INGERSOLL-RAND®

XFE/EPE/HPE 50
XF/EP/HP 60
XF/EP/HP/XP 75-100
ML/MM/MH 37-75

OPERATORS/ INSTRUCTION MANUAL OPTIONS

Before installation or starting the compressor for the first time, this manual should be studied carefully to obtain a clear knowledge of the unit and of the duties to be performed while operating and maintaining the unit.

RETAIN THIS MANUAL WITH UNIT.
This Technical manual contains IMPORTANT SAFETY DATA and should be kept with the air compressor at all times.

More Than Air. Answers.

Online answers: http://www.air.ingersoll-rand.com

APDD 696B
November 1999

AIR COMPRESSOR GROUP
BONDED WARRANTY & REGISTERED START UP

Warranty

The Company warrants that the equipment manufactured by it and delivered hereunder will be free of defects in material and workmanship for a period of twelve months (see extended airend warranty) from the date of placing the Equipment in operation or eighteen months (see extended airend warranty) from the date of shipment from Davidson, NC, whichever shall first occur. The Purchaser shall be obligated to promptly report any failure to conform to this warranty, in writing to the Company in said period, whereupon the Company shall, at its option, correct such nonconformity, by suitable repair to such equipment or, furnish a replacement part F.O.B. point of shipment, provided the Purchaser has stored, installed maintained and operated such Equipment in accordance with good industry practices and has complied with specific recommendations of the Company. Accessories or equipment furnished by the Company, but manufactured by others, shall carry whatever warranty the manufacturers have conveyed to the Company and which can be passed on to the Purchaser. The Company shall not be liable for any repairs, replacements, or adjustments to the Equipment or any costs of labor performed by the Purchaser or others without Company's prior written approval.

The effects of corrosion, erosion and normal wear and tear are specifically excluded. Performance warranties are limited to those specifically stated within the Company's proposal. Unless responsibility for meeting such performance warranties are limited to specified tests, the Company's obligation shall be to correct in the manner and for the period of time provided above.

THE COMPANY MAKES NO OTHER WARRANTY OR REPRESENTATION OF ANY KIND WHATSOEVER, EXPRESSED OR IMPLIED, EXCEPT THAT OF TITLE, AND ALL IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, ARE HEREBY DISCLAIMED.

Correction by the Company of nonconformities whether patent or latent, in the manner and for the period of time provided above, shall constitute fulfillment of all liabilities of the Company for such nonconformities whether based on contract, warranty negligence, indemnity, strict liability or otherwise with respect to or arising out of such Equipment.

The purchaser shall not operate Equipment which is considered to be defective, without first notifying the Company in writing of its intention to do so. Any such Equipment will be at Purchaser's sole risk and liability.

Limitation or Liability

The remedies of the Purchaser set forth herein are exclusive, and the total liability of the Company with respect to this contract or the Equipment and services furnished hereunder, in connection with the performance or breach thereof, or from the manufacture, sale, delivery, installation, repair or technical direction covered by or furnished under this contract, whether passed on contract, warranty negligence, indemnity, strict liability or otherwise, shall not exceed the purchase price of the unit of Equipment upon which such liability is based.

The Company and its suppliers shall in no event be liable to the Purchaser, any successors in interest or any beneficiary or assignee of this contract for any consequential, incidental, indirect, special or punitive damages arising out of this contract or any breach thereof, or any defect in, or failure of, or malfunction of the Equipment hereunder, whether based upon loss of use, lost profits or revenue, interest, lost goodwill, work stoppage, impairment of other goods, loss by reason of shutdown or non-operation, increased expenses of operation, cost of purchase of replacement power or claims of Purchaser or customers of Purchaser for service interruption whether or not such loss or damage is based on contract, warranty, negligence, indemnity, strict liability or otherwise.

EXTENDED DRIVETRAIN WARRANTY

Intellisys Compressors
50-450 HP

The Ingersoll-Rand Company Rotary Screw Air Compressor that has been filled prior to its original shipment from Ingersoll-Rand Company with ULTRA COOLANT and which has been operated solely on ULTRA COOLANT thereafter shall have its DRIVETRAIN warranted for twenty four (24) months from the date of placing the COMPRESSOR in operation or thirty (30) months from the date of shipment, whichever occurs first.

Except for the above warranty period, the standard warranty provisions shall apply and the conditions outlined herein are understood to be a supplement to the standard Ingersoll-Rand Company warranty.

This EXTENDED DRIVETRAIN WARRANTY applies only to 50-450 HP Intellisys COMPRESSORS operating on ULTRA COOLANT after February 1, 1990.

ROTARY SCREW AIR COMPRESSOR

This unit was purchased from:

_____

_____

_____

Ingersoll-Rand Company reserves the right to make changes or add improvements without notice and without incurring any obligation to make such changes or add such improvements to products sold previously.

Number of units on order: _____

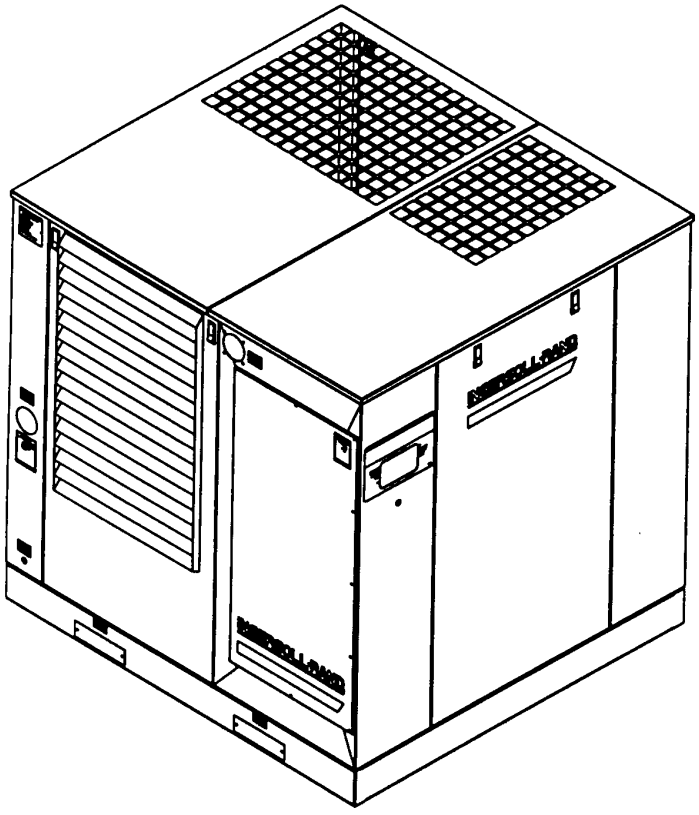
Customer Order Number: _____

Ingersoll-Rand Company Order Number: _____

For ready reference, record the serial number and model number of your unit here:

Serial Number: _____

Model Number:_____



TYPICAL UNIT

TABLE OF CONTENTS

GENERAL INFORMATION

Weight:	**See foundation plan, Section 7.0**
Cooling Air Flow:	**See foundation plan, Section 7.0**
Ambient Temperature Limit:	**35°F to 115°F (2°C to 46°C)**
Coolant:	**Factory Filled SSR Ultra Coolant**
Coolant Change:	**8000 hours or two years, whichever comes first**
Coolant Capacity:	**50-60 hp 5.0 gal. (18.9 liters)** **37-45 kw 5.0 gal. (18.9 liters)** **75-100 hp 9.0 gal. (34.2 liters)** **55-75 kw 9.0 gal. (34.2 liters)**
Discharge Temperature Limit:	**228°F (109°C)**
Power Inlet Wiring:	**Recommended conduit: metallic flexible Greenfield, or equivalent,**
Tools:	**U.S. Standard and metric are required to perform maintenance**

0.0 SAFETY AND WARNINGS

0.1 SAFETY INSTRUCTIONS

Before you install this air compressor you should take the time to carefully read all the instructions contained in this manual.

Electricity and compressed air have the potential to cause severe personal injury or property damage.

Before installing, wiring, starting, operating or making any adjustments, identify the components of the air compressor using this manual as a guide.

The operator should use common sense and good working practices while operating and maintaining this unit. Follow all codes, pipe adequately, understand the starting and stopping sequence. Check the safety devices by following the procedure contained in this manual.

Maintenance should be done by qualified personnel, adequately equipped with proper tools. Follow the maintenance schedules as outlined in the operators manual to ensure problem free operation after start up.

Safety instructions in the operators manual are bold-faced for emphasis. The signal words DANGER, WARNING and CAUTION are used to indicate hazard seriousness levels as follows:

⚠ 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.**

0.2 SAFETY PRECAUTIONS

SAFETY PRECAUTIONS

BEFORE PROCEEDING, READ CAREFULLY BEFORE INSTALLING THE COMPRESSOR OR PERFORMING ANY MAINTENANCE

WARNING

COMPRESSED AIR AND ELECTRICITY ARE DANGEROUS.

BEFORE DOING ANY WORK ON THIS UNIT, BE SURE THE ELECTRICAL SUPPLY HAS BEEN CUT OFF–LOCKED & TAGGED AND THE ENTIRE COMPRESSOR SYSTEM HAS BEEN VENTED OF ALL PRESSURE.

1. Do not remove the covers, loosen or remove any fittings, connections or devices when this unit is in operation. Hot liquid and air under pressure that are contained within this unit can cause severe injury or death.

2. The compressor has high and dangerous voltage in the motor starter and control box. All installations must be in accordance with recognized electrical codes. Before working on the electrical system, be sure to remove voltage from the system by use of a manual-disconnect-switch. A circuit breaker or fuse safety switch must be provided in the electrical supply line leading to the compressor.

Those responsible for installation of this equipment must provide suitable grounds, maintenance clearance and lightning arrestors for all electrical components as stipulated in O.S.H.A. 1910.308 through 1910.329.

3. Do not operate the compressor at higher discharge pressure than those specified on the Compressor Nameplate or motor overload will occur. This condition will result in compressor motor shutdown.

4. Use only safety solvent for cleaning the compressor and auxiliary equipment.

5. Install a manual shut off valve (isolation type) in the discharge line. When a safety valve is installed between the isolation valve and the compressor, it must have sufficient capacity to relieve the full capacity of the compressor(s).

6. Whenever pressure is released through the pressure relief valve, it is due to excessive pressure in the system. The cause for the excessive pressure should be investigated immediately.

7. Before doing any mechanical work on the compressor:

a.) Shut the unit down.

b.) Electrically isolate the compressor by use of the manual disconnect switch in the power line to the unit. Lock and tag the switch so that it cannot be operated.

c.) Vent pressure from the compressor and isolate the unit from any other source of air.

8. There can be adverse effects if compressor lubricants are allowed to enter plant air systems.

Air line separators, properly selected and installed, will minimize any liquid carry-over.

The use of plastic bowls on line filters without metal guards can be hazardous. From a safety standpoint, metal bowls should be used on any pressurized system. Review of your plant air line system is recommended.

9. When a receiver is installed, it is recommended that occupational safety and health standards as covered in the Federal Register, Volume 36, number 105, part 11, paragraph 1910.169 be adhered to in the installation and maintenance of this receiver.

10. Before starting the compressor, its maintenance instructions should be thoroughly read and understood.

11. After maintenance functions are completed, covers and guards must be replaced.

⚠ SAFETY SHUTDOWN

CHECK HIGH AIR TEMPERATURE

There is a high discharge air temperature shutdown function built into the Intellisys on each compressor. It is factory pre-set at 228°F (109°C). This function should be checked at regular intervals for proper operation, once a month is recommended. The procedure is:

1. Block off the cooling air discharge.
2. The compressor discharge temperature will rise at a rapid rate. Shutdown should occur when the discharge temperature reaches the pre-set maximum discharge air temperature setting of the Intellisys. The display should indicate “HIGH AIREND TEMP” and the alarm light will be illuminated.

The actual temperature at which shutdown occurs should be recorded for comparison to the Intellisys set point and with similar future test results.

⚠ WARNING

Failure to adhere to these recommendations can result in mechanical failure, property damage and serious injury or death.

All air and water inlet, and air and water discharge pipework to and from the inlet and discharge port connections must take into account vibration, pulsations, temperature, maximum pressure applied, corrosion and chemical resistance. In addition, it should be noted that lubricated compressors will discharge some oil into the air stream; therefore, compatibility between discharge piping, system accessories and software must be assured.

For the foregoing reasons, the use of plastic piping, soldered copper fittings and rubber hose as discharge piping is not recommended. In addition, flexible joints and/or flex lines can only be considered for such purposes if their specifications fit the operating parameters of the system.

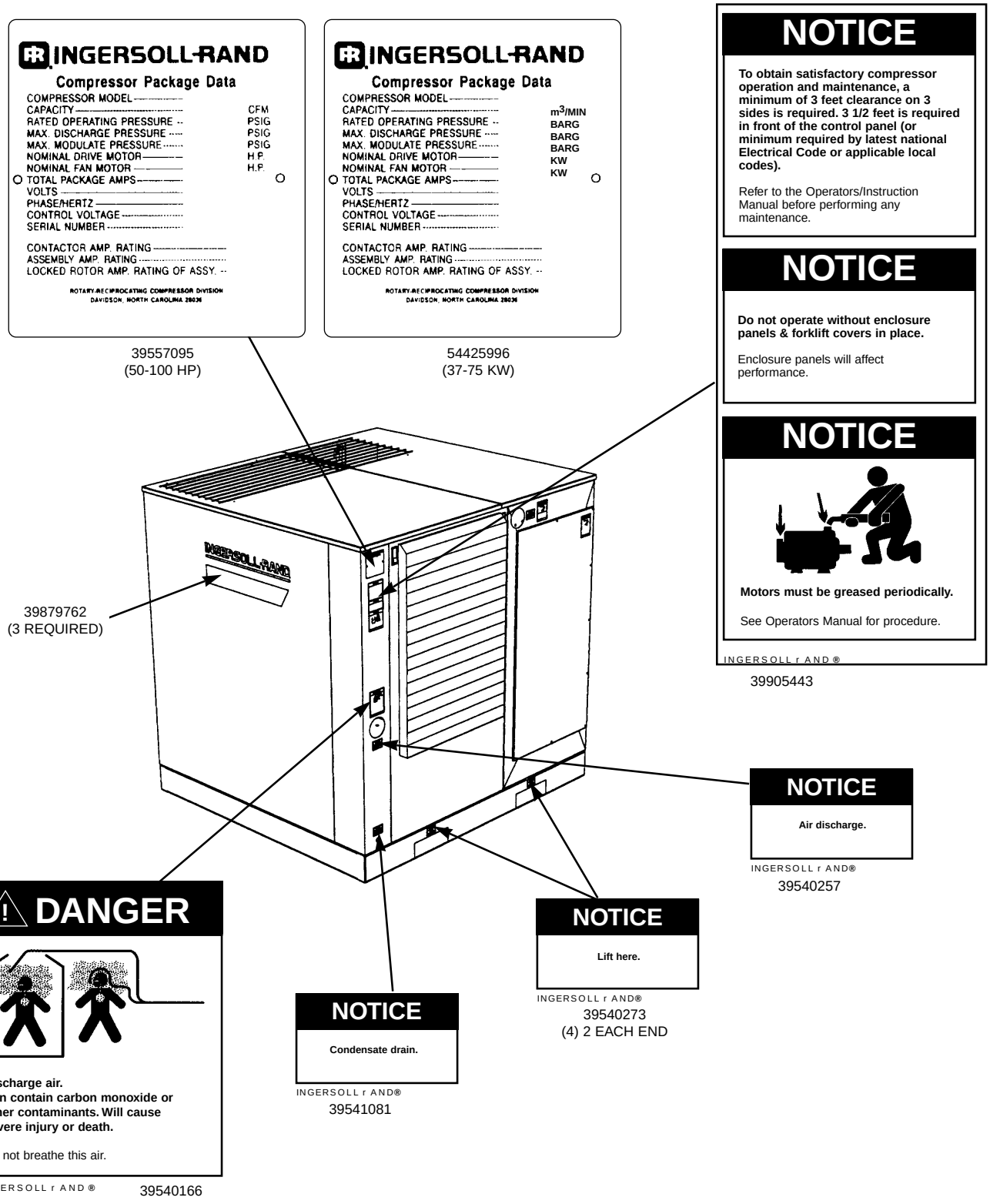
It is the responsibility of the installer and owner to provide the appropriate service pipework to and from the machine.

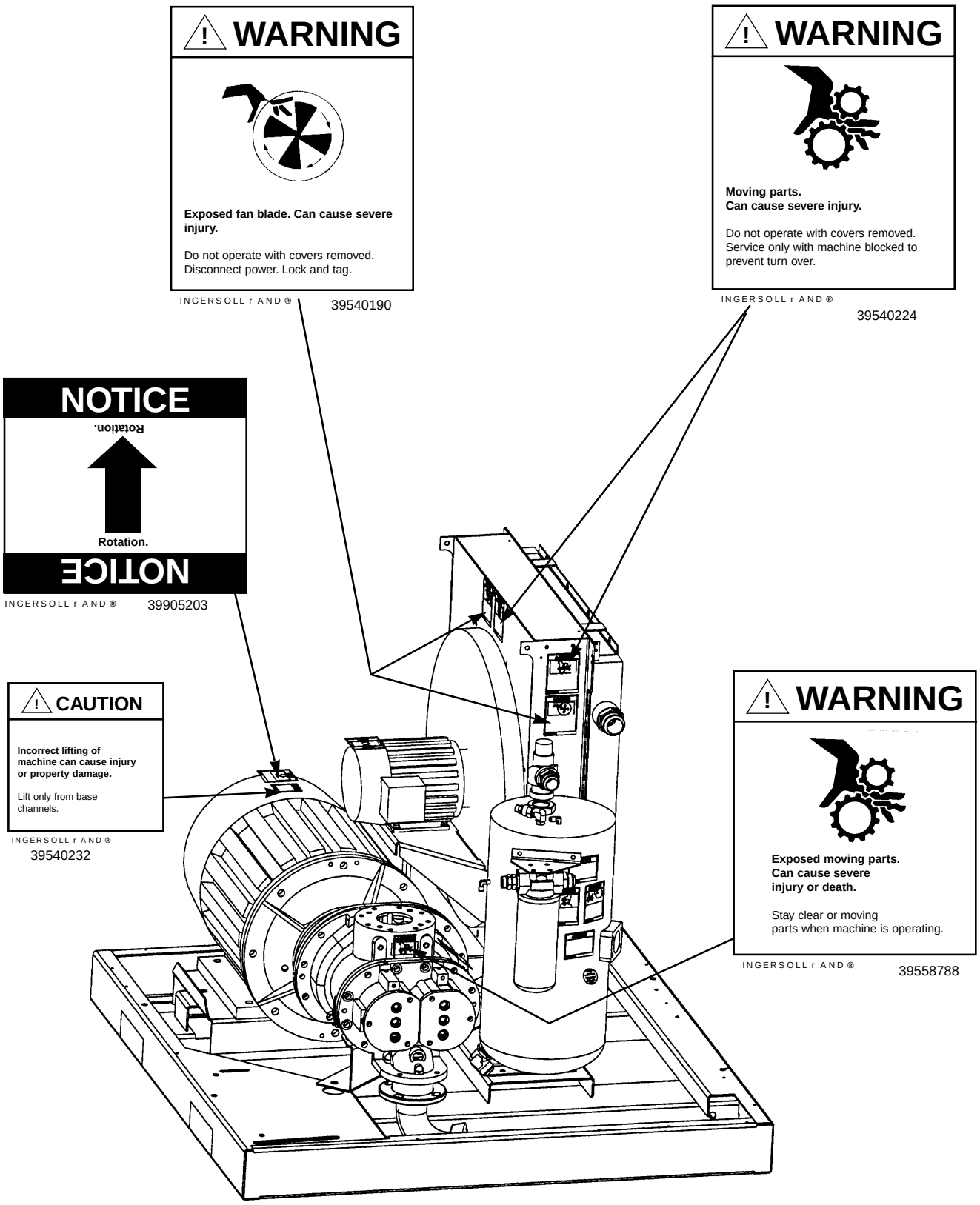
⚠ WARNING

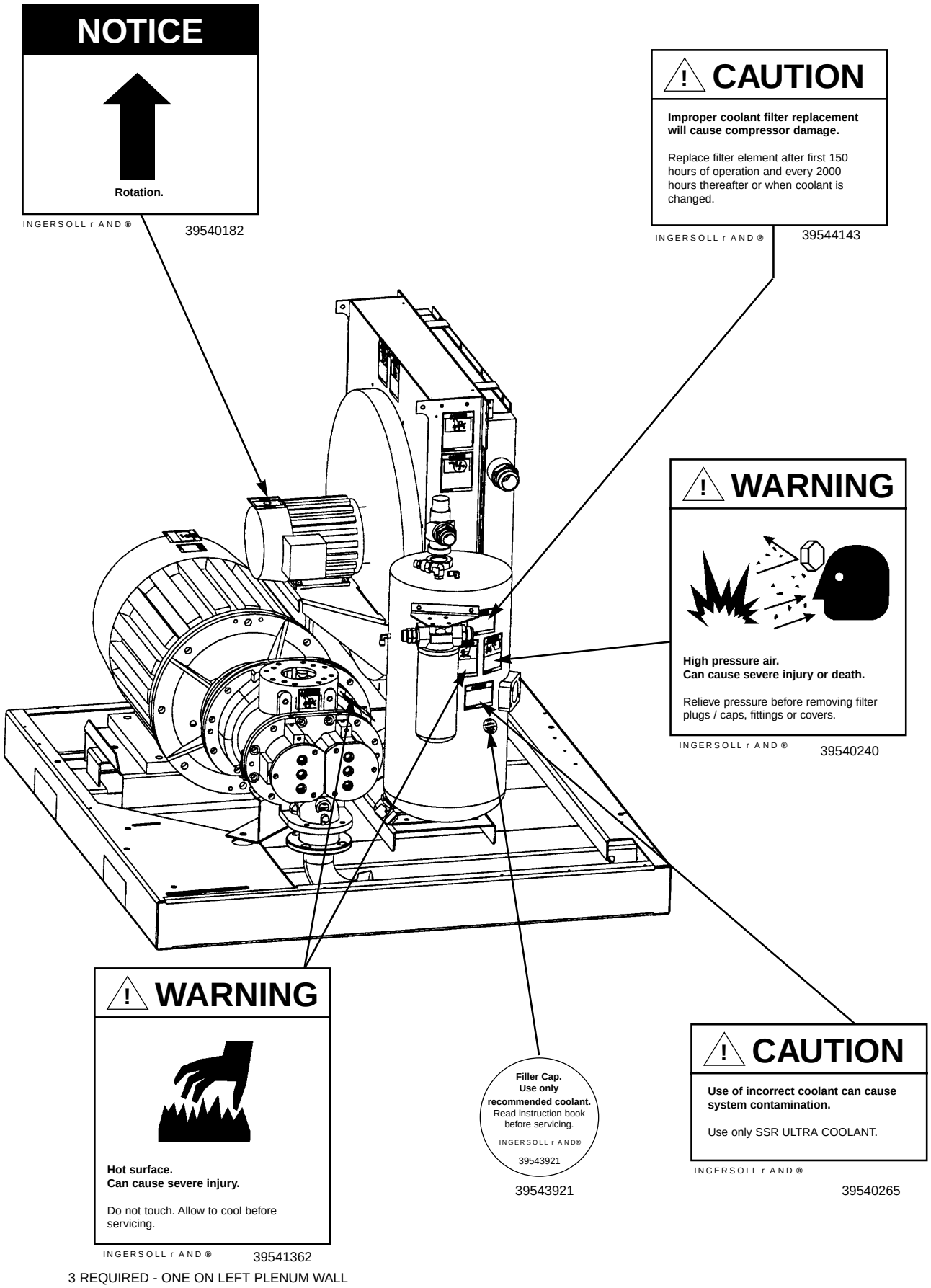
“Ingersoll-Rand air compressors are not designed, intended, or approved for breathing air applications. Ingersoll-Rand does not approve specialized equipment for breathing air application and assumes no responsibility or liability for compressors used for breathing air services.”

0.3 DECALS

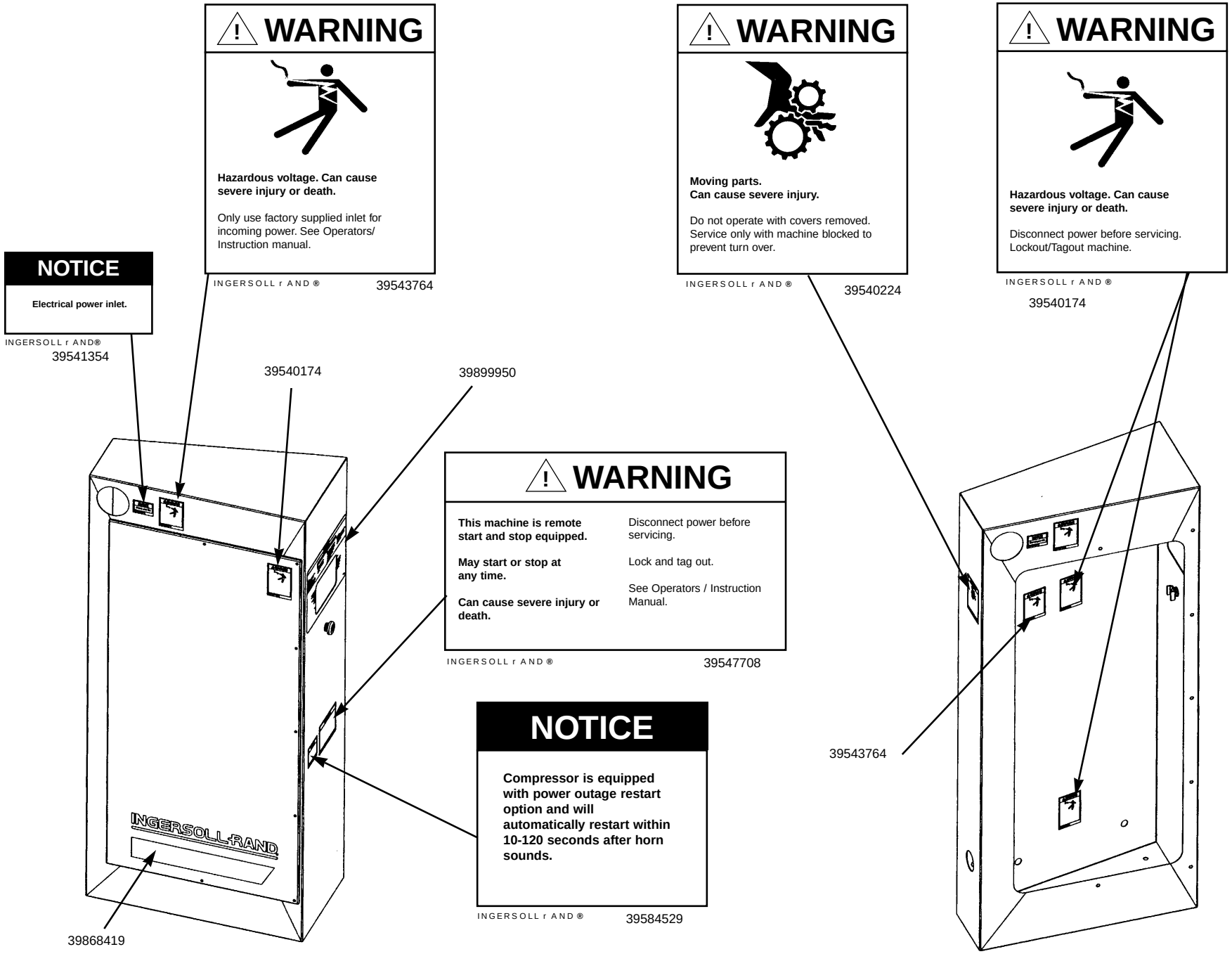
This section contains representative examples of decals which will be appearing throughout this manual and are applied to the compressor unit. If for some reason a decal is defaced, painted over, or parts are replaced, we recommend that you obtain a replacement kit as listed in the spare parts section of the Parts List Manual (Form APDD 751).




WARNING
Exposed fan blade. Can cause severe injury.
Do not operate with covers removed. Disconnect power. Lock and tag.
INGERSOLL r AND ®
39540190
WARNING
Moving parts.
Can cause severe injury.
Do not operate with covers removed. Service only with machine blocked to prevent turn over.
INGERSOLL r AND ®
39540224
NOTICE
Rotation.
Rotation.
NOTICE
INGERSOLL r AND ®
39905203
CAUTION
Incorrect lifting of machine can cause injury or property damage.
Lift only from base channels.
INGERSOLL r AND ®
39540232
WARNING
Exposed moving parts.
Can cause severe injury or death.
Stay clear or moving parts when machine is operating.
INGERSOLL r AND ®
39558788



3 REQUIRED - ONE ON LEFT PLENUM WALL


WARNING
Hazardous voltage. Can cause severe injury or death.
Only use factory supplied inlet for incoming power. See Operators/ Instruction manual.
INGERSOLL r AND ®
39543764
WARNING
Moving parts.
Can cause severe injury.
Do not operate with covers removed. Service only with machine blocked to prevent turn over.
INGERSOLL r AND ®
39540224
WARNING
Hazardous voltage. Can cause severe injury or death.
Disconnect power before servicing. Lockout/Tagout machine.
INGERSOLL r AND ®
39540174
NOTICE
Electrical power inlet.
INGERSOLL r AND®
39541354
39540174
39899950
WARNING
This machine is remote start and stop equipped.
May start or stop at any time.
Can cause severe injury or death.
Disconnect power before servicing.
Lock and tag out.
See Operators / Instruction Manual.
INGERSOLL r AND ®
39547708
NOTICE
Compressor is equipped with power outage restart option and will automatically restart within 10-120 seconds after horn sounds.
INGERSOLL r AND ®
39584529
39543764
39868419
INGERSOLL-RAND

1.0 RECEIPT OF EQUIPMENT

1.1 INSPECTION

When you receive the compressor please inspect it closely. Any indication of careless handling by the carrier should be noted on the delivery receipt especially if the compressor will not be immediately uncrated. Obtaining the delivery man's signed agreement to any noted damages will facilitate any future insurance claims.

IMPORTANT

READ THIS
LOST OR DAMAGED GOODS

THOROUGHLY INSPECT THIS SHIPMENT IMMEDIATELY UPON ARRIVAL

OUR RESPONSIBILITY FOR THIS SHIPMENT CEASED WHEN THE CARRIER SIGNED BILL OF LADING

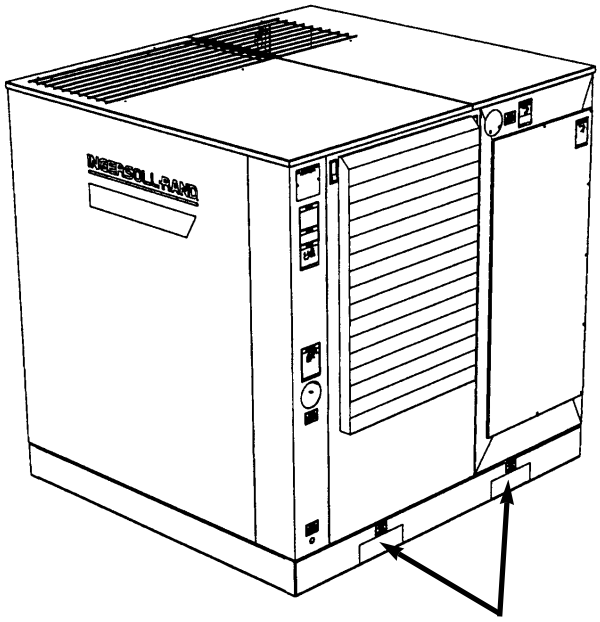
If goods are received short or in damaged condition, it is important that you notify the carrier and insist on a notation of the loss or damage across the face of the freight bill. Otherwise no claim can be enforced against the transportation company.

If concealed loss or damage is discovered, notify your carrier at once and request an inspection. This is absolutely necessary. Unless you do this the carrier will not entertain any claim for loss or damage. The agent will make an inspection and grant a concealed damage notation. If you give the transportation company a clear receipt for goods that have been damaged or lost in transit, you do so at your own risk and expense.

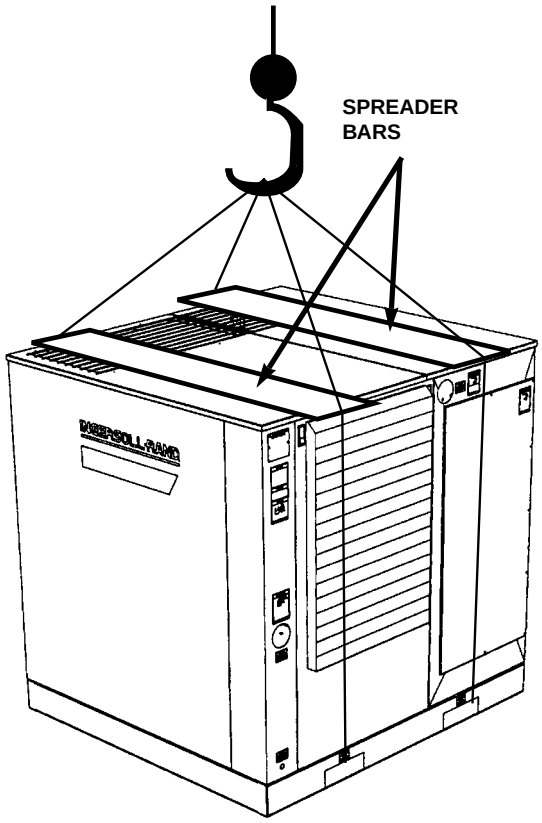
WE, AT I-R, ARE WILLING TO ASSIST YOU IN EVERY POSSIBLE MANNER TO COLLECT CLAIMS FOR LOSS OR DAMAGE, BUT THE WILLINGNESS ON OUR PART DOES NOT MAKE US RESPONSIBLE FOR COLLECTION OF CLAIMS OR REPLACEMENT OF MATERIAL. THE ACTUAL FILING AND PROCESSING OF THE CLAIM IS YOUR RESPONSIBILITY.

Ingersoll-Rand Company
Davidson, North Carolina

APDDGFO-99-79



FORKLIFT PADDING WILL REDUCE SCRATCHES AND MARS



1.2 UNPACKING AND HANDLING

The compressor package has been mounted on a base which provides for forklifting between the two side channels to facilitate handling during shipment. Care in positioning the forklifts is important because the location of the center of gravity is strongly affected by the location of the compression module and drive motor.

Slings can be used to lift the crates, but spreader bars must be used to prevent the slings from exerting a force against the sides of the crates.

1.3 TOOLS

Remove compressor unit from wooden skid. A crowbar and hammer will be needed.

2.0 INSTALLATION

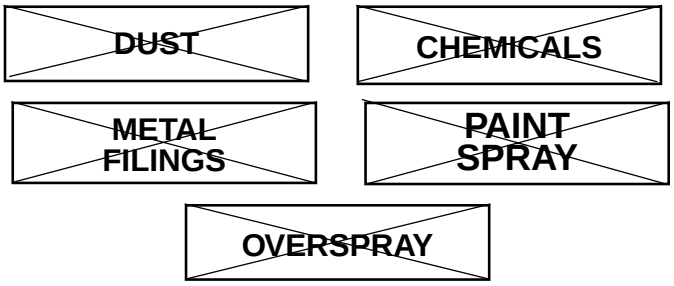
2.1 VENTILATION

Oil flooded rotary air compressors produce large amounts of heat. Because of this large heat production, the compressor must be placed in a room with adequate ventilation.

If heated air from the compressor exhaust is allowed to recirculate back to the compressor, the compressor will overheat and shut down. **This heat must be exhausted from the room.** You should take this into consideration when you decide where to place the compressor within your plant. Consider that the required maintenance clearance is 3 ft (.9 m) all around the compressor. However 42" (1.06m), or minimum required by latest NEC or applicable local codes, must be maintained in front of starter box door.

Ambient temperatures higher than 115°F (46°C) should be avoided as well as areas of high humidity.

Consider also the environment surrounding or near the compressor. The area selected for the location of the compressor should be free of dust, chemicals, metal filings, paint fumes and overspray.



2.2 FOUNDATION REQUIREMENTS

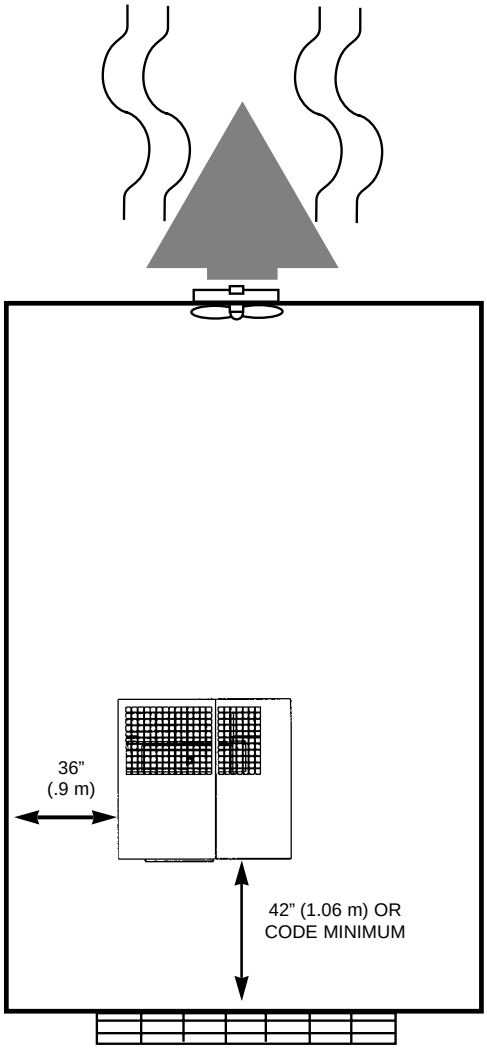
Refer to the foundation plan for the particular model compressor to be installed. See Section 7.0.

The compressor can be installed on any level floor that is capable of supporting it. Compressor weights are listed on the foundation plans.

When sound transmission is of particular importance it is often helpful to install a sheet of rubber-fabric-matting, or cork under the compressor to reduce the possibility of resonant sounds being transmitted or amplified through the floor.

⚠ NOTICE

Never elevate the compressor unit above the floor level. This may allow air to enter the cabinet under the base. Performance will be affected.



2.3 PIPING

The use of plastic bowls on line filters without metal guards can be hazardous. Their safety can be affected by either synthetic lubricants or the additives used in mineral oil. From a safety standpoint, metal bowls should be used on any pressurized system. Review of your plant air line system is recommended.

⚠ WARNING

Do not use plastic pipe, soldered copper fittings or rubber hose for discharge piping.

The built-in aftercooler reduces the discharge air temperature well below the dew point (for most ambient conditions), therefore, considerable water vapor is condensed. To remove this condensation, each compressor with built-in aftercooler is furnished with a combination condensate separator/trap.

2.3 PIPING (Continued)
A dripleg assembly and isolation valve should be mounted near the compressor discharge. A drain line should be connected to the condensate drain.

IMPORTANT: The drain line must slope downward from the compressor to work properly.

NOTE: For ease of inspection of the automatic drain trap operation, the drain piping should include an open funnel.

It is possible that additional condensation can occur if the downstream piping cools the air even further and low points in the piping systems should be provided with driplegs and traps.

IMPORTANT: Discharge piping should be at least as large as the discharge connection at the compressor enclosure. All piping and fittings must be suitable for the maximum operating temperature of the unit and, at a minimum, rated for the same pressure as the compressor sump tank.

⚠ NOTICE

Do not use the compressor to support the discharge pipe.

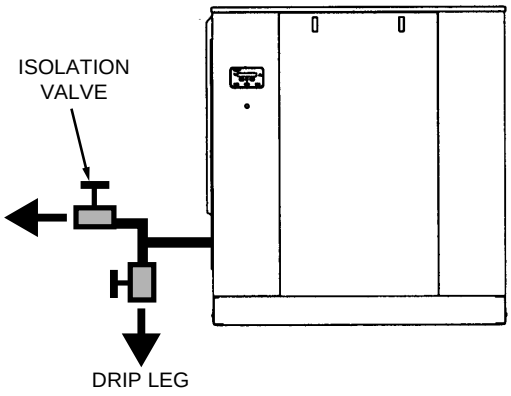
Careful review of piping size from the compressor connection point is essential. Length of pipe, size of pipe, number and type of fittings and valves must be considered for optimum efficiency of your compressor.

It is essential when installing a new compressor to review the total plant air system. This is to ensure a safe and effective total system.

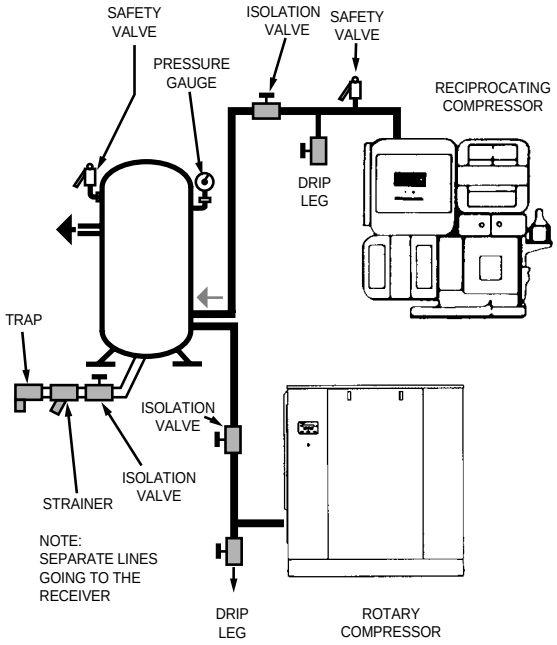
Liquid water occurs naturally in air lines as a result of compression. Moisture vapor in ambient air is concentrated when pressurized and condenses when cooled in downstream air piping.

Moisture in compressed air is responsible for costly problems in almost every application that relies on compressed air. Some common problems caused by moisture are rusting and scaling in pipelines, clogging of instruments, sticking of control valves, and freezing of outdoor compressed air lines. Any of these could result in partial or total plant shutdown.

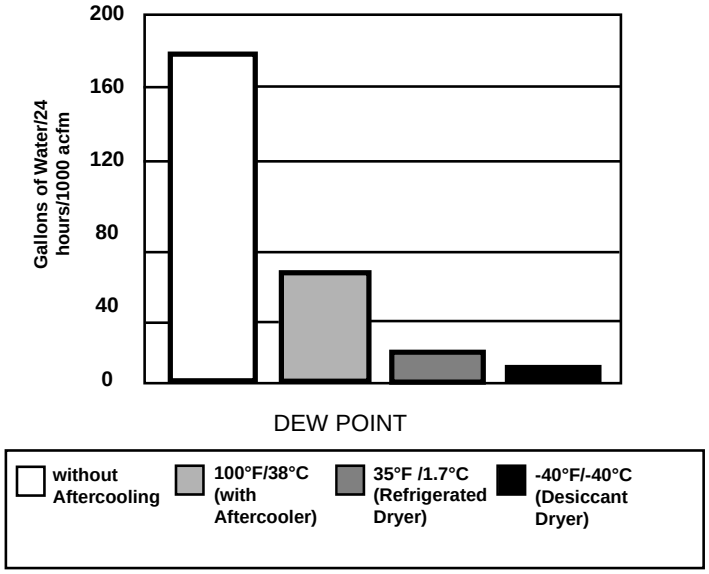
Compressed air dryers reduce the water vapor concentration and prevent liquid water formation in compressed air lines. Dryers are a necessary companion to filters, aftercoolers, and automatic drains for improving the productivity of compressed air systems.



DISCHARGE PIPING WITH AFTERCOOLER



ROTARY-RECIP IN PARALLEL



MOISTURE CONTENT OF COMPRESSED AIR

Two types of dryers, refrigerated or desiccant, are used to correct moisture related problems in a compressed air system. Refrigerated dryers are normally specified where compressed air pressure dew points of 33°F (1°C) to 39°F (4°C) are adequate. Desiccant dryers are required where pressure dew points must be below 33°F (1°C).

Contact your local Ingersoll-Rand distributor for assistance in selecting correct Ingersoll-Rand filtration or drying products.

NOTE: Screw type compressors should not be installed in air systems with reciprocating compressors without a means of pulsation isolation, such as a common receiver tank. We recommend both types of compressor units be piped to a common receiver utilizing individual air lines.

When two rotary units are operated in parallel, provide an isolation valve and drain trap for each compressor before the common receiver.

2.4 ELECTRICAL INSTALLATION

Before proceeding further, we recommend that you review the safety data in the front of this manual.

Locate the compressor data plate on the left rear corner of the unit.

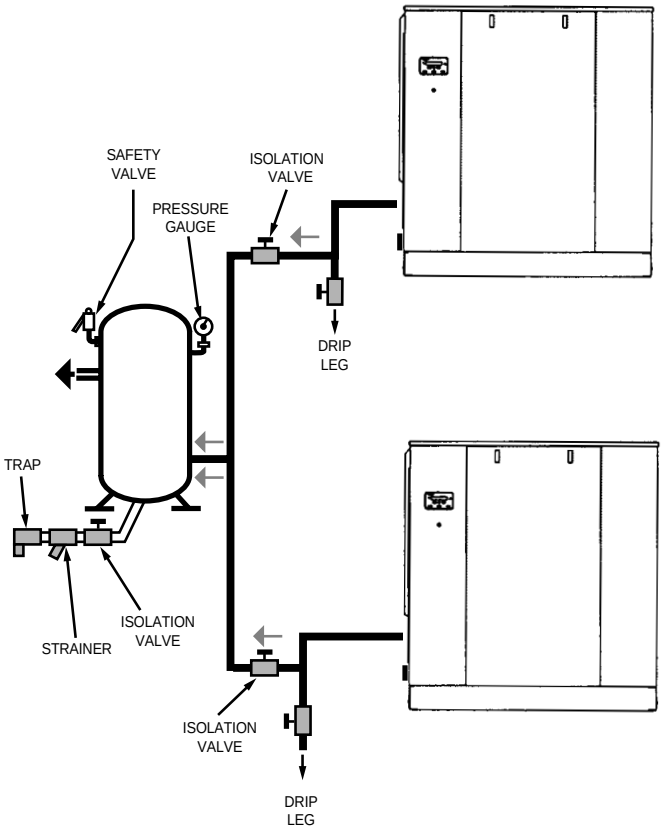
The data plate lists the rated operating pressure, the maximum discharge pressure and the electric motor characteristics and power.

Confirm that the line voltage and compressor nameplate voltage are the same and that the standard starter box meets the intent of NEMA 1 guidelines.

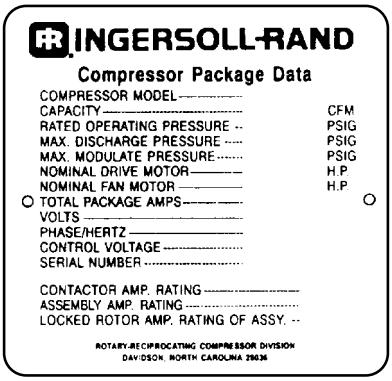
Open the starter box door. Confirm that all electrical connections are made and tightened. Confirm that the control transformer is wired correctly for supply voltage. See Figure 2.4-1 on next page for typical control transformer wiring.

FUSE TABLE

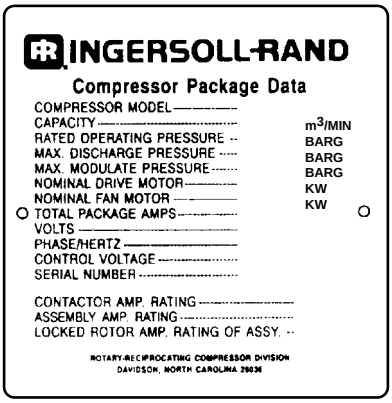
STARTER SIZE	CONTROL TRANSFORMER (T1) SIZE	1FU & 2FU PRIMARY FUSE (Amp)	4FU & 5FU SECONDARY FUSE (Amp)	3FU SECONDARY FUSE (Amp)
C85 FV	330VA	2.5 A	2.0 A	3.2 A
B110 FV	330VA	2.5 A	2.0 A	3.2 A
B180 FV	330VA	2.5 A	2.0 A	3.2 A
B250 FV	330VA	2.5 A	2.0 A	3.2 A
C43 S-D	230VA	1.8 A	2.0 A	2.0 A
C60 S-D	230VA	1.8 A	2.0 A	2.0 A
C72 S-D	230VA	1.8 A	2.0 A	2.0 A
C85 S-D	330VA	2.5 A	2.0 A	3.2 A
B110 S-D	330VA	2.5 A	2.0 A	3.2 A
B180 S-D	330VA	2.5 A	2.0 A	3.2 A



ROTARY TWO COMPRESSOR SYSTEM

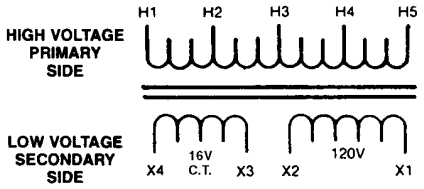


39557095
(50-100 HP)



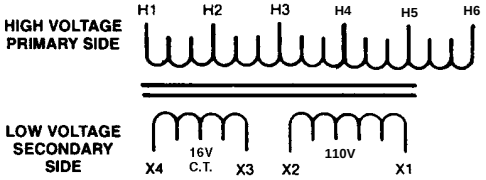
54425996
(37-75 KW)

LINE VOLTS	HZ	LINE	SEC VOLTS	LINE
200	60	H4-H5	120	X1-X2
			8	X3-X4
			8	X4-X5
220/230	60	H3-H5	120	X1-X2
			8	X3-X4
			8	X4-X5
380	60	H3-H5	120	X1-X2
			8	X3-X4
			8	X4-X5
440/460	60	H2-H5	120	X1-X2
			8	X3-X4
			8	X4-X5
575	60	H1-H5	120	X1-X2
			8	X3-X4
			8	X4-X5



***TYPICAL 60 HZ CONTROL TRANSFORMER**

LINE VOLTS	HZ	LINE	SEC VOLTS	LINE
220	50	H5-H6	110	X1-X2
			8	X3-X4
			8	X4-X5
380	50	H4-H6	110	X1-X2
			8	X3-X4
			8	X4-X5
415	50	H2-H6	110	X1-X2
			8	X3-X4
			8	X4-X5
550	50	H1-H6	110	X1-X2
			8	X3-X4
			8	X4-X5



***TYPICAL 50 HZ CONTROL TRANSFORMER**

****THESE DIAGRAMS ARE FOR REFERENCE ONLY. LOCATE THE WIRING DIAGRAM AFFIXED TO THE TOP OF THE CONTROL TRANSFORMER TO DETERMINE PROPER WIRE CONNECTIONS.***

FIGURE 2.4-1 TYPICAL CONTROL TRANSFORMER WIRING

ELECTRICAL INSTALLATION (Continued)
Inspect the motor and control wiring for tightness.

Close and fasten the starter box door.

Rotation Check
Locate the rotation decal on each motor.

Drive Motor
The correct compressor drive motor rotation is clockwise when viewed from the rear or non-drive end of the motor. See Figure 2.4-2.

⚠ CAUTION

If the compressor is operated in the opposite direction of rotation, airend damage can result and is not warrantable.

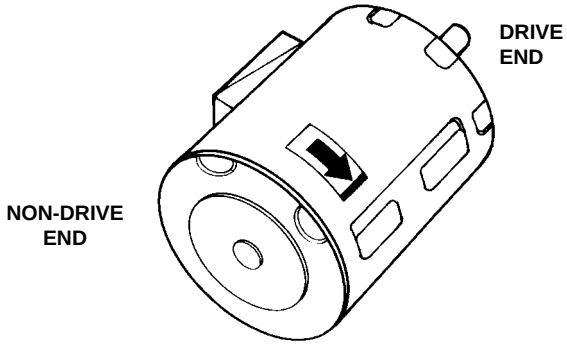


FIGURE 2.4-2 DRIVE MOTOR ROTATION

ELECTRICAL INSTALLATION (Continued)

The Intellisys will automatically shut the unit down if the compressor rotation is incorrect, and “CK MTR ROTATION” will appear in the display, also the alarm light will be on. See Section 6.

For the compressor motor rotation check, the motor jogging time must be as short as possible.

After depressing the start button, IMMEDIATELY depress the “EMERGENCY STOP” button. Should the motor rotation be incorrect, put main disconnect in the OFF position, lock and tag. See Figure 2.4-3.

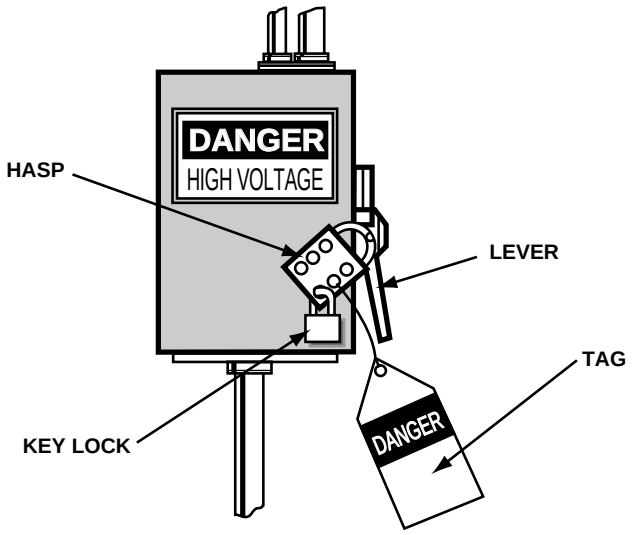


FIGURE 2.4-3 MAIN DISCONNECT LOCKED AND TAGGED

Open the starter box door.

Interchange any two line connections (L1, L2 or L3) at the starter. Close and fasten the starter box door. Recheck for correct rotation.

Fan Motor
Observe the compressor cooling fan. The rotation should be in accordance with the fan rotation decal affixed to the fan motor. Cooling air should exhaust through fan end of compressor enclosure.

Should the motor rotation not be correct, put the main disconnect in the OFF position, lock and tag.

Interchange any two fan motor leads at the fan motor overload relay (FMS/OL). Close and fasten the starter box door. Recheck for correct rotation.

Fan motor rotation is clockwise when viewed from the fan motor side.

Intellisys Operating Instructions
Read and understand the following Intellisys Operating Instructions (See Figure 2.4-4) prior to operating the unit.

NOTE: These instructions are also contained on the decal near the Intellisys panel of the unit.

NOTICE

Intellisys Operating Instructions

Before installing, operating, or performing any maintenance on this unit, read and understand the instructions in the Operators / Instruction Manual

Before Starting
1. Check coolant level. Add coolant if necessary.
2. Verify that main isolation valve is open.
3. If water-cooled, turn on water.
4. Close main disconnect switch. The “POWER” light indicates that line and control voltages are available for starting. “UNLOAD” indicator light will be on.

Starting
1. Push “START”. Compressor will load automatically and the air pressure will rise if there is sufficient demand for air.

Stopping
1. Push “UNLOADED STOP”. Compressor will immediately unload and continue to run unloaded approximately 7 seconds. Compressor will then stop. If compressor is running unloaded when “UNLOADED STOP” is pushed, compressor will stop immediately.
2. Open main disconnect switch.

Stopping - Emergency
1. If there is a need to stop the compressor immediately or if the “UNLOADED STOP” does not stop the compressor after 7 seconds, push “EMERGENCY STOP”
2. Open main disconnect switch.

FIGURE 2.4-4 INTELLISYS OPERATING INSTRUCTIONS

2.5 OUTDOOR SHELTERED INSTALLATION

Many times a compressor must be installed outside due to jobsite conditions or limited space within a manufacturing facility. When this occurs there are certain items that should be incorporated into the installation to help ensure trouble free operation. These items have been listed below plus Figure 2.5-1 has been included to show a typical outdoor sheltered installation. The unit must be purchased with the Outdoor Modification Option to provide NEMA 4 electrics, TEFC motor, and a cabinet exhaust on the side of the unit rather than the top to prevent recirculation of cooling air.

- The compressor should be on a concrete pad designed to drain water away. If the concrete pad is sloped, then the compressor must be leveled. In order to properly pull cooling air through the enclosure, the base/skid must be sealed to the concrete pad.

- The roof of the shelter should extend a minimum of 4 ft (1.2 m) around all sides of the compressor to prevent direct rain and snow from falling on the unit.

- Air-cooled machines must be arranged under the shelter in a way that prevents air recirculation (i.e. hot exhaust back to the package inlet).

- If the installation includes more than one compressor, the hot air exhaust should not be directed towards the fresh air intake of the second unit or an Air Dryer.

- If a standard machine is to be installed outside, the ambient temperature must never drop below 35°F (1.7°C).

- If ambient temperature drops below 35°F (1.7°C) to as low as –10°F (–23°C) the unit must be supplied with the Low Ambient Option. Installations below –10°F (–23°C) ambient are not recommended. The Low Ambient Option requires a separate power source to operate internal heaters.

- Arrange the machine with the Intellisys controller/starter enclosure facing away from the sun as radiant heat can affect starter/Intellisys performance. Also direct sunlight and UV rays will degrade the membrane touch panel. This is not a warrantable situation.

- Power disconnect switch should be within line of sight and in close proximity to the unit. N.E.C. and local electrical codes must be followed when installing the power disconnect switch.

- Condensate drains must never be allowed to drain on the ground. Run to a suitable sump for future collection and disposal or separation of lubricant and water mixture.

- Incoming power connections must use suitable connectors for outdoor weather tight service.

- A minimum of 3 ft (.9 m) clearance must be allowed on all four sides of the unit for service access. However 42” (1.06m), or minimum required by latest NEC or applicable local code, must be maintained in front of starter box door.

- If possible, access by a forklift and/or an overhead beam hoist should be kept in mind (for eventual service to airend or motor).

- If the area around the installation contains fine airborne dust or lint and fibers etc., then the unit should be purchased with the High Dust Filter Option.

- Some type of protection such as a fence or security system, should be provided to prevent unauthorized access.

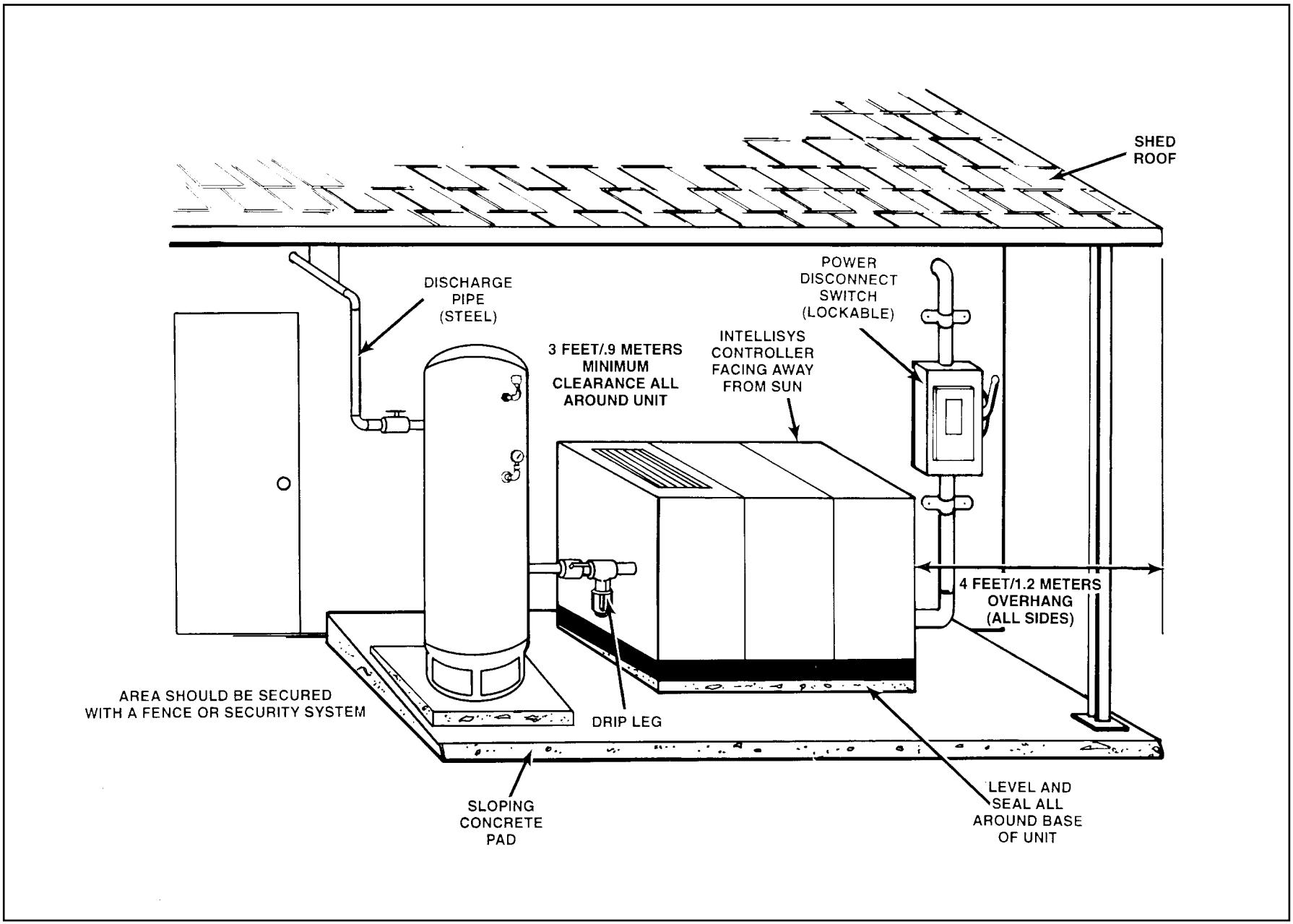
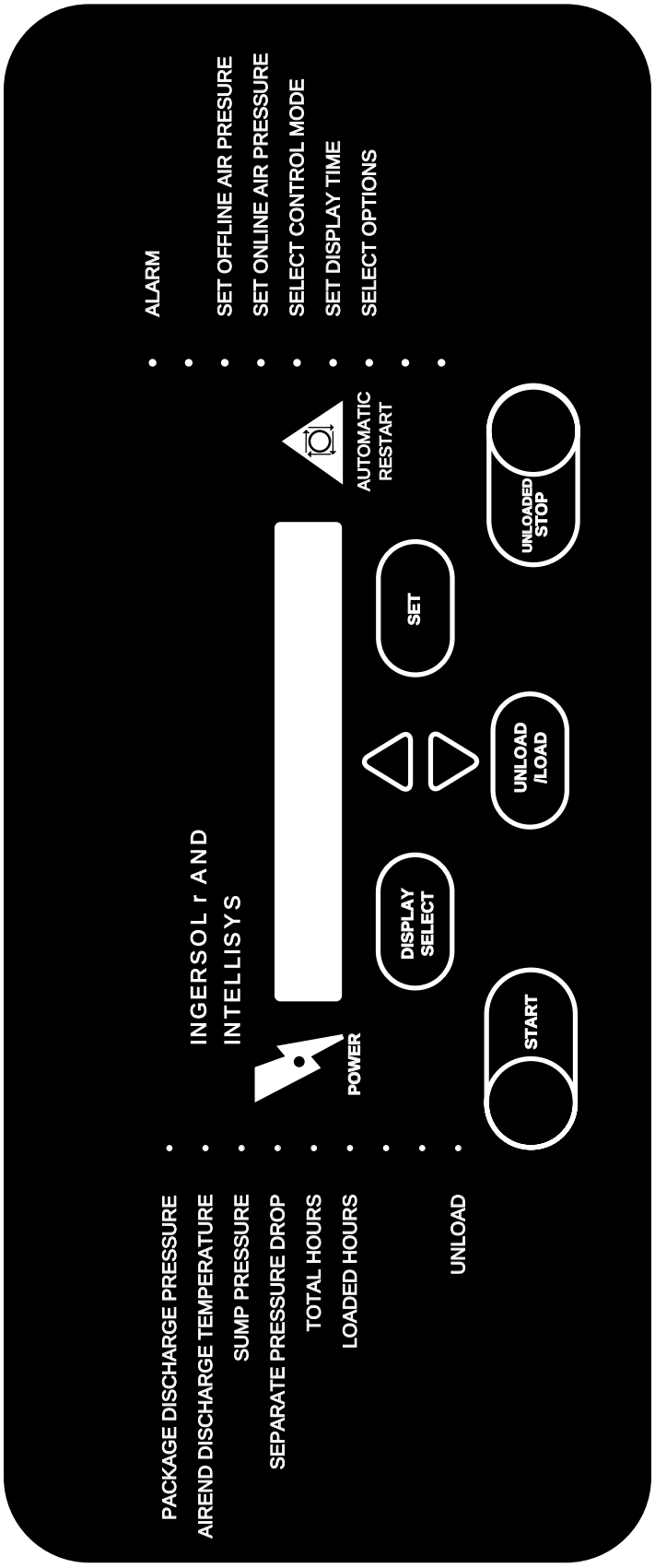


FIGURE 2.5-1 TYPICAL OUTDOOR SHELTERED INSTALLATION

3.0 INTELLISYS

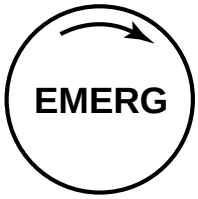


INTELLISYS CONTROLLER

3.0 INTELLISYS

3.1 EMERGENCY STOP SWITCH

Pressing this switch stops the compressor immediately. Compressor cannot be restarted until switch is manually reset. Turn clockwise to reset.



3.2 POWER ON LIGHT (Inside Starter Box)

Indicates control voltage is available to the control circuit and line voltage is available for starting.

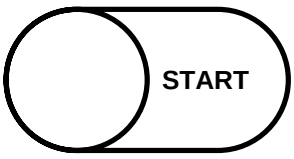
3.3 POWER INDICATOR LIGHT

Indicates voltage is available to the intellisys controller.

3.4 PUSH BUTTONS

START

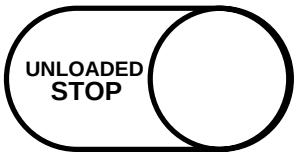
If the display shows READY TO START, pressing this button will start the compressor. The compressor will start and load automatically if there is a demand for air.



If in the display table press this button to exit the display table. Display will show “CHECKING MACHINE” then “READY TO START”.

UNLOAD STOP

Pressing this button will activate the unload stop. If the compressor is running loaded, it will unload. Seven seconds later it will stop. if the compressor is running unloaded, it will stop immediately. Pressing this button with the unit stopped will flash all L.E.D.’s for a light check and flash the software version number in the display.



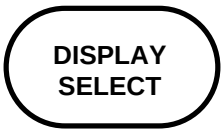
UNLOAD/LOAD

If the unit is running loaded, pressing this button will cause the unit to unload, the unload indicator light will be on. The unit will not load until the button is pressed again. If the unit is running unloaded, pressing this button will load the unit in the ON/OFF LINE or MOD/ACS control mode previously operating.

3.4 PUSH BUTTONS (Continued)

DISPLAY SELECT

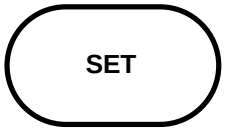
Pressing this button will change the information selected for the display. The display table will be incremented. If the button is held, this display table will scroll. This button can also be used to exit the set point procedure.



NOTE: For readings less than 1 hr., hourmeter displays minutes. After 1 hr. the hourmeter displays hours.

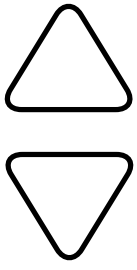
SET

The SET button is used to enter the set point procedure. The set button is also used to reset warnings and alarms. Pressing this button once will reset a warning, twice will clear an alarm.



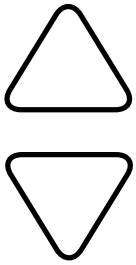
ARROWS

These buttons have several functions. If the Intellisys is in the set point mode, the ARROWS are used to change the set point values. If the unit has multiple alarms or warnings, the ARROWS are used to scroll through these conditions. The ARROWS have a function in the calibration routine, which will be described later.



PRESSURE SENSOR CALIBRATION (ZEROING) ROUTINE

This routine is entered if the unit is not running and both the up and down arrows button are pressed at the same time. Make sure all pressure is relieved from the compressor before calibration. The display will flash the message “CALIBRATING”. After calibration is completed the display will indicate “READY TO START”. Zeroing should only be done after a pressure sensor has been replaced or any controller change.



3.5 SET POINT PROCEDURE

This procedure allows the customer to modify 14 variables in the controller logic.

At this time, press the SET button to enter the setpoint routine. The SET OFFLINE AIR PRESSURE indicator will light and the display will show:

XXXX PSI

OFFLINE AIR PRESSURE is the first set point and XXXX stands for the value of the set point. Press the SET button to select the set point to be adjusted. Press the up or down arrow buttons to raise or lower the set point value. Press the SET button to move to the next set point. If the set point value has been adjusted, press the SET button to enter the new value. The display will flash to acknowledge.The next set point will then be displayed. If the value of the set point was not changed, pressing the SET button will only step to the next set point. When the SELECT OPTIONS set point is entered, the SELECT OPTIONS indicator will light, and the setpoints for options Auto Start/Stop or Remote Start/Stop will only be accessible and displayed if the option module is installed in the unit. The Power Outage Restart setpoints will only be accessible and displayed if the combination Auto/Remote Start/Stop/Power Outage Restart option module is installed in the unit. The set point routine can be exited by pressing the DISPLAY/SELECT button or exit will be automatic after 30 sec.

The following is a list of the set points. Also included are maximum and minimum limits, step size, and units of measure.

	MIN	MAX	STEP	UNIT
OFFLINE PRESSURE	75	RATED + 3	1	PSI
ONLINE PRESSURE	65	OFFLINE - 10	1	PSI
CONTROL MODE	MOD/ACS - MODULATION - ON/OFF LINE			
DISPLAY TIME	10	600	10	SEC
AUTO RESTART	OFF	ON	---	---
AUTO RESTART TIME	2	60	1	MIN
SEQUENCER	OFF	ON	---	---
REMOTE START/STOP *	OFF	ON	---	---
POWER OUT/RESTART*	OFF	ON	---	---
POWER OUT RESTART TIME *	10	120	1	SEC
DELAY LOAD TIME	0	60	1	SEC
LEAD/LAG**	---	---	---	---
LAG OFFSET	0	45	1	PSI
LOW AMBIENT	OFF	ON	---	---

*Optional

** The lead/lag feature allows the customer to choose one compressor as the “lead” compressor and any others as the “lag” compressor (simulates the mode of a sequencer). The lag compressor’s on-line and off-line pressures are determined by subtracting the lag offset set-point from the on-line and off-line pressure set-points of the lead compressor.

3.6 WARNINGS

When a warning occurs, the alarm indicator will flash and the display will alternate between the current message and the warning message. If multiple warnings exist, the message

SCROLL FOR WARN

will be substituted for the warning messages. The up and down arrows can be used to obtain the warnings

A warning needs to be reset by an operator. The warning will clear when the SET button is pressed once. The following is a list of the warning messages.

1) CHG SEPR ELEMENT
This warning will occur if the pressure on the Separator is 12 psig (.8 bar) greater than the pressure at the Package discharge and the unit is fully loaded.

2) HIGH AIREND TEMP
This will occur if the Airend Discharge Temperature (2ATT) exceeds 221°F (105°C).

3) HIGH AIR PRESS
This will occur if the unit is connected to an ISC (sequencer), and the line pressure exceeds the max. offline pressure for 3 seconds.

4) T2 SENSOR FAILURE
This will occur when the Low Ambient Option is turned on and either the low ambient sensor is not installed or is broken.

3.7 ALARMS

When an alarm occurs, the alarm indicator will light and display will show actual alarm message. If alternately multiple alarms have occurred the display will show SCROLL FOR ALARM. In this situation the up and down arrows will be used to view the alarm messages. All alarms (with the exception of the emergency stop) will be reset by twice pressing the SET button. Any exceptions to the above will be explained in the alarm description.

The following is a list of the alarm messages.

1) LOW SUMP PRESS
This will occur if the unit is running and sump pressure is too low.

2) HIGH AIR PRESS
This will occur if the unit is running and sump pressure is greater than unit rated operating pressure plus 20 psig (1.4 bar), plus the separator pressure drop, or the line pressure is 15 psig (1.0 bar) above the rated pressure.

3) HIGH AIREND TEMP
This will occur if airend discharge temperature is greater than 228°F (109°C).

4) STARTER FAULT 1SL (2SL)
This alarm will occur if the starter contacts open while the unit is running. This alarm will also occur if the unit is given the stop command and the starter contacts do not open. 1SL refers to the auxiliary circuit on starter contactor 1M. 2SL refers to the auxiliary circuit on starter contacts 2M and 1S.

5) MAIN MTR OVERLD
This will occur if a motor overload is sensed.

6) FAN MTR OVERLOAD
This will occur if a fan motor overload is sensed.

7) TEMP SENSOR FAIL
This will occur when the sensor temperature is recognized as missing or broken.

8) REMT STOP FAIL
This will occur if the momentary remote stop switch does not disengage by the time the unit attempts to start.

9) REMT START FAIL
This will occur if the momentary remote start switch does not disengage by the time star-delta transition occurs.

10) CK MTR ROTATION
This alarm will occur if a unit is started and compressor has incorrect rotation.

11) CALIBRATION FAIL
This alarm will occur if the sensor calibration routine is executed and the sensor reading exceeds 10% of scale.

12) NO CONTROL POWER
This alarm will occur when the controller senses a loss of control power.

13) PRES SENSOR FAIL
Whenever the pressure sensor is recognized as missing or broken, a pressure sensor failure alarm will occur.

14) LOW UNLOAD SUMP
This alarm will occur if the unit is running unloaded and sump pressure is less than 15 psig (1.0 bar).

INITIAL CHECK ALARMS

15) HIGH AIREND TEMP

This will occur if airend discharge temperature is greater than 217°F (103°C).

This alarm will only occur when the machine is not running. When it occurs, the message MUST COOL DOWN is added to the alternating group of alarm messages.

EMERGENCY STOP

This will occur when the EMERGENCY STOP button is engaged. The alarm indicator will light and display will show:

EMERGENCY STOP

Disengage the EMERGENCY STOP button and press the SET button twice to reset this alarm.

4.0 SYSTEMS

4.1 GENERAL SYSTEM INFORMATION

The SSR compressor is an electric motor driven, single stage, screw compressor—complete with accessories piped, wired and baseplate mounted. It is a totally self-contained air compressor package.

A standard compressor is composed of the following:

Inlet air filtration
Compressor and motor assembly
Pressurized coolant system with cooler
Separation system
Capacity control system
Motor starting control system
Instrumentation
Safety provisions
Aftercooler
Moisture separator and drain trap

Optional accessories can provide for such things as remote starting or stopping and sequencer.

4.2 AIR COOLED COMPRESSORS

Design Temperatures

The standard compressor is designed for operation in an ambient range of 35°F. to 115°F. (1.7°C. to 46°C.). When conditions other than design levels described are encountered, we recommend you contact your nearest Ingersoll-Rand representative for additional information.

The standard maximum temperature (115°F.) is applicable up to an elevation of 3300 ft. (1000 meters) above sea level. Above this altitude, significant reductions in ambient temperature are required if a standard drive motor is to be used.

Coolant Cooler

The cooler is an integral assembly of core, fan and fan-motor, mounted in the compressor. The cooling air flows in through the left side of the enclosure, through the vertically mounted cooler core, and discharges upward through the top of the enclosure.

Cooling Fan Motor

In a standard compressor, the cooling fan motors are wired at the factory. They are three-phase-motors. Each is protected by a fan motor starter/overload. The fan motor is energized at the same time the compressor drive motor is energized. The fan motor starter/overload is wired in series with the compressor drive motor overload. If an overload occurs in the fan motor circuit, both the fan motor and compressor drive motor will stop.

Aftercooler

The discharge air aftercooling system consists of a heat exchanger (located at the cooling air discharge of the machine), a condensate separator, and an automatic drain trap.

By cooling the discharge air, much of the water vapor naturally contained in the air is condensed and eliminated from the downstream plant-piping and equipment.

4.3 COOLANT SYSTEM

Coolant is forced by pressure from the receiver-separator sump to the inlet port of the coolant cooler and the bypass port of the thermostatic control valve.

The thermostatic control valve controls the quantity of coolant necessary to provide a suitable compressor injection temperature. When the compressor starts cold, part of the coolant will bypass the cooler. As the system temperature rises above the valve setting, the coolant will be directed to the cooler. During periods of operation in higher ambient temperatures, all the coolant flow will be directed through the cooler.

The compressor injection minimum temperature is controlled to preclude the possibility of water vapor condensing in the receiver. By injecting coolant at a sufficiently high temperature, temperature of the discharge air and lubricant mixture will be kept above the dew point.

The controlled temperature coolant passes through a filter to the airend under constant pressure.

4.4 COMPRESSED AIR SYSTEM

The air system is composed of:

1. Inlet air filter
2. Inlet valve
3. Rotors
4. Coolant/air separator
5. Minimum pressure/check valve
6. Aftercooler
7. Moisture separator/drain trap

Air enters the compressor, passing through the inlet air filter and inlet valve.

Compression in the screw-type air compressor is created by the meshing of two helical rotors (male and female) on parallel shafts, enclosed in a heavy-duty cast iron housing, with air inlet and outlet ports located on opposite ends. The grooves of the female rotor mesh with, and are driven by, the male rotor. Tapered roller bearings at the discharge end prevent axial movement of the rotors.

The air-coolant mixture discharges from the compressor into the separation system. This system, self-contained in the receiver tank, removes all but a few PPM of the coolant from the discharge air. The coolant is returned to the system and the air passes to the aftercooler. The aftercooling system consists of a heat exchanger, a condensate separator, and a drain trap. By cooling the discharge air, much of the water vapor naturally contained in the air is condensed and eliminated from the downstream plant-piping and equipment.

During unloaded operation, the inlet valve closes and the blowdown solenoid valve opens, expelling any compressed air back to the compressor inlet.

4.5 COOLANT/AIR SEPARATION SYSTEM

The coolant/air separation system is composed of a separator tank with specially designed internals, a two-stage, coalescing-type separator element, and provision for return of the separated fluid back to the compressor.

Operation

The coolant and air discharging from the compressor flow into the separator tank through a tangential inlet. This inlet directs the mixture along the inner circumference of the separator tank, allowing the coolant stream to collect and drop to the separator tank sump.

Internal baffles maintain the circumferential flow of remaining coolant droplets and air. In an almost continuous change of direction of flow, more and more droplets are removed from the air by inertial action and then returned to the sump.

The air stream, now essentially a very fine mist, is directed to the separator element.

The separator element is constructed with two concentric, cylindrical sections of closely packed fibers, each held in steel mesh. It is flange-mounted at the receiver-outlet-cover.

The air stream enters the separator element radially and the mist coalesces to form droplets. The droplets collected on the outer first stage fall to the receiver sump. Those collected on the inner second stage collect near the outlet of the element, and are drawn back to the compressor inlet through a filter-screen and orifice fitting installed in the separator scavenge line.

The air stream, now essentially free of coolant, flows from the separator to the aftercooler, then to the condensate separator, and on to the plant air system.

4.6 ELECTRICAL SYSTEM

The electrical system of each SSR compressor is built around the microprocessor-based Intellisys controller.

The standard electrical/electronic components, enclosed in a readily accessible enclosure include:

1. SSR Intellisys controller
2. Control transformers and fuses
3. Compressor motor starter, with auxiliary contacts and overload relays
4. Cooling fan motor starter/overload

4.7 COMPRESSOR CONTROL SYSTEM

The Intellisys® controls the various operating modes of the compressor, monitors key compressor operating parameters, and shuts the compressor down in the case of an operating problem. The control system has customer adjustable inputs as described in the Intellisys® section 3.0. The compressor control system has the following standard features.

- Automatic Unloaded Start.
- On/Off Line Capacity Control.
- Unloaded Stop.
- Automatic Start/Stop.
- Compressor Fault Warning.
- Compressor Fault Alarm Shutdown.

The following paragraphs provide a description of the standard features. Please also refer to the flow schematic in section 7.0.

Automatic Unloaded Start

Pushing the start button signals the Intellisys® to engage the starter coils and opens the oil stop valve (5SV). The compressor will always start in the unloaded mode, with the inlet valve in the closed position and the blowdown valve open to vent the pressure from the separator tank. The unloaded start ensures that the compressor has a low starting torque requirement and that proper oil flow is established before the compressor loads. Compressors with full voltage starters will not load for seven seconds after the starter button is pressed. Compressors with optional star-delta starters will not load until two seconds after star-delta transition. If system pressure is below the on line set point pressure, the compressor will automatically load at this time. Press the load/unload button to prevent the compressor from loading.

Adjustment Of Unloaded Sump Pressure.

During unloaded operation, the inlet valve must allow some air flow past it to maintain sump pressure for proper lubricant flow. This air is compressed by the compression module and vented through the blowdown valve (3SV). By adjusting the closed position of the inlet valve plate, the unloaded sump pressure can be varied. The unloaded sump pressure is set at the factory and should not need adjustment under most circumstances. If adjustment is required use the following procedure.

Tools Required

- 1/2" open end wrench.
- 9/16" open end wrench.
- Loctite® 242 or equivalent.

With the compressor shut down remove the nut that fastens the inlet valve pivot anchor to the bracket on the inlet valve. Apply Loctite® 242 or equivalent to threads on spacer and loosely install nut. Start compressor and press the unload button so that the compressor will not load. Use the display select button to indicate sump pressure on the display. Move the position of the pivot anchor to alter the sump pressure until the sump pressure is between 25-35 psig (1.7-2.4 bar). Moving the pivot towards the inlet valve will raise the sump pressure. Moving the pivot away from the inlet valve will lower the sump pressure. Once the position is correct, fully tighten the nut.

On/Off Line Control

The standard control system provides for either full compressor capacity flow or zero flow based on the system pressure. If the system pressure falls below the on line set point, the Intellisys® energizes the load/unload solenoid (1SV) and the blowdown solenoid (3SV). This causes the inlet valve to open and the blowdown valve to close. Compressed air flows into the system.

If system pressure reaches the off line setting, the compressor unloads to minimize power demands. The Intellisys® de-energizes the load/unload solenoid (1SV) and the blowdown solenoid (3SV). This causes the inlet valve to close and vents the separator tank. The minimum pressure check valve (MPCV) closes to prevent back flow from the compressed air system. The compressor operates at minimum power until the system pressure falls to the on-line pressure setting.

Delay Load Time

This is the amount of time the line pressure must remain below the on line set point before the compressor will load or start (if the unit was stopped due to an auto start/stop situation). This timer will not delay loading after a start or if the time is set to zero. The delay load time feature is useful if the compressor is operating as a backup to another compressor and is normally stopped in auto start/stop mode. The delay load time prevents the compressor from starting and loading if the system air pressure momentarily drops below the on line setting of the backup compressor. If no delay is desired the delay load time setting should be set to zero.

Unloaded Stop

If the compressor is running at full load and the unloaded stop button is depressed, the compressor will unload and stop only after running unloaded for seven seconds. If the compressor is already unloaded, the compressor will stop immediately. Use of the unloaded stop button is the preferred method of stopping the compressor. If an immediate shutdown is required the EMERGENCY STOP button should be used.

Automatic Start/Stop Control

Many plant air systems have widely varying air demands or large air storage capacity which allows for automatic standby air capacity control.

The Intellisys system has been designed to carry out this function utilizing a software option module. Automatic Start/Stop is available as a factory installed option or as a field installation kit.

During periods of low air demand, if the line pressure rises to the upper set point, the Intellisys begins to time out. If the line pressure remains above the lower set point for as long as the set time, the compressor will stop. At the same time, the display will indicate the compressor has shut down automatically and will restart automatically. An automatic restart will occur when the line pressure drops to the lower set point.

The upper and lower set points and shutdown delay time are set on the Intellisys control panel. There is a 10 second delay after shutdown during which the compressor will not restart even if line air pressure drops below the lower set point. This is to allow the motor to come to a complete stop and the Intellisys controller to collect current data of operating conditions. If line air pressure is below the lower set point at the end of 10 seconds, the unit will start unless the load delay timer is set greater than 10 seconds.

Delay Load Time

This is the amount of time the line pressure must remain below the online set point before the compressor will load or start (if the unit was stopped due to an auto start/stop situation). This timer will not delay loading after a start or if the time is set to 0. When the delay load timer becomes active, the display will show the delay load countdown. Once the countdown reaches 0, the unit will load or start.

Automatic Start/Stop Operation

When in operation, the compressor must meet two specific timing intervals before the Intellisys controller will stop the unit in an Automatic Start/Stop situation.

For this discussion, the timers will be called timer "A" and timer "B".

FIRST
Timer "A" prevents the compressor from automatically starting more than 6 times an hour by requiring the unit to run at least 10 minutes after each automatic start.

This 10 minute run period can be loaded, unloaded or a combination of the two and allows dissipation of heat generated within the motor windings at start.

SECOND
After the compressor has started and reached the off-line setting and has unloaded, timer "B" requires the unit to run unloaded for a period of time that the operator can adjust between 2 and 60 minutes.

The setting of timer "B" is part of the options setpoint routine and the timer cancels any accumulated time if the compressor reloads before the timer cycle has finished.

An important point... This unloaded run time may, or may not, be included in the mandatory 10 minute run time used to cool the motor windings.

When the compressor has completed the settings of both timer "A" and timer "B", the Intellisys controller stops the compressor and displays "STOPPED IN AUTO RESTART."

Pressure sensor 3APT continues to monitor the package discharge pressure and sends information to the controller which automatically restarts the compressor when the pressure falls to the on-line setting.

An advantage to this method of automatic start/stop control is allowing the compressor to stop much sooner in certain situations and timer settings, thereby reducing power costs.

Some Examples of Operation

EXAMPLE 1
The operator selects an unloaded run time of 2 minutes in the OPTION routine and starts the compressor. The unit runs loaded for 8 minutes, unloads and then runs unloaded for two more minutes.

The total running time is 10 minutes which satisfies timer “A” plus the unit ran two minutes unloaded which also satisfies timer “B,” therefore, the unit stops automatically.

This example shows how timer “B” can sometimes be included within the timer “A” interval. Think of the two timers as running parallel.

EXAMPLE 2
The operator selects an unloaded run time of 3 minutes in the OPTION routine and starts the compressor. The unit runs loaded for 10 minutes and then unloads.

At this point, timer “A” has been satisfied but timer “B” still wants the compressor to run unloaded 3 more minutes before allowing an automatic stop.

The total run time for this example will be 13 minutes.

Remember.... If the unit reloads before timer “B” finishes the 3 minute setting, the partial time is canceled and timer “B” must restart the 3 minute cycle when the compressor unloads again.

EXAMPLE 3
The operator selects an unloaded run time of 10 minutes in the OPTION routine and starts the compressor. The unit runs loaded 12 minutes and then unloads.

After 12 minutes of running, the 10 minute mandatory run-time for timer “A” has been met but the compressor must continue to run unloaded an additional 10 minutes to satisfy timer “B”.

After 10 minutes of unloaded run time, the compressor is stopped automatically and the total run time was 22 minutes.

4.8 OPTIONS

Several options are available with the Intellisys® control. These include starter options, remote start/stop option, power outage restart, sequencer control, and modulation control.

4.8.1 Starter Options

The standard compressor is supplied with an automatic across-the-line (full voltage) starter. This starter is fully controlled by the Intellisys® and supplies full line voltage to the compressor motor at startup.

Optional reduced voltage (star-delta) starting is available, fully installed, at the factory and is also controlled by the Intellisys®. This starter initially provides a reduced voltage to the compressor motor to reduce starting current spike. After the compressor motor is at full speed, the starter transitions to supply full line voltage to the compressor motor.

4.8.2 Remote Start/Stop

The remote start/stop option allows the operator to control the compressor from a remote mounted start/stop station. This option may be factory installed or a field installation kit is available. This feature requires a software option module.

With the optional plug-in module installed, two different switches can be wired to the controller for remote start/stop. (Refer to Electrical Schematics 7.1 or 7.2 for wiring locations). The switches are customer supplied and must be of momentary type. The stop switch contacts are normally closed and the start switch contacts are normally open.

When starting the compressor from the remote location, the Start button must be held **depressed for approximately 2 seconds** to activate the remote start function and then **released within a maximum of 7 seconds** or a Remote Start Failure alarm will occur.

4.8.3 Power Outage Restart

For customers that have interruption in their incoming power supply to the compressor and must maintain an uninterrupted supply of compressor air, the Power Outage Restart Option allows an Intellisys® compressor to automatically restart after incoming power is restored.

The Power Outage Restart Option is turned on by plugging in the required option module and enabling it through the set point routine. The restart time delay, which is adjustable from 10-120 seconds, can also be adjusted while in the set point routine on the Intellisys® controller. Any time power is restored to the compressor after a power interruption, a horn located on the side of the starter box will sound during the restart time delay (10-120 seconds) , after which the compressor will automatically start. After starting, the compressor will return to the mode of operation that the compressor was in prior to the power interruption.

This option may be installed at the factory or in the field by using an available kit. The remote start/stop option is included with this option.

4.8.4 Sequencer Control

Sequencer control capability can be added to the Intellisys® system by using a sequencer interface. This option is available as a field installation kit.

4.8.5 Modulation

On/Off Line control is the most efficient mode of operation for the compressor. For compressed air systems that have a continuous demand near the full capacity of the compressor, modulation control will prevent excessive cycling of the compressor and provide a more constant supply pressure. Modulation control will also prevent excessive cycling if the compressed air system volume is small. An air compressor should never be installed in a compressed air system volume with a ratio of receiver volume (in gallons) to total compressor capacity (in cubic feet per minute) of less than one.

On/Off Line Control

The modulation control system retains all the features of on-line/off-line control but provides for throttling of the compressed air flow to match system demand. The compressor can be set to operate in "ON/OFF LINE" control using the set point procedure even if the compressor has the modulation option. If the compressor is set in the on line/off line control mode, it operates as described in section 4.7.

Modulation Only

The "MODULATlON" control mode can be selected during the set point procedure on a compressor that has the modulation option installed. To load, the Intellisys® energizes the load solenoid (1SV) and blowdown solenoid (3SV) as in on line/off line control. The Intellisys® also energizes the modulation solenoids (2SV and 6SV). This connects regulated pressure from the modulator valve (MV) to the air cylinder. The regulated pressure decreases with increasing system pressure near the set point of the modulation valve. This causes the inlet valve to throttle the compressor flow. The modulator valve is factory set such that the compressor will modulate to approximately 60% of rated capacity before the off line pressure is reached. If the system pressure continues to increase, the compressor will unload at the off line pressure setting. If the system pressure falls below the on line set point, the compressor will load in the modulation control mode.

Modulate/ACS Control

In compressors equipped with the modulation option the "MOD/ACS" control mode allows the Intellisys® to select the most appropriate control mode to match system demands. This eliminates the need for manual selection of the control mode to accommodate various compressed air demand cycles.

When operating in the MOD/ACS" control mode, the compressor automatically defaults to the on line/off line control mode. If the compressor completes three load/unload cycles within a three minute time period the Intellisys® determines that there is a high demand for compressed air. The Intellisys® switches to modulation control in an attempt to match the compressed air demand by regulating the flow. The compressor continues to operate in the modulation control mode until the compressor operates unloaded for three minutes. This is an indication that compressed air usage has fallen off and that on/off line is a more appropriate control mode. The Intellisys® changes the control mode to on/off line and continues to operate in this manner until three load/unload cycles occur within three minutes.

Modulate Control Valve Adjustment

Tools Required

- 7/16" open end wrench.
- Pressure Gauge 0-100 PSIG (0-6.9 barg)
- Loctite® PST or equivalent.

The modulator valve is set at the factory to modulate at the compressor's rated pressure. For example a compressor with a 125 psig (8.6 bar) pressure rating will modulate up to 60% capacity when the system pressure is near the default off line setting of 128 psig. (8.8 bar). The following procedure describes the method of setting the modulation valve. The desired pressure should never be more than 3 psig (.2 bar) below the off line pressure entered during the set point routine. For example if the off line pressure is set at 96 psig (6.6 bar), the desired set point pressure should be 93 psig (6.4 bar).

Ensure that the compressor is isolated from the compressed air system by closing the isolation valve and venting pressure from the system.

Ensure that the main power disconnect switch is locked open and tagged.

1. Remove the 1/8" NPT plug from the tee in the control piping and connect a pressure gauge to this port.

2. Reconnect power to the compressor. When display reads "READY TO START," enter the set points routine and set control mode to "MODULATION".

3. Start the compressor and elevate system pressure to desired set point pressure. This pressure must be maintained while adjusting the modulator valve.

4. Loosen the lock nut on the bottom of the modulator valve and turn the adjusting screw to modify the modulation valve set pressure. Turning the screw counterclockwise (as viewed from the top) raises the set point pressure. Turning the screw clockwise lowers the set point pressure.

5. Adjust the screw while maintaining system pressure at the desired value until the output pressure of the modulator valve is 30 psig (2.1 bar). Tighten the locknut.

6. Stop the compressor and lock open the main disconnect. Ensure that all pressure is vented from the system.

7. Remove pressure gauge from modulation valve and re-install 1/8" NPT plug in tee in control piping using Loctite® PST or equivalent to seal threads.

NOTES:

5.0 SCHEDULED PREVENTATIVE MAINTENANCE

5.1 MAINTENANCE SCHEDULE

THE MAINTENANCE SCHEDULE SPECIFIES ALL RECOMMENDED MAINTENANCE REQUIRED TO KEEP THE COMPRESSOR IN GOOD OPERATING CONDITION. **SERVICE AT THE INTERVAL LISTED OR AFTER THAT NUMBER OF RUNNING HOURS, WHICHEVER OCCURS FIRST.**

Action	Part or Item	Running Hours	Time Interval (whichever comes first) 1 Week 1 Mo. 3 Mo. 6 Mo. Yearly 2 Years
Inspect	Coolant level	Weekly	x
Inspect	Discharge temperature (air)	Weekly	x
Inspect	Separator element differential	Weekly	x
Inspect	Air filter Delta P (at full load)	Weekly	x
Replace	Coolant filter*	150	x (initial change only)
Check	Temperature sensor	1000	x
Replace	Food grade coolant (when used)	1000	x
Inspect	Hoses	1200	x
Replace	Coolant filter*	2000	x (subsequent changes)
Clean	Separator scavenge screen and orifice	4000	x
Clean	Cooler cores**	4000	x
Replace	Air filter*	4000	x
Replace	Separator element* *See special note.		
Replace	Ultra Coolant*	8000	x
Inspect	Starter contactors	8000	x
Service	Drive/Fan motor lubrication		See Section 5.10.

* In very clean operating environments and where inlet filter is changed at the above prescribed intervals. In extremely dirty environments change coolant, filters, and separator elements more frequently.

** Clean cooler cores if discharge air temperature is excessive or if unit shutdown occurs on high air temperature.

5.2 MAINTENANCE RECORDS

It is very important that you, the owner, keep accurate and detailed records of all maintenance work you, or the Ingersoll-Rand Distributor or Air Center perform on your compressor. This includes but is not limited to coolant filter, separator, inlet air filter and so forth. This information must be kept by you, the owner, should you require warranty service work by your Ingersoll-Rand Distributor or Air Center. Maintenance record sheets are located at the back of this manual.

5.3 MAINTENANCE PROCEDURES

Before starting any maintenance, be certain the following is heeded.

1. Read Safety Instructions.
2. Use correct tools.
3. Have recommended spares on hand.

SPECIAL NOTE:
Replace separator element when the separator differential pressure (△ P) reaches three times the initial pressure drop or a maximum pressure differential of 12 psi (.8 bar) at full load or if the Intellisys warning CHG SEPR ELEMENT is displayed. See Section 3.6.

5.4 INLET AIR FILTER

The filter should be changed when the filter indicator shows red.

The filter should be changed every 4000 hours and more frequently in dirty environments because coolant, coolant filter, separator element, and airend life are a direct function of how well you maintain and replace the inlet air filter.

To change inlet filter elements, loosen wing nut on top of inlet filter housing. Lift cover up and away to expose element/s.

Carefully remove the old element/s to prevent dirt from entering the inlet valve. Discard old element/s.

Thoroughly clean the element housing and wipe all surfaces.

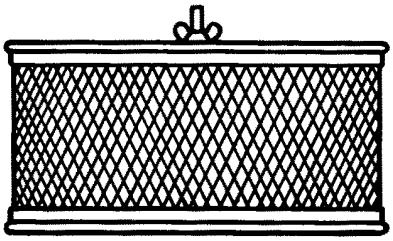
Install new element/s and inspect to ensure that they have seated properly.

Install top of inlet filter housing.

Inspect the rubber seal on the retainer wing nut and replace seal if required.

Tighten wing nut.

Start machine and run in the load mode to verify filter condition.



INLET AIR FILTER
75-100 HP (55-75 kw)
REQUIRES TWO (2) ELEMENTS

⚠ NOTICE

Improper coolant filter replacement will cause compressor damage.

Replace filter element after first 150 hours of operation and every 2000 hours thereafter or when coolant is changed.

Ingersoll-Rand
Rotary-Recip Compressor Division
Davidson, NC

5.5 COOLANT FILTER

The coolant filter should be changed after the first 150 hours of operation and every 2000 hours thereafter, or when the coolant is being changed. In dirty operating environments the filter should be changed more frequently.

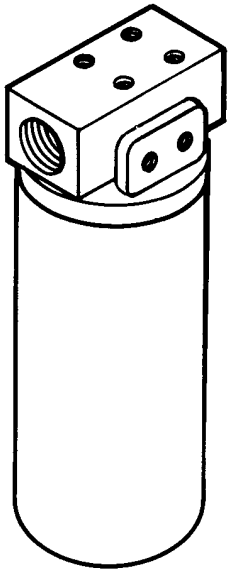
Use a suitable device and loosen the old element. Use drain pan to catch any leakage during removal. Discard old element.

Wipe the sealing surface of the filter with a clean, lint-free rag to prevent the entry of dirt into the system.

Remove the replacement element from its protective package. Apply a small amount of clean lubricant on the rubber seal and install the element.

Screw element/s on until the seal makes contact with the head of the filter assembly. Tighten approximately one-half turn additional.

Start unit and check for leaks.



COOLANT FILTER 50-100 HP (37-75 kw)

5.6 COOLANT

- SSR Ultra Coolant (Standard Factory Fill)
- SSR H1-F Food Grade (Optional)

SSR Ultra Coolant is a polyglycol base coolant. Change Ultra Coolant after every 8000 hours or every two years, whichever comes first.

SSR Food Grade Coolant is a polyalphaolefin base coolant. Change after every 1000 hours or every 6 months whichever comes first. Do not operate unit beyond this 1000 hour lubricant change interval, as lubricant degradation will occur.

Items Required
In addition to the tools normally found in any reasonably equipped serviceman's toolbox, the following items should be available at the work site:

1) Suitable drain pan and container to hold lubricant drained from unit.
2) A quantity of proper lubricant sufficient to refill the compressor.
3) A minimum of one replacement coolant filter element of the proper type for the unit to be worked on.

There is a coolant drain hose supplied with each compressor. The drain hose is placed in the starter box when shipped from the factory.

The coolant should be drained soon after the compressor has been shut down. When the coolant is hot, drainage will be more complete and any particles in suspension in the coolant will be carried out with the coolant.

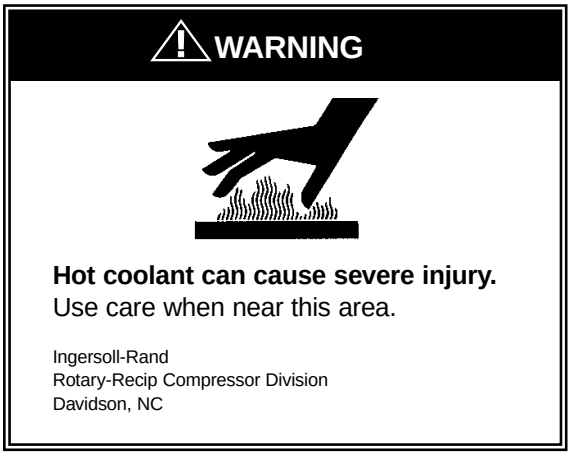
Hot coolant can cause severe injury. Use care when draining separator tank.

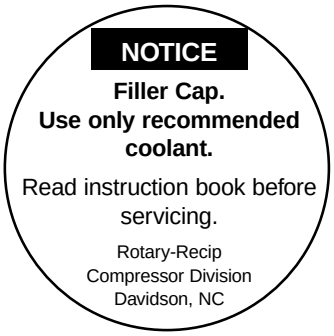
To drain the unit, remove plug from drain valve located on the bottom of the separator tank. Install supplied drain hose and fitting assembly in end of drain valve and place end of hose in a suitable pan. Open drain valve to start drainage. After draining is complete, close valve, remove hose and fitting assembly from valve, and store in a suitable location for future use. Replace plug in end of drain valve.

Do not store drain hose in starter box after it has been used to drain the separator tank.

Coolant fill quantity

50 hp (37 kw)	5.0 gallons (19.0 liters)
60 hp (45 kw)	5.0 gallons (19.0 liters)
75/100 hp (55-75 kw)	9.0 gallons (34.2 liters)





5.6 COOLANT (Continued)

After the unit is drained and a new coolant filter element is installed, refill the system with fresh coolant. Bring the receiver level of coolant up to the midpoint of the sight glass. Replace the fill cap. Start the compressor and run it for a short time. The correct coolant level is at the midpoint of the sight glass with the unit running in the 'UNLOADED" mode.

5.7 SEPARATOR TANK SCAVENGE SCREEN/ORIFICE

Tools Required

- Open end wrench
- Pliers

Procedure

The screen/orifice assemblies are similar in appearance to a straight tubing connector and will be located between two pieces of 1/4 inch O.D. scavenge line tubing.

The main body is made from 1/2 inch hexagon shaped steel and the diameter of the orifice and a direction-of-flow arrow is stamped in flat areas of the hexagon.

A removable screen and orifice is located in the exit end of the assembly (See Figure 5.7-1) and will require cleaning as outlined in the Maintenance Schedule, Section 5.1.

To remove the screen/orifice, disconnect the scavenge line tubing from each end. Hold the center section firmly and use a pair of pliers to gently grasp the exit end of the assembly that seals against the scavenge line tubing. Pull the end out of the center section while using care to prevent damage to the screen or sealing surfaces.

Clean and inspect all parts prior to reinstallation.

When the assembly is installed, confirm the direction of flow to be correct. Observe the small arrow stamped in the center section and ensure the direction flow to be from the separator tank to the airend.

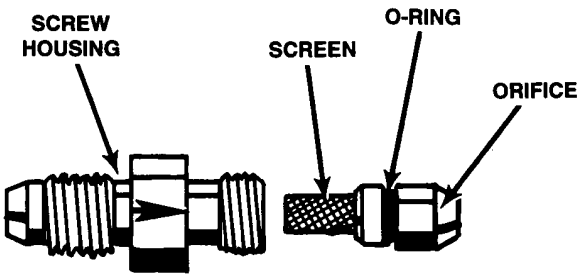


FIGURE 5.7-1 SEPARATOR TANK SCAVENGE SCREEN/ORIFICE

5.8 COOLANT SEPARATOR ELEMENT

To check condition of separator element, run compressor in full load mode and at rated pressure and select "SEPARATOR PRESSURE DROP" in display table. If display says "XX PSI", then no maintenance is required. If warning light is on and display says "CHG SEPR ELEMENT" then the separator should be replaced.

Loosen the fitting that holds the scavenge tube into the tank and withdraw the tube assembly.

Disconnect blowdown valve from elbow in tank cover.

Disconnect tube from fitting on minimum pressure check valve. Loosen tube nut on same tube at aftercooler inlet then swing tube away from tank cover.

Use a suitable wrench and remove the bolts that hold the tank cover in position. Remove cover by lifting up and away.

Carefully lift the separator element up and out of the tank. Discard the faulty element.

Clean the gasket surface on both the tank and its cover. Exercise care to prevent pieces of the old gasket from falling down into the tank.

Check the tank to be absolutely certain that no foreign objects such as rags or tools have been allowed to fall into the tank. Install replacement element down into the tank after checking the new element gaskets for possible damage. Center the element up within the tank.

Place the tank cover in its correct position and install bolts. Tighten the bolts in a cross-pattern (Reference Figure 5.8-1) to prevent over-tightening one side of the cover. An improperly tightened cover will likely result in a leak.

Tank Cover Bolt Torque Values	
5/8 UNC	150 ft. lb.(203 N-M)

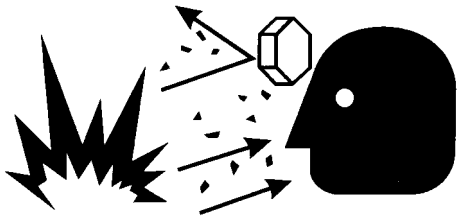
Inspect tank scavenge screen and orifice. Clean if necessary following instructions in Section 5.7.

Install scavenge tube down into the tank until the tube just touches the separator element. Tighten fittings.

Install the regulation lines in their original position.

Start unit, check for leaks, place in service.

WARNING



High pressure air.
Can cause severe injury or death.

Relieve pressure before removing filter plugs / caps, fittings or covers.

RECOMMENDED BOLT TIGHTENING CROSS PATTERN

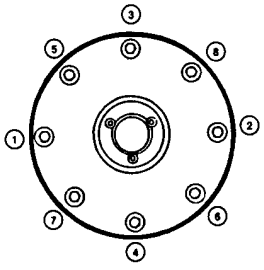


FIGURE 5.8-1

5.9 COOLER CORES: CLEANING

Ensure that the compressor is isolated from the compressed air system by closing the isolation valve and venting pressure from the drip leg.

Ensure that the main power disconnect switch is locked open and tagged. (See Figure 5.9-1).

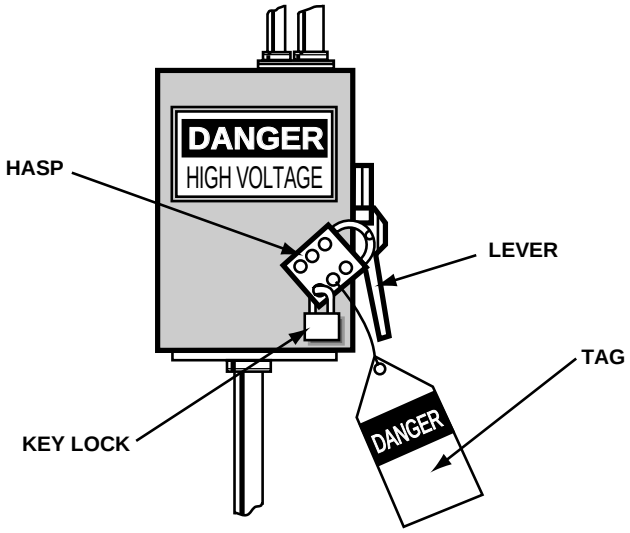


FIGURE 5.9-1 MAIN DISCONNECT LOCKED AND TAGGED

Tools Required

- Screwdriver
- Wrench set
- Air hose equipped with approved O.S.H.A. nozzle. **On units sold outside the U.S.A. consult local codes.**

5.9-1 Air Cooled Coolers

Procedure

Visually check the outside of the cooler cores to be certain that a complete outside cleaning of the cooler is required. Frequently, dirt, dust or other foreign material, may only need to be removed with an air hose to remedy the problem.

When the cooler is covered with a combination of oil, grease or other heavy substances that may affect the unit's cooling, then it is recommended that the cooler cores be thoroughly cleaned on the outside.

If it is determined that the compressor operating temperature is higher than normal due to the internal passages of the cooler cores being restricted with deposits or foreign material, then the cooler should be removed for internal cleaning.

Coolant Coolers

Following are instructions for removal and internal cleaning of coolant/aftercooler.

1) Remove right side panel.
2) Remove 6 screws in right side plenum wall and remove plenum wall.
3) Remove 8 screws in left side plenum wall and remove plenum wall.
4) Remove hose from aftercooler discharge (right side) and plug hole.
5) Disconnect tube from aftercooler inlet (left side). Loosen tube nut on opposite end of tube and rotate tube away. Plug hole in aftercooler.
6) Loosen hose nuts 1/4 turn on oil cooler inlet and outlet hoses. This will allow hose fittings to swivel without causing kink in hose.
7) Remove 6 screws in cooler support panel to allow cooler to swing out on hinges.
8) Cover opening that exposes fan and fan motor to ensure water does not spray onto motors.
9) Before cleaning coolers, check to ensure all connections are plugged to prevent contamination of compressor system.

⚠ CAUTION

Strong cleaners can harm aluminum cooler parts. Follow cleaner manufacturer's instructions for use.

Wear appropriate safety equipment.

10) After cleaning is complete, reassemble in reverse order.
11) Replace enclosure panels.

5.9-2 Water Cooled Coolers

Procedure

A periodic inspection and maintenance program should be implemented for water cooled heat exchangers. The following steps should be taken.

1. Inspect filters in system and replace or clean as required.

2. Carefully examine tubes for scale and clean if necessary. If a cleaning solution is used, be sure to wash out all chemicals thoroughly with clean water before returning the compressor to service. After cleaning, examine the cooler for erosion or corrosion.

5.9-2 Water Cooled Coolers (Continued)

Cleaning

The interior tube surfaces can be cleaned by several methods. Flushing a high velocity stream of water through the tubes will remove many forms of deposits. More severe deposits may require running wire brushes or rods through the tubes. Also, rubber plugs can be forced through the tubes if a special air or water gun is available for this procedure.

A qualified cleaning service should be used for the cleaning process. These organizations can evaluate the type of deposit to be removed and supply the appropriate solution and method for a complete cleaning job.

Precautions

When re-installing bonnets to cooler shell, tighten bolts uniformly in a cross-pattern. Overtightening can result in cracking of bonnet.

Cleaning solutions must be compatible with metallurgy of cooler.

Care must be taken to avoid damaging tubes if mechanical cleaning procedure is used.

5.10 MOTOR LUBRICATION

The induction-type squirrel cage motors have antifriction ball or roller bearings front and rear. At periodic intervals they require relubrication.

NOTICE: 50 Hz TEFC motors have sealed bearings that do not require relubrication.

Relubrication Interval
(or 9 months, whichever comes first)
1000 hours.....all 60 Hz TEFC drive motors
2000 hours..... all 60 Hz ODP drive motors and all fan motors

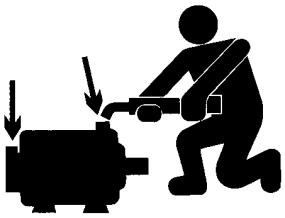
Relubrication amount

Motor Frame Size	Lubricant Amount in³	cc	oz.	grams
56-145*				
182-215	.5	8	.4	11
254-286	1.0	1 6	.8	23
324-365	1.5	25	1.2	34
404-449	2.5	40	2.0	57

* No greasing required (permanently lubricated bearings)

Improper lubrication can be a cause of motor bearing failure. The quantity of grease added should be carefully controlled. The smaller motors must be greased with a lesser amount of grease than larger motors.

NOTICE



Motors MUST be greased periodically. See Operators Manual for procedure.

39570098

⚠ CAUTION

Overgreasing can be a cause of bearing and motor failure. Make sure dirt and contaminants are not introduced when adding grease.

Procedure for relubrication

⚠ CAUTION

Grease should be added when the motor is stopped and power disconnected.

When regreasing, stop motor. Disconnect power; lock out and tag. Remove outlet plugs (or spring-loaded grease relief plugs if present). The outlet plug may not be accessible on the fan end of some TEFC motors.

5.10 MOTOR LUBRICATION (Continued)

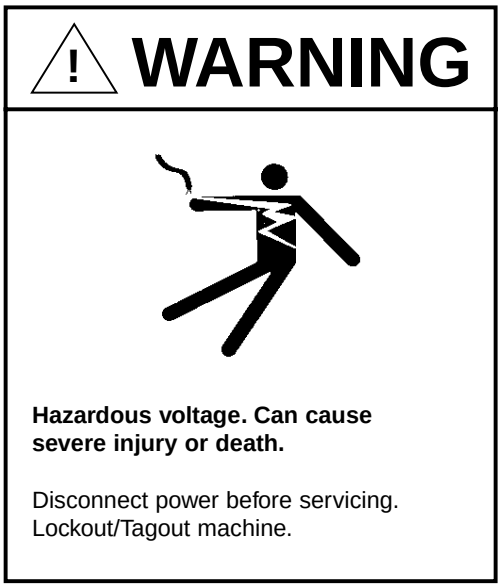
Grease relief along shaft can occur, precluding necessity of removing this plug if inaccessible. The inlet grease gun fittings and outlet plugs (or spring-loaded reliefs) are located at each end of the motor housing. The drive end reliefs protrude out the circumference of the lower portion of the end bell near a flange bolt. The drive end outlet plugs are located just behind the flange in the air intake area at about the 5 or 6 o'clock position.

1) Free drain hole of any hard grease (use piece of wire if necessary).

2) Use a hand lever type grease gun. Determine in advance the quantity of grease delivered with each stroke of the lever. A graduated cylinder showing cubic centimeters (cc) may be used, or a 35mm film canister can give a close approximation for 2 cubic inches when filled.

3) Add the recommended volume of the recommended lubricant. **Do not expect grease to appear at the outlet, but if it does, discontinue greasing at once.**

4) Run motor for about 30 minutes before replacing outlet plugs or reliefs. **BE SURE TO SHUT MOTOR DOWN, DISCONNECT POWER, LOCK OUT AND TAG, AND REPLACE THESE DRAIN FITTINGS TO PRECLUDE LOSS OF NEW GREASE AND ENTRANCE OF CONTAMINANTS!**



<u>Recommended Motor Grease</u>

Most motors require:

Mobilith SHC 220.....Mobil

Use the grease as indicated on a special grease information nameplate on the motor. Use of alternative greases can result in shortened motor life due to incompatibility of greases. If there is not a grease nameplate on the motor use:

Chevron Black Pearl #2
(Preferred).....Standard Oil of California

Chevron SRI 2.....Standard Oil of California

Motor Bearing Maintenance (Stored Units)

To ensure that complete contact is maintained between the motor bearings and the bearing grease on units to be placed in storage for extended intervals, the following motor maintenance procedure should be adhered to:

1) Prior to placing a unit in storage, rotate the motor several revolutions by hand in the proper direction of rotation.

2) Thereafter, rotate the motor as described in Step 1 at three month intervals until such time as the unit is placed in service.

3) If the storage time is to exceed a total of nine (9) months duration, the compressor must be ordered with long term storage option.

5.11 LONG TERM STORAGE

General
The factory, upon special request, prepares compressor units for long term storage. In such cases, a special bulletin is supplied for storage and start-up procedures.

The bulletin provides special procedures for rotation and lubrication of compressors during storage.

Before actual start-up of the compressor, the unit must be drained of coolant containing vapor space inhibitors. Procedure for long term storage start-up is covered in the special bulletin APDD 339.

5.12 COOLANT/LUBRICANT CHANGEOUT

Ingersoll-Rand does not recommend changeout of coolant/lubricants, however, if a coolant/lubricant change cannot be avoided, procedure APDD 106E-87 should be obtained from your Ingersoll-Rand representative.

5.13 INTELLISYS REMOVAL

Ensure that the compressor is isolated from the compressed air system by closing the isolation valve and venting pressure from the drip leg.

Ensure that the main power disconnect switch is locked open and tagged (See Figure 5.13-1).

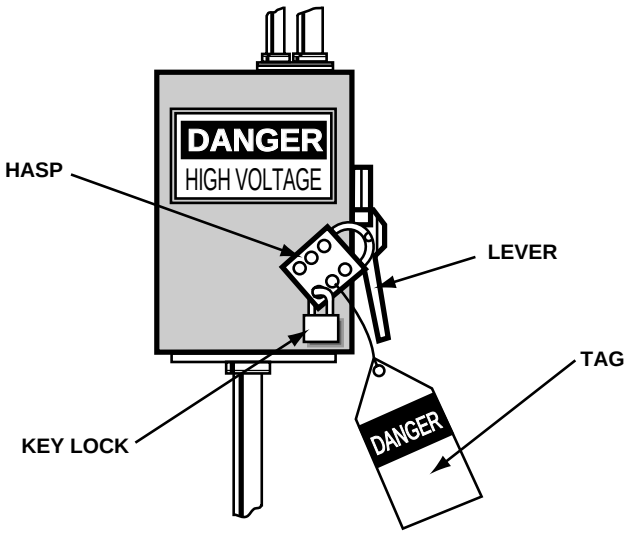


FIGURE 5.13-1 MAIN DISCONNECT LOCKED AND TAGGED

Follow these **precautions to minimize damage** from static electricity. Static can cause severe damage to microcircuits.

1) Make the least possible movement to avoid building up static electricity from your clothing or tools.

2) Discharge potential static electricity by touching (grounding) yourself to the starter box.

3) Handle circuit boards only by their edges.

4) Do not place the controller or power supply assembly on any metal surface.

5) Leave the replacement parts in their protective bags until ready for installation.

Tools:
Screwdriver Size #1, flathead
3/8 inch hex driver

Before removing any components, open the starter box door and check all wiring for tightness. A loose wire or bad connection may be the cause of problems.

Controller Removal:

1) Open the starter box door.

2) Remove the five electrical plug-in connectors from the top of the controller.

3) Remove (2) mounting rails that attach the Intellisys® Controller at the side of the control box.

4) Remove the controller. Remove any option modules which must be installed in the new controller.

5.14 COOLANT HOSES

The flexible hoses that carry coolant to and from the oil cooler may become brittle with age and will require replacement. Have your local Ingersoll-Rand distributor check them every 2 years.

Ensure that the compressor is isolated from the compressed air system by closing the isolation valve and venting pressure from the drip leg.

Ensure that the main power disconnect switch is locked open and tagged.

Removal

Remove enclosure panels.

Drain coolant into a clean container. Cover the container to prevent contamination. If the coolant is contaminated, a new charge of coolant **must** be used.

Hold fitting securely while removing hose.

Installation

Install the new hoses and reassemble the package by reversing the disassembly procedure. Start the compressor and check for leaks.

5.15 AIREND DISCHARGE HOSE

The flexible hose from the airend discharge to separator tank may become brittle with age and require replacement. Check this hose as per the maintenance schedule in Section 5.1.

Removal

Ensure that the compressor is isolated from the compressed air system by closing the isolation valve and venting pressure from the drip leg.

Ensure that the main power disconnect switch is locked and tagged.

50 & 60 HP (37-45 KW) Machines:

Disconnect hose nut from piping at each end of discharge hose and remove. Hold fittings securely while removing hose.

75 & 100 HP (55-75 KW) Machines:

Remove (4) bolts in flange at each end of discharge hose. Retain flanges and bolts for replacement.

6.0 TROUBLE SHOOTING CHART

TROUBLE	CAUSE &/OR DISPLAY	WHAT TO DO
Compressor fails to start.	110/120V control voltage not available.	— Check fuses. Check transformers and wiring connections.
	"STARTER FAULT 1SL (2SL)"	— Inspect contactors.
	"EMERGENCY STOP"	— Rotate emergency stop button to disengage, and press"SET" button twice.
	"MAIN MTR OVER LD" or "FAN MTR OVERLOAD"	— Manually reset main or fan motor overload relay, and press "SET"button twice.
	"PRES SENSOR FAIL" or "TEMP SENSOR FAIL"	— Check for defective sensor, bad sensor connection, or broken sensor wires.
Compressor shuts down.	"HIGH AIREND TEMP"	— Insure that installation area has adequate ventilation. — Insure that cooling fan is operating. If not reset circuit breaker inside starter box. — Check coolant level. Add if required. — Cooler cores dirty. Clean coolers.
NOTE: If a shutdown occurs, press the DISPLAY SELECT button once to activate the L.E.D. display table. Using the adjacent up and down arrows, the values displayed will be those immediately preceding shutdown. Use these values when trouble shooting a problem.	"HIGH AIR PRESS"	— Check for restricted or malfunctioning blowdown valve or minimum pressure check valve.
	"LOW SUMP PRESS"	— Check for air leak from tank or blowdown piping. — Adjust sump pressure.
	"PRES SENSOR FAIL" or "TEMP SENSOR FAIL"	— Check for defective sensor, bad sensor connection, or broken sensor wires.
	"CK MOTOR ROTATION"	— Interchange any two line connections (L1,L2,L3) at the starter.
	"MAIN MTR OVERLD"	— Check for loose wires. — Check supply voltage. — Check heater size.
	"FAN MTR OVERLOAD"	— Check for loose wires. — Check supply voltage. — Fan motor overload tripped — Check for dirty cooler cores.
	"STARTER FAULT 1SL (2SL)"	— Inspect starter contactors. — Check for loose wires.
Low system air pressure	Compressor running in "Unload" Mode.	— Press "UNLOAD/LOAD" button.
	Controller off-line set point too low.	— Press "UNLOAD/STOP" button, set off-line set point at a higher value.
	Dirty air filter element.	— Check filter condition. Replace as required.
	Air leak.	— Check air system piping.
	Moisture separator trap drain stuck open.	— Inspect and repair.
	Inlet valve not fully open.	— Inspect and repair. Check control system operation.
	System demand exceeds compressor delivery.	— Install larger or an additional compressor.

TROUBLE SHOOTING CHART (Continued)

TROUBLE	CAUSE &/OR DISPLAY	WHAT TO DO
High coolant consumption/coolant in air system	Excessive coolant level.	— Check level, lower if necessary by draining.
	Plugged separator element.	— Check separator pressure drop.
	Separator element leak.	— Check separator pressure drop. If low, replace element.
	Plugged separator scavenge orifice/ screen.	— Remove and inspect orifice/screen. Clean if required.
	Compressor operating at low pressure (75 psig / 5 barg) or below.	— Operate at rated pressure. — Reduce system load.
	Coolant system leak.	— Inspect and repair leaks.
Water in Air System	Defective moisture separator/drain trap	— Inspect and clean if required. Replace separator/trap if defective.
	Trap drain or drain piping plugged.	— Inspect and clean.
	Aftercooler core dirty.	— Inspect and clean.
	Enclosure panels not in place.	— Install enclosure panels.
	Drain line/drip leg incorrectly installed.	— Slope drain line away from trap. Install drip leg.
	No refrigerated or desiccant dryer in air system.	— Contact local Ingersoll-Rand Distributor or Air Center.
Excessive noise level	Compressor defective. (Bearing failure or rotor contact.)	— Contact authorized Distributor or Air Center immediately, do not operate unit.
	Enclosure panels not in place. Loose component mounting.	— Install enclosure panels. Inspect and tighten.
Excessive vibration	Loose components	— Inspect and tighten.
	Motor or compressor bearing failure.	— Contact authorized Distributor or Air Center immediately, do not operate unit.
	External sources.	— Inspect area for other equipment.
Pressure relief valve opens	Compressor operating over pressure.	— Adjust Intellisys set points.
	Defective valve.	— Replace valve.

7.0 REFERENCE DRAWINGS

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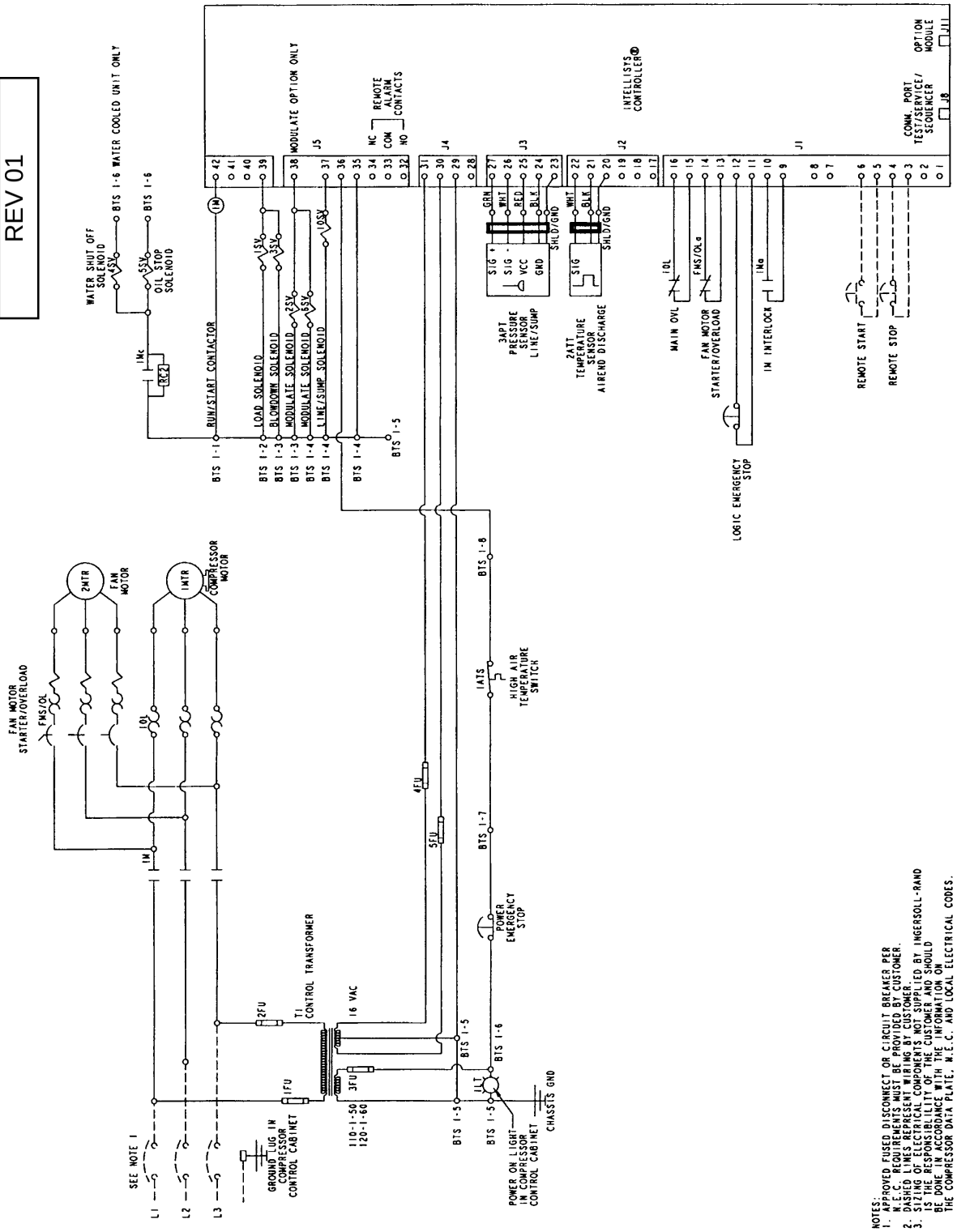
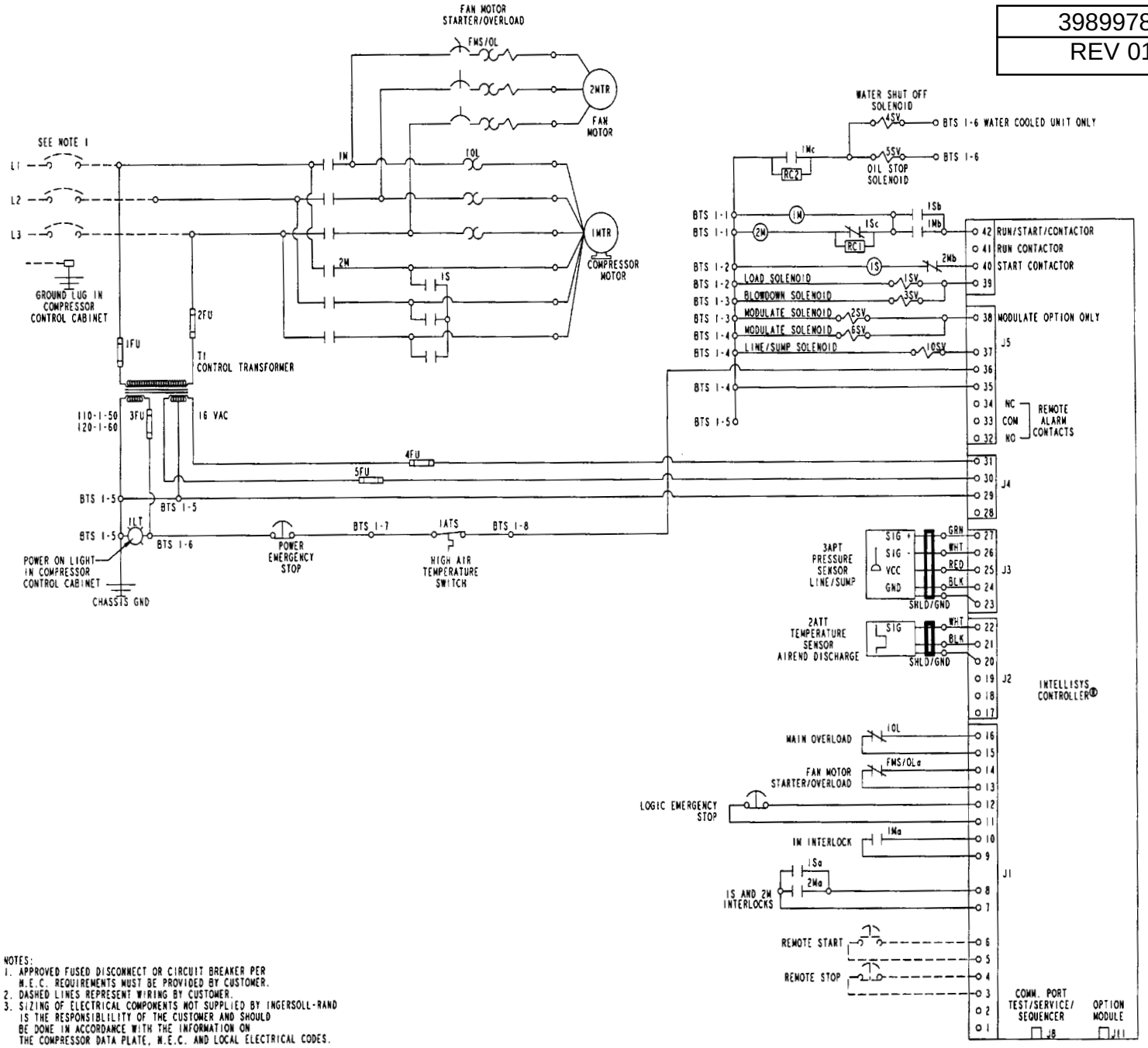
REV 01



7.1 ELECTRICAL SCHEMATIC-FULL VOLTAGE



NOTES:
1. APPROVED FUSED DISCONNECT OR CIRCUIT BREAKER PER N.E.C. REQUIREMENTS MUST BE PROVIDED BY CUSTOMER.
2. DASHED LINES REPRESENT WIRING BY CUSTOMER.
3. SIZING OF ELECTRICAL COMPONENTS NOT SUPPLIED BY INGERSOLL-RAND IS THE RESPONSIBLILITY OF THE CUSTOMER AND SHOULD BE DONE IN ACCORDANCE WITH THE INFORMATION ON THE COMPRESSOR DATA PLATE, N.E.C. AND LOCAL ELECTRICAL CODES.

7.2 ELECTRICAL SCHEMATIC-STAR-DELTA

7.3 FOUNDATION PLAN (AIR COOLED)

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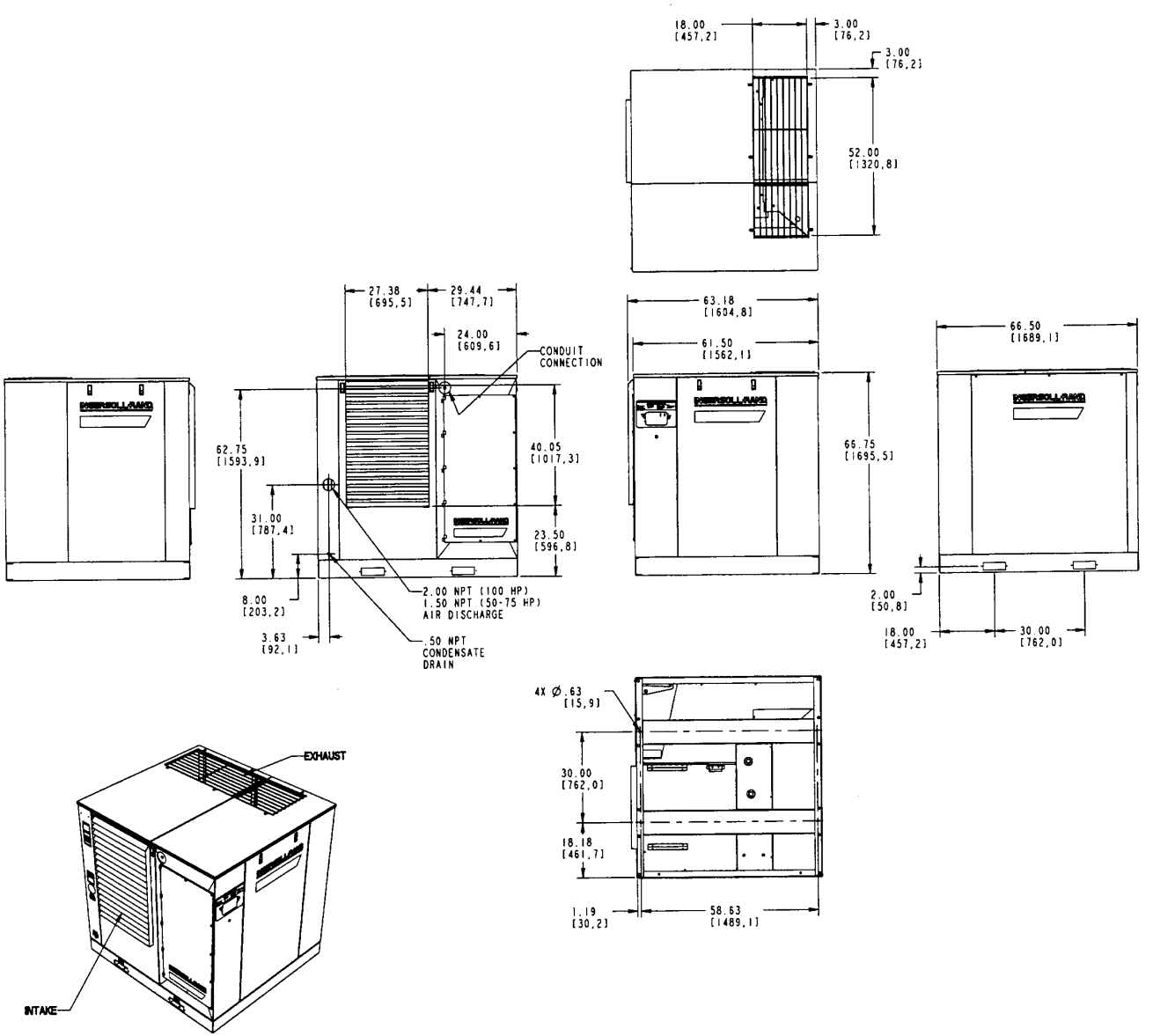
REV 03



NOTES:

1. WEIGHT (APPROXIMATE) 50 HP - 2,000 LBS. (907 KG)
   60 HP - 2,100 LBS. (953 KG)
   75 HP - 2,800 LBS. (1,270 KG)
   100 HP - 2,900 LBS. (1,315 KG)
2. COOLANT - LUBRICANT FILL QTY (APPROXIMATE)
   DRY - 9 GAL (34.2 L)
   TANK ONLY - 6.2 GAL (23.5 L)
3. TOLERANCE ON ALL DIMENSIONS +/- .12(3 MM)
4. ALL DIMENSIONS IN INCHES (MM).
5. 36.00 (914.4) MINIMUM LENGTH OF WIRE FROM POWER INLET OPENING TO STARTER.
6. AIR FLOW - 50-60 HP 6500 CFM (3.1 M3/S).
   AIR FLOW - 75-100 HP 7200 CFM (3.4 M3/S).)
7. RECOMMENDED CLEARANCE ON THREE SIDES 36.00 (914.4); 42.00 (1067) IN FRONT OF STARTER DOOR OR MINIMUM AS REQUIRED BY LATEST NATIONAL ELECTRICAL CODE OR APPLICABLE LOCAL CODES.
8. EXTERNAL PIPING SHALL NOT EXERT ANY UNRESOLVED MOMENTS OR FORCES ON UNIT.
9. THERE SHOULD BE NO PLASTIC PIPING ATTACHED TO THIS UNIT OR USED FOR ANY LINES DOWNSTREAM.
10. FORKLIFT HOLE COVERS MUST BE INSTALLED AFTER UNIT IS IN PLACE.
11. FIELD INSTALLED DUCTING TO AND FROM COMPRESSOR CANNOT ADD MORE THAN 0.25 INCHES OF WATER AIR RESISTANCE.

39907894
REV 03

NOTES:

1. WEIGHT (APPROXIMATE) 50 HP - 2,000 LBS. (907 KG)
   60 HP - 2,100 LBS. (953 KG)
   75 HP - 2,800 LBS. (1,270 KG)
   100 HP - 2,900 LBS. (1,315 KG)
2. COOLANT - LUBRICANT FILL QTY (APPROXIMATE)
   DRY - 9 GAL (34.2 L)
   TANK ONLY - 6.2 GAL (23.5 L)
3. TOLERANCE ON ALL DIMENSIONS +/- .12(3 MM)
4. ALL DIMENSIONS IN INCHES (MM).
5. 36.00 (914.4) MINIMUM LENGTH OF WIRE FROM POWER INLET OPENING TO STARTER.
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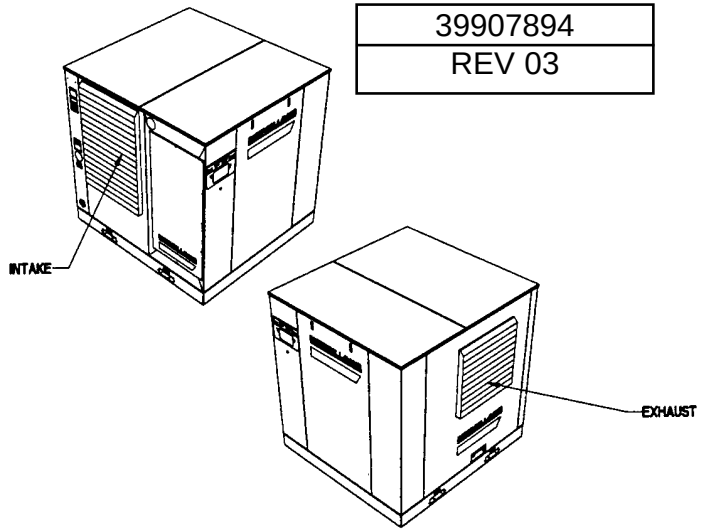
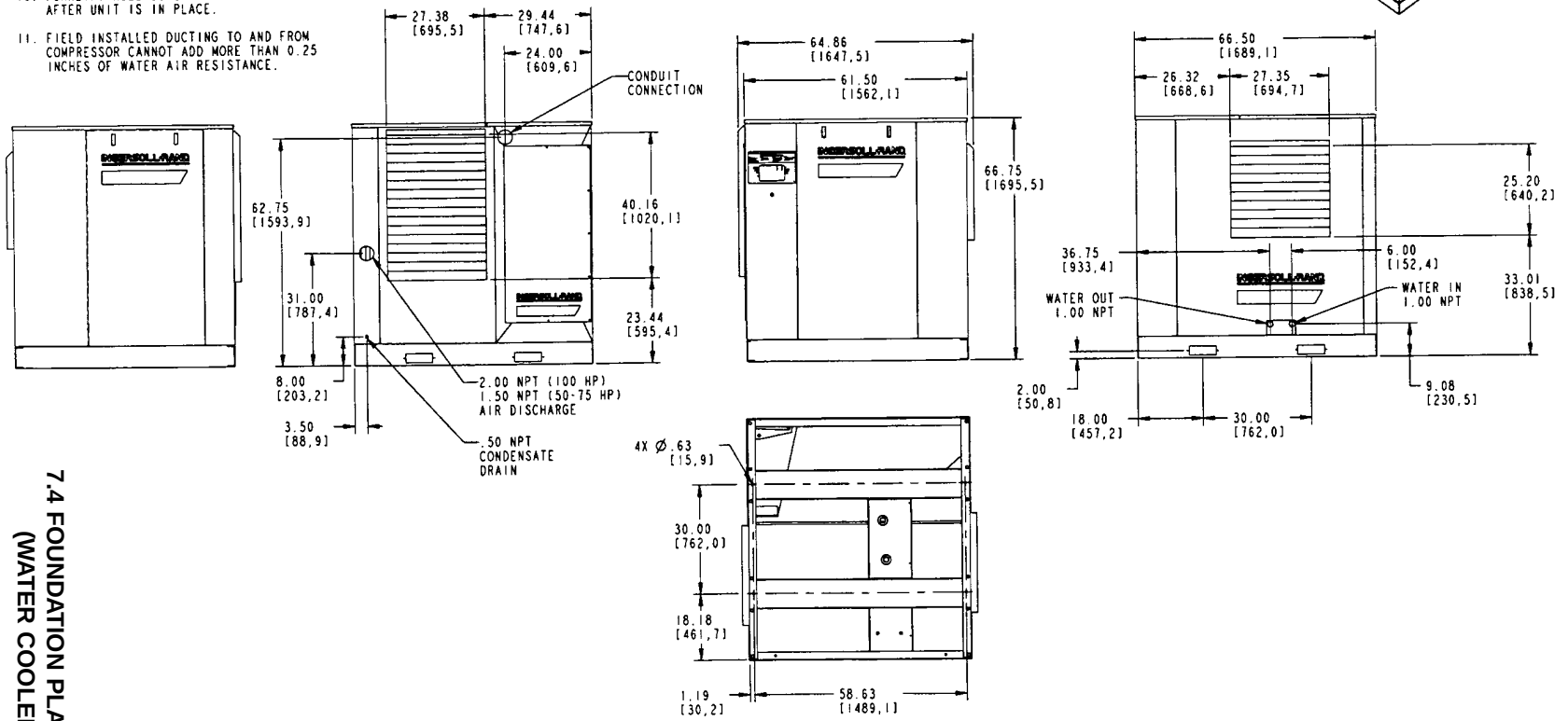
11. FIELD INSTALLED DUCTING TO AND FROM COMPRESSOR CANNOT ADD MORE THAN 0.25 INCHES OF WATER AIR RESISTANCE.





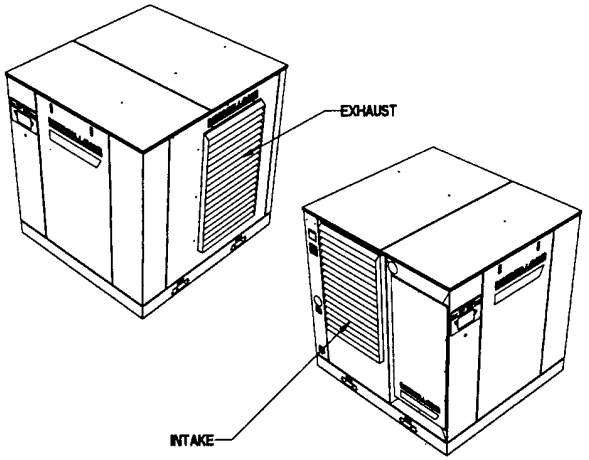
7.4 FOUNDATION PLAN (WATER COOLED)

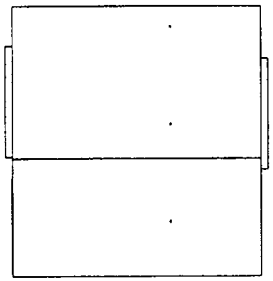
7.5 FOUNDATION PLAN - OUTDOOR MOD

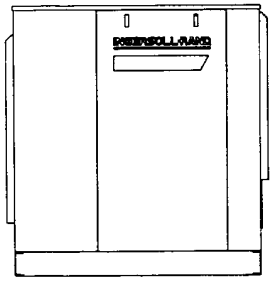
39907886
REV 03

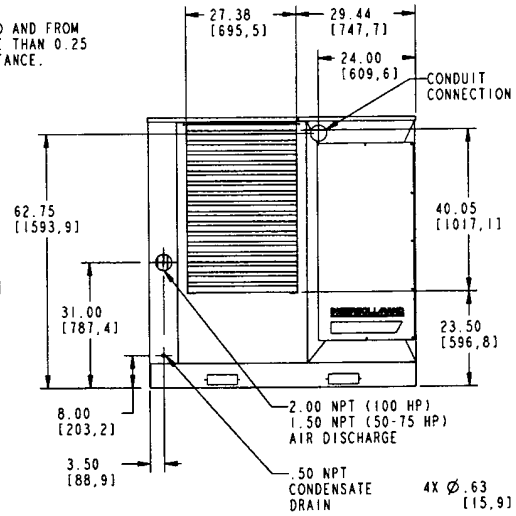
NOTES:

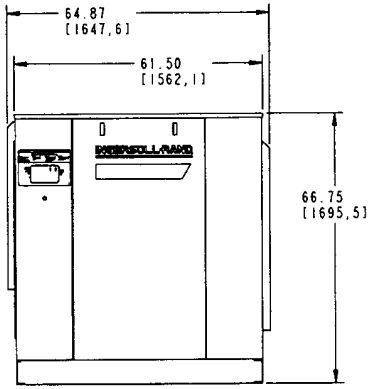
1. WEIGHT (APPROXIMATE) 50 HP - 2,000 LBS. (907 KG)
   60 HP - 2,100 LBS. (953 KG)
   75 HP - 2,800 LBS. (1,270 KG)
   100 HP - 2,900 LBS. (1,315 KG)
2. COOLANT - LUBRICANT FILL QTY (APPROXIMATE)
   DRY - 9 GAL (34.2 L)
   TANK ONLY - 6.2 GAL (23.5 L)
3. TOLERANCE ON ALL DIMENSIONS +/- .12(3 MM)
4. ALL DIMENSIONS IN INCHES (MM).
5. 36.00 (914.4) MINIMUM LENGTH OF WIRE FROM POWER INLET OPENING TO STARTER.
6. AIR FLOW - 50-60 HP 6500 CFM (3.1 M3/S).
   AIR FLOW - 75-100 HP 7200 CFM (3.4 M3/S).)
7. RECOMMENDED CLEARANCE ON THREE SIDES 36.00 (914.4); 42.00 (1067) IN FRONT OF STARTER DOOR OR MINIMUM AS REQUIRED BY LATEST NATIONAL ELECTRICAL CODE OR APPLICABLE LOCAL CODES.
8. EXTERNAL PIPING SHALL NOT EXERT ANY UNRESOLVED MOMENTS OR FORCES ON UNIT.
9. THERE SHOULD BE NO PLASTIC PIPING ATTACHED TO THIS UNIT OR USED FOR ANY LINES DOWNSTREAM.
10. FORKLIFT HOLE COVERS MUST BE INSTALLED AFTER UNIT IS IN PLACE.
11. FIELD INSTALLED DUCTING TO AND FROM COMPRESSOR CANNOT ADD MORE THAN 0.25 INCHES OF WATER AIR RESISTANCE.

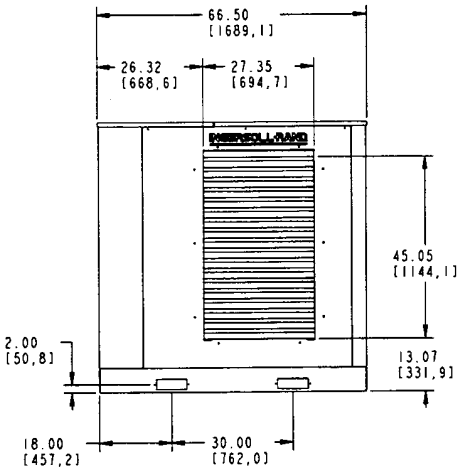


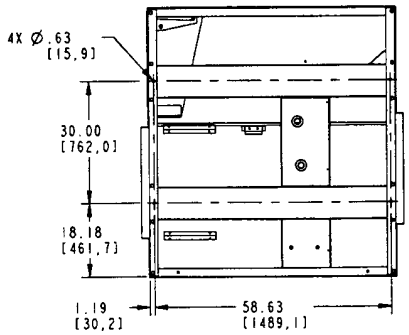












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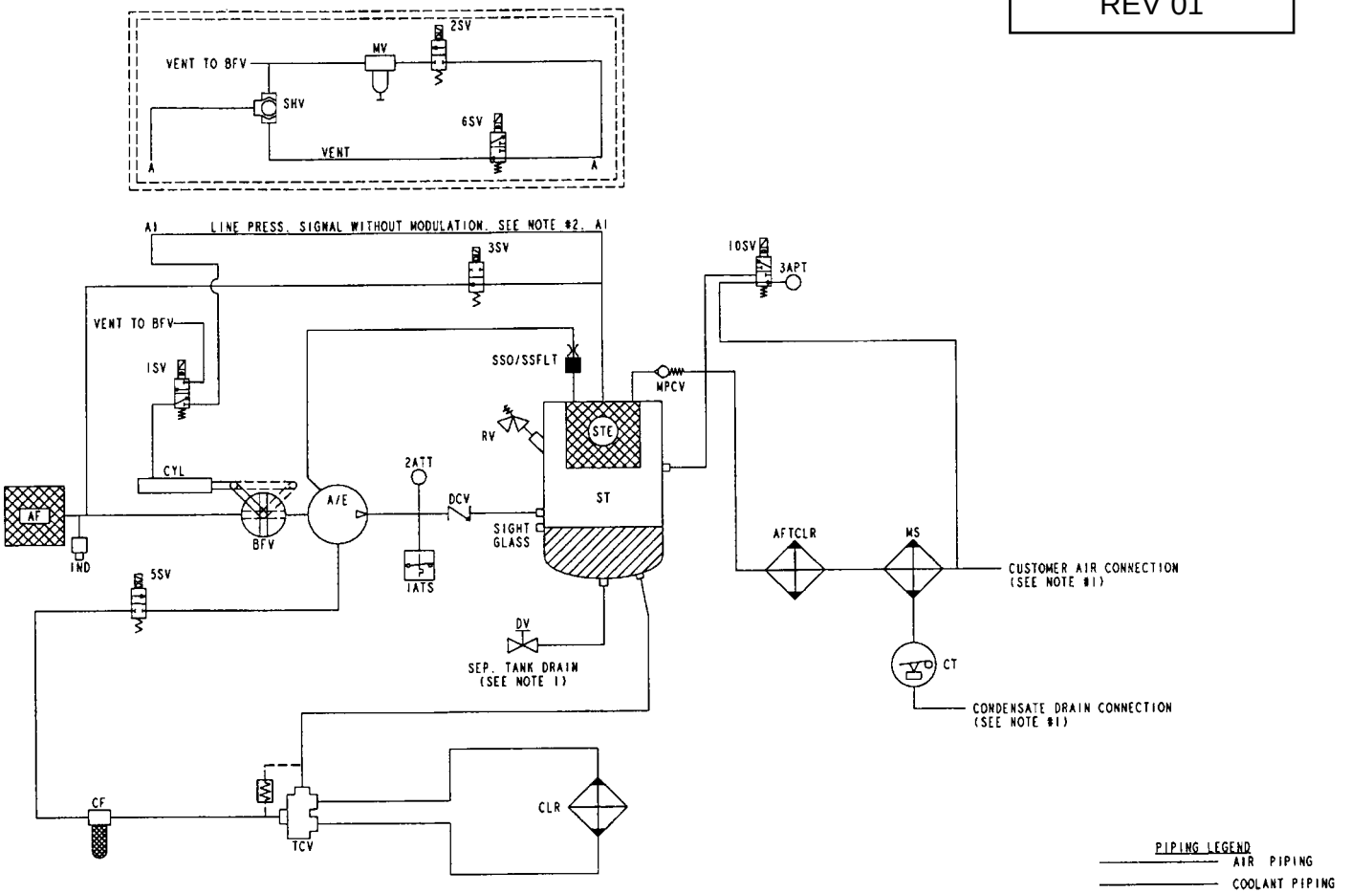
REV 01

LEGEND

ABBR	DESCRIPTION
A/E	AIREND
ST	SEPARATOR TANK
STE	SEPARATOR TANK ELEMENT
AF	INLET AIR FILTER
BFV	AIR INLET CONTROL VALVE
DCV	DISCHARGE CHECK VALVE
MPCV	MINIMUM PRESSURE CHECK VALVE
RV	SEPARATOR TANK RELIEF VALVE
CF	COOLANT FILTER
TCV	THERMOSTATIC CONTROL VALVE
DV	COOLANT DRAIN VALVE
1SV	LOAD SOLENOID VALVE
2SV	MODULATION SOLENOID VALVE(OPTIONAL)
3SV	BLOWDOWN SOLENOID VALVE
5SV	COOLANT STOP SOLENOID VALVE
6SV	MODULATION SOLENOID VALVE (OPTIONAL
10SV	LINE/SUMP SOLENOID VALVE
CLR	COOLANT COOLER
AFTCLR	AFTERCOOLER
MS	MOISTURE SEPARATOR
SSO	SEPARATOR TANK SCAVENGE ORIFICE
3APT	LINE/SUMP PRESSURE TRANDUCER
2ATT	AIREND DISCHARGE TEMPERATURE SENSOR
1ATS	HIGH AIR TEMPERATURE SWITCH
MV	MODULATION VALVE(OPTIONAL)
SHV	SHUTTLE VALVE (OPTIONAL)
CYL	PNEUMATIC CYLINDER
IND	MECHANICAL AIR FILTER INDICATOR
CT	CONDENSATE TRAP
SSFLT	ST SCAVENGE SCREEN AND ORIFICE



NOTES:

1. FOR CUSTOMER CONNECTION SIZES AND LOCATIONS SEE FOUNDATION PLAN OF UNIT.
2. COMPONENTS INSIDE DOUBLE LINES ARE FOR MODULATION ONLY. REMOVE LINE BETWEEN POINTS A1-A1 AND CONNECTS POINTS A TO A1 FOR MODULATION.

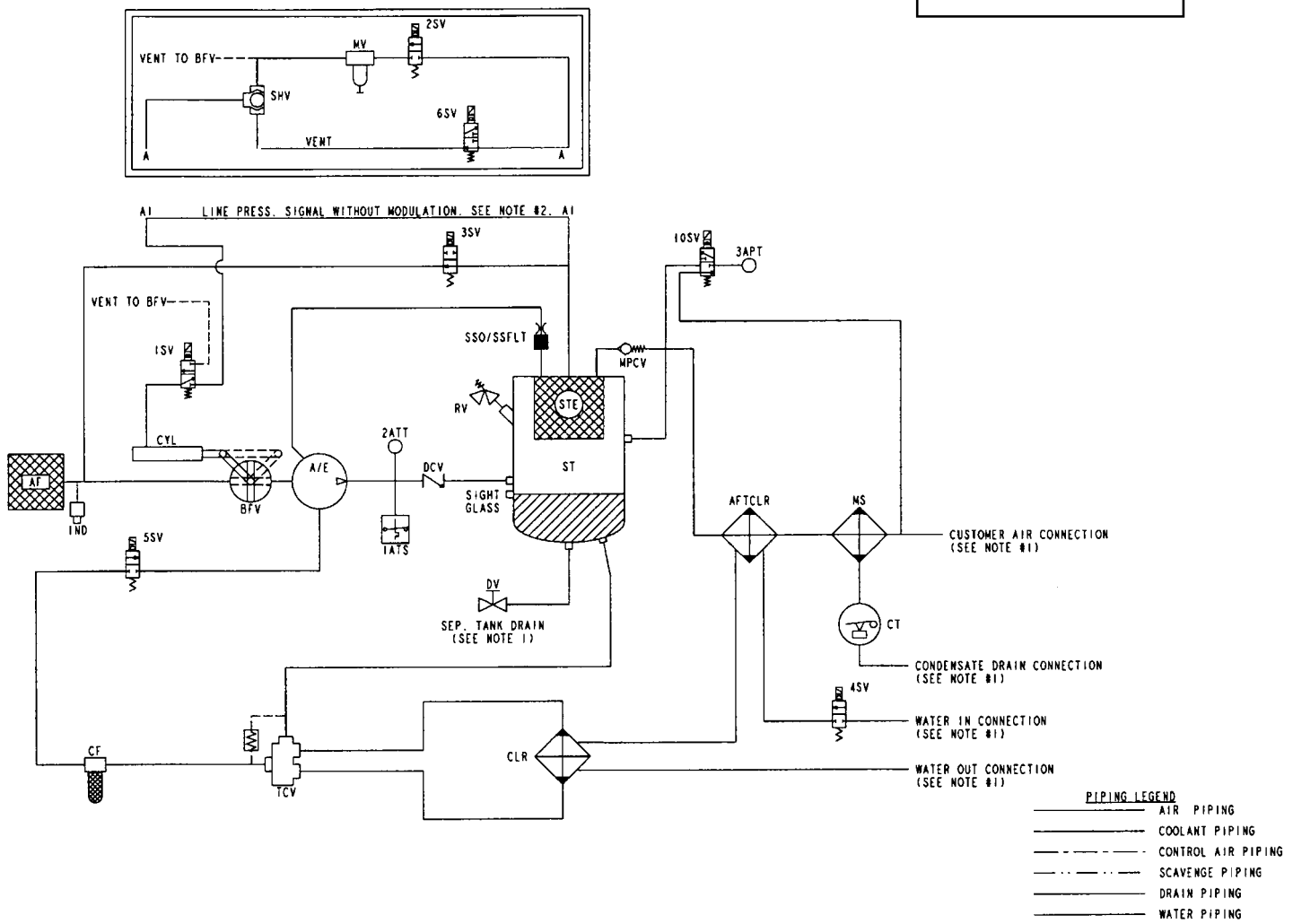
7.6 BASIC FLOW SCHEMATIC - AIR COOLED

7.7 BASIC FLOW SCHEMATIC - WATER COOLED

39899836
REV 01

LEGEND

ABBR	DESCRIPTION
A/E	AIREND
ST	SEPARATOR TANK
STE	SEPARATOR TANK ELEMENT
AF	INLET AIR FILTER
BFV	AIR INLET CONTROL VALVE
DCV	DISCHARGE CHECK VALVE
MPCV	MINIMUM PRESSURE CHECK VALVE
RV	SEPARATOR TANK RELIEF VALVE
CF	COOLANT FILTER
TCV	THERMOSTATIC CONTROL VALVE
DV	COOLANT DRAIN VALVE
1SV	LOAD SOLENOID VALVE
2SV	MODULATION SOLENOID VALVE(OPTIONAL)
3SV	BLOWDOWN SOLENOID VALVE
4SV	WATER SHUT OFF SOLENOID VALVE
5SV	COOLANT STOP SOLENOID VALVE
6SV	MODULATION SOLENOID VALVE (OPTIONAL
10SV	LINE/SUMP SOLENOID VALVE
CLR	COOLANT COOLER
AFTCLR	AFTERCOOLER
MS	MOISTURE SEPARATOR
SSO	SEPARATOR TANK SCAVENGE ORIFICE
3APT	LINE/SUMP PRESSURE TRANDUCER
2ATT	AIREND DISCHARGE TEMPERATURE SENSOR
1ATS	HIGH AIR TEMPERATURE SWITCH
MV	MODULATION VALVE(OPTIONAL)
SHV	SHUTTLE VALVE (OPTIONAL)
CYL	PNEUMATIC CYLINDER
IND	MECHANICAL AIR FILTER INDICATOR
CT	CONDENSATE TRAP
SSFLT	ST SCAVENGE SCREEN AND ORIFICE

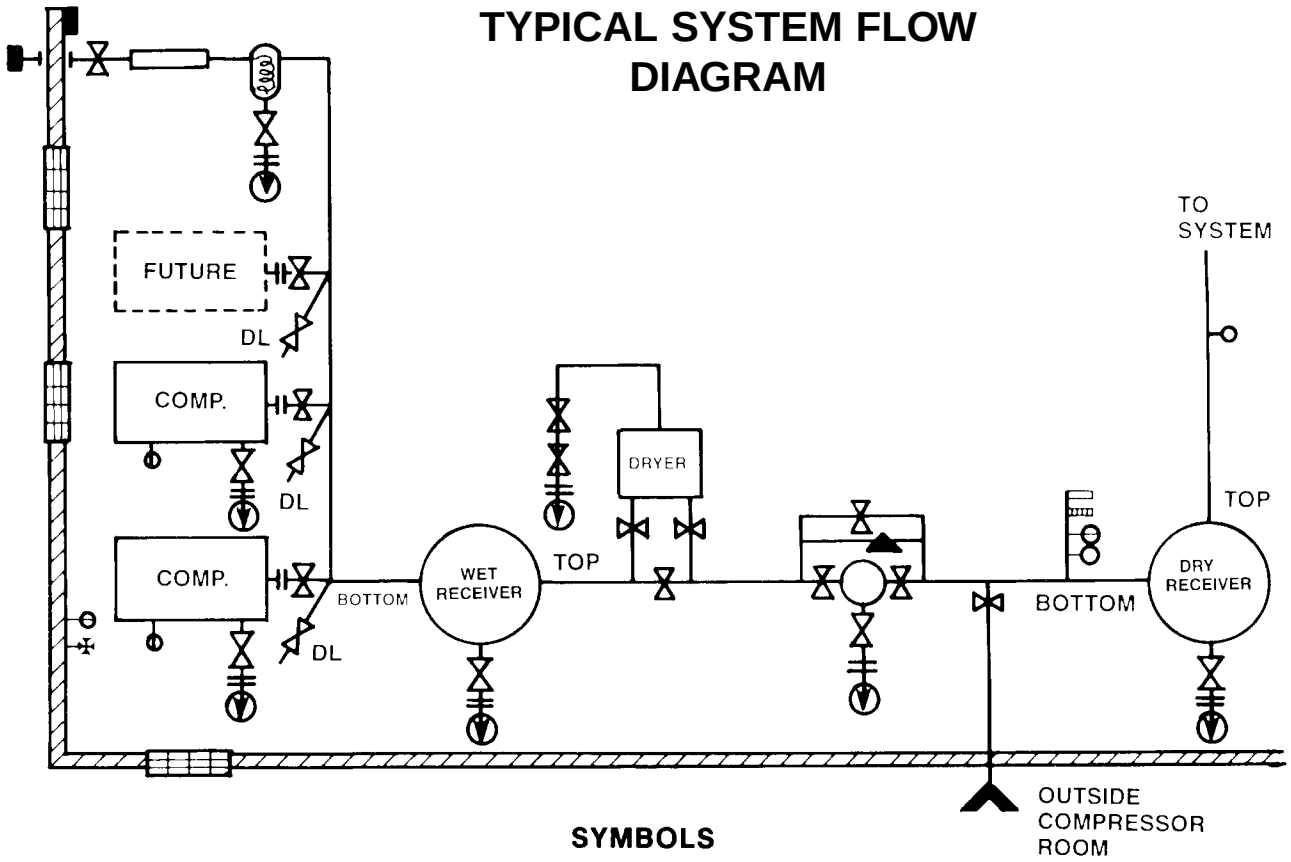


NOTES:

1. FOR CUSTOMER CONNECTION SIZES AND LOCATIONS SEE FOUNDATION PLAN OF UNIT.

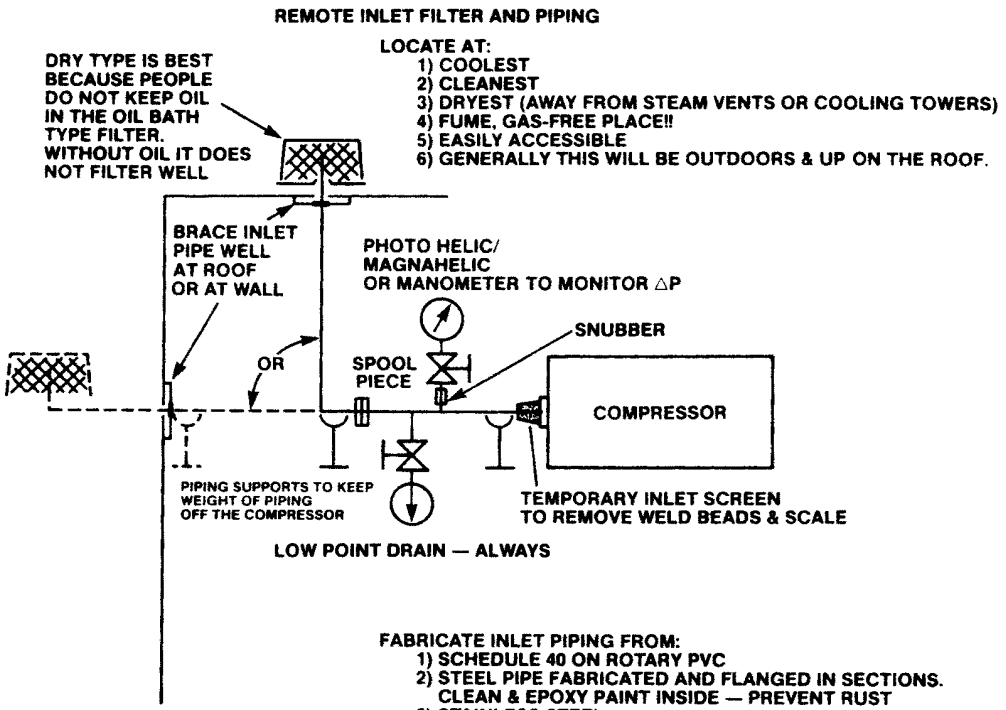
2. COMPONENTS INSIDE DOUBLE LINES ARE FOR MODULATION ONLY. REMOVE LINE BETWEEN POINTS A1-A1 AND CONNECTS POINTS A TO A1 FOR MODULATION.

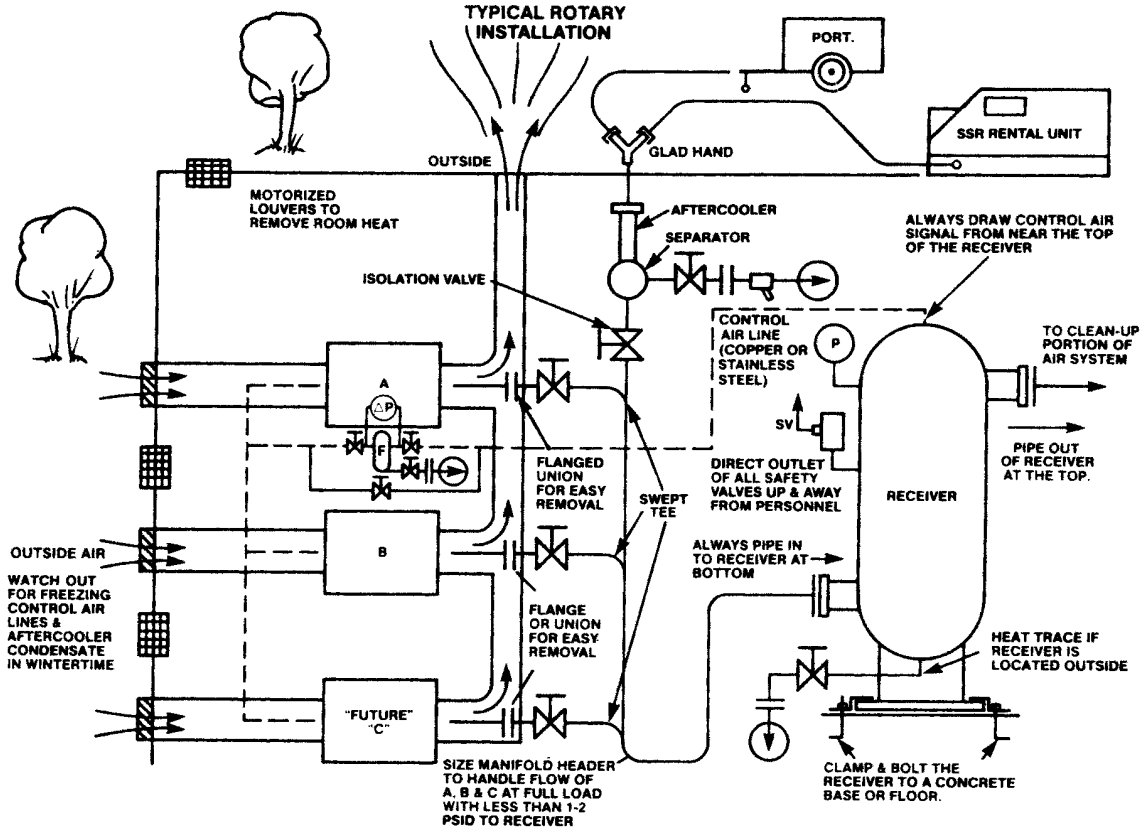
TYPICAL SYSTEM FLOW DIAGRAM



SYMBOLS

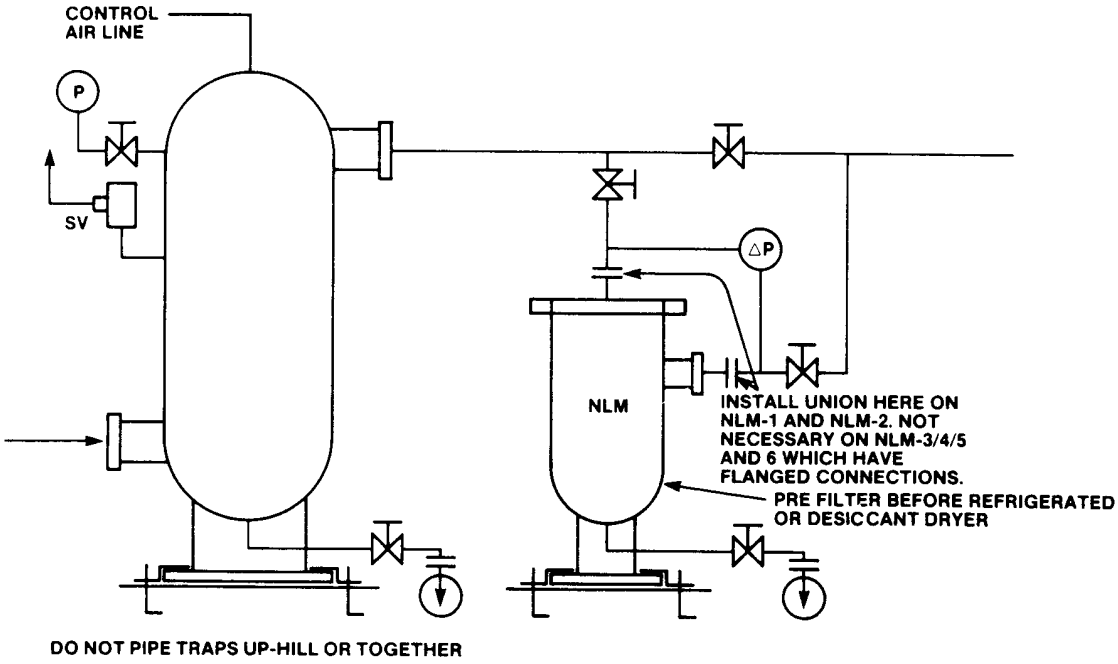
	GLADHAND	Emergency Standby Air Hook Up. Complete with Necessary Fitting for Portable or IR Rental Air Unit from Local IR Distributor
	VALVE	Water, Or Ball Type Valve
	UNION	Aids in Disconnecting Compressor from the System
	PRESSURE GAUGE	
	THERMOMETER	
DL	DRIP LEG	
	MANOMETER	
	DIFFERENTIAL PRESSURE INDICATOR	
	I-R AUTOMATIC DRAIN VALVE	
	FALSE LOADER	Blows off Air Outside of Compressor Room
	SYSTEM INSTRUMENTATION INCLUDES: Nephelometer; Hygrometer; Pressure; Temperature	
	VENTILATION	Motorized Louvers, Exhaust Fans
	AFTERCOOLER/SEPARATOR, ISOLATION VALVE, UNION, STRAINER AND TRAP	



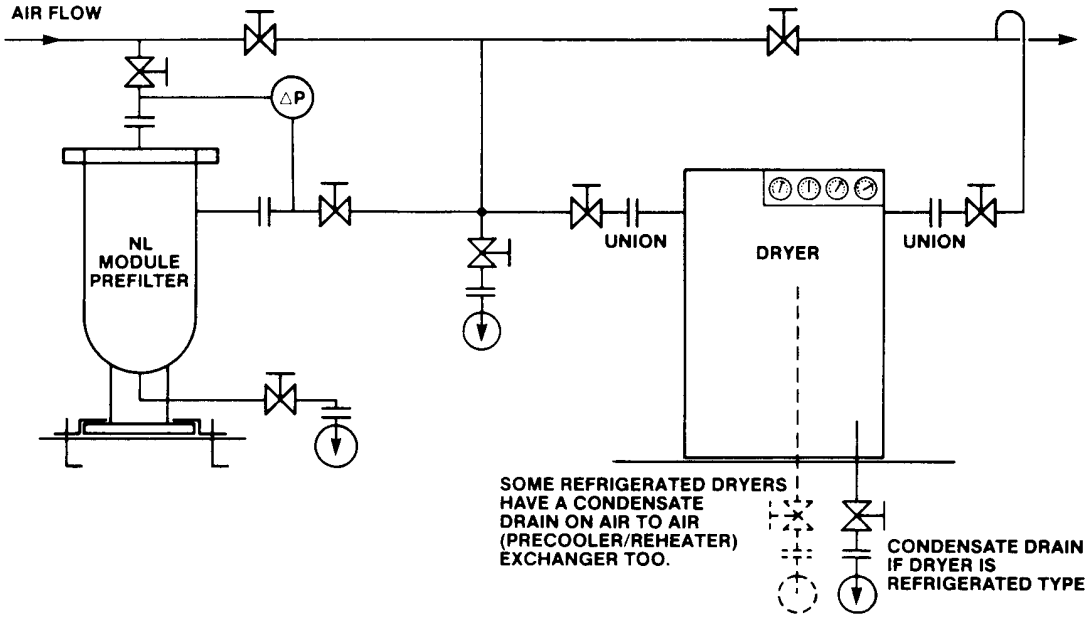


7.8 TYPICAL SYSTEM FLOW DIAGRAMS

RECEIVER AND NLM CLEANUP PIPING

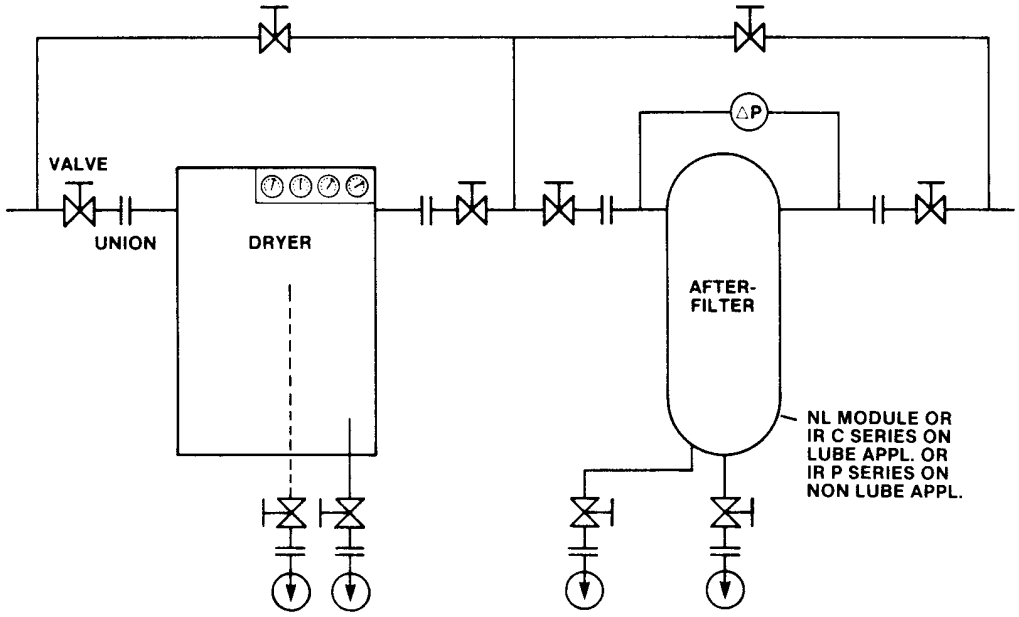


PRE-FILTER & DRYER WITH BLOCK & BYPASS

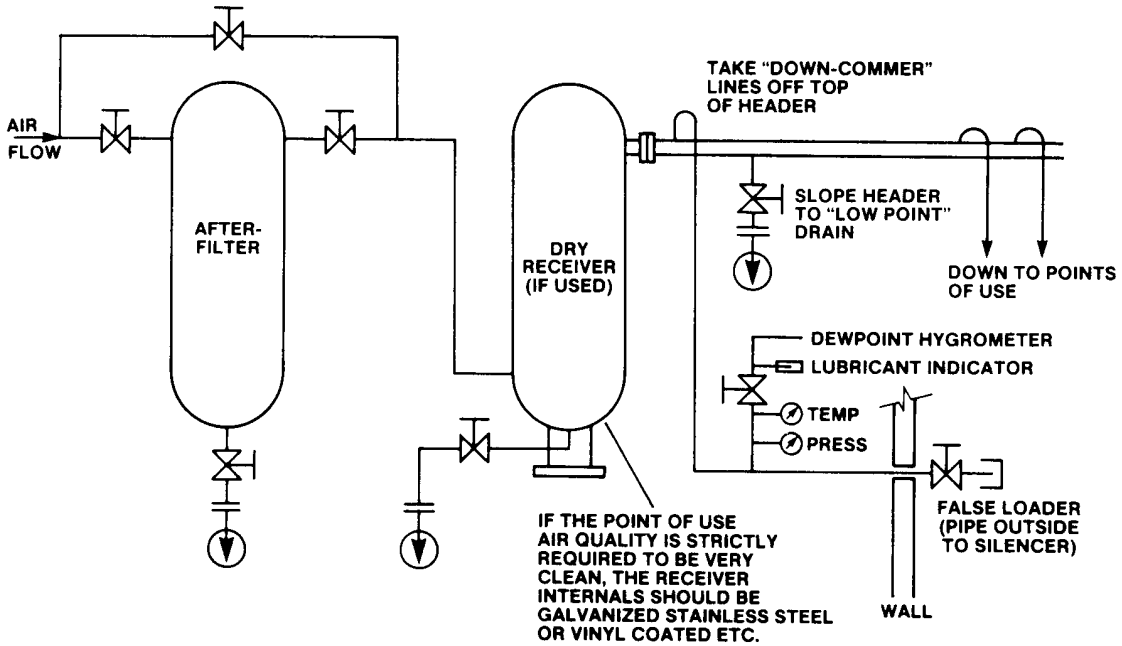


7.8 TYPICAL SYSTEM FLOW DIAGRAMS

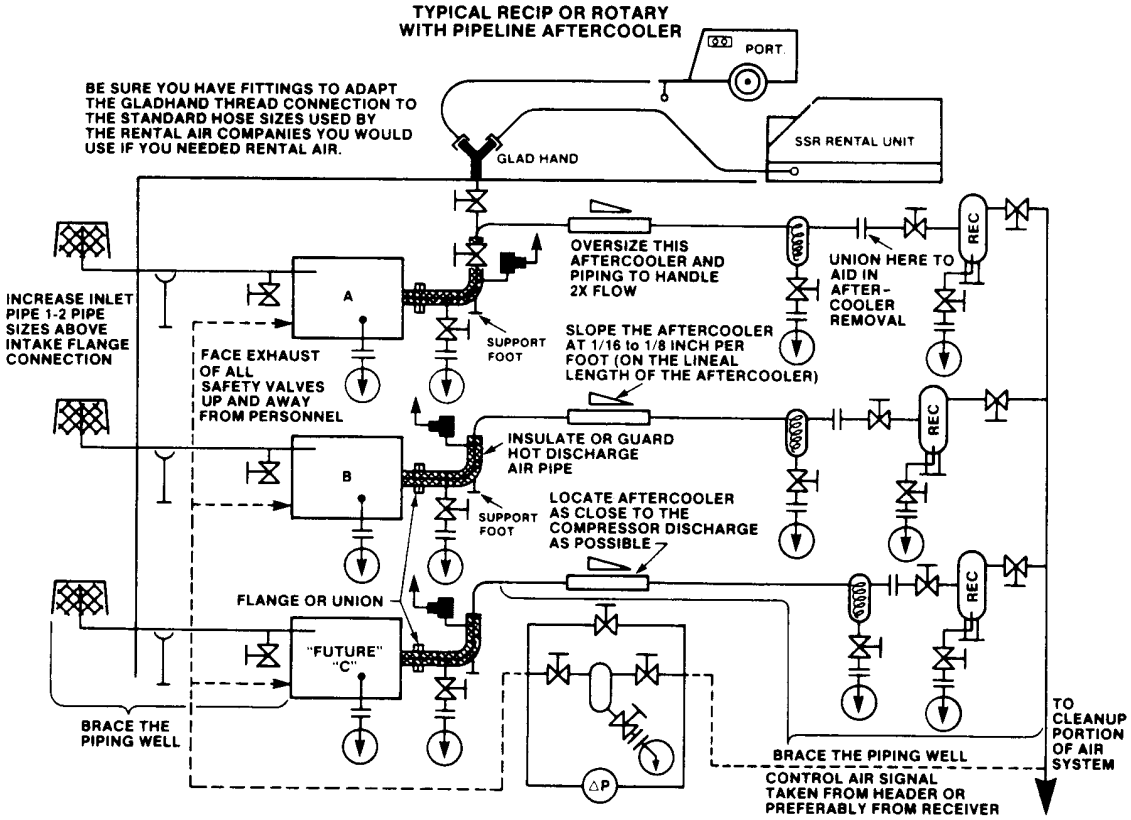
DRYER WITH POLISHING (NLM OR IR C SERIES) OR PARTICULATE IR P SERIES (FOR DESICCANT DRYERS)



DRY RECEIVER AND MONITORING DEVICES ON AIR QUALITY



7.8 TYPICAL SYSTEM FLOW DIAGRAMS



7.8 TYPICAL SYSTEM FLOW DIAGRAMS

8.0 WATER QUALITY RECOMMENDATIONS

Water quality is often overlooked when the cooling system of a water cooled air compressor is examined. Water quality determines how effective the heat transfer rate, as well as the flow rate will remain during the operation life of the unit. It should be noted that the quality of water used in any cooling system does not remain constant during the operation of the system. The water makeup is affected by evaporation, corrosion, chemical and temperature changes, aeration, scale, and biological formations. Most problems in a cooling system show up first in a reduction in the heat transfer rate, then in a reduced flow rate, and finally with damage to the system.

There are many constituents in the water system that must be balanced to have a good stable system. The following is a list of the major components that should be monitored:

SCALE
Scale formation inhibits effective heat transfer, yet it does help prevent corrosion. Therefore, a thin uniform coating of calcium carbonate is desired on the inner surfaces.

Perhaps the largest contributor to scale formation is the precipitation of calcium carbonate out of the water. This is dependent on temperature and pH. The higher the pH value the greater the chance of scale formation. Scale can be controlled with water treatment.

CORROSION
In contrast to scale formation is the problem of corrosion. Chlorides cause problems because of their size and conductivity. Low pH levels promote corrosion, as well as high levels of dissolved oxygen.

FOULING
Biological and organic substances (slime) can also cause problems, but in elevated temperature environments such as cooling processes, they are not major concerns. If they create problems with clogging, commercial shock treatments are available.

To ensure good operation life and performance of the compressor cooling system, the recommended acceptable ranges for different water constituents are included below:

PARAMETER	CONCENTRATION	FREQUENCY OF ANALYSIS
Corrosivity (hardness, pH, total dissolved solids, temperature at inlet, alkalinity)	Langelier Index 0 to 1	Monthly (if stable for 3 to 4 months, analyze quarterly)
Iron	< 2 ppm	Monthly
Sulfate	< 50 ppm	Monthly
Chloride	< 50 ppm	Monthly
Nitrate	< 2 ppm	Monthly
Silica	< 100 ppm	Monthly
Dissolved oxygen	0 ppm (as low as possible)	Daily (if stable, analyze weekly)
Oil and grease	< 5 ppm	Monthly
Ammonia	< 1 ppm	Monthly

Recommended equipment for on-site analysis includes a thermometer, pH meter, and dissolved oxygen meter. Dissolved oxygen and temperature must be measured on-site and it is recommended that pH be measured on-site. All other analyses should be performed by a professional water quality analyst. The Langelier Index (LI) is calculated using the following equation and the tables found on the following pages.

LI = pH - (9.30 + Total Dissolved Solids chart value + Temperature chart value) + Hardness chart valve + Alkalinity chart value)

The LI is zero when the water is in chemical balance. If the LI is greater than zero, there is a tendency to form scale. If the LI is less than zero, the water tends to be corrosive.

Dissolved oxygen may be controlled in closed cooling towers. Several types of treatments are commercially available to remove dissolved oxygen. For open cooling towers, dissolved oxygen is not an easily controlled parameter. Also, a filtration system is recommended for the water going into the air compressor when using an open cooling tower.

It should be noted that Ingersoll-Rand's guidelines and recommendations should be used in evaluating the water systems and the problems that may occur in the normal operation of our air compressors. If water problems persist or are not covered above, you should consult a professional.

LANGELIER INDEX CHART VALUES

Total dissolved solids (ppm)

TOTAL SOLIDS (PPM)	
50	.07
75	.08
100	.10
150	.11
200	.13
300	.14
400	.16
600	.18
800	.19
1000	.20

Temperature (°F)

TENS \ UNITS	0	2	4	6	8
30		2.60	2.67	2.54	2.81
40	2.48	2.45	2.43	2.40	2.37
50	2.34	2.31	2.28	2.25	2.22
60	2.20	2.17	2.14	2.11	2.09
70	2.06	2.04	2.03	2.00	1.97
80	1.95	1.92	1.90	1.88	1.86
90	1.84	1.82	1.80	1.78	1.76
100	1.74	1.72	1.71	1.09	1.67
110	1.05	1.64	1.62	1.60	1.58
120	1.67	1.63	1.53	1.51	1.50
130	1.48	1.46	1.44	1.43	1.41
140	1.40	1.38	1.37	1.35	1.34
150	1.32	1.31	1.29	1.28	1.27
160	1.26	1.24	1.23	1.22	1.21
170	1.19	1.18	1.17	1.10	

Hardness (ppm)

TENS \ UNITS	0	1	2	3	4	5	6	7	8	9
0				0.08	0.20	0.30	0.38	0.43	0.51	0.56
10	0.60	0.64	0.68	0.72	0.73	0.78	0.81	0.83	0.86	0.88
20	0.90	0.92	0.94	0.96	0.98	1.00	1.02	1.03	1.05	1.06
30	1.08	1.09	1.11	1.12	1.13	1.15	1.16	1.17	1.18	1.19
40	1.20	1.21	1.23	1.24	1.25	1.26	1.26	1.27	1.28	1.29
50	1.30	1.31	1.32	1.33	1.34	1.34	1.35	1.36	1.37	1.37
60	1.38	1.39	1.39	1.40	1.41	1.42	1.42	1.43	1.43	1.44
70	1.45	1.45	1.46	1.47	1.47	1.48	1.48	1.49	1.49	1.50
80	1.51	1.51	1.52	1.52	1.53	1.53	1.54	1.54	1.55	1.55
90	1.56	1.56	1.57	1.57	1.58	1.58	1.58	1.59	1.59	1.60
100	1.60	1.61	1.61	1.61	1.62	1.62	1.63	1.63	1.64	1.64
110	1.64	1.65	1.65	1.66	1.66	1.66	1.67	1.67	1.67	1.68
120	1.68	1.68	1.69	1.69	1.70	1.70	1.70	1.71	1.71	1.71
130	1.72	1.72	1.72	1.73	1.73	1.73	1.74	1.74	1.74	1.75
140	1.75	1.75	1.75	1.76	1.76	1.76	1.77	1.77	1.77	1.78
150	1.78	1.78	1.78	1.79	1.79	1.79	1.80	1.80	1.80	1.80
160	1.81	1.81	1.81	1.81	1.82	1.82	1.82	1.82	1.83	1.83
170	1.83	1.84	1.84	1.84	1.84	1.85	1.85	1.85	1.85	1.85
180	1.86	1.86	1.86	1.86	1.87	1.87	1.87	1.87	1.88	1.88
190	1.88	1.88	1.89	1.89	1.89	1.89	1.89	1.90	1.90	1.90
200	1.90	1.91	1.91	1.91	1.91	1.91	1.92	1.92	1.92	1.92

HUNDREDS \ TENS	0	10	20	30	40	50	60	70	80	90
200		1.92	1.94	1.96	1.98	2.00	2.02	2.03	2.03	2.06
300	2.08	2.09	2.11	2.12	2.13	2.13	2.16	2.17	2.18	2.19
400	2.20	2.21	2.23	2.24	2.23	2.26	2.26	2.27	2.28	2.29
500	2.30	2.31	2.32	2.33	2.34	2.34	2.35	2.36	2.37	2.37
600	2.38	2.39	2.39	2.40	2.41	2.42	2.42	2.43	2.43	2.44
700	2.45	2.45	2.46	2.47	2.47	2.48	2.48	2.49	2.49	2.50
800	2.51	2.51	2.52	2.52	2.53	2.53	2.54	2.54	2.55	2.55
900	2.56	2.56	2.57	2.57	2.58	2.58	2.58	2.59	2.60	2.60

Alkalinity (ppm)

TENS \ UNITS	0	1	2	3	4	5	6	7	8	9
0		0.00	0.30	0.48	0.60	0.70	0.78	0.85	0.90	0.93
10	1.00	1.04	1.08	1.11	1.15	1.18	1.20	1.23	1.26	1.29
20	1.30	1.32	1.34	1.36	1.38	1.40	1.42	1.43	1.45	1.46
30	1.48	1.49	1.51	1.52	1.53	1.54	1.56	1.67	1.58	1.59
40	1.60	1.61	1.62	1.63	1.64	1.65	1.66	1.67	1.68	1.69
50	1.70	1.71	1.72	1.72	1.73	1.74	1.75	1.76	1.76	1.77
60	1.78	1.79	1.79	1.80	1.81	1.81	1.82	1.83	1.83	1.84
70	1.85	1.85	1.86	1.86	1.87	1.88	1.88	1.89	1.89	1.90
80	1.90	1.91	1.91	1.92	1.92	1.93	1.93	1.94	1.94	1.95
90	1.95	1.96	1.96	1.97	1.97	1.98	1.98	1.99	1.99	2.00
100	2.00	2.00	2.01	2.01	2.02	2.02	2.03	2.03	2.03	2.04
110	2.04	2.05	2.05	2.05	2.06	2.06	2.06	2.07	2.07	2.08
120	2.08	2.08	2.09	2.09	2.09	2.10	2.10	2.10	2.11	2 11
130	2.11	2.12	2.12	2.12	2.13	2.13	2.13	2.14	2.14	2.14
140	2.15	2.15	2.15	2.16	2.16	2.16	2.16	2.17	2.17	2.17
150	2.18	2.18	2.18	2.18	2.19	2.19	2.19	2.20	2.20	2.20
160	2.20	2.21	2.21	2.21	2.21	2.22	2.22	2.23	2.23	2.23
170	2.23	2.23	2.23	2.24	2.24	2.24	2.24	2.25	2.25	2.25
180	2.26	2.26	2.26	2.26	2.26	2.27	2.27	2.27	2.27	2.28
190	2.28	2.28	2.28	2.29	2.29	2.29	2.29	2.29	2.30	2.30
200	2.30	2.30	2.30	2.31	2.31	2.31	2.31	2.32	2.32	2.32

HUNDREDS \ TENS	0	10	20	30	40	50	60	70	80	90
200		2.32	2.34	2.36	2.38	2.40	2.42	2.43	2.43	2.46
300	2.48	2.49	2.51	2.52	2.53	2.54	2.56	2.57	2.58	2.59
400	2.60	2.61	2.62	2.63	2.64	2.65	2.66	2.67	2.68	2.69
500	2.70	2.71	2.72	2.72	2.73	2.74	2.75	2.76	2.76	2.77
600	2.78	2.79	2.79	2.80	2.81	2.81	2.82	2.83	2.83	2.84
700	2.85	2.85	2.86	2.86	2.87	2.88	2.88	2.89	2.89	2.90
800	2.90	2.91	2.91	2.92	2.92	2.93	2.93	2.94	2.94	2.95
900	2.95	2.96	2.96	2.97	2.97	2.98	2.98	2.99	2.99	3.00

9.0 MAINTENANCE RECORD

DATE	RUN TIME (HOURS)	WORK DONE	QTY.	UNIT MEASURE	WORK BY

MAINTENANCE RECORD

DATE	RUN TIME (HOURS)	WORK DONE	QTY.	UNIT MEASURE	WORK BY

MAINTENANCE RECORD

DATE	RUN TIME (HOURS)	WORK DONE	QTY.	UNIT MEASURE	WORK BY

MAINTENANCE RECORD

DATE	RUN TIME (HOURS)	WORK DONE	QTY.	UNIT MEASURE	WORK BY