully-featured, functionally-complete available today.

Installation

A proper sequencing installation requires two or more Gardner Denver rotary air compressors complete with “AUTO SENTRY®-ES” controllers, piped into a common air system, interconnected as described above. For best performance, the units must be piped directly to the receiver, without any intervening check valves, dryers, or other restrictions. The receiver should also be sized to prevent excessive drops or rapid rises in pressures during the operation as described below. All standard practices common to sound air compressor installations such as proper sizing of discharge piping, proper electrical supply and conductor sizing, and grounding are to be observed. The serial communica-

tions interface meets RS-485 standards, the most widely used interface in harsh, industrial environments today. However it is still recommended that the communications cables be routed through metallic conduit to provide them with both mechanical protection and electromagnetic shielding.

Each control circuit board has two modular jacks which accept RJ-12 telephone plugs. One jack is vacant, the other has a short pigtail plugged into it. To interconnect two compressors, plug the cable into the vacant jack on each controller. For installations of more than two units, the pigtail plug must be disconnected on all controllers except the two at each end of the communications line. The order of interconnection has no effect on the system operation. The following conditions are necessary and sufficient for proper operation:

1. Every compressor must have a cable connecting it to another compressor. One less cable than the number of units sequenced must be used.
2. Each board that has only one cable connected to it must have its pigtail plugged into the unused jack. All installations will have two such units.

Operation

1. Establishing the Initial Sequence

Operation of compressors in sequence requires only a press of the 'sequence' key on each compressor in the system. Since the sequencing algorithm includes provisions for automatic replacement of a failed master or 'lead' compressor, it is important for the operator to be aware of the hierarchy of events when starting the system.

The first compressor placed into sequence mode will become the master. However, since any compressor first placed into sequence has no way of knowing whether or not a master exists, it will first assume the highest rotation number available. For example if the number of units to be sequenced is programmed at four, any compressor will start out in position four when placed in sequence mode. It will then listen on the communications line for a call from the master.

If no call is received, it will assume position three and again wait for a call from the master. After another lack of a master call, it assumes position two. Subsequently, it assumes position one which makes it the master. As soon as a master is established, it immediately attempts to call all other units and assigns them successive rotation positions. The system is now active.

Before a master is established, the system is not deprived of air. This is due to one of the outstanding features of the "AUTO SENTRY®-ES" sequencing system: pressure control is always executed locally at each individual compressor. The effective setpoint for compressor control is the **programmed setpoint mi-**

nus 3(rotation number – 1). So while a compressor (or compressors) is/are counting down towards establishing a master, they are also capable of delivering air at a pressure determined by the above formula.

To ensure that two or more machines do not simultaneously decrement their rotation numbers and simultaneously become masters, it is advisable to place the desired master in sequence mode first and wait until the first decrement in rotation number is seen (about 7 seconds) before placing subsequent compressors in sequence mode. If it is desired to dictate the complete initial sequence manually, wait until the previous machine decrements one position and then place the next desired compressor in sequence mode. If it is acceptable to let the master determine the initial sequence, simply wait until the master has decremented its rotation number once, and then place all remaining compressors in sequence mode. Remember that once a master is established, no further self-decrementing is done by the individual compressors. Instead, they will wait until the master assigns them a rotation number.

Rotation numbers are displayed in the bottom display line, with the mode indication. For example, the mode indication for the current master is SEQ1; for the first lag compressor, SEQ2; second lag, SEQ; etc.

2. How the "AUTO SENTRY®-ES" Controls Pressure While Sequencing

Each compressor operates exactly the same as if it were in AUTO mode with one exception: it has a dynamic setpoint. The initial setpoint is determined by the equation shown above. A compressor is started when the system pressure drops below its programmed reset point, after waiting for [**LAG START INTERVAL' times (rotation number – 1)**] seconds. This prevents all lag compressors from starting at once. Note that a compressor's [**LAG START INTERVAL' times (rotation number – 1)**] timer is not reset to zero until that compressor is started or until another unit in the system stops. This means that the time for the next lag compressor to come on may be somewhat less than 'LAG START INTERVAL'.

EXAMPLE:

In a three compressor sequence system, SET PRESSURE = 100 PSI; RESET PRESSURE = 90 PSI; LAG START INTERVAL = 15 seconds. The lead compressor is running alone, maintaining 100 PSI by modulation when an air tool is brought on line causing the air demand to exceed the capacity of the lead compressor. When the pressure drops to 90 PSI, the #2 unit times out its 15 second timer and starts. It takes 5 additional seconds for the pressure to rise above 90 PSI. The #3 unit whose timer was initially set at 30 seconds (15 x [3 – 1]), has counted down 20 seconds (the total time that system pressure was below 90 PSI). If air demand increases again, the pressure will have to fall below 90 PSI for only 10 seconds more to start unit #3.

As was previously stated, a lag compressor's modulation setpoint (PSET for short) is **[SET PRESSURE – 3(rotation number – 1)]**. Thus in the above example, the first lag compressor (rotation #2) has a PSET of 97 PSI; the second lag, 94 PSI, and so on. But look what happens in an eight compressor installation: The eighth compressor will have an initial setpoint of $[100 - 3(8 - 1)]$, or 79 PSI. Does this mean that an eight compressor installation must operate 21 PSI below the desired operating point when all compressors are running? NO! This is where the "AUTO SENTRY[®]-ES" dynamic setpoint control takes over. This is how it works: Whenever the system pressure is below the programmed RESET PRESSURE, the PSET of each lag compressor is incremented 1 PSI every thirty seconds. Thus, after a short interval (about five minutes in this example), the PSET of the last sequenced compressor will climb up until either it equals the RESET PRESSURE, or a decrease in demand causes the actual system pressure to rise above the RESET PRESSURE. It can be seen then, that except for short periods just after a sudden increase in demand, the "AUTO SENTRY[®]-ES", with its dynamic setpoint control, will maintain system pressure between the limits of RESET PRESSURE and SET PRESSURE. Remember, RESET and SET PRESSURE values are programmed by the operator so the operating range is completely programmable and predictable.

Dynamic setpoint control will also work in reverse of the operation described above. Obviously, incrementing setpoints will cause overlap of the compressors' modulation ranges. While this enables us to maintain a higher pressure than competitor's sequencers, overlap is undesirable as demand decreases, because a system could end up with several compressors running partially loaded instead of running the minimum number of fully loaded compressors. To overcome this, as pressure rises through the range between RESET and SET, the lag compressors' PSET's are now decremented, reversing the effect described above during periods of high demand. The "AUTO SENTRY[®]-ES" keeps track of all functions at all times so there is never any mix-up of setpoints and the proper rotation sequence is always maintained.

The Automatic Sequence Change

After the master (lead) compressor has served for the duration programmed (TRANSFER INTERVAL), it relinquishes control and assigns itself the highest available rotation number. The lag compressors detect the loss of the master and decrement their rotation numbers. Number 2 becomes number 1, the new master, number 3 becomes number 2, etc.

It should be noted also that whenever the master detects a missing rotation number, such as when a compressor is turned off that was previously in the rotation, it will automatically 'close the gap' by decrementing the

rotation numbers of all compressors whose rotation numbers were greater than the missing number. Likewise, if for whatever reason, the master compressor fails to carry out its role, all lag compressors begin decrementing their rotation number until a new master is established. Regardless of the scenario, the end result will always be that the compressors that remain in rotation will always end up with the lowest possible rotation numbers.

Other Features

Any air system will exhibit pressure differences from one point to the next. Even a well designed multi-compressor installation will show 'minor' pressure variations between one compressor's discharge point and another compressor's discharge. These points will also vary from the central system (normally the air storage receiver). The "AUTO SENTRY[®]-ES" sequencing system is designed to tolerate minor variations. These pressure differences wreak havoc with conventional sequencers. If a central sequencer is used, it will be sensing a lower pressure than is seen at each compressor. With such systems, there is always a chance that the sequencer could cause a compressor to over pressure due to this pressure drop. The alternative has been to set the central sequencer to a lower pressure to prevent this or allow local override of the sequencer by the local pressure control, neither of which is desirable in the scheme of maintaining plant pressure efficiently with sequencing. The "AUTO SENTRY[®]-ES" sequencing system will automatically adjust the system to prevent over pressures in any individuals.

The "AUTO SENTRY[®]-ES" sequencing system lets each compressor control itself independently about a setpoint (PSET) derived to cause staggered operation, or sequencing. The aforementioned pressure drops can also cause derogatory effects (mainly skewed, or out of sequence operation) to the sequencing algorithm used by the "AUTO SENTRY[®]-ES".

Since these pressure variations are not constant (they will vary due to demand changes, compressor load percentage changes, and number of compressors running), any scheme to compensate for the pressure variations must be dynamic. The exclusive dynamic setpoint control feature enables this error correction scheme to be accomplished rather easily.

Here's how it works: The master continually receives system pressure values from every machine in the sequence rotation. The values are averaged and this average is then distributed to all lag compressors. All compressors, lead and lag, then compare their local pressure reading to the average and adjust their PSET by the amount of error. The effect is that all compressors are controlling to a single pressure reading, a reading that is not one that is picked up somewhere removed from the compressor, but an average of actual discharge pressures.

It should be noted that the pressure displayed on the top line by all sequenced compressors is this average.

CONNECTION TO EXTERNAL CONTROLS

The ES controller offers interconnection points for external controls and indicators. This allows simple connection to remote controls and indicators, or integration into any plantwide controls system.

Remote On / Off – Remote on–off control of the system requires only a simple two–wire control, with an isolated contact suitable for 120 volts, 1 amp. This may be a switch, a timer contact, a relay contact, or a PLC output. To connect, simply run the two wires to the control enclosure, remove the jumper between terminal 6 and terminal 9 on the terminal strip, and connect the two wires to terminal 6 and terminal 9.

The air compressor will operate normally in its selected mode whenever this contact is closed (turned on). Note that the keypad is always the master control; the operating mode must be selected at the keypad, and the remote is not capable of starting a unit after the [STOP/RESET] key has been pressed to place the controller in the “READY” state. When the contact is opened (turned off), operation depends on how the controller has been programmed and what it is doing prior to opening the contact.

If the compressor was already stopped in automatic or sequence modes, it will remain stopped and will not restart until the contact is closed. The display will flash the message “REMOTE STOP” to indicate that it is waiting for the remote signal.

If the compressor was running in any mode when the contact was opened, and the remote response is programmed for “IMMEDIATE”, the compressor will immediately unload and blowdown. After completion of blowdown, the motors will stop, and the unit will be in the “REMOTE STOP” mode as indicated above.

If the compressor was running in any mode when the contact was opened, and the remote response is programmed for “TIMED UNLOAD”, the compressor will immediately unload and blowdown. It will then continue to run unloaded for whatever period has been programmed for “AUTO TIME” (or will complete the remaining auto time if already blown down). After completion, the motors will stop, and the unit will be in the “REMOTE STOP” mode as indicated above. This is the preferred setting for automatic remote controls which may cycle in less than 1/2 hour, as the motor is always cooled evenly and rapid start cycles are prevented.

Alarm Relay – The ES controller is provided with an alarm relay which may be connected to a remote mounted indicator light, horn, or into a PLC input of a plantwide control system. The contact is commercial

rated 2 amps at 120 volts. The relay is turned on whenever there is a shutdown condition requiring service at the compressor, and remains off during normal operation, stopping, or power off conditions. The external connections from the controller are from an isolated form C (single–pole, double–throw) contact. This allows control of either a “compressor okay” or a “compressor shutdown” remote indicator.

To use this relay, connect the supply wire for the remote circuit to terminal 33 (relay common) on the terminal strip. Connect a wire to the indicator from either terminal 31 (normally open) or from terminal 32 (normally closed). Connect the other side of the indicator to its neutral.

Serial Communications

If units are NOT connected in sequence, the serial port is available for communications of compressor data to external monitoring systems. Data available include all pressures and temperatures, and a reports of internal service data. This is accessible with a PC or PLC with an RS–485 communications port. For protocol information, request drawing 202EWD1255.

OTHER CONTROL DEVICES

In addition to the electronic controller noted above, the following components are also used to control operation of the compressor unit.:

Relief Valve (FIGURE 1–2, page 2) – A pressure relief valve(s) is (are) installed in the final discharge line and set to approximately 120–125% of the unit’s full load operating pressure for protection against over pressure. Periodic checks should be made to ensure its (their) operation.

The relief valve should be tested for proper operation at least once every year. To test the relief valve, raise the system operating pressure to 75% of the relief valve set pressure and manually open the valve with the hand lever. Hold the valve open for a few seconds and allow it to snap shut.

WARNING

When the relief valve opens, a stream of high velocity air is released, resulting in a high noise level and possible discharge of accumulated dirt or other debris. Always wear eye and ear protection and stand clear of the discharge port when testing the relief valve to prevent injury.

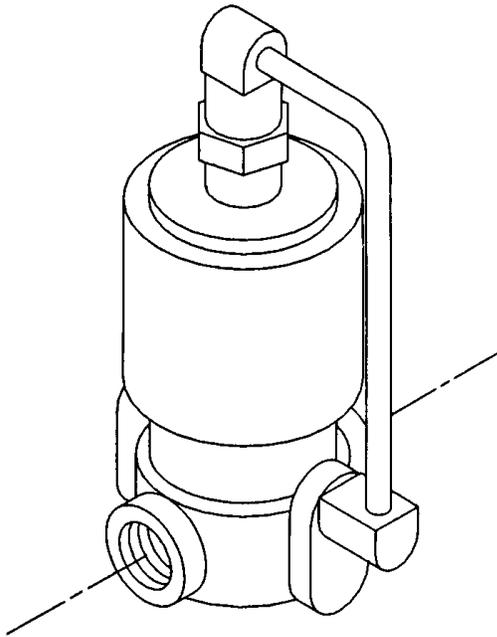


FIGURE 4-3 – BLOWDOWN VALVE



CAUTION

Never paint, lubricate or alter a relief valve. Do not plug vent or restrict discharge.



WARNING

Operation of unit with improper relief valve setting can result in severe personal injury or machine damage.

Insure properly set valves are installed and maintained.

Blowdown Valve (FIGURE 4-3) – This valve normally is used for control functions, but also serves to relieve reservoir pressure following a shutdown. The blowdown valve is a two-way solenoid valve which is piped into the water reservoir outlet ahead of the minimum pressure valve. When the solenoid is de-energized, the valve opens and the coolant system is blown down. When the solenoid is energized, the valve closes to allow the coolant system to pressurize. A control air

check valve is provided to ensure that the inlet valve is closed during blowdown.

Oil Level Gauge (FIGURE 1-6, Section 1, page 4) – This gauge is located on the oil reservoir and indicates the oil level.

Discharge Check Valve – (FIGURE 1-4, page 3) – This valve functions as a check valve to prevent back flow of air from the shop air line when the unit stops, unloads, or is shut down. When the compressor starts, the valve opens after the compressor reservoir pressure exceeds the system pressure.

Inlet Valve (FIGURE 1-4, page 3, and FIGURE 4-4, page 33) – The Inlet valve restricts the inlet to control delivery and closes to unload the compressor. At shutdown, the inlet valve closes to prevent the back flow of air.

The inlet valve position is controlled by air pressure in its piston cylinder, which is controlled by the “AUTO SENTRY®-ES” through solenoid valves IVC and IVO. As pressure to the piston is increased, the valve closes to restrict air flow and compressor delivery.

Solenoid Valves IVC and IVO – These valves control position of the inlet valve in response to signals from the “AUTO SENTRY®-ES”. With both valves de-energized, the normally open IVC valve allows control pressure to the inlet piston to close the valve. If IVC only is energized, the inlet valve is held in its current position. If both valves are energized, control pressure is relieved from the inlet piston to allow the valve to open.

Pressure Regulator – The pressure regulator is used to supply a constant and low control pressure to prevent damage to the inlet valve from “slamming.” The regulator should be set for 25-30 psig.

Shuttle Valve (FIGURE 4-5, page 33) – Also known as a double check valve, the shuttle valve is a device which will take two (2) supply signals and allow the one with the highest pressure to pass through. The shuttle valve is used to provide control air pressure from either the reservoir or plant air system, as required during different operating conditions.

System Pressure Transducer – This transducer is connected after the minimum pressure valve. It converts the pressure in the plant air system into an electrical signal for use by the “AUTO SENTRY®-ES” controller for modulation and control.

Reservoir Pressure Transducer – This transducer is connected to the coolant system. Its signal is used to prevent loaded starts, monitor coolant pressure, and monitor the condition of the water filter.

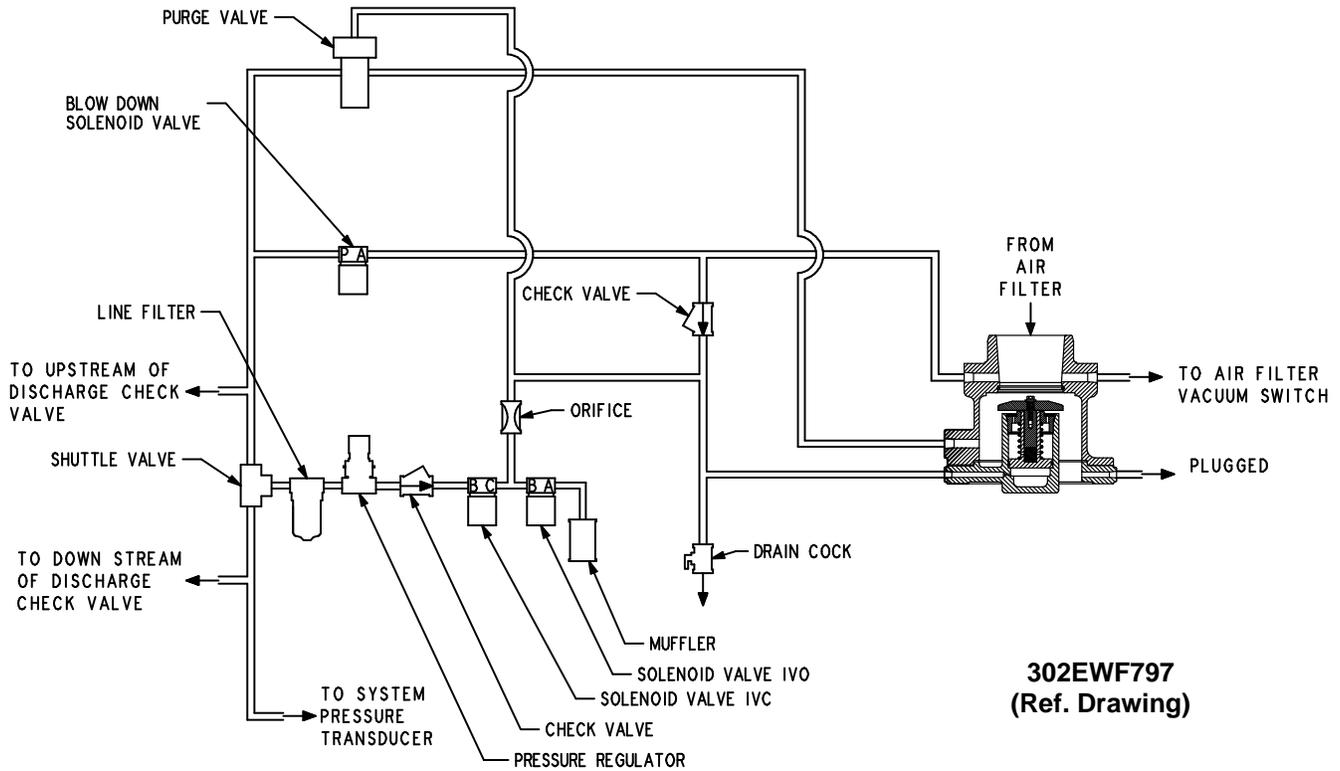


FIGURE 4-4 – INLET VALVE

Oil Pressure Transducer – This signal from transducer is used to monitor the lubrication oil system operation.

Air Filter Vacuum Switch – This switch is used to monitor air filter condition and alert the user if the filter requires service or replacement.

Discharge Thermistor – This sensor is located directly in the compressor discharge. Its signal is used to monitor compressor temperature and shut down the compressor if a coolant problem is detected.

Oil Thermistor – This sensor is located in the oil piping and is used to monitor lubrication oil temperature.

System Thermistor – This sensor is located in the unit discharge piping after the aftercooler. Its signal is used for gauging and temperature shutdowns.

Water Level Switches – This assembly is located within the reservoir, and normally simply monitors and maintains coolant level. If water cannot be adequately drained, the controller will shut down due to high water level.

Water Solenoid Valves (FIGURE 1-6, page 4) – The fill and drain valves respond to the signal from the water level switches to maintain water level. The fill valve adds coolant to the system by injection into the

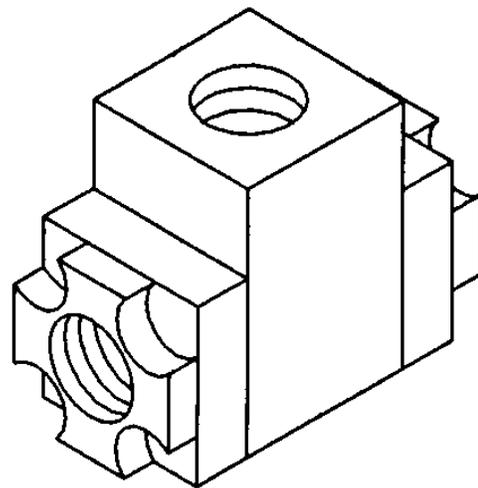


FIGURE 4-5 – SHUTTLE VALVE

compressor. The drain valve drains water from the reservoir.

Optional Switches – The “Auto Sentry®-ES” controller has one additional input available for dealer or user installed optional shutdown switches. If the contact is opened, the compressor will be shut down, and will dis-

play a user selectable message (refer to unit setup adjustments for list of messages).

Emergency Stop Push-Button – This is a maintained push-button, and removes power from the controller outputs regardless of controller status. It is located on the upper section of the panel, next to the keypad. This should be used for emergency purposes only – use the keypad [STOP/RESET] for normal controlled stopping.

 **WARNING**

Automatic restarting or electrical shock can cause injury or death. Open, tag and lockout main disconnect and any other circuits before servicing the unit.

Control Transformer – This changes the incoming power voltage to 110–120 volts for use by all unit con-

trol devices. Two primary and one secondary fuse are provided. Refer to adjacent labeling for replacement information.

Terminal Strip – This provides connections for all 110–120 volt devices not contained within the enclosure.

Pump and Fan Starter – The starter is used to provide control and overload protection for the fan and oil pump. Overload heaters should be selected and adjusted based on the motor nameplate amps and the instructions located inside the cover of the electrical enclosure.

Main Starter – This starter is used to provide control and overload protection for the main drive motor. Full voltage starters employ a single contactor, overload heaters should be selected and adjusted based on the motor nameplate amps and the instructions located inside the cover of the enclosure. Wye-delta starters employ three contactors which are controlled sequentially to provide low current starting. For wye-delta starters, the motor nameplate amps must be first multiplied by 0.577 before using the heater table.

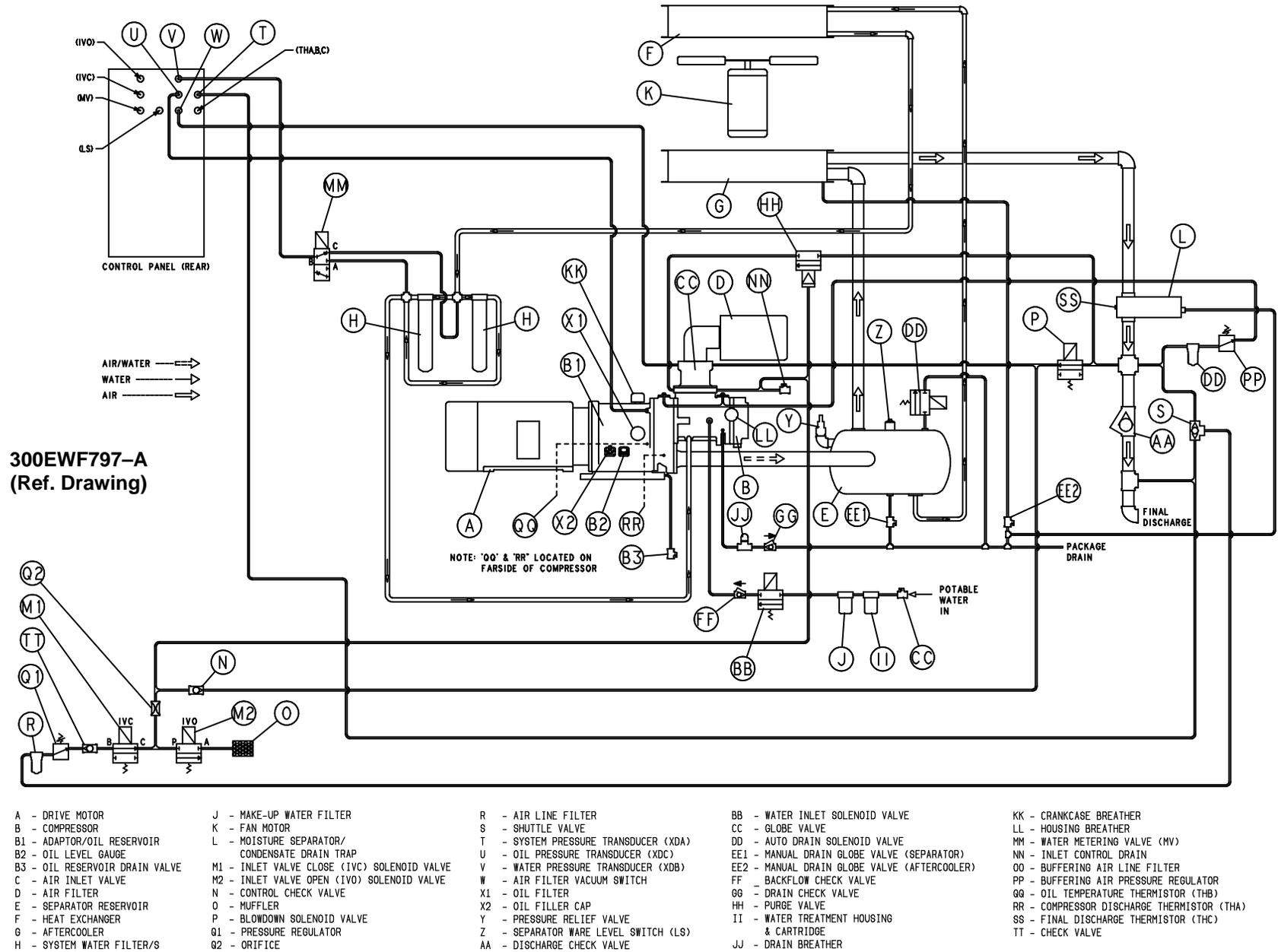
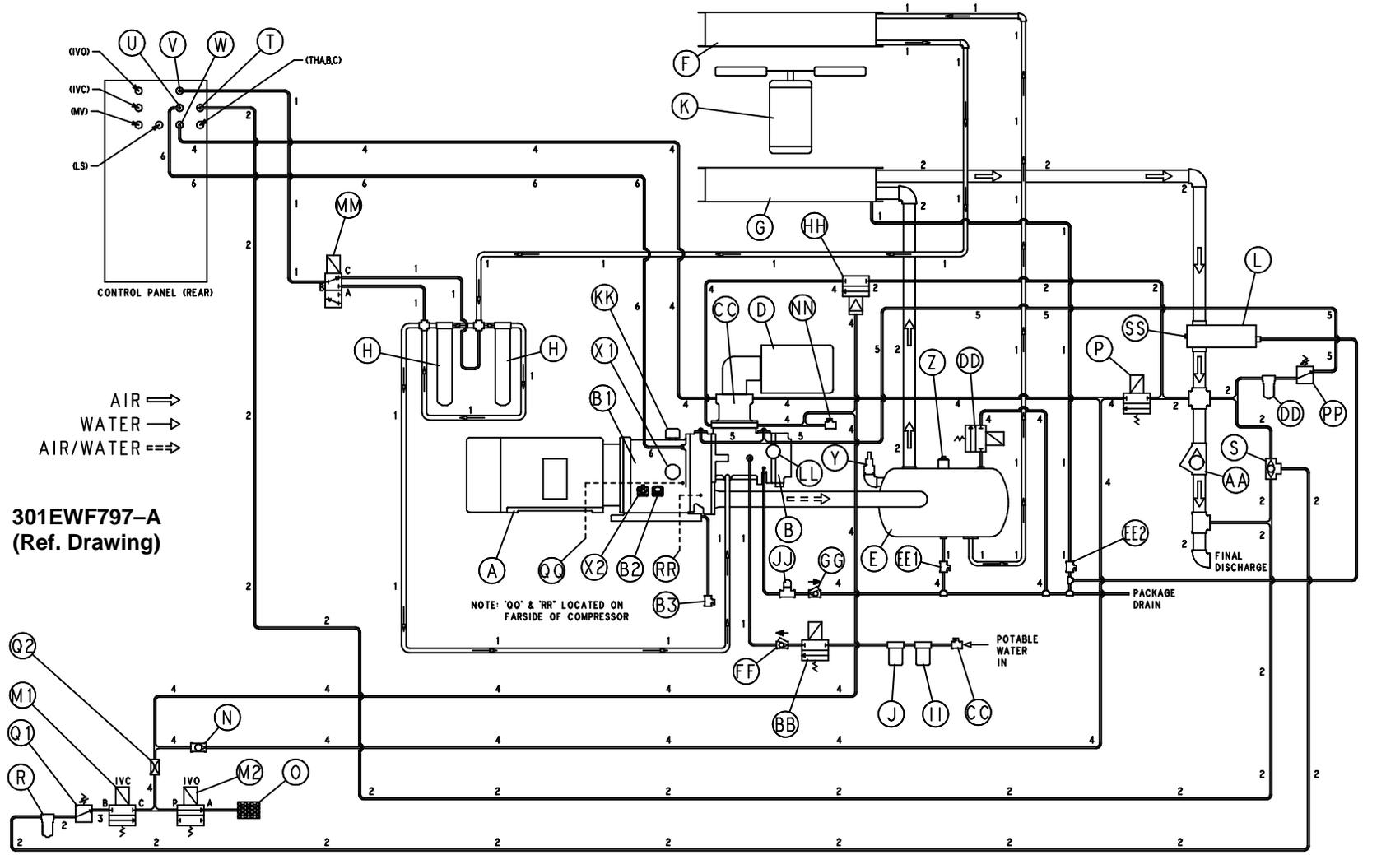


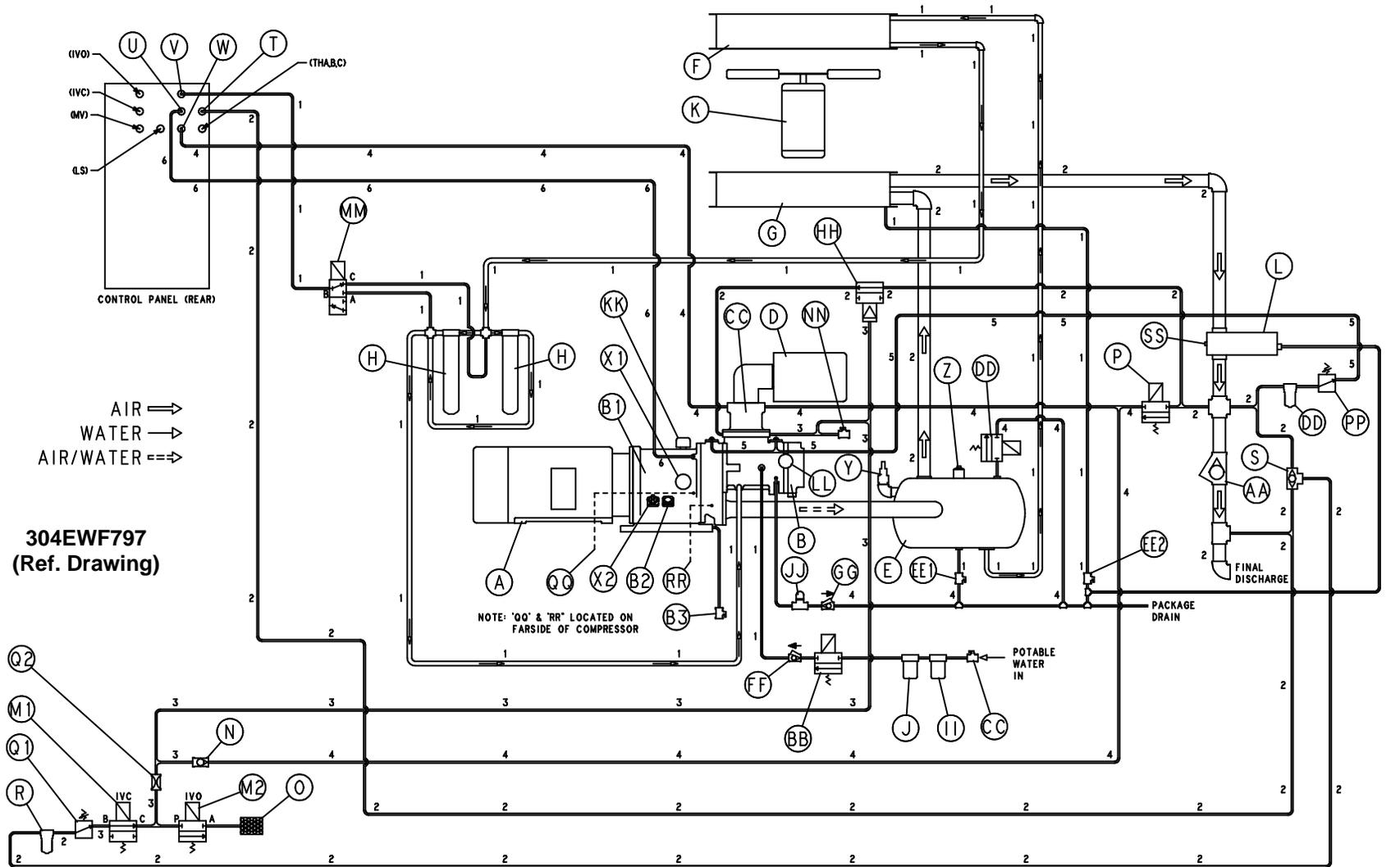
FIGURE 4-6 - CONTROL SCHEMATIC - AIR COOLED



301EWF797-A
(Ref. Drawing)

- | | | | |
|--|---|---|---|
| <ul style="list-style-type: none"> A - DRIVE MOTOR B - COMPRESSOR B1 - ADAPTOR/OIL RESERVOIR B2 - OIL LEVEL GAUGE B3 - OIL RESERVOIR DRAIN VALVE C - AIR INLET VALVE D - AIR FILTER E - SEPARATOR RESERVOIR F - HEAT EXCHANGER G - AFTERCOOLER H - SYSTEM WATER FILTER/S J - MAKE-UP WATER FILTER K - FAN MOTOR L - MOISTURE SEPARATOR/CONDENSATE DRAIN TRAP | <ul style="list-style-type: none"> M1 - INLET VALVE CLOSE (IVC) SOLENOID VALVE M2 - INLET VALVE OPEN (IVO) SOLENOID VALVE N - CONTROL CHECK VALVE O - MUFFLER P - BLOWDOWN SOLENOID VALVE Q1 - PRESSURE REGULATOR Q2 - ORIFICE R - AIR LINE FILTER S - SHUTTLE VALVE T - SYSTEM PRESSURE TRANSDUCER (XDA) U - SYSTEM WATER TRANSDUCER (XDC) V - WATER PRESSURE TRANSDUCER (XDB) W - AIR FILTER VACUUM SWITCH | <ul style="list-style-type: none"> X1 - OIL FILTER X2 - OIL FILLER CAP Y - PRESSURE RELIEF VALVE Z - SEPARATOR WARE LEVEL SWITCH (LS) AA - DISCHARGE CHECK VALVE BB - WATER INLET SOLENOID VALVE CC - GLOBE VALVE DD - AUTO DRAIN SOLENOID VALVE EE1 - MANUAL DRAIN GLOBE VALVE (SEPARATOR) EE2 - MANUAL DRAIN GLOBE VALVE (AFTERCOOLER) FF - BACKFLOW CHECK VALVE GG - DRAIN CHECK VALVE HH - PURGE VALVE | <ul style="list-style-type: none"> II - WATER TREATMENT HOUSING & CARTRIDGE JJ - DRAIN BREATHER KK - CRANKCASE BREATHER LL - HOUSING BREATHER NN - INLET CONTROL DRAIN OO - BUFFERING AIR LINE FILTER PP - BUFFERING AIR PRESSURE REGULATOR RR - COMPRESSOR DISCHARGE THERMISTOR (THA) SS - FINAL DISCHARGE THERMISTOR (THC) |
|--|---|---|---|
-
1. FULL WATER PRESSURE
 2. FULL AIR PRESSURE
 3. CONTROL AIR PRESSURE (25-35 PSI)
 4. ATMOSPHERIC PRESSURE OR EXHAUSTING
 5. SEAL PURGE AIR (3-5 PSI)
 6. OIL PRESSURE (10-20 PSI)

FIGURE 4-7 - CONTROL SCHEMATIC - COMPRESSOR AT FULL LOAD - CONSTANT SPEED MODE



- | | | | | |
|--|---|---|--|--|
| <ul style="list-style-type: none"> A - DRIVE MOTOR B - COMPRESSOR B1 - ADAPTOR/OIL RESERVOIR B2 - OIL LEVEL GAUGE B3 - OIL RESERVOIR DRAIN VALVE C - AIR INLET VALVE D - AIR FILTER E - SEPARATOR RESERVOIR F - HEAT EXCHANGER G - AFTERCOOLER H - SYSTEM WATER FILTER/S J - MAKE-UP WATER FILTER K - FAN MOTOR L - MOISTURE SEPARATOR/CONDENSATE DRAIN TRAP | <ul style="list-style-type: none"> M1 - INLET VALVE CLOSE (IVC) SOLENOID VALVE M2 - INLET VALVE OPEN (IVO) SOLENOID VALVE N - CONTROL CHECK VALVE O - MUFFLER P - BLOWDOWN SOLENOID VALVE Q1 - PRESSURE REGULATOR Q2 - ORIFICE R - AIR LINE FILTER S - SHUTTLE VALVE T - SYSTEM PRESSURE TRANSDUCER (XDA) U - OIL PRESSURE TRANSDUCER (XDC) V - WATER PRESSURE TRANSDUCER (XDB) W - AIR FILTER VACUUM SWITCH | <ul style="list-style-type: none"> X1 - OIL FILTER X2 - OIL FILLER CAP Y - PRESSURE RELIEF VALVE Z - SEPARATOR WARE LEVEL SWITCH (LS) AA - DISCHARGE CHECK VALVE BB - WATER INLET SOLENOID VALVE CC - GLOBE VALVE DD - AUTO DRAIN SOLENOID VALVE EE1 - MANUAL DRAIN GLOBE VALVE (SEPARATOR) EE2 - MANUAL DRAIN GLOBE VALVE (AFTERCOOLER) FF - BACKFLOW CHECK VALVE GG - DRAIN CHECK VALVE HH - PURGE VALVE | <ul style="list-style-type: none"> II - WATER TREATMENT HOUSING & CARTRIDGE JJ - DRAIN BREATHER KK - CRANKCASE BREATHER LL - HOUSING BREATHER NN - INLET CONTROL DRAIN OO - BUFFERING AIR LINE FILTER PP - BUFFERING AIR PRESSURE REGULATOR QQ - OIL TEMPERATURE THERMISTOR (THB) RR - COMPRESSOR DISCHARGE THERMISTOR (THA) SS - FINAL DISCHARGE THERMISTOR (THC) | <ol style="list-style-type: none"> 1. FULL WATER PRESSURE 2. FULL AIR PRESSURE 3. CONTROL AIR PRESSURE (25-35 PSI) 4. ATMOSPHERIC PRESSURE OR EXHAUSTING 5. SEAL PURGE AIR (3-5 PSI) 6. OIL PRESSURE (10-20 PSI) |
|--|---|---|--|--|

FIGURE 4-8 - CONTROL SCHEMATIC - COMPRESSOR UNLOADED - CONSTANT SPEED MODE

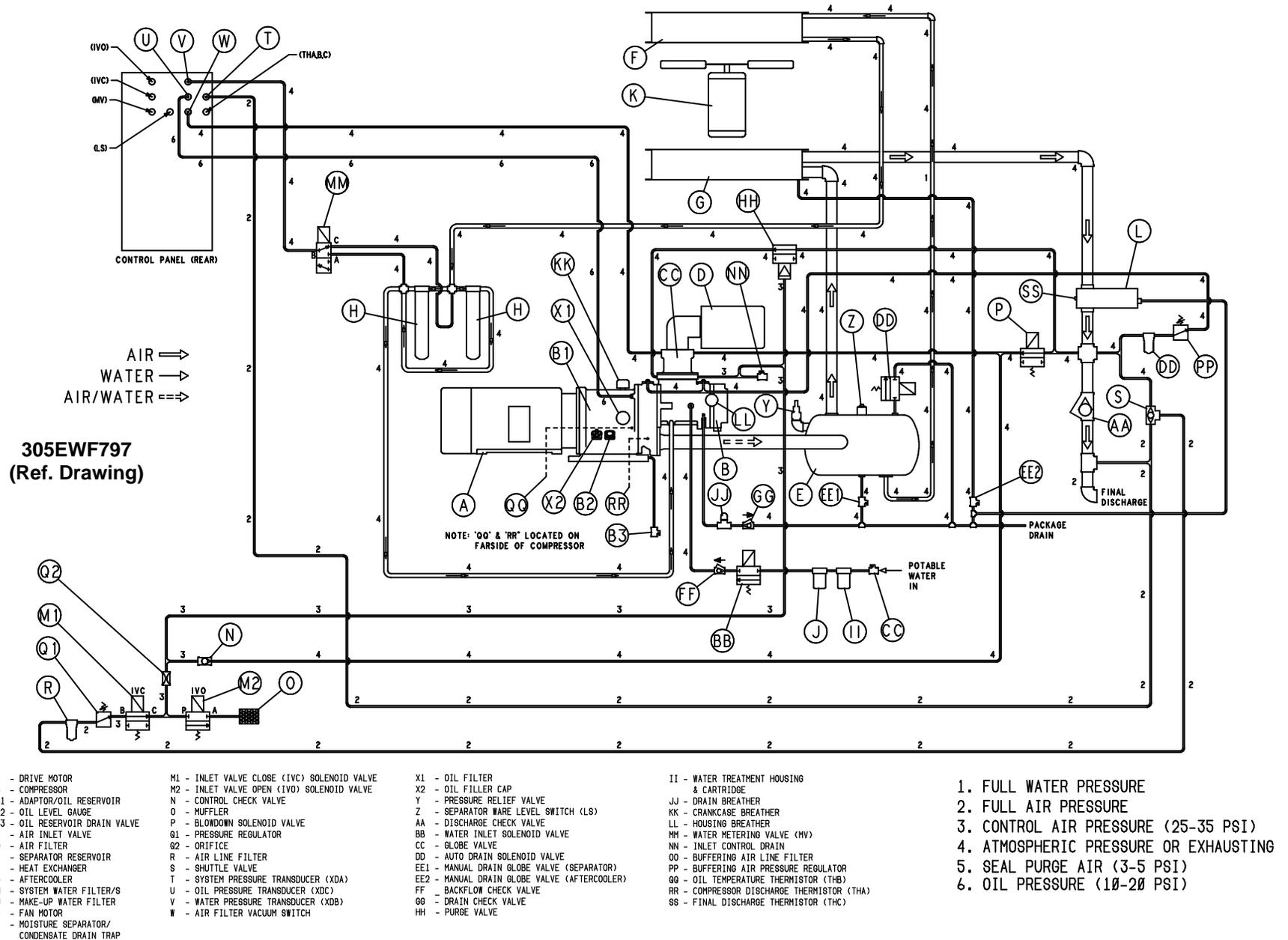
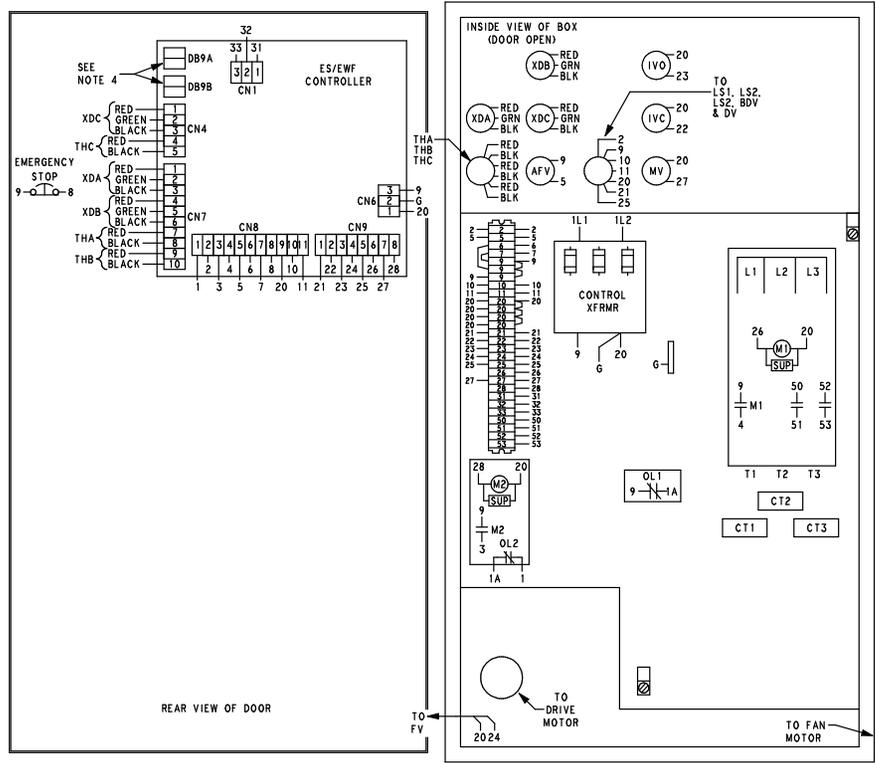
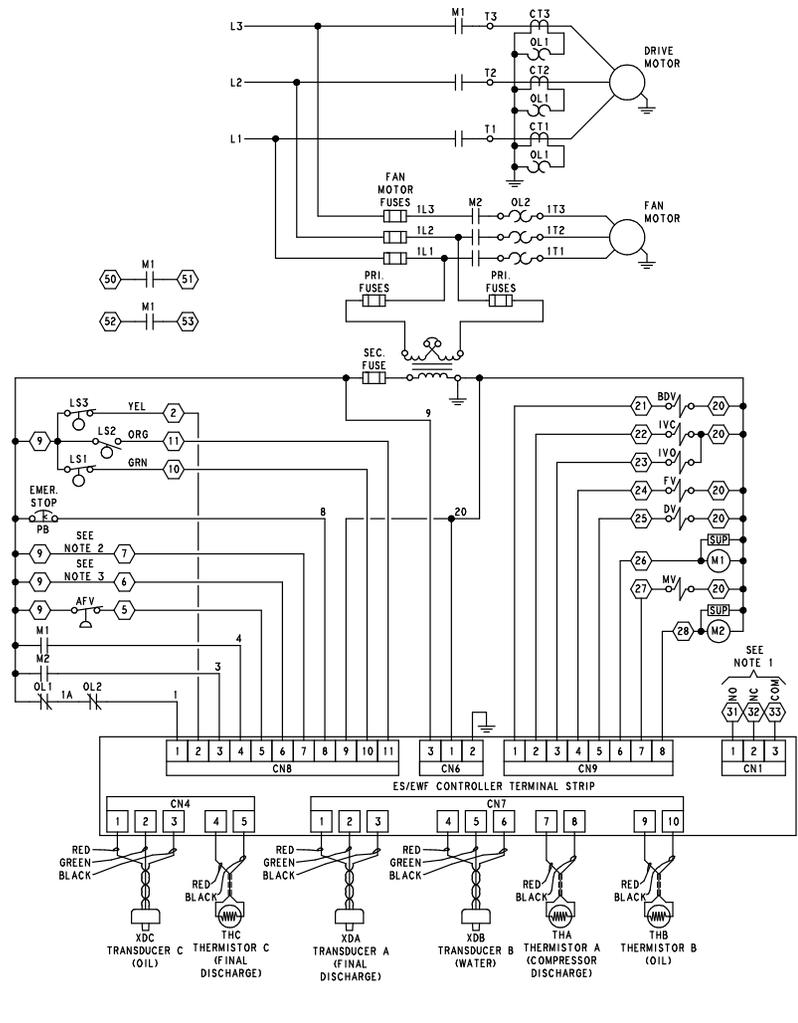


FIGURE 4-9 - CONTROL SCHEMATIC - COMPRESSOR UNLOADED - LOW DEMAND MODE



- LEGEND:**
- CT1-3 - OVERLOAD RELAY CURRENT TRANSFORMER
 - AFV - AIR FILTER VACUUM SWITCH
 - BDV - BLOWDOWN SOLENOID VALVE
 - IVC - INLET VALVE CLOSE SOLENOID VALVE
 - IVO - INLET VALVE OPEN SOLENOID VALVE
 - LS1 - FILL LEVEL SWITCH
 - LS2 - DRAIN LEVEL SWITCH
 - LS3 - HIGH WATER LEVEL SWITCH
 - SUP - SUPPRESSOR
 - THA - THERMISTOR A (COMPRESSOR DISCHARGE)
 - THB - THERMISTOR B (OIL)
 - THC - THERMISTOR C (FINAL DISCHARGE)
 - XDA - TRANSDUCER A (FINAL DISCHARGE)
 - XDB - TRANSDUCER B (WATER)
 - XDC - TRANSDUCER C (OIL)
 - FV - FILL SOLENOID VALVE
 - DV - DRAIN SOLENOID VALVE
 - MV - METERING SOLENOID VALVE
- - CONNECTION TO CONTROL BOARD
 ○ - PANEL TERMINAL BLOCK

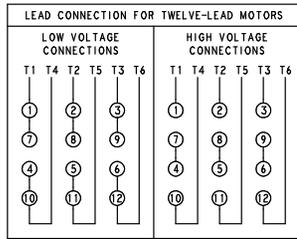
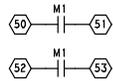
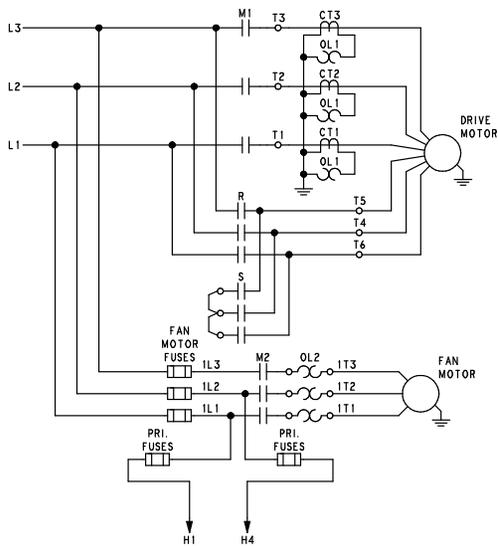
- NOTE 1:** FORM C CONTACT FOR USE BY OTHERS. CONTACT OPERATES FOLLOWING COMPRESSOR SHUTDOWN. RATING: 120VAC, 2 AMP.
- NOTE 2:** FOR USE WITH OPTIONAL SHUTDOWN SWITCH. REMOVE JUMPER BETWEEN TERMINALS 7 & 9. CONNECT N.C. SHUTDOWN SWITCH CONTACT TO TERMINALS 7 & 9.
- NOTE 3:** FOR CONTROL BY REMOTE CONTACT. REMOVE JUMPER BETWEEN TERMINALS 6 & 9. CONNECT CONTACT TO TERMINALS 6 & 9.
- NOTE 4:** DB9A & DB9B ARE FOR USE OF OPTIONAL COMMUNICATIONS CABLE.
- NOTE 5:** WHEN A WATER CONTROL SOLENOID VALVE IS USED, WIRE TO TERMINALS 28 & 20.



**300EWF546-A
(Ref. Drawing)**

MAIN MOTOR	FV STARTER
FAN MOTOR	AIR/WATER COOLED
CONTROLLER	ES/EWF
ACCESSORY	NONE

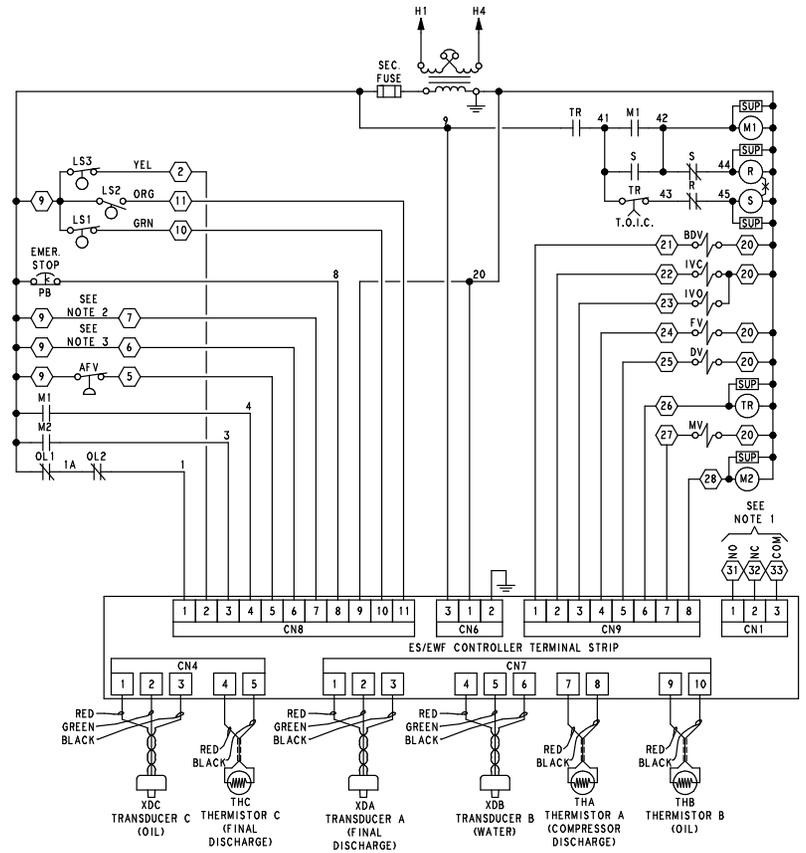
FIGURE 4-10 - WIRING DIAGRAM - FULL VOLTAGE



- LEGEND:
- CT1-3 - OVERLOAD RELAY CURRENT TRANSFORMER
 - AFV - AIR FILTER VACUUM SWITCH
 - BDV - BLOWDOWN SOLENOID VALVE
 - IVC - INLET VALVE CLOSE SOLENOID VALVE
 - IVO - INLET VALVE OPEN SOLENOID VALVE
 - LS1 - FILL LEVEL SWITCH
 - LS2 - DRAIN LEVEL SWITCH
 - LS3 - HIGH WATER LEVEL SWITCH
 - SUP - SUPPRESSOR
 - THA - THERMISTOR A (COMPRESSOR DISCHARGE)
 - THB - THERMISTOR B (OIL)
 - THC - THERMISTOR C (FINAL DISCHARGE)
 - XDA - TRANSDUCER A (FINAL DISCHARGE)
 - XDB - TRANSDUCER B (WATER)
 - XDC - TRANSDUCER C (OIL)
 - FV - FILL SOLENOID VALVE
 - DV - DRAIN SOLENOID VALVE
 - MV - METERING SOLENOID VALVE



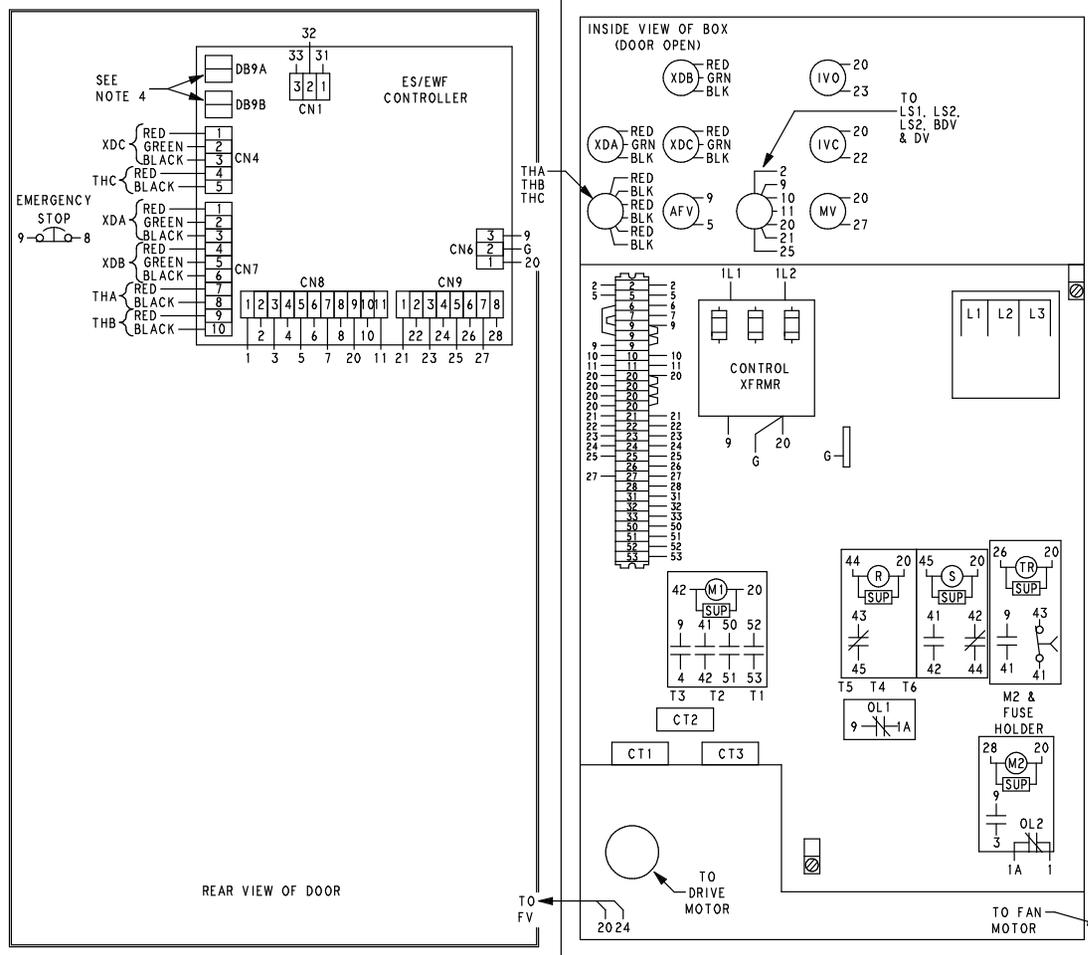
- NOTE 1: FORM C CONTACT FOR USE BY OTHERS. CONTACT OPERATES FOLLOWING COMPRESSOR SHUTDOWN. RATING: 120VAC, 2 AMP.
- NOTE 2: FOR USE WITH OPTIONAL SHUTDOWN SWITCH. REMOVE JUMPER BETWEEN TERMINALS 7 & 9. CONNECT N.C. SHUTDOWN SWITCH CONTACT TO TERMINALS 7 & 9.
- NOTE 3: FOR CONTROL BY REMOTE CONTACT. REMOVE JUMPER BETWEEN TERMINALS 6 & 9. CONNECT CONTACT TO TERMINALS 6 & 9.
- NOTE 4: DB9A & DB9B ARE FOR USE OF OPTIONAL COMMUNICATIONS CABLE.
- NOTE 5: WHEN A WATER CONTROL SOLENOID VALVE IS USED, WIRE TO TERMINALS 28 & 20.



MAIN MOTOR	Y-D STARTER
FAN MOTOR	AIR/WATER COOLED
CONTROLLER	ES/EWF
ACCESSORY	NONE

301EWF546-A
(Ref. Drawing)

FIGURE 4-11 - WIRING DIAGRAM - WYE DELTA



301EWF546-A
(Ref. Drawing)

FIGURE 4-12 - WIRING DIAGRAM - WYE DELTA

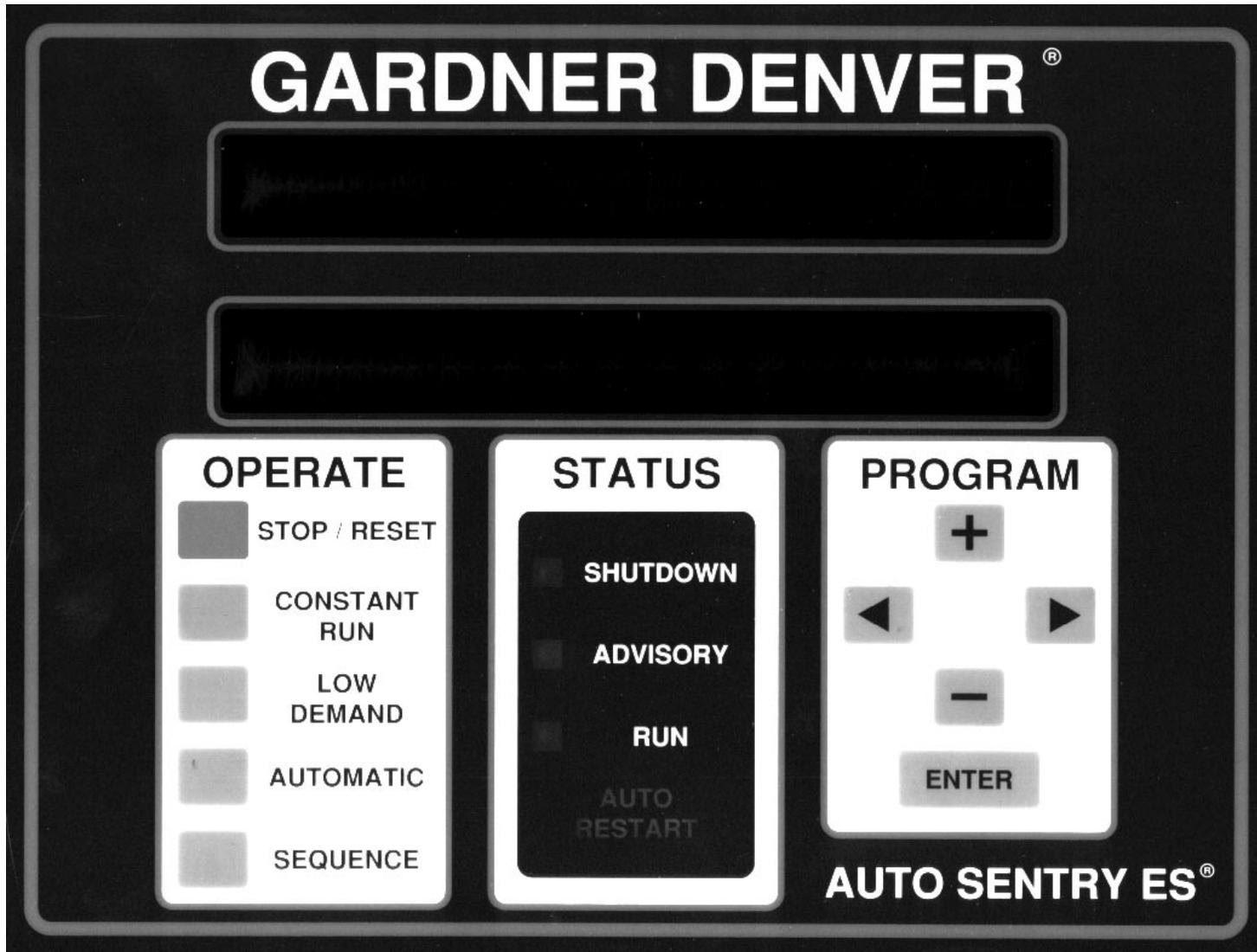


FIGURE 4-13 – AUTO SENTRY-ES CONTROLLER DISPLAY

SECTION 5 LUBRICATION

COMPRESSOR OIL SYSTEM – The oil reservoir is filled with lubricant at the factory before shipment. A tag on the reservoir fill cap indicates the type of oil in the reservoir as it left the factory.

RECOMMENDED LUBRICANT – Gardner Denver compressors are factory filled with AEON™ lubricants. These lubricants are formulated to the highest quality standards and are factory authorized, tested and approved for use in rotary screw compressors.

AEON™ lubricants are available through your authorized Gardner Denver compressor distributor.

OIL SPECIFICATIONS – The air end reservoir is factory filled with AEON™ 9000 SP lubricant. AEON™ 9000 SP is a synthetic extended life lubricant which can extend lubricant change intervals 4 to 10 times that of a petroleum based lubricant. A lubricant analysis program for a periodic check of lubricant quality and remaining life can maximize the change interval.

High Temperature Operation – Gardner Denver® AEON™ 9000 SP lubricant will operate at sustained temperatures up to 210° F when unusually high temperatures are encountered.

Material Safety Data Sheets (MSDS) are available for all AEON lubricants from your authorized Gardner Denver distributor or by calling 217-222-5400.



CAUTION

Use of improper lubricants will cause damage to equipment. Do not mix different types of lubricants or use inferior lubricants.



CAUTION

Improper equipment maintenance with use of synthetic lubricants will damage equipment. Oil change intervals must be adhered to for maximum compressor protection and efficiency. See Maintenance Schedule, page 50.



WARNING

High temperature operation can cause damage to equipment or personal injury. Do not repeatedly restart the unit after high temperature stops operation. Find and correct the malfunction before resuming operation.

LUBRICANT MAINTENANCE INTERVAL – Recommended oil change interval is 8000 hours or one year, whichever comes first, based on normal operating conditions. Severe operating conditions may require shorter change intervals. A good lubricant analysis program is helpful in planning the change interval. The oil filter element should always be changed when the oil is replaced. The refill capacity of the oil system is approximately 8 gallons (30 liters).

OIL FILTER ELEMENT – Normally, the replaceable element only needs to be replaced when the oil is changed every 8000 hours or 1 year, whichever comes first. A clogged or dirty element will cause low oil pressures which can shut the unit down.

BREATHER – The breathers for the reservoir and air end should be cleaned once a year or whenever the oil filter is replaced. Remove the breather, clean and rinse with a solvent, and completely dry the element before reassembly.

OIL LEVEL GAUGE (FIGURE 1-5, page 3, and FIGURE 5-1) indicates the amount of oil in the oil reservoir. Read oil level only when unit is in operation at full load. Note that during operation the oil level can fluctuate as the compressor loads and unloads. Gauge level readings at the bottom of the “RED” range or at the top of the “YELLOW” range during operation indicate that oil needs to be added or drained to maintain the proper oil level.

COMPRESSOR OIL SYSTEM CHECK –

Oil temperature – 140° to 160° F (60° to 71° C) – indicated by the “AUTO SENTRY®-ES” controller display.

Oil Pressure – 15 to 25 psig (1.0 to 1.8 bar) indicated by the “AUTO SENTRY®-ES” controller display, after the unit has reached normal operating temperatures.

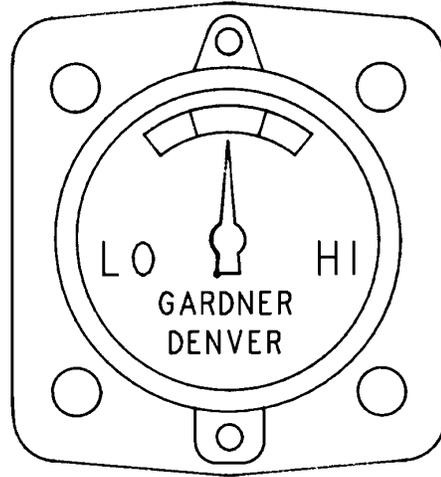
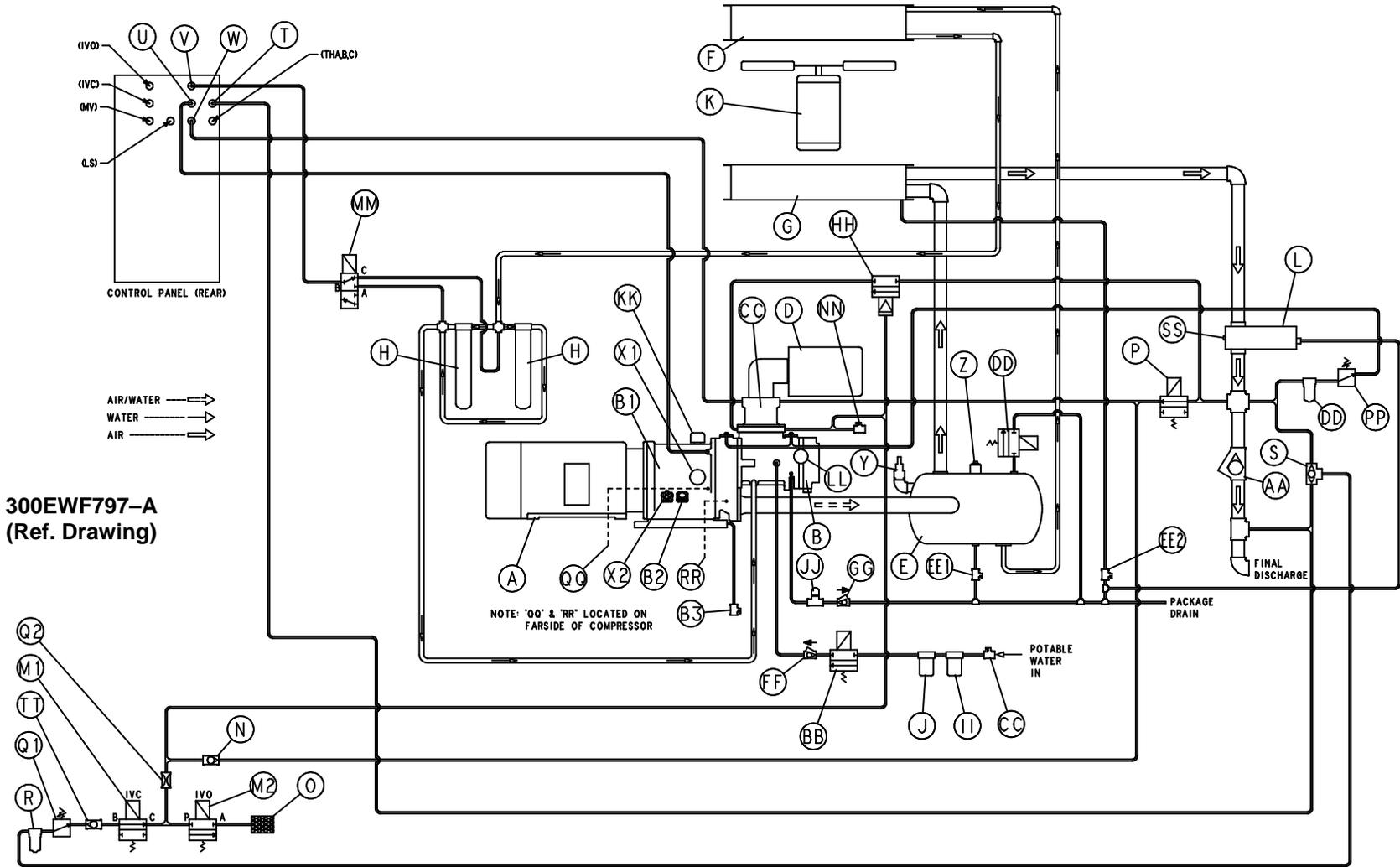
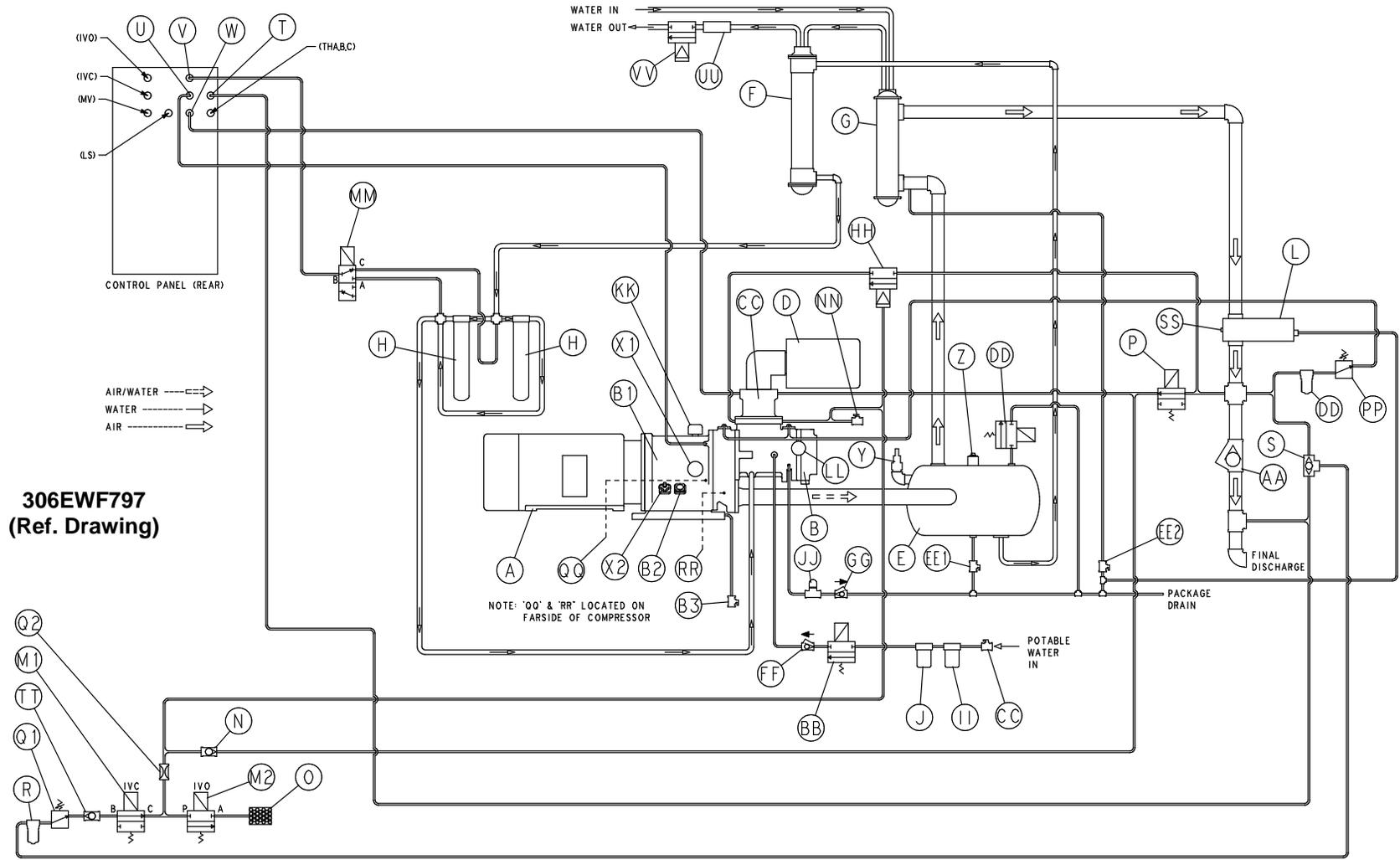


FIGURE 5-1 – OIL LEVEL GAUGE

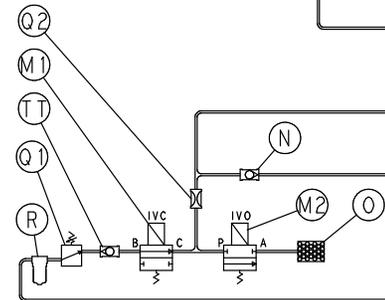


- | | | | | |
|--------------------------------|--|--------------------------------------|--|--|
| A - DRIVE MOTOR | J - MAKE-UP WATER FILTER | R - AIR LINE FILTER | BB - WATER INLET SOLENOID VALVE | KK - CRANKCASE BREATHER |
| B - COMPRESSOR | K - FAN MOTOR | S - SHUTTLE VALVE | CC - GLOBE VALVE | LL - HOUSING BREATHER |
| B1 - ADAPTOR/OIL RESERVOIR | L - MOISTURE SEPARATOR/
CONDENSATE DRAIN TRAP | T - SYSTEM PRESSURE TRANSDUCER (XDA) | DD - AUTO DRAIN SOLENOID VALVE | MM - WATER METERING VALVE (MV) |
| B2 - OIL LEVEL GAUGE | M1 - INLET VALVE CLOSE (IVC) SOLENOID VALVE | U - OIL PRESSURE TRANSDUCER (XDC) | EE1 - MANUAL DRAIN GLOBE VALVE (SEPARATOR) | NN - INLET CONTROL DRAIN |
| B3 - OIL RESERVOIR DRAIN VALVE | M2 - INLET VALVE OPEN (IVO) SOLENOID VALVE | V - WATER PRESSURE TRANSDUCER (XDB) | EE2 - MANUAL DRAIN GLOBE VALVE (AFTERCOOLER) | OO - BUFFERING AIR LINE FILTER |
| C - AIR INLET VALVE | N - CONTROL CHECK VALVE | W - AIR FILTER VACUUM SWITCH | FF - BACKFLOW CHECK VALVE | PP - BUFFERING AIR PRESSURE REGULATOR |
| D - AIR FILTER | O - MUFFLER | X1 - OIL FILTER | GG - DRAIN CHECK VALVE | QQ - OIL TEMPERATURE THERMISTOR (THB) |
| E - SEPARATOR RESERVOIR | P - BLOWDOWN SOLENOID VALVE | X2 - OIL FILLER CAP | HH - PURGE VALVE | RR - COMPRESSOR DISCHARGE THERMISTOR (THA) |
| F - HEAT EXCHANGER | Q1 - PRESSURE REGULATOR | Y - PRESSURE RELIEF VALVE | II - WATER TREATMENT HOUSING
& CARTRIDGE | SS - FINAL DISCHARGE THERMISTOR (THC) |
| G - AFTERCOOLER | Q2 - ORIFICE | Z - SEPARATOR WARE LEVEL SWITCH (LS) | JJ - DRAIN BREATHER | TT - CHECK VALVE |
| H - SYSTEM WATER FILTER/S | | AA - DISCHARGE CHECK VALVE | | |

FIGURE 5-2 - FLOW DIAGRAM (AIR COOLED)



**306EWF797
(Ref. Drawing)**



- | | | | | |
|--------------------------------|--|--------------------------------------|--|--|
| A - DRIVE MOTOR | J - MAKE-UP WATER FILTER | S - SHUTTLE VALVE | CC - GLOBE VALVE | LL - HOUSING BREATHER |
| B - COMPRESSOR | L - MOISTURE SEPARATOR/CONDENSATE DRAIN TRAP | T - SYSTEM PRESSURE TRANSDUCER (XDA) | DD - AUTO DRAIN SOLENOID VALVE | MM - WATER METERING VALVE (MV) |
| B1 - ADAPTOR/OIL RESERVOIR | M1 - INLET VALVE CLOSE (IVC) SOLENOID VALVE | U - OIL PRESSURE TRANSDUCER (XDC) | EE1 - MANUAL DRAIN GLOBE VALVE (SEPARATOR) | NN - INLET CONTROL DRAIN |
| B2 - OIL LEVEL GAUGE | M2 - INLET VALVE OPEN (IVO) SOLENOID VALVE | V - WATER PRESSURE TRANSDUCER (XDB) | EE2 - MANUAL DRAIN GLOBE VALVE (AFTERCOOLER) | OO - BUFFERING AIR LINE FILTER |
| B3 - OIL RESERVOIR DRAIN VALVE | N - CONTROL CHECK VALVE | W - AIR FILTER VACUUM SWITCH | FF - BACKFLOW CHECK VALVE | PP - BUFFERING AIR PRESSURE REGULATOR |
| C - AIR INLET VALVE | O - MUFFLER | X1 - OIL FILTER | GG - DRAIN CHECK VALVE | QQ - OIL TEMPERATURE THERMISTOR (THB) |
| D - AIR FILTER | P - BLOWDOWN SOLENOID VALVE | X2 - OIL FILLER CAP | HH - PURGE VALVE | RR - COMPRESSOR DISCHARGE THERMISTOR (THA) |
| E - SEPARATOR RESERVOIR | Q1 - PRESSURE REGULATOR | Y - PRESSURE RELIEF VALVE | II - WATER TREATMENT HOUSING & CARTRIDGE | SS - COMPRESSOR DISCHARGE THERMISTOR (THC) |
| F - HEAT EXCHANGER | Q2 - ORIFICE | Z - SEPARATOR WARE LEVEL SWITCH (LS) | JJ - WATER BREATHER | TT - CHECK VALVE |
| G - AFTERCOOLER | R - AIR LINE FILTER | AA - DISCHARGE CHECK VALVE | KK - CRANKCASE BREATHER | UU - WATER FLOW CONTROL VALVE*** |
| H - SYSTEM WATER FILTER/S | | BB - WATER INLET SOLENOID VALVE | | VV - MAGNETIC WATER SHUTOFF VALVE*** |

*** - OPTIONAL EQUIPMENT

FIGURE 5-3 - FLOW DIAGRAM (WATER COOLED)

SECTION 6 AIR FILTER

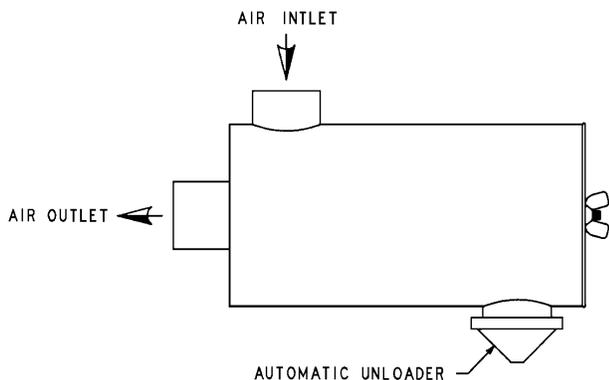


FIGURE 6-1 – HEAVY DUTY AIR FILTER (STANDARD)

HEAVY-DUTY AIR FILTER (FIGURE 6-1) furnished as standard equipment on units with an enclosure is a heavy-duty washable element dry type air filter. The air filter must receive proper maintenance if maximum service is to be obtained from the unit. Establishing adequate and timely filter service is **MOST IMPORTANT**. An improperly maintained air filter can cause a loss of compressor air delivery.

Filter Element – Service the air filter element when the “CHANGE AIR FILTER” LED is illuminated. Clean every 50 to 150 operating hours depending on dust conditions.

NOTICE

Use only genuine Gardner Denver air filter elements on Gardner Denver compressor units. Genuine parts are available through your authorized Gardner Denver distributor.

To service:

1. Remove the wingnut and pull out the filter element.
2. Visually inspect the element. If cleaning is not necessary, reinstall the filter element. If the element requires cleaning, follow steps 3, 4 and 5.

3. Wash the element by soaking about 15 minutes in warm water with a mild nonsudsing detergent. Rinse the element thoroughly with clean water; a hose may be used if the water pressure does not exceed 40 psig (2.8 bar).
4. Inspect the element for ruptures or cracks in the pleated media; replace the element if any are found. Inspect the gasket on the bottom (outlet end) of the element; replace the entire element if the gasket is damaged. A spare element will keep down time to a minimum.
5. Allow the element to air dry **COMPLETELY**. Do not expose the element to heat over 150° F (66° C). Install the element in the filter body and fasten securely with the wing nut.

⚠ WARNING

Do not oil this element. Do not wash in inflammable cleaning fluids. Do not use solvents other than water. Improper cleaning may damage the element.

NOTICE

Never operate the unit without the element. Never use elements that are damaged, ruptured or wet. Never use gaskets that won't seal. Keep spare elements and gaskets on hand to reduce downtime. Store elements in a protected area free from damage, dirt and moisture. Handle all parts with care.

Filter Element Life – The element should be replaced after six (6) cleanings or if:

1. Visual inspection indicates a rupture, crack or pin hole in the pleated media. Inspection should be done by placing a bright light inside the element.

2. Pressure drop through a filter with a freshly cleaned element is below three (3) inches (76 mm) of water with the compressor running at full load – this would indicate a rupture or crack.

Inlet Tube – Inspect the inlet screen and tube for dirt accumulation each time the filter is serviced. Clean the

tube when required by ramming a clean dry cloth through the tube. Wipe the inside of the filter body to remove any dirt falling from the inlet tube before reinstalling the element.

Causes of short element life include: severe dust conditions, infrequent servicing, improper cleaning, or contamination by oil or chemical fumes.

SECTION 7 COUPLING

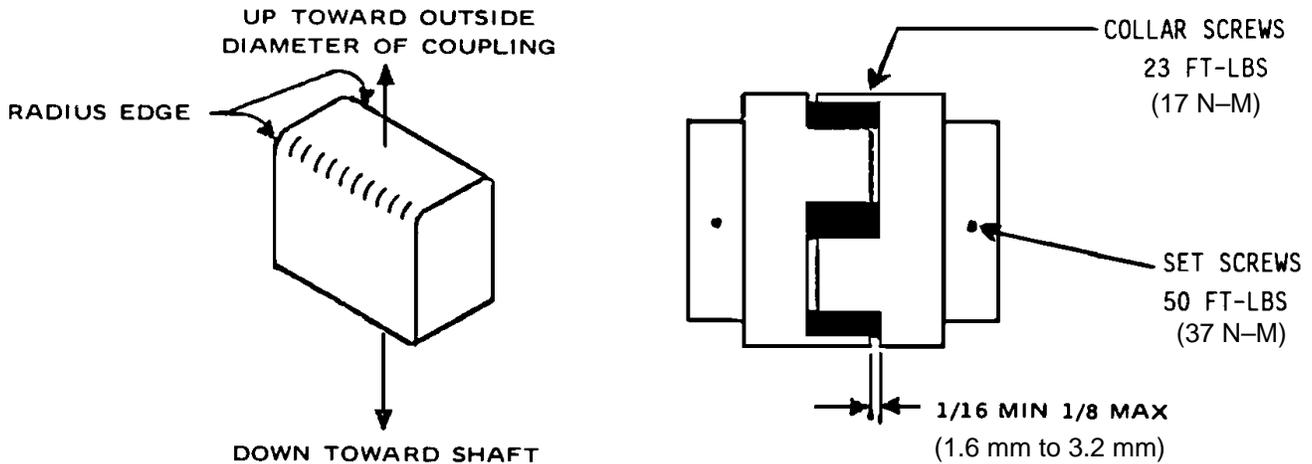


FIGURE 7-1 – INSTALLATION OF COUPLING CUSHIONS

DANGER

Rotating machinery can cause personal injury or death. Turn the unit completely off, open the main disconnect, tag and lockout before servicing the coupling.

- Working through the coupling guard opening, center the coupling over the gap between the shafts, maintaining the gap as shown in FIGURE 7-1 between the ends of the jaws on one coupling body and the flange on the opposite coupling body. Tighten set screws in each coupling body.
- Insert individual cushions as shown in FIGURE 7-1 and slide the collar over the cushions and secure with cap screws. Reinstall the cover plate.

COUPLING – The motor and compressor are direct connected by a resilient type flexible coupling with several individual cushions, FIGURE 7-1. The coupling does not require lubrication.

If maintenance on mating parts is required, reassemble coupling as follows:

Individual Cushion Design (FIGURE 7-1)

- Slide coupling halves over shaft extensions. Be sure the collar is installed on the shaft behind one coupling body.
- Assemble the motor on the compressor.

DANGER

Rotating machinery can cause personal injury or death. Do not operate unit with either the coupling guard or the collar removed. All bolts and screws must be properly tightened.

Alignment – The coupling is permanently aligned by the flanges on the compressor and motor.

SECTION 8 MAINTENANCE SCHEDULE

SERVICE CHECK LIST –

Air Filter – Operating conditions determine frequency of service. The “CHANGE AIR FILTER” LED will illuminate to signal that the air filter requires servicing or changing. See “Air Filter,” Section 6, page 47.

Water Filter – Operating conditions and water quality determine the frequency of service. The “CHG WATER FILTER” LED will illuminate to signal that the water filter requires changing. See “Changing the Injection Water Filter,” Section 2, page 15.

Motor Lubrication – Refer to Section 2, page 17, and Maintenance Schedule Chart below.

Every 8 Hours Operation

1. Observe if the unit loads and unloads properly.
2. Check discharge pressure and temperature.
3. Drain the petcock on the inlet valve control line & seal purge air line.
4. Check Panel LED’s for advisories.

Every 125 Hours Operation

1. Check for dirt accumulation on heat exchanger/aftercooler core faces and the cooling fan. If cleaning is required, clean the exterior fin surfaces of the cores by blowing compressed air carrying a nonflammable safety solvent in a direction opposite that of the cooling fan air flow. This cleaning operation will keep the exterior cooling surfaces clean and ensure effective heat dissipation.
2. Check the reservoir oil level – add oil if required. Loss of oil will be because of seal failure or leaks in the system and should be fixed immediately.

Every 8000 Hours Operation

1. Change the compressor lubricant. UNDER ADVERSE CONDITIONS, CHANGE MORE FREQUENTLY (refer to “Oil Change Interval”, page 43). Flush system if required. DO NOT MIX LUBRICANTS.
2. Change the oil filter element. Change whenever the oil is changed.

Every Year

1. Check the relief valve for proper operation. See Section 4, page 31.
2. Inspect check valve seals.

MAINTENANCE SCHEDULE (See detail notes above)

Maintenance Action

Maintenance Action	As Indicated By Auto–Sentry–ES	Every 8 Hours	Every 125 Hours	Every 8000 * Hours	Every Year
Change Air Filter	•				
Change Water Filter	•				
Check For Proper Load/Unload		•			
Check Discharge Pressure/Temp		•			
Check Dirt Accumulation on Cooler			•		
Check Reservoir Oil Level			•		
Change Oil Filter Element	•			•	•
Change Compressor Lubricant (AEON 9000 SP)	•			•	•
Check Relief Valve					•
Inspect Check Valve Seals (Every Year)					•
Drain Petcock on Inlet Valve Control Line & Seal Purge Air Line		•			

* Or one year, whichever comes first.

SECTION 9 TROUBLE SHOOTING

SYMPTOM	POSSIBLE CAUSE	REMEDY
Compressor fails to start.	<ol style="list-style-type: none"> 1. Wrong lead connections. 2. Blown fuse(s) in control box. 3. Motor starter overload heaters tripped. 4. Pressure in reservoir. 5. Read error message on control panel. 6. Remote Contact is open 	<ol style="list-style-type: none"> 1. Change leads. 2. Replace fuse(s). 3. Reset and investigate cause of overload. 4. Inspect blowdown valve. 5. Take appropriate action. See Section 10. 6. Replace switch or jumper. (terminals 6 & 9).
Compressor starts but stops after a short time.	<ol style="list-style-type: none"> 1. High discharge temperature. 2. High discharge temperature sensor malfunction. 3. Blown fuse in starter/control box. 4. Motor starter overload heaters trip. 	<ol style="list-style-type: none"> 1. See "High Discharge Air Temperature," this section, page 52. 2. Replace switch. 3. Replace fuse (investigate if fuses continue to blow). 4. Reset and investigate cause of overload.
Compressor does not unload (or load).	<ol style="list-style-type: none"> 1. Improperly adjusted control. 2. Air leak in control lines. 3. Restricted control line. 4. Blowdown valve malfunction. 	<ol style="list-style-type: none"> 1. Refer to Section 4 and adjust control. 2. Determine source of leak and correct. 3. Clean control lines. 4. Repair, clean or replace valve.
Compressor cycles from load to unload excessively.	<ol style="list-style-type: none"> 1. Insufficient receiver capacity. 2. Restriction in control tubing. 	<ol style="list-style-type: none"> 1. Increase receiver size. 2. Inspect and clean control tubing.

SYMPTOM	POSSIBLE CAUSE	REMEDY
Compressor is low on delivery and pressure.	1. Restricted air filter.	1. Clean or replace filter.
	2. Sticking inlet valve.	2. Inspect and clean inlet valve.
	3. Unload pressure adjusted too low.	3. Adjust the unload pressure. See Section 4, page 21.
	4. Discharge check valve stuck closed.	4. Disassemble and clean valve.
High discharge air temperature.	1. Dirty or clogged cooler face.	1. Clean cooler.
	2. Insufficient cooling air flow.	2. Provide unrestricted supply of cooling air.
	3. Clogged water injection filter or cooler (interior).	3. Replace filter or clean cooler.

NOTICE

Gardner Denver factory remanufactured replacement compressor air end units are available from your authorized distributor, on an exchange basis, for all rotary screw compressor units.

SECTION 10 TROUBLE SHOOTING CONTROLS

AUTO SENTRY[®]-ES CONTROLLER

DISPLAY MODES

The normal display indicates the package service pressure, the airend discharge temperature, the total running hours, and one of the following operating modes. The green run light will be on for any operating mode, whether the compressor is running or not.

READY	The compressor has been stopped by pressing the [STOP/RESET] key.
CON	The compressor is operating in the Constant Run mode.
LDM	The compressor is operating in the Low Demand mode.
AUTO	The compressor is operating in the Automatic mode.
SEQ n	The compressor is operating in the Sequence mode.

The following alternate displays may be called by pressing a cursor [<] or [>] key

DIS TMP	The temperature at the airend discharge
RES PRES	The pressure in the water reservoir
DIF PRES	The pressure drop across the water filter
SYS TMP	The temperature at the service connection
SYS PRES	The pressure at the service connection
OIL TMP	The temperature of the injected lubricating oil
OIL PRES	The pressure of the injected lubricating oil
TOT HRS	The total hours of compressor running
LOAD HRS	The hours of compressor delivery
BD TMR	The time remaining before a blowdown will be allowed
AUTO TMR	The time remaining of unloaded motor operation

ADVISORY TROUBLE SHOOTING GUIDE

All advisories are indicated on the keypad by a yellow indicator in the Status area, and one of the following messages alternating with the normal lower line display. Perform service or maintenance as indicated, then clear the advisory as instructed in Section 4.

Message	Action Needed
CHNG AIR FILTER	Excessive vacuum has been detected after the air filter, indicating it has become full. Change the air filter to ensure maximum air delivery.
CHNG H2O FILTER	The differential pressure across the water filter has risen to over 30 psid. Change the filter to ensure an adequate flow of coolant.
CHNG OIL FILTER	The unit has been operated for the programmed number of hours since the last filter replacement. Change the filter to ensure an adequate flow of lubricant.
CHANGE OIL	The unit has been operated for the programmed number of hours since the last oil change. Change the oil to ensure lubricant quality.

ADVISORY TROUBLE SHOOTING GUIDE (Continued)

HIGH DISCH TEMP HIGH OIL TEMP HIGH SYS TEMP	The temperature was greater than 180° F (82° C) at: (1) the airend discharge, (2) oil injection or (3) the package service connection. Ensure that the compressor receives adequate cooling air or water, and that the coolers are not plugged.
LOW AMB TEMP	The temperature was less than 40 degrees F (4 degrees C) at: (1) the airend discharge, (2) oil injection or (3) the package service connection. Ensure that the compressor is located in a room protected from freezing temperatures.

SHUTDOWN TROUBLE SHOOTING GUIDE

Message

Action Needed

All shutdowns are indicated on the keypad by the word "SHUTDOWN" on the top line of the display, and one of the following messages on the lower line of the display. The red indicator in the Status area will be steadily lit while the conditions exist, and will flash after the condition has been corrected. Perform service as indicated. Press the [STOP/RESET] key to clear the shutdown.

BAD FLOAT SWITCH	120 volts is present at both terminal 10 and 11 of the terminal strip. This indicates a likely wiring error to the float switch; check and correct. It may also indicate a short within the switch itself.
CHECK CN4	Both inputs at connector 4 of the controller are off. The most common cause for this is that the connector plug has been pulled out. Plug the connector back in firmly.
CHECK CN7	All inputs at connector 7 of the controller are off. The most common cause for this is that the connector plug has been pulled out. Plug the connector back in firmly.
CHECK CN8	120 volts has been removed from ALL inputs to connector 8 of the controller. The most common cause for this is that the connector plug has been pulled out. Plug the connector back in firmly.
CHNG H2O FILTER	The differential pressure across the water filter has risen to over 40 psid. Change the filter to ensure an adequate flow of coolant.
EMERGENCY STOP	The Emergency Stop button has been pressed. Pull it back out to its normal position. If the button has not been pressed, check that the contact block is firmly mounted in the right or left (not center) position of the operator. Check for loose connections which would remove 120 volts from connector 8–8 of the controller.
EXTERNAL DEVICE	120 volts has been removed from terminal 7 of the terminal strip. This is normally shipped jumpered directly to terminal 9, but the jumper may be removed to add a field installed shutdown switch. Reset the external switch.
HIGH DIS TEMP R	This indicates that the controller has detected a rapid temperature rise in the airend discharge. This normally would indicate a loss of coolant injection into the airend. Completely check all water piping, the filter, and flow controls for blockage or freezing. This may also be caused by a loose connection at connector 7 of the controller. Monitor the temperature carefully during restarts after servicing.
HIGH DISCH TEMP	This indicates that the controller has detected temperature in excess of the programmed high temperature limit at the airend discharge. The most common cause for this is inadequate package cooling. Ensure proper air flow for aircooled units, or adequate cooling water for water cooled units. Monitor the temperature carefully during restarts after servicing.

SHUTDOWN TROUBLE SHOOTING GUIDE (Continued)

HIGH OIL PRESS	Pressure in excess of the programmed high pressure limit has been detected. This is set at 125 psig (8.5 bars) for units with a mechanical oil pump. Check for blockages in the oil injection piping. Other possible causes are thick or cold oil, loose connections to the transducer, electrical noise and transients, or improper setting of the oil pump type.
HIGH OIL TEMP	This indicates that the controller has detected temperature in excess of the programmed high temperature limit in the oil piping. The most common cause for this is inadequate package ventilation. Monitor the temperature carefully during restarts after servicing.
HIGH OIL TEMP R	This indicates that the controller has detected a rapid temperature rise in the oil piping. This may also be caused by a loose connection at connector 7 of the controller. Monitor the temperature carefully during restarts after servicing.
HIGH RESVR PRESS	Pressure in excess of the programmed high pressure limit has been detected. This shutdown will occur if a loss of pneumatic controls occurs. Check the inlet valve, all control piping, solenoid valves, and all other control devices to find the cause for the inlet valve not closing. Other possible causes are loose connections to the transducer, electrical noise and transients, or improper setting of the high pressure limit.
HIGH SYSTEM PRESS	Pressure in excess of the programmed high pressure limit has been detected. The most likely cause is other, higher pressure compressors on the same air system; separate these from this compressor unit. Other possible causes are loose connections to the transducer, electrical noise and transients, or improper setting of the high pressure limit.
HIGH SYS TEMP	This indicates that the controller has detected temperature in excess of the programmed high temperature limit at the package discharge. The most common cause for this is inadequate package cooling. Ensure proper air flow for aircooled units, or adequate cooling water for water cooled units. Monitor the temperature carefully during restarts after servicing.
HIGH VIBRATION	120 volts has been removed from terminal 7 of the terminal strip. This is normally shipped jumpered directly to terminal 9, but the jumper may be removed to add a field installed shutdown switch. Reset the external switch.
HIGH WATER LEVEL	120 volts has been removed from terminal 2 of the terminal strip. This normally indicates that a high water level in the reservoir has opened switch LS3 of the float switch assembly. Check that the drain is clear and that the drain solenoid valve is functioning properly. This may also indicate a loose connection along wire 2.
LOW DISCH TEMP	The temperature, as measured at the airend discharge, has fallen below freezing. Repair room heating to prevent further damage to the unit.
LOW OIL PRESSURE	The controller has attempted to run the compressor and oil pump, but the oil pressure is not adequate for proper lubrication. If the compressor is starting before this shutdown occurs, check for proper rotation, adequate oil fill, and blockages or leaks, and proper connection of the oil pressure transducer. If the compressor does not start prior to this message, check that configuration adjustments select the mechanical oil pump.
LOW OIL TEMP	The temperature, as measured in the oil piping, has fallen below freezing. Repair room heating to prevent further damage to the unit.

SHUTDOWN TROUBLE SHOOTING GUIDE (Continued)

LOW SYS TEMP	The temperature, as measured at the service connection, has fallen below freezing. Repair room heating to prevent further damage to the unit.
LV RELAY	120 volts has been removed from terminal 7 of the terminal strip. This is normally shipped jumpered directly to terminal 9, but the jumper may be removed to add a field installed shutdown switch. Reset the external switch.
MOTOR CONTACT	The controller has attempted to turn off the compressor, but is still receiving a return signal from the starter's auxiliary contact. Check that the starter operates freely and that the contact block is properly installed on the starter.
MOTOR OVERLOAD	One of the motor overload relays within the electrical control box has tripped, indicating high motor shaft load, low voltage, or excessive imbalance in the incoming power. Disconnect and lock out power, open the box, and press the reset buttons one at a time – the tripped one will click when reset. Measure motor amps, and take corrective actions to get all currents within the motor nameplate rating. If overloads had not tripped, check for the cause that 120 volts was removed from connector 8–1 of the controller.
MOTOR STARTER	The controller has attempted to start the compressor, but did not receive a return signal from the starter's auxiliary contact. If the starter does not pick up when attempting to start, check that connector 9 of the controller is plugged in firmly, and check the starter coil. If the starter does pick up, but this message appears, check that the auxiliary contact block is properly installed on the starter and wired to connector 8, terminal 4.
OPEN THERM	The controller has detected an open connection to thermistor: (A) airend discharge, (B) oil injection, or (C) final package discharge at the service valve. This normally indicates a loose or broken connection at the controller connector 4 or 7; check and correct the connection. This could also be indicating a broken wire or thermistor probe.
OPEN XDUCER	Signal voltage has fallen too low at transducer: (A) Final discharge, (B) Water, or (C) Oil. This error is frequently the result of the transducers being improperly zeroed. Disconnect the air lines to the transducers and follow the procedure indicated in the adjustment instructions. This may also indicate a loose connection of the red wire to the transducer or a defective transducer. Check connections, or replace transducer if necessary.
PHASE RELAY	120 volts has been removed from terminal 7 of the terminal strip. This is normally shipped jumpered directly to terminal 9, but the jumper may be removed to add a field installed shutdown switch. Reset the external switch.
POWER FAILURE	The power to the compressor unit has been turned off and back on. Press [STOP/RESET] and select an operating mode.
PUMP/FAN CONTACT	The controller has attempted to turn off the pump and fan, but is still receiving a return signal from the starter's auxiliary contact. Check that the starter operates freely and that the contact block is properly installed on the starter.
PUMP/FAN STARTER	The controller has attempted to start the pump and fan, but did not receive a return signal from the starter's auxiliary contact. If the starter does not pick up when attempting to start, check that connector 9 of the controller is plugged in firmly, and check the starter coil. If the starter does pick up, but this message appears, check that the auxiliary contact block is properly installed on the starter and wired to connector 8, terminal 3.

SHUTDOWN TROUBLE SHOOTING GUIDE (Continued)

SHORTED THERM	The controller has detected a shorted connection to thermistor: (A) airend discharge, (B) oil injection, or (C) final package discharge to the service valve. This normally indicates a faulty connection (e.g. wire strands touching) at the controller connector 4 or 7; check and correct the connection. This could also be indicating a damaged wire or thermistor probe.
SHORTED XDUCER	Signal voltage has exceeded approximately 4.6 volts at transducer: (A) Final discharge, (B) Water, or (C) Oil. This may indicate a loose connection of the black wire to the transducer or a defective transducer. Check connections, or replace transducer if necessary.
WATER PRESS	120 volts has been removed from terminal 7 of the terminal strip. This is normally shipped jumpered directly to terminal 9, but the jumper may be removed to add a field installed shutdown switch. Reset the external switch.

CONTROLS TROUBLE SHOOTING GUIDE

The following are recommended service actions. Observe all instructions noted elsewhere in this manual. All electrical service is to be performed only by a qualified electrician.

Symptom	Recommended action
No display, compressor stopped	Check incoming power to the compressor unit. Ensure that the disconnect is on and that fuses have not blown (or circuit breaker tripped). If power is being properly supplied to the control box, check the fuses located at the fan starter, the control transformer fuses, and the fuse located on the ES controller chassis near connector CN-6.
Message	Action Needed
Compressor will not start.	To operate, the controller must be placed into an operating mode (e.g. "AUTO"); press the [STOP/RESET] key to put the control into the "READY" state, then select a mode with the operating mode keys. In AUTOMATIC and SEQUENCE modes, compressors will not start until the pressure drops below the reset pressures.
Display indicates "NOT BLOWN DOWN"	The controller prevents attempts to start the main motor if the reservoir pressure is over 5 psig. Pressure continues to be relieved from the reservoir while this message is on, and the compressor will start automatically after the pressure has dropped. If this message remains with NO pressure in the reservoir, follow the transducer zeroing procedure found in the controls adjustment section.
Display indicates "REMOTE STOP"	The controller is provided with an input for user-furnished remote controls. This display indicates that 120 volt is removed from terminal 6 of the terminal strip. Check all connections of the factory installed jumper, or the customer-provided controls, if applicable.
Display indicates "SHUTDOWN"	If the display indicates "SHUTDOWN", refer to the shutdown troubleshooting section for assistance. In addition to the messages shown, there are several internal and system diagnostics performed by the controller. Consult the factory for additional assistance.

CONTROLS TROUBLE SHOOTING GUIDE (Continued)

Compressor runs, but does not load	In the CONSTANT RUN and LOW DEMAND modes, the compressor will not load until the pressure drops below reset pressure. Refer to the operating instructions for further information. If pressure is below the reset pressure, check that the inlet valve operates freely. Check that the IVO and IVC valves are wired and operating properly.
Compressor runs, unloads at low pressure	If the inlet valve closes at low pressure, check the wiring to the blowdown valve and the piping and check valves in its discharge line.
Compressor does not modulate	The ES controller operates the inlet valve to maintain pressure near the set pressure, matching delivery to demand. If the pressure continues to rise above set pressure, check that the inlet valve operates freely, and that control air is supplied to the IVC valve. If modulation does not close the valve, it will be closed during a blowdown as pressure approaches the high pressure limit.
Compressor cycles rapidly between load and unload	The external air receiver should be sized appropriately to prevent rapid cycles. The rapid response time in the CONSTANT RUN mode will operate with small receivers, but any plant air system will operate more efficiently with adequately sized storage. Refer to the operating instructions for further information.
Display is illegible	Extra segments or "ghosting" of characters indicate damage probably from excessive high voltage. Replace the controller, and install protection to prevent further damage to electrical equipment.
Erratic pressures in SEQUENCE only	The sequencing system transmits low-level signal between units to communicate pressures. Units must be properly grounded to a good ground system, the communications cable should use only appropriate quality cable, and the cable should be run in its own conduit.
Compressor cycles rapidly in SEQUENCE mode only	In the sequence mode, the operating system requires all compressors be piped directly to receiver, such that all transducers sense the same pressure. Check valves or restrictions between compressors and the storage will cause system instability. Run units in AUTOMATIC mode until the system is corrected.
Pressure display error	Accuracy of the pressure display and controls requires that the controller and transducers be calibrated together. This MUST be done with no pressure at the transducer, or errors will occur. This is easiest to check with all pressure removed. All pressure displays should indicate 0 psi (0 bar) ± 1 psi. If the display indicates greater pressures, recalibrate the system as instructed in the configuration adjustments. Note: reservoir pressure may drop below zero psig when the compressor is stopped, but will return slowly to zero as the vacuum is relieved.

GENERAL PROVISIONS AND LIMITATIONS

Gardner Denver Machinery Inc. (the "Company") warrants to each original retail purchaser ("Purchaser") of its new products from the Company or its authorized distributor that such products are, at the time of delivery to the Purchaser, made with good material and workmanship. No warranty is made with respect to:

1. Any product which has been repaired or altered in such a way, in the Company's judgment, as to affect the product adversely.
2. Any product which has, in the Company's judgment been subject to negligence, accident, improper storage, or improper installation or application.
3. Any product which has not been operated or maintained in accordance with the recommendations of the Company.
4. Components or accessories manufactured, warranted and serviced by others.
5. Any reconditioned or prior owned product.

Claims for items described in (4) above should be submitted directly to the manufacturer.

WARRANTY PERIOD

The Company's obligation under this warranty is limited to repairing or, at its option, replacing, during normal business hours at an authorized service facility of the Company, any part which in its judgment proved not to be as warranted within the applicable Warranty Period as follows.

COMPRESSOR AIR ENDS

Compressor air ends, consisting of all parts within and including the compressor cylinder and gear housing, are warranted for 24 months from date of initial use or 27 months from date of shipment to the first purchaser, whichever occurs first.

Any disassembly or partial disassembly of the air end, or failure to return the "unopened" air end per Company instructions, will be cause for denial of warranty.

OTHER COMPONENTS

All other components are warranted for 12 months from date of initial use or 15 months from date of shipment to first purchaser, whichever occurs first.

LABOR TRANSPORTATION AND INSPECTION

The Company will provide labor, by Company representative or authorized service personnel, for repair or

replacement of any product or part thereof which in the Company's judgment is proved not to be as warranted. Labor shall be limited to the amount specified in the Company's labor rate schedule.

Labor costs in excess of the Company rate schedule amounts or labor provided by unauthorized service personnel is not provided for by this warranty.

All costs of transportation of product, labor or parts claimed not to be as warranted and, of repaired or replacement parts to or from such service facilities shall be borne by the Purchaser. The Company may require the return of any part claimed not to be as warranted to one of its facilities as designated by Company, transportation prepaid by Purchaser, to establish a claim under this warranty.

Replacement parts provided under the terms of the warranty are warranted for the remainder of the Warranty Period of the product upon which installed to the same extent as if such parts were original components.

DISCLAIMER

THE FOREGOING WARRANTY IS EXCLUSIVE AND IT IS EXPRESSLY AGREED THAT, EXCEPT AS TO TITLE, THE COMPANY MAKES NO OTHER WARRANTIES, EXPRESSED, IMPLIED OR STATUTORY, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY.

THE REMEDY PROVIDED UNDER THIS WARRANTY SHALL BE THE SOLE, EXCLUSIVE AND ONLY REMEDY AVAILABLE TO PURCHASER AND IN NO CASE SHALL THE COMPANY BE SUBJECT TO ANY OTHER OBLIGATIONS OR LIABILITIES. UNDER NO CIRCUMSTANCES SHALL THE COMPANY BE LIABLE FOR SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES, EXPENSES, LOSSES OR DELAYS HOWSOEVER CAUSED.

No statement, representation, agreement, or understanding, oral or written, made by any agent, distributor, representative, or employee of the Company which is not contained in this Warranty will be binding upon the Company unless made in writing and executed by an officer of the Company.

This warranty shall not be effective as to any claim which is not presented within 30 days after the date upon which the product is claimed not to have been as warranted. Any action for breach of this warranty must be commenced within one year after the date upon which the cause of action occurred.

Any adjustment made pursuant to this warranty shall not be construed as an admission by the Company that any product was not as warranted.

Gardner
Denver

For additional information contact your local representative or Gardner Denver Machinery Inc., Customer Service Department, 1800 Gardner Expressway, Quincy, Illinois 62301
Telephone: (800) 682-9868 FAX: (217) 224-7814



Sales and Service in all major cities.

For parts information, contact Gardner Denver, Master Distribution Center, Memphis, TN
Telephone: (800) 245-4946 FAX: (901) 542-6159

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