Ingersoll Rand

125-200 HP/90-160 KW SINGLE STAGE AND 100-200 HP/75-160 KW TWO STAGE UNITS

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.

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Phone: 1-800-526-3615

CCN: 80440415 REV: B

FORM: APDD 738B
November 2002

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.

Note that this is Ingersoll-Rand's standard warranty. Any warranty in force at the time of purchase of the compressor or negotiated as part of the purchase order may take precendence over this warranty.

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: _____

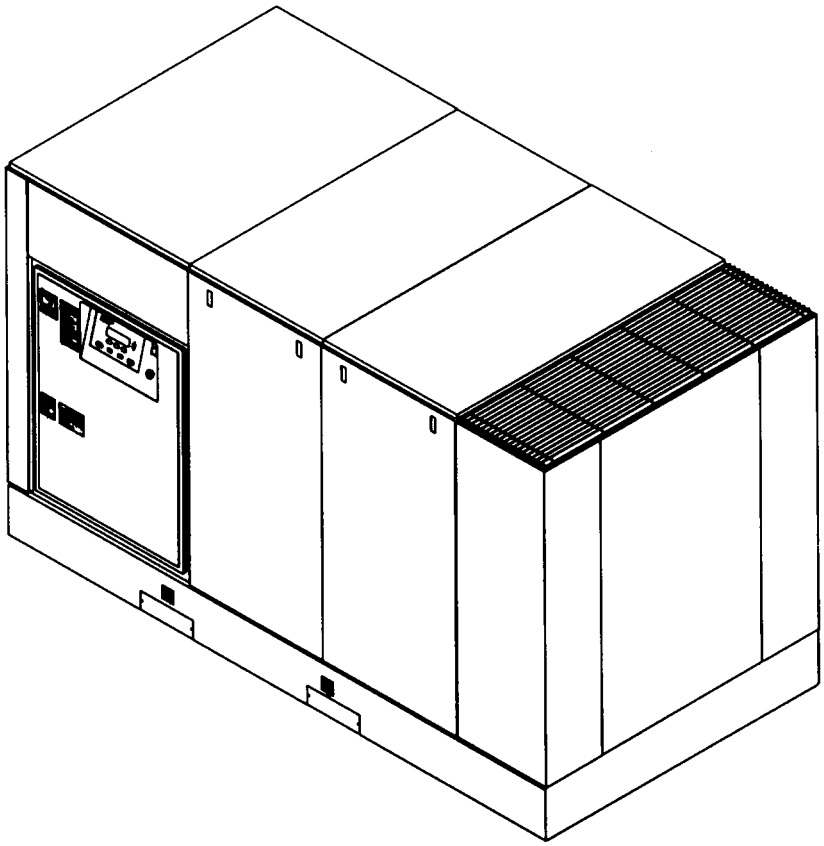


TABLE OF CONTENTS

Weight ..... **See foundation plan, Section 8.0**

Cooling Air Flow ..... **See foundation plan, Section 8.0**

Ambient Temperature Limits ..... **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
125/200 HP (90-160 KW) -
Single Stage ..... **23.0 gallons (87.4 liters)**
100 HP (75 KW) -
Two Stage ..... **22.0 gallons (83.3 liters)**
125-200 HP (90-160 KW) -
Two Stage ..... **30.0 gallons (113.6 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 DISCH TEMP” and flash “ALARM”.

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.

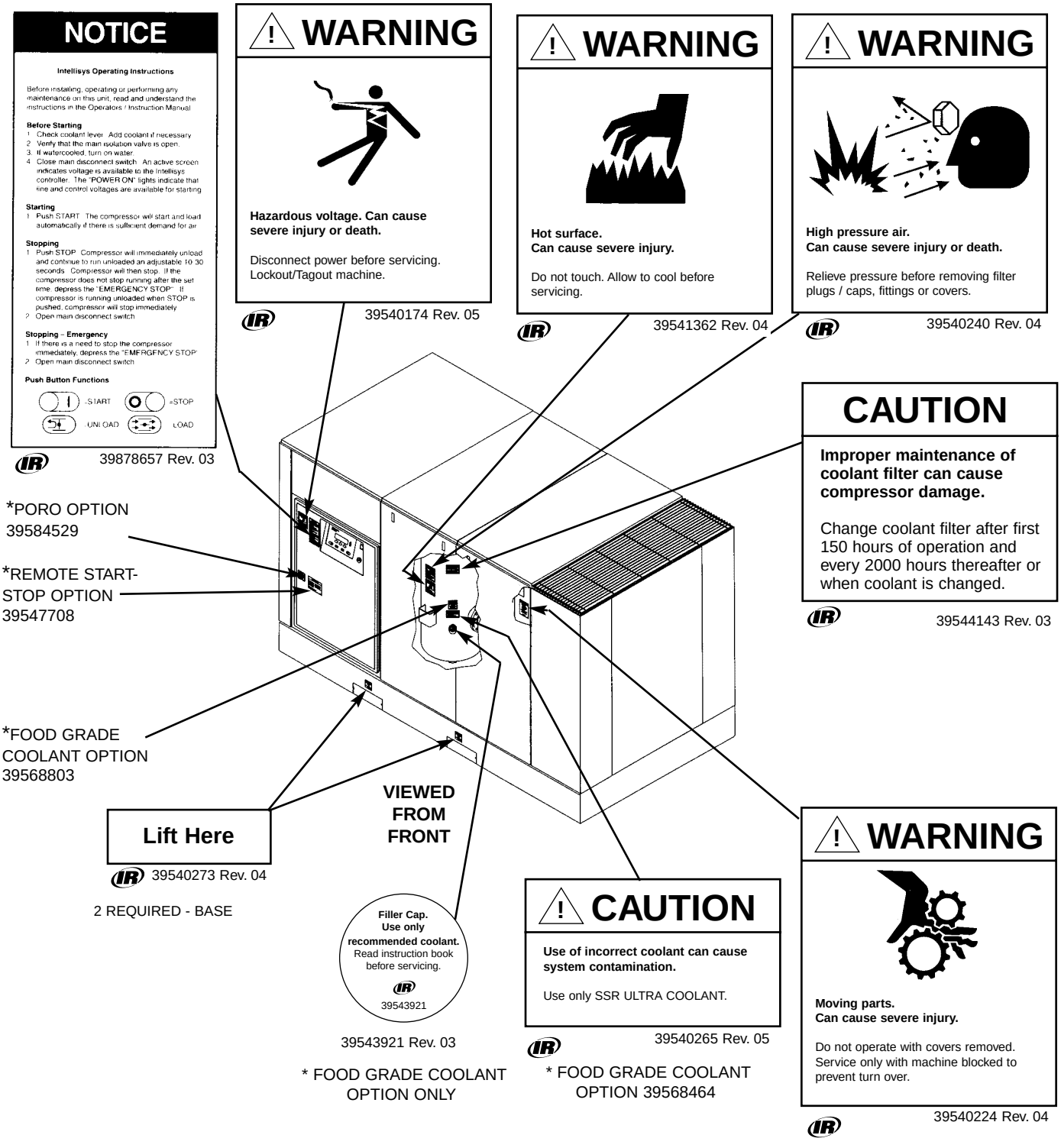
It is the responsibility of the installer and owner to provide the appropriate service pipework to and from the machine.

⚠ WARNING

“Ingersoll-Rand air compressors are not designed, intended, or approved for breathing air. 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 735 for single stage and Form APDD 736 for two stage units.



*ITEMS MARKED WITH * ARE OPTIONS THAT ARE AVAILABLE

0.3 DECALS (continued)

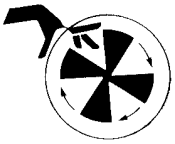
⚠ WARNING

Moving parts.
Can cause severe injury.

Do not operate with covers removed. Service only with machine blocked to prevent turn over.

39540224 Rev. 04

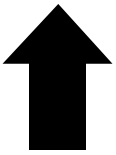
⚠ WARNING



Exposed fan blade. Can cause severe injury.

Do not operate with covers removed. Disconnect power. Lock and tag.

39540190 Rev. 04



Rotation.

39540182 Rev. 04

54425996 Rev.C (75-160KW)

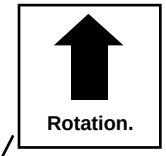
39557095 Rev.05 (100-200 HP)

⚠ WARNING

Hot surface.
Can cause severe injury.

Do not touch. Allow to cool before servicing.

39541362 Rev. 04



Rotation.

39544150 Rev. 03

Air Discharge

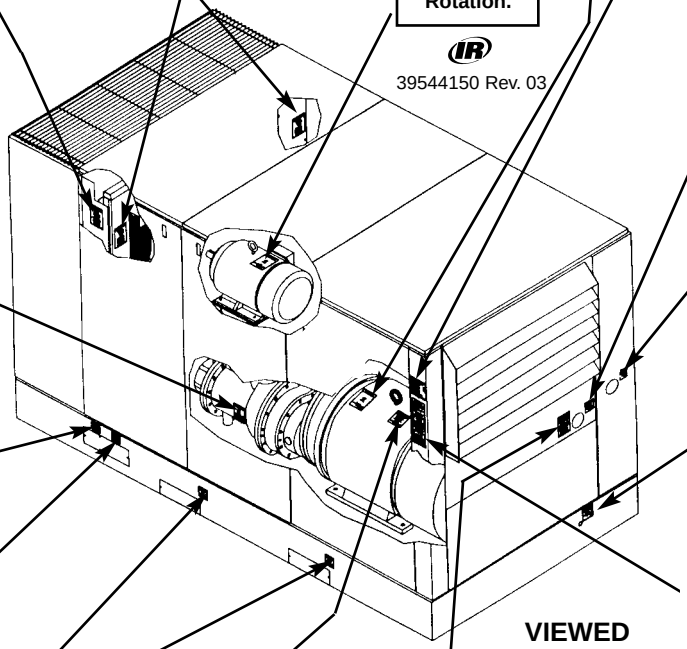
39540257 Rev. 04

Electrical power inlet.

39541354 Rev. 03

Condensate drain.

39541081 Rev. 04



* **Water out.**

39541321 Rev. 04

* **Water in.**

39541339 Rev. 03

Lift Here

39540273 Rev. 04

⚠ CAUTION

Incorrect lifting of machine can cause injury or property damage.

Lift only from base channels.

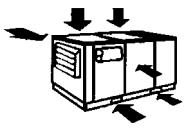
39540232 Rev.03

VIEWED FROM REAR

NOTICE

To obtain satisfactory compressor operation and maintenance a minimum of 3 feet clearance on 3 sides is required 3-1/2 feet is required in front of the control panel (or minimum required by latest National Electrical code or applicable local codes).

Refer to the Instruction / Operators Manual before any maintenance.



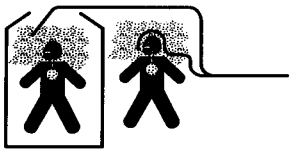
Do not operate without enclosure panels and forklift covers in place.

Enclosure panels will affect performance.

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

39857552 Rev. 04

⚠ DANGER



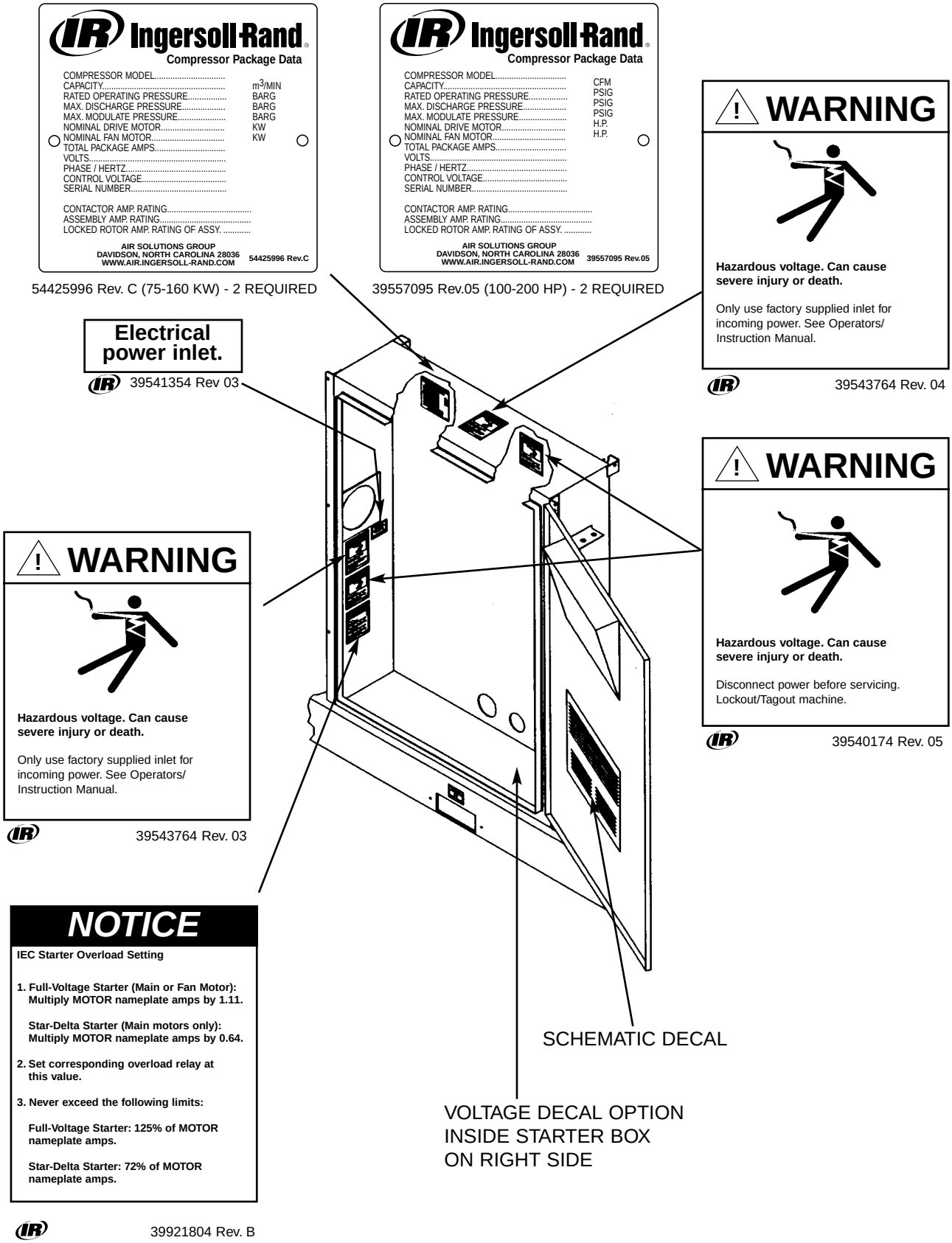
Discharge air.
Can contain carbon monoxide or other contaminants. Will cause severe injury or death.

Do not breathe this air.

39540166 Rev. 06

* WATERCOOLED UNITS ONLY

0.3 DECALS (continued)



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

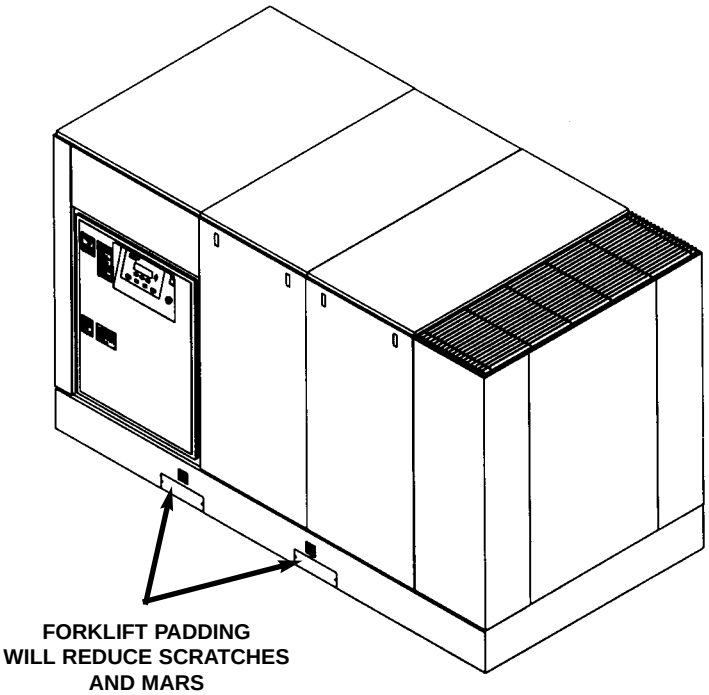
If goods are received short or in damaged condition, it is important that you notify the carrier and insist on a notation of the loss or damage across the face of the freight bill. Otherwise no claim can be enforced against the transportation company.

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.

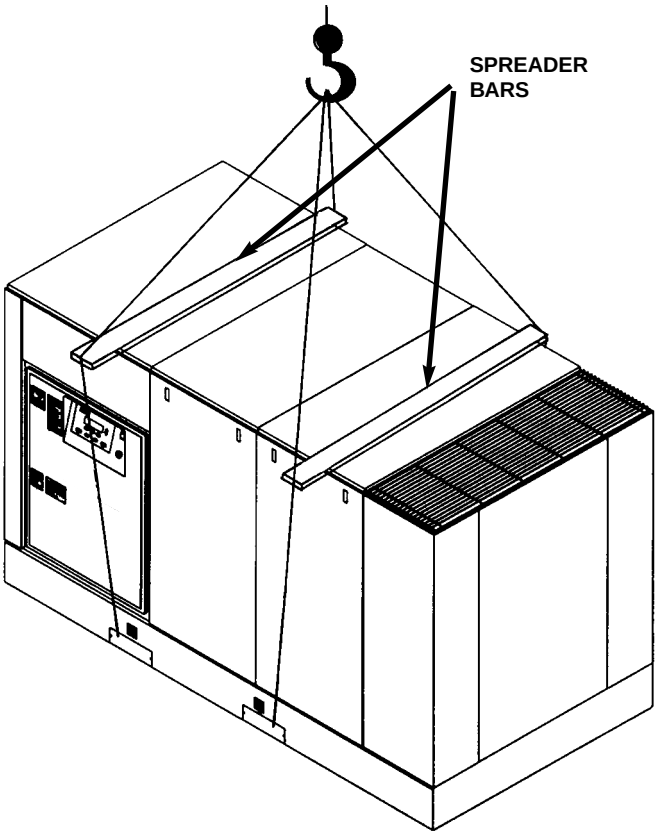
WE, AT I-R, ARE WILLING TO ASSIST YOU IN EVERY POSSIBLE MANNER TO COLLECT CLAIMS FOR LOSS OR DAMAGE, BUT THE WILLINGNESS ON OUR PART DOES NOT MAKE US RESPONSIBLE FOR COLLECTION OF CLAIMS OR REPLACEMENT OF MATERIAL. THE ACTUAL FILING AND PROCESSING OF THE CLAIM IS YOUR RESPONSIBILITY.

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.

IMPORTANT

Before starting this air compressor unit, the shipping brace(s) must be removed. Save the brace(s) for future use.

See tag in unit.

2.0 INSTALLATION

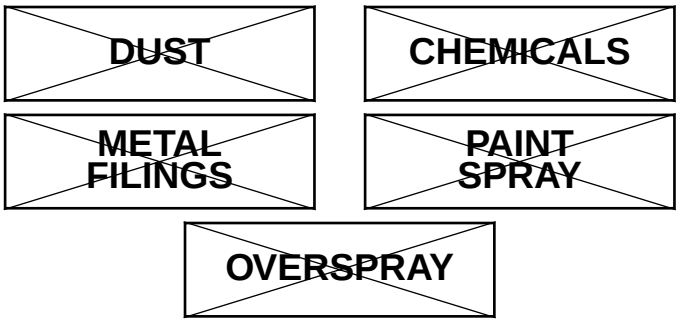
2.1 VENTILATION

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 control panel.

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

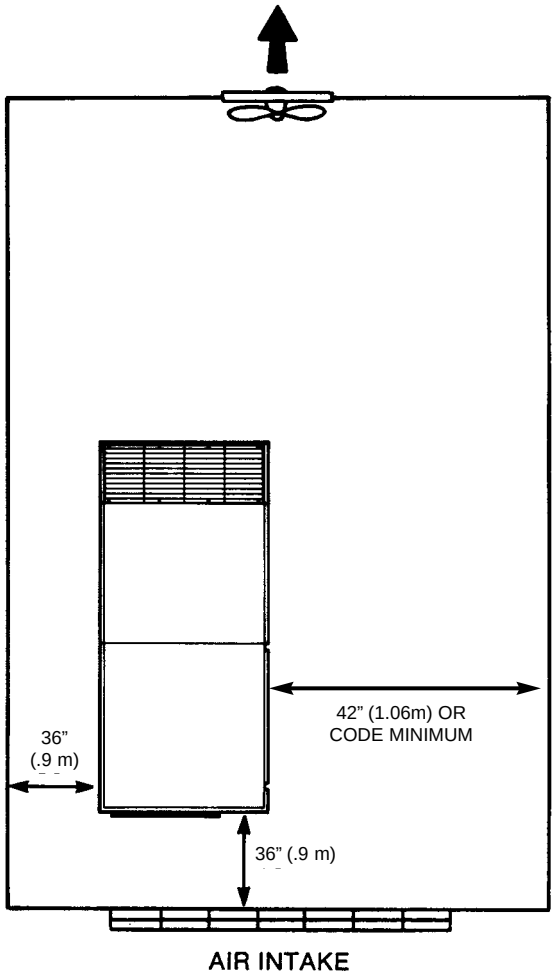
Refer to the foundation plan for the particular model compressor to be installed. See Section 8.0.

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 in the base.

IMPORTANT: The drain line must slope downward from the base 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.

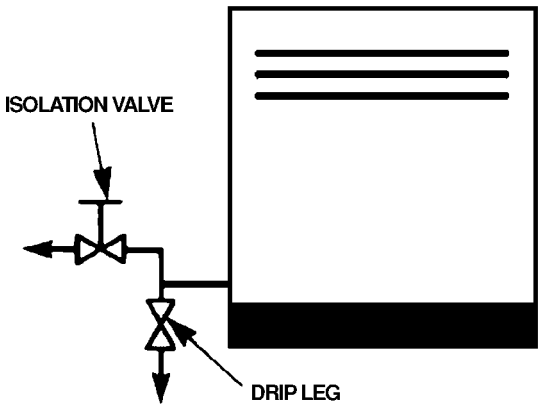
Careful review of piping size from the compressor connection point is essential. Length of pipe, size of pipe, number and type of fittings and valves must be considered for optimum efficiency of your compressor.

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.

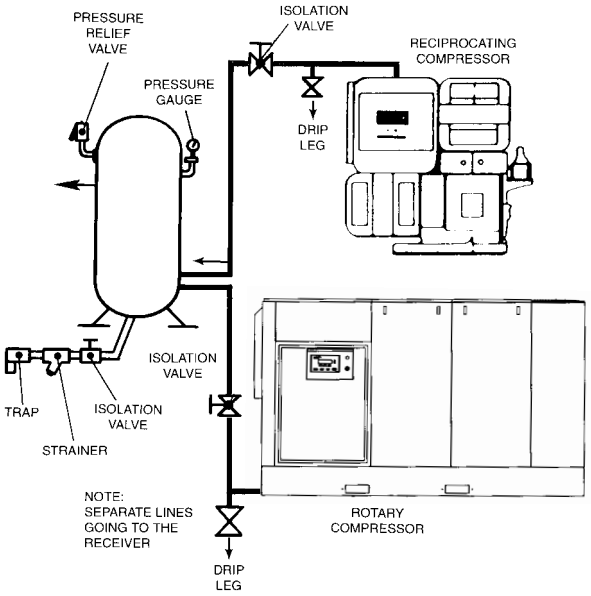
Liquid water occurs naturally in air lines as a result of compression. Moisture vapor in ambient air is concentrated when pressurized and condenses when cooled in downstream air piping.

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.

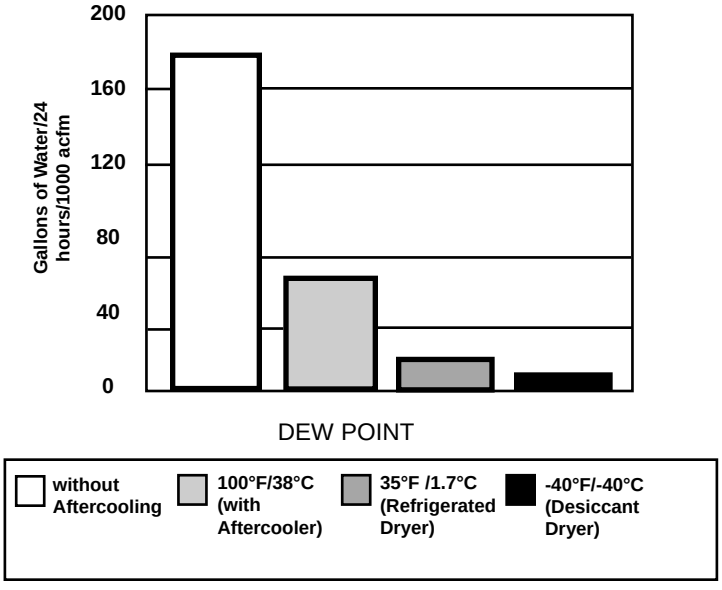
Compressed air dryers reduce the water vapor concentration and prevent liquid water formation in compressed air lines. Dryers are a necessary companion to filters, aftercoolers, and automatic drains for improving the productivity of compressed air systems.



DISCHARGE PIPING WITH AFTERCOOLER



ROTARY-RECIP IN PARALLEL



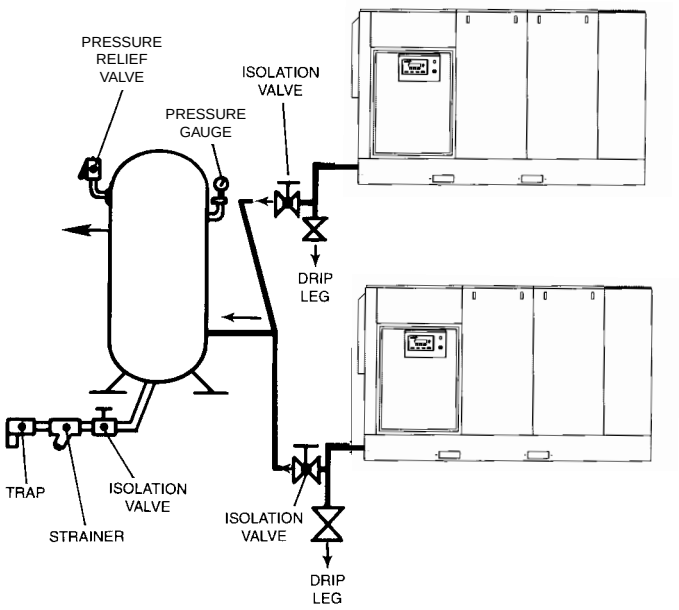
MOISTURE CONTENT OF COMPRESSED AIR

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.



ROTARY TWO COMPRESSOR SYSTEM

2.4 ELECTRICAL INSTALLATION

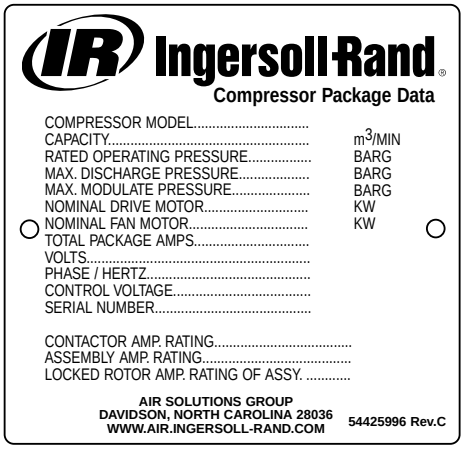
Before proceeding further, we recommend that you review the safety data in the front of this manual.

Locate the compressor data plate on the side of the cooler box or end 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.

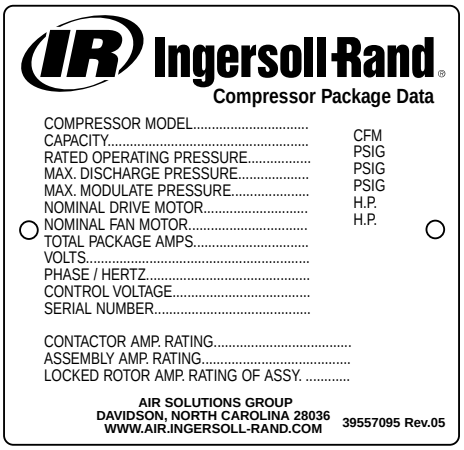
Open the starter box door. Confirm that all electrical connections are made and tightened. Confirm that the control transformer is wired correctly for supply voltage. See Figure 2.4-1 on next page for typical control transformer wiring.


Ingersoll-Rand
Compressor Package Data

COMPRESSOR MODEL	
CAPACITY	m^3/MIN
RATED OPERATING PRESSURE	BARG
MAX. DISCHARGE PRESSURE	BARG
MAX. MODULATE PRESSURE	BARG
NOMINAL DRIVE MOTOR	KW
NOMINAL FAN MOTOR	KW
TOTAL PACKAGE AMPS	
VOLTS	
PHASE / HERTZ	
CONTROL VOLTAGE	
SERIAL NUMBER	
CONTACTOR AMP. RATING	
ASSEMBLY AMP. RATING	
LOCKED ROTOR AMP. RATING OF ASSY.	

AIR SOLUTIONS GROUP
DAVIDSON, NORTH CAROLINA 28036
WWW.AIR.INGERSOLL-RAND.COM
54425996 Rev.C

54425996 Rev. C (75-160 KW)


Ingersoll-Rand
Compressor Package Data

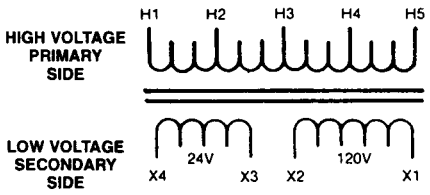
COMPRESSOR MODEL	
CAPACITY	CFM
RATED OPERATING PRESSURE	PSIG
MAX. DISCHARGE PRESSURE	PSIG
MAX. MODULATE PRESSURE	PSIG
NOMINAL DRIVE MOTOR	H.P.
NOMINAL FAN MOTOR	H.P.
TOTAL PACKAGE AMPS	
VOLTS	
PHASE / HERTZ	
CONTROL VOLTAGE	
SERIAL NUMBER	
CONTACTOR AMP. RATING	
ASSEMBLY AMP. RATING	
LOCKED ROTOR AMP. RATING OF ASSY.	

AIR SOLUTIONS GROUP
DAVIDSON, NORTH CAROLINA 28036
WWW.AIR.INGERSOLL-RAND.COM
39557095 Rev.05

39557095 Rev.05 (100-200 HP)

Line Volts	Hz	Primary Line	Secondary Volts	Secondary Line
200	60	H4-H5	120	X1-X2
			24	X3-X4
230	60	H3-H5	120	X1-X2
			24	X3-X4
460	60	H2-H5	120	X1-X2
			24	X3-X4
575	60	H1-H5	120	X1-X2
			24	X3-X4

CONTROL TRANSFORMER (T1) CONNECTIONS, 60 HZ

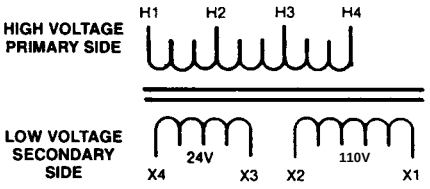


TRANSFORMER (T1) TERMINALS, 60 HZ

***TYPICAL 60 HZ CONTROL TRANSFORMER**

Line Volts	Hz	Primary Line	Secondary Volts	Secondary Line
380	50	H3-H4	110	X1-X2
			24	X3-X4
415	50	H2-H4	110	X1-X2
			24	X3-X4
550	50	H1-H4	110	X1-X2
			24	X3-X4

CONTROL TRANSFORMER (T1) CONNECTIONS , 50HZ



TRANSFORMER (T1) TERMINALS, 50 HZ

***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.

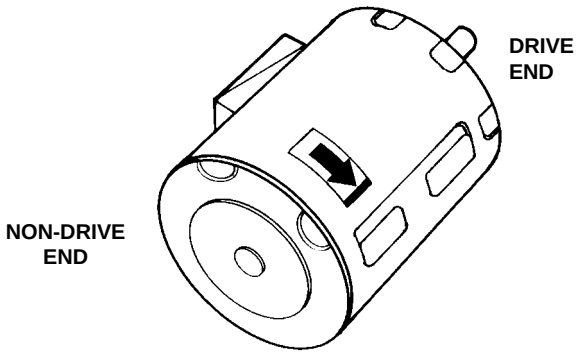


FIGURE 2.4-2 DRIVE MOTOR ROTATION

ELECTRICAL INSTALLATION (Continued)
The Intellisys will automatically shut the unit down if the compressor rotation is incorrect, and the display will indicate “CHECK MOTOR ROTATION” and will flash “ALARM”.

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.

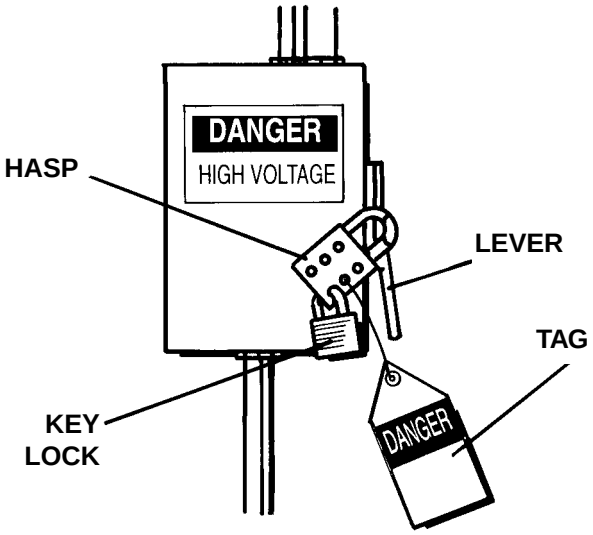


FIGURE 2.4-3 MAIN DISCONNECT LOCKED AND TAGGED

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.

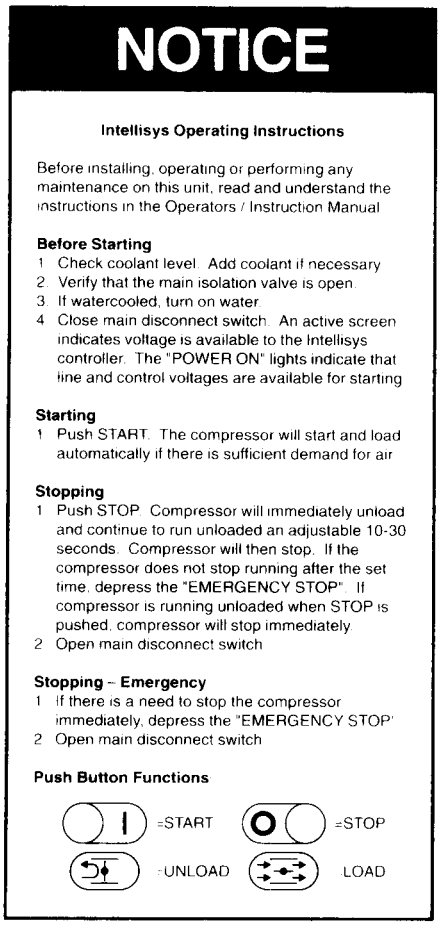
Should the motor rotation not be correct, put the main disconnect in the OFF position, lock and tag.

Interchange any two fan motor leads at the fan motor manual starter (MMS). 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 the main isolation valve is open.
3. If watercooled, turn on water.
4. Close main disconnect switch. An active screen indicates voltage is available to the Intellisys controller. The "POWER ON" lights indicate that line and control voltages are available for starting

Starting
1. Push START. The compressor will start and load automatically if there is sufficient demand for air

Stopping
1. Push STOP. Compressor will immediately unload and continue to run unloaded an adjustable 10-30 seconds. Compressor will then stop. If the compressor does not stop running after the set time, depress the "EMERGENCY STOP". If compressor is running unloaded when 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, depress the "EMERGENCY STOP"
2. Open main disconnect switch

Push Button Functions

=START =STOP

=UNLOAD LOAD

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 and a cabinet exhaust on the end 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 aftercooler, 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 dump 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. 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 and TEFC motors.

- If larger debris, such as leaves or trash, are blowing in the area, the Inlet Panel Filter Accessory should be purchased and added to the unit (ship loose item).

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

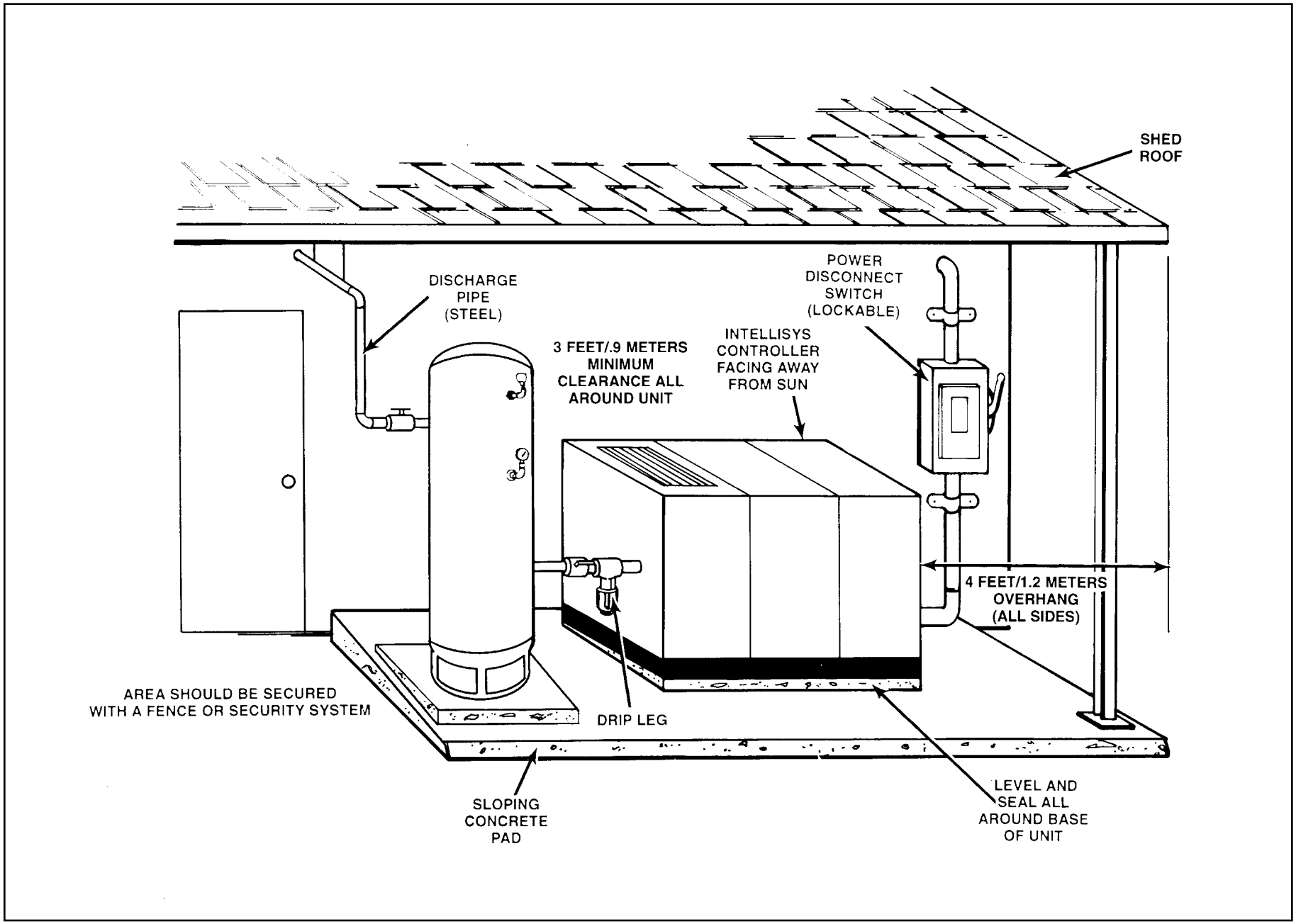
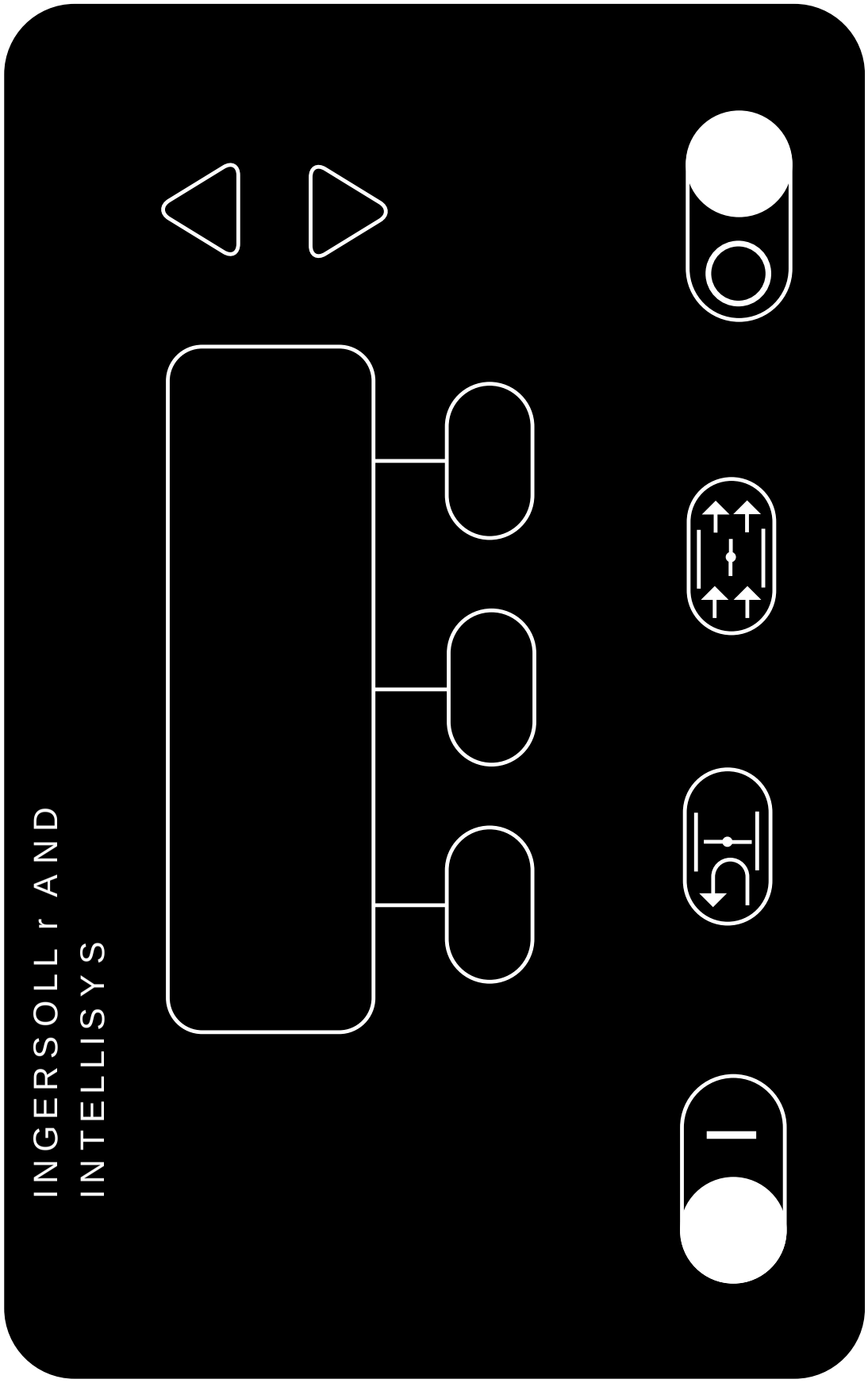


FIGURE 2.5-1 TYPICAL OUTDOOR SHELTERED INSTALLATION

3.0 INTELLISYS

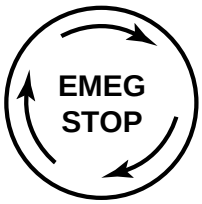


INTELLISYS CONTROLLER

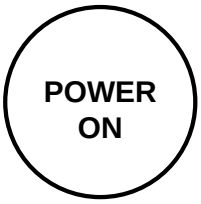
3.0 INTELLISYS

3.1 INTELLISYS CONTROLS

EMERGENCY STOP
Pressing this switch stops the compressor immediately. The compressor can not be restarted until the switch is manually reset. Turn the switch knob clockwise to reset.

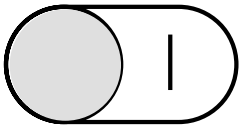


POWER ON LIGHT
This indicates the control voltage and the line voltage are available for starting.

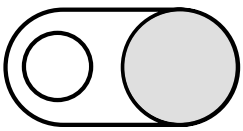


The operator panel is divided into two areas. The bottom row of four buttons provides direct control over the starting, stopping, unloading and loading of the compressor. These are defined by the symbols printed on the buttons themselves, as shown here.

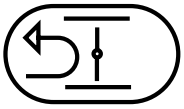
START
Pressing this button will start the compressor if the display shows “Ready To Start”. The compressor will start and load if there is sufficient demand for air.



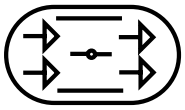
STOP
Pressing this button will activate the unloaded stop sequence. If the compressor is running loaded, it will unload and continue to run unloaded for an adjustable 10 to 30 seconds and then stop. If the compressor is running unloaded, it will stop immediately.



UNLOAD
Pressing this button will cause the compressor to unload and remain unloaded. The display will indicate the machine is “Running Unloaded”, and “Mode: UNLOAD”.

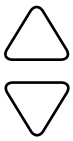


LOAD
Pressing this button will cause the compressor to load if the compressor is running and if the “Discharge Pressure” is less than the “Online Pressure”. This also returns the machine to the operating mode that is specified by the “Mode of Operation” set point.



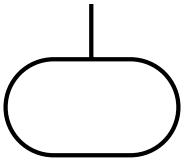
The other five buttons provide access to various operator-selectable functions and machine operating conditions. The purpose of each of these buttons is defined by the display screen and the particular function being performed at that time.

ARROWS
These up and down buttons have multiple functions relating to the right half of the display screen. When lists are presented, the buttons are used to move up or down through the items on the list. The small arrow(s) displayed in the upper right corner of the display screen indicate when you can move up (designated by arrow head pointing up) and/or down (designated by arrow head pointing down) through the list.

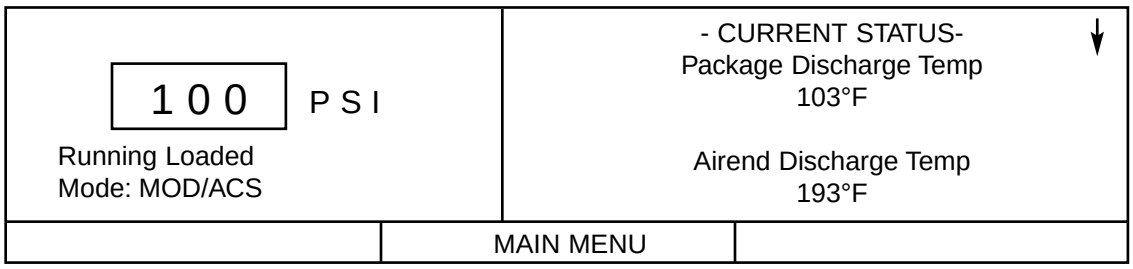


When the value of a specific machine operating parameter is highlighted on the display screen for the purpose of changing that value, the buttons are used to change the value itself.

DISPLAY BUTTONS
The functions of the three buttons below the display screen change and are defined by the words immediately above them in the bottom line of the screen. Each function, such as MAIN MENU, STATUS, SET, etc., is described in appropriate sections in this manual.



3.2 DISPLAY SCREEN



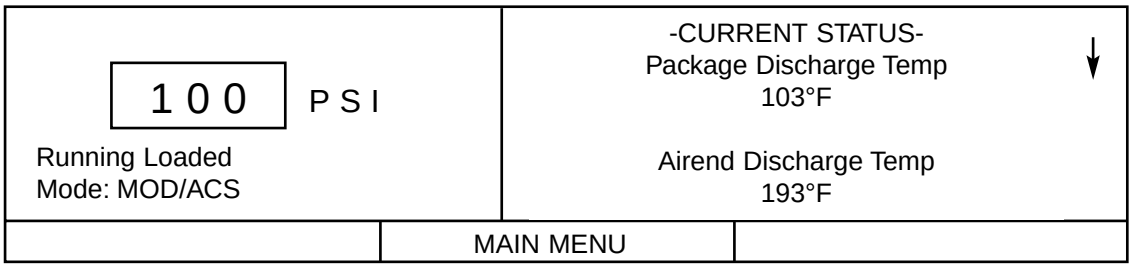
The display screen is divided into three functional areas, as seen in the typical CURRENT STATUS screen shown here.

The left side continuously shows the package discharge pressure in large numbers, with the line directly below the numbers showing the running condition of the machine, and the line below that showing the present mode of operation.

The right side shows various items or lists such as the machine's CURRENT STATUS readings, the MAIN MENU, the OPERATOR SETPOINTS list, etc. Any of the lists can be moved up or down by pressing the arrow buttons to the right of the screen. The small arrow(s) displayed in the upper right corner of the screen indicate when you can move up (designated by arrow head pointing up) and/or down (designated by arrow head pointing down) through a list. The arrow buttons are also used to change an individual item's value. At certain times, items and/or their values are "highlighted". This means they are displayed as light characters on a dark background.

The bottom of the screen is divided into thirds with the words in each small box showing the function of the button directly beneath it. The words will change in these boxes depending on what actions are permitted at any particular time. The action resulting from pressing each of these buttons is indicated in Figure 3.2.1, which can be used as a quick reference of how to step the controller screen through any desired function.

3.3 CURRENT STATUS



The CURRENT STATUS screen is considered the "normal" display that the controller shows.

The following items and their present values can be displayed on the right side of the screen by pressing the up and down arrow buttons.

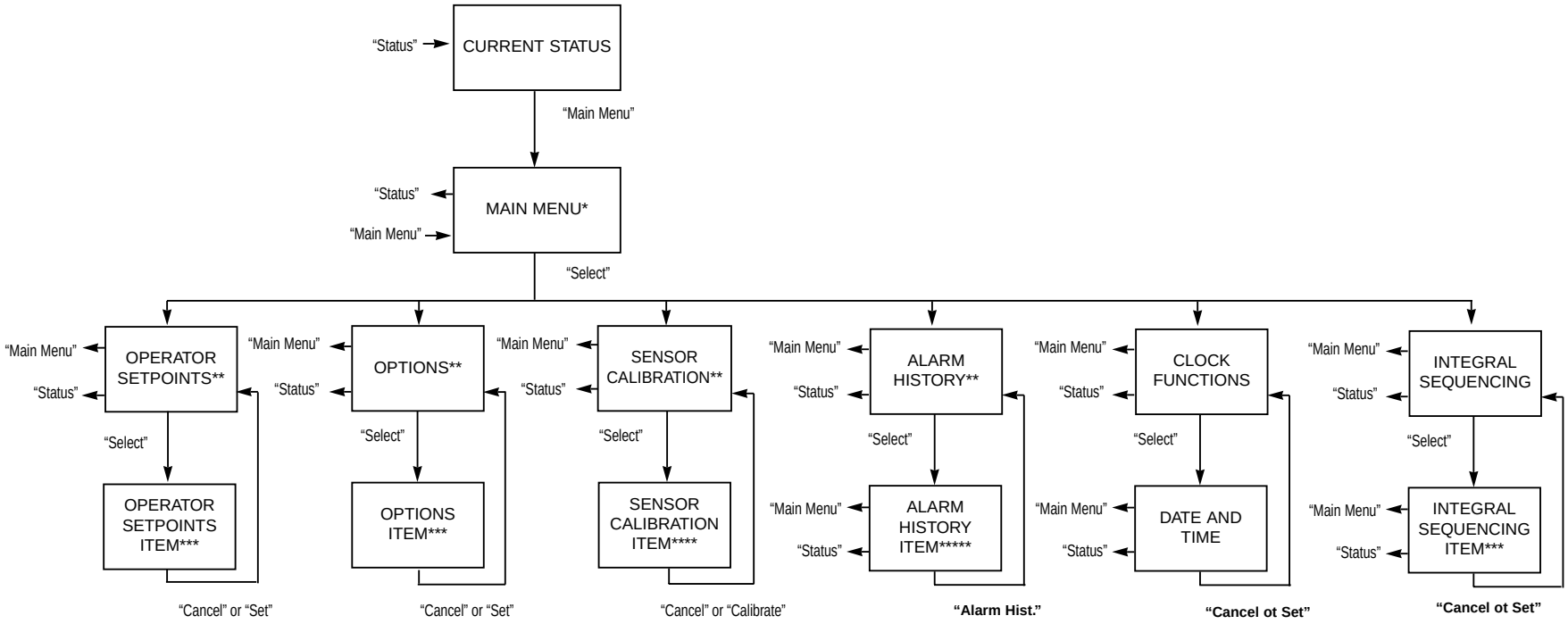
CURRENT STATUS Items

Discharge Temperature
Airend Discharge Temperature
Injected Temperature
Sump Pressure
Separator Pressure Drop
Coolant Filter
Inlet Vacuum
Inlet Filter
Total Hours
Loaded Hours
% Load Modulation
Unloaded Inlet Vacuum
Coolant Pressure
Time & Date
Software Title and Version

The controller automatically returns the display to this CURRENT STATUS screen from other screens if no buttons are pressed within 30 seconds.

The MAIN MENU screen can be accessed from the CURRENT STATUS screen by pressing the MAIN MENU button, identified by the words "MAIN MENU" in the bottom line of the screen directly above the center button.

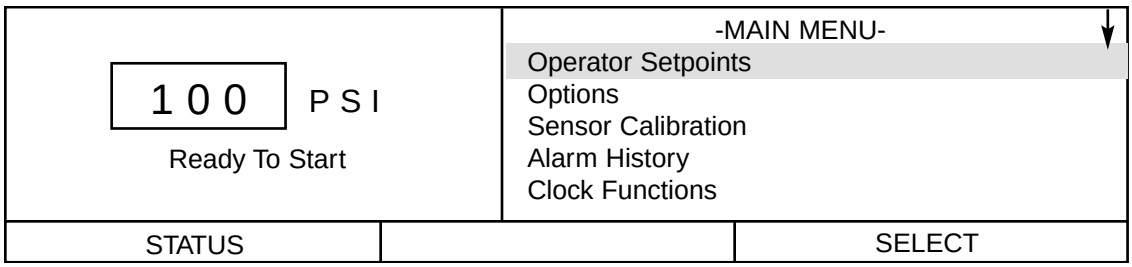
INTELLISYS
Operator Panel Flow Diagram
Figure 3.2.1



NOTE - Use the UP and DOWN arrows to move between selections. Items will be highlighted in inverse display mode.

* - Selecting the highlighted item will display the corresponding menu.
** - Selecting the highlighted item will place the value in edit mode. This is indicated by only the value being displayed in inverse display mode.
*** - The UP and DOWN arrows will alter the value. Depressing "Cancel" will exit the edit mode and leave the value unchanged. Depressing "Set" will save the new value and flash the value to indicate acceptance.
**** - Depressing "Cancel" will exit calibration mode. Depressing "Calibrate" will calibrate selected sensor.
***** - Use UP and DOWN arrows to scroll through list of status items.

3.4 MAIN MENU

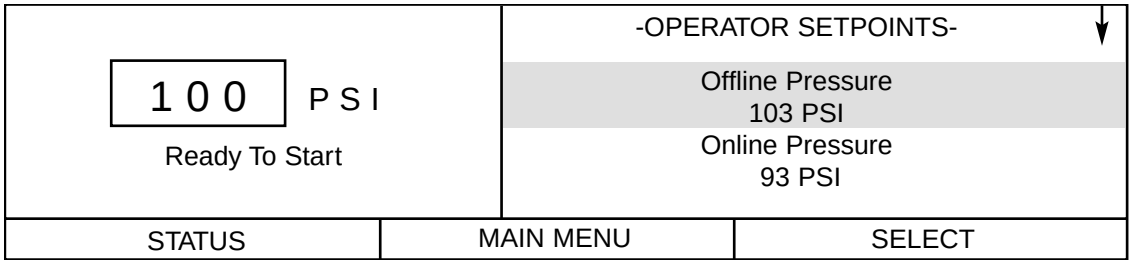


The MAIN MENU screen is the point from which various operator functions can be accessed. Refer to the reference diagram in Figure 3.2.1.

Each of the functions can be chosen by using the up and down arrows to highlight it on the screen.

The controller will go to the highlighted function if the SELECT button is pressed or will return to the CURRENT STATUS screen if the STATUS button is pressed.

3.5 OPERATOR SETPOINTS



Setpoints are user-adjustable variables in the controller logic that can be set using the OPERATOR SETPOINTS screen.

The name and value of each of the setpoints listed below can be seen on the screen by moving the list up and down using the arrow buttons.

OPERATOR SETPOINTS	RANGE	STEP	UNIT
Lead/Lag	Lead or Lag	---	---
Offline Pressure	75 to RATED +3	1	PSIG
Online Pressure	65 to OFFLINE - 10	1	PSIG
Lag Offset	0 to 45	1	PSIG
Mode of Operation	MOD/ACS, ON/OFF LINE, MODULATION ONLY	---	---
Max Modulation Pressure	Online + 10 to Offline + 7	1	PSIG
Stop Delay Time	10 to 60	1	SEC
Star-Delta Time*	5 to 20	1	SEC
(Screen) Contrast	0 to 10	1	---

* Does not apply to automatic across the line starters.

Setpoints associated with options are described in the OPTIONS Section 3.6.

A setpoint's value can be changed by first highlighting the item and its value and pressing the SELECT button to highlight just the value. When the value line is highlighted by itself, the value can be adjusted using the up and down arrow buttons. The CANCEL and SET buttons appear at this time. Press the SET button to enter the new value, or press the CANCEL button to return to the value of the setpoint prior to using the arrows. The displayed value will flash twice to indicate it has been entered into the setpoint, and the pair of setpoint item and value display lines will again be highlighted together.

Operator set points can be exited by pressing the STATUS or MAIN MENU buttons. If no buttons are pressed within 30 seconds, the display will return to the CURRENT STATUS screen.

3.5.1 Lead/Lag- This setpoint is used for setting lead or lag operation. If set to lead, the controller will load and unload the compressor by the online and offline setpoints. If set to lag, the controller will subtract the lag offset (see 3.5.4) from the online and offline set points and operate the compressor at the lower pressure range.

3.5.2 Offline Pressure- This setpoint is the pressure the compressor will unload at if it is operating in on/off line mode.

3.5.3 Online Pressure- This setpoint is the pressure the compressor will load at.

3.5.4 Lag Offset- This setpoint is used with the lead/lag operation. If the lead/lag set point is set to lag (see 3.5.1), the value of the lag offset will be subtracted from the online and offline setpoints.

3.5.5 Mode of Operation- This setpoint is used to select the operating mode of the compressor. The choices are MOD/ACS, ON/OFF LINE, and MODULATION ONLY. See section 5.8 for more information on these operating modes.

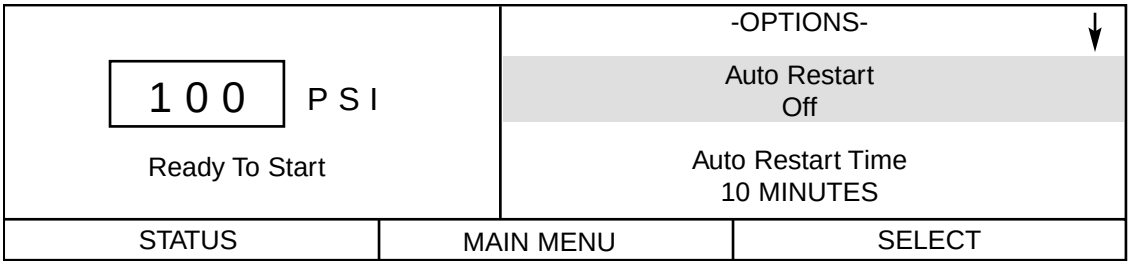
3.5.6 Max Modulation Pressure- This setpoint is the pressure the compressor will unload at if it is modulating. As the package discharge pressure rises toward this value, the inlet valve will start to close. The compressor will unload once the package discharge reaches this value. See section 5.8 for more information on modulation.

3.5.7 Stop Delay Time- This setpoint is the minimum amount of time the compressor will run unloaded before stopping. This period does not apply to alarms (shutdowns).

3.5.8 Star-Delta Time- This setpoint is only used with star-delta starters. It is not used if the starter is full voltage or a remote starter. This is the time period between starting and star-delta transition.

3.5.9 Contrast- This setpoint is used to improve the display on the Intellisys.

3.6 OPTIONS



Options are turned on or off and their associated values are set using the OPTION screen.

Some options require additional machine hardware and the proper “Option Module” to plug into the Intellisys controller. Descriptions of the options operations are in Section 7.0. The name and value of each of the options listed in the right hand column can be seen by moving the list up and down using the arrow buttons.

An Option item’s value can be changed the same way OPERATOR SETPOINTS values are changed. See Section 3.5 for an explanation.

OPTIONS ITEMS	RANGE	STEP	UNIT
Auto Restart	On/Off	---	---
Auto Restart Time	2 to 60	1	MIN
Auto Restart Delay Time	0 to 60	1	SEC
Sequencer	On/Off	---	---
Remote Start/Stop	On/Off	---	---
Power Out Restart	On/Off	---	---
Power Out Restart Time	10 to 600	1	SEC
Low Ambient	On/Off	---	---
Min. Cooler Out Temp	30 to 150	1	Deg. F
Separator Delta-P Solenoid	On/Off	---	---
Separator Delta-P Sensor	On/Off	---	---
Lead/Lag Cycle Length	0-750	1	HRS
Scheduled Start	00:00 to 23:59	1	TIME
Scheduled Stop	00:00 to 23:59	1	TIME
High Dust Filter	On/Off	---	---
Modbus Protocol	On/Off/ICU	---	---
Modbus Address	1 to 247	1	---

3.6 OPTIONS (CONTINUED)

3.6.1 Auto Restart- This setpoint is used to enable or disable the auto restart option.

3.6.2 Auto Restart Time- This setpoint is the minimum time period the compressor must run unloaded before it can stop in the auto restart mode.

3.6.3 Auto Restart Delay Time- If the compressor is stopped in auto restart, this setpoint is the number of seconds the package discharge pressure must remain below the online pressure setpoint before the compressor will restart.

3.6.4 Sequencer- This setpoint is used to enable or disable sequencer operation.

3.6.5 Remote Start/Stpop- This setpoint is used to enable or disable the remote start/stop option.

3.6.6 Power Out Restart- This setpoint is used to enable or disable the power out restart option, if it is installed.

3.7.7 Power Out Restart Time- If the power out restart option is installed and enabled, this setpoint is time period between power returning to the compressor and the compressor starting.

3.6.8 Low Ambient- This setpoint enables or disables the low ambient option. If the low ambient option is enabled, sensor 3CTT must be installed in the compressor.

3.6.9 Minimum Cooler Out Temperature- When the low ambient option is installed, this setpoint is the minimum temperature to which the coolant must rise before the compressor will load.

3.6.10 Separator Delta-P Solenoid- This setpoint enables or disables the separator delta-p solenoid option. Enabling this option will automatically disable the Separator Delta-P Sensor option.

3.6.11 Separator Delta-P Sensor- This setpoint enables or disables the separator delta-p sensor option. Enabling this option will automatically disable the Separator Delta-P Solenoid option.

3.6.12 Lead/Lag Cycle Length- This setpoint enables the automatic cycling between lead and lag operation. If it is set to a value greater than 0, the controller will cycle between lead and lag operation. The value of this set point is the cycle length in real time hours. A value of 0 will disable the automatic cycling between lead and lag.

3.6.13 Scheduled Start- If the scheduled start/stop option is installed, this set point is the time of the day (hour and minute) that the compressor will automatically start. To disable this option, set it to the same value as the scheduled stop (section 3.6.14).

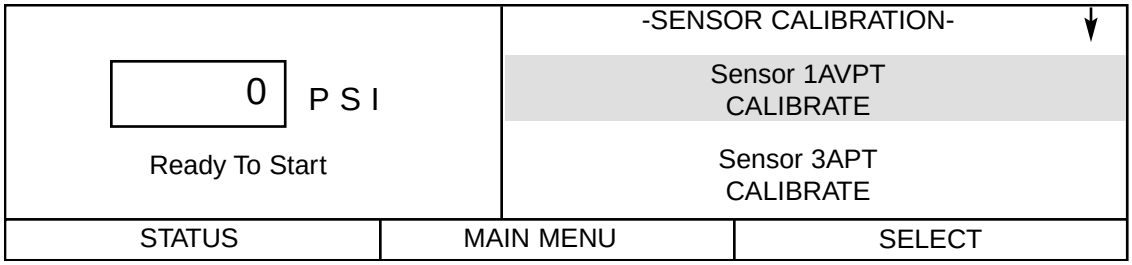
3.6.14 Scheduled Stop- If the scheduled start/stop option is installed, this setpoint is the time of the day (hour and minute) that the compressor will automatically stop. To disable this option, set it to the same value as the scheduled start (section 3.6.13).

3.6.15 High Dust Filter- This option enables or disables the high dust filter operation.

3.6.16 Modbus Protocol- This option is for Ingersoll-Rand service use only.

3.6.17 Modbus Address- This feature is used with the Modbus Protocol and is for Ingersoll-Rand service use only.

3.7 SENSOR CALIBRATION



Pressure sensor calibration is done through the SENSOR CALIBRATION screen. Sensor calibration can only take place when the machine is stopped. Calibration needs to be done only after a sensor has been replaced or the Intellisys controller has been replaced.

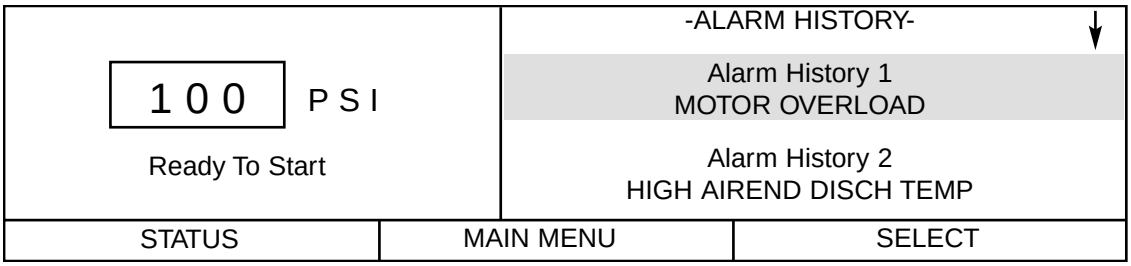
Each of the sensors listed below can be chosen by using the up and down arrow buttons to highlight it on the screen.

SENSOR CALIBRATION Items
Sensor 1AVPT
Sensor 3APT
Sensor 4APT
Sensor 5CPT
Sensor 6APT

Select the highlighted sensor by pressing the SELECT button. Press the CALIBRATE button to start the automatic calibration procedure, or press the CANCEL button to not calibrate it and return to the sensor list.

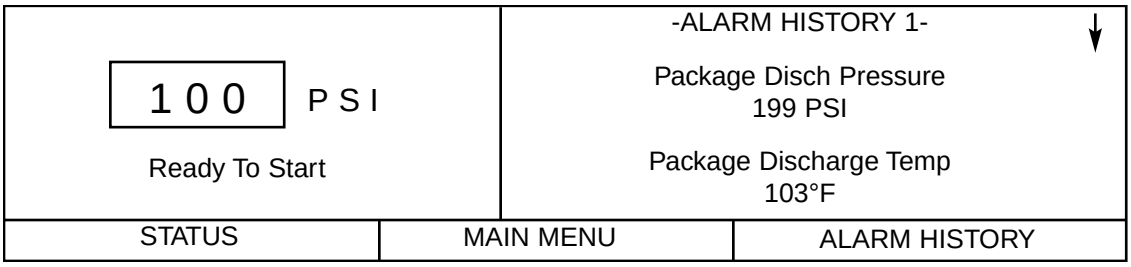
The calibration screen can be exited by pressing either the STATUS or MAIN MENU buttons. If no buttons are pressed within 30 seconds, the display will return to the CURRENT STATUS screen.

3.8 ALARM HISTORY



Alarm History displays each of the Alarm messages for the last 15 Alarms experienced by the machine. It also gives access to displaying the machine operating conditions that existed at the time of each Alarm. The first one shown, “Alarm History 1”, was the most recent Alarm to occur. Note that multiple, consecutive EMERGENCY STOP Alarms are not recorded as separate Alarms, only the first one will be shown.

Each of the last 15 Alarm messages can be seen by moving the Alarm History list up and down using the arrow buttons. Pressing the SELECT button when one of the Alarms is highlighted will display the list of machine values that existed at the time that particular Alarm occurred.



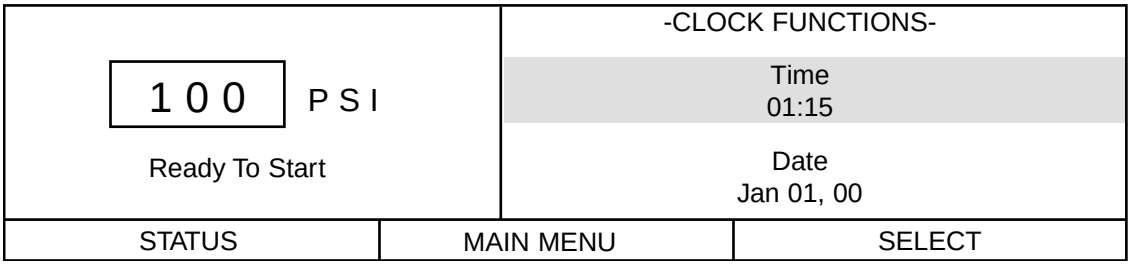
The name and value of each of the items listed below can be seen by moving the list up and down using the arrow buttons. Pressing the ALARM HIST. button will return the display to the ALARM HISTORY screen.

ALARM HISTORY Items

Discharge Pressure
Discharge Temperature
Airend Discharge Temperature
Injected Temperature
Sump Pressure
Separator Press. Drop
Coolant Filter
Inlet Vacuum
Inlet Filter
Total Hours
Loaded Hours
% Load Modulation
Unloaded Inlet Vacuum
Coolant Pressure
Time & Date

Alarm histories can be exited by pressing either the STATUS or MAIN MENU buttons. If no buttons are pressed within 30 seconds, the display will return to the CURRENT STATUS screen.

3.9 CLOCK FUNCTIONS

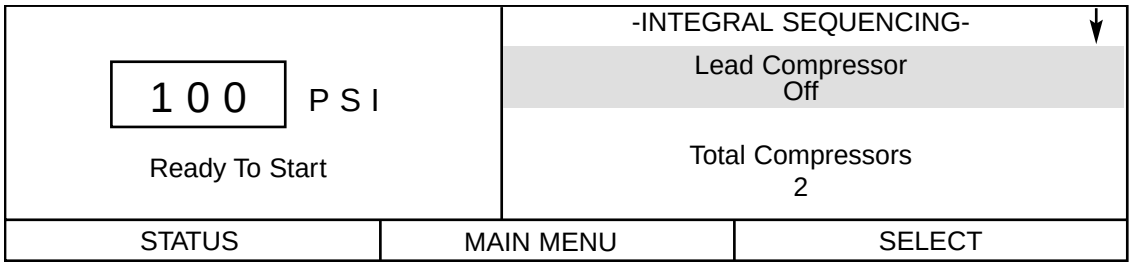


The date and time for the real time clock is set through the CLOCK FUNCTIONS screen. Use the up and down arrows to highlight either TIME or DATE. Select the highlighted setting by pressing SELECT.

If TIME is selected, first the hours will be highlighted. Adjust the hours (00-23 hour clock) by using the up and down arrows. Once the correct time is in the display, press SET to highlight the minutes. Adjust the minutes (00-59) and then press SET to complete setting the time.

If DATE is selected, first the month will be highlighted. Adjust the month by using the up and down arrows and then press SET to highlight the date. Once the correct date is displayed, press SET to highlight the year. Once the correct year is displayed, press SET to complete setting the date.

3.10 INTEGRAL SEQUENCING



Integral Sequencing is set up using the INTEGRAL SEQUENCING screen. A description of integral is in section 7.0. The name and value of each of the integral sequencing setpoints as listed in the right hand column can be seen by moving the list up and down using the arrow buttons.

3.10.1 Lead Compressor- The choices for this setpoint are On, Off, Always, and Never. On, means the compressor is the lead unit. Off, means the compressor is not the lead unit, but it could become the lead unit. If Always is selected, the compressor is the lead unit and it will not transfer the lead to another compressor. Never, means the compressor is not the lead unit and will never become the lead unit. The operator must set one unit (and only one) to On or Always to start integral sequencing.

3.10.2 Total Compressors- This is the total number of compressors in the integral sequence. This setpoint must be set to the same number on each compressor.

3.10.3 Compressor Address- This is the address of the compressor in the integral sequence. No two compressors can have the same address. Two compressors with the same address will cause communication failures.

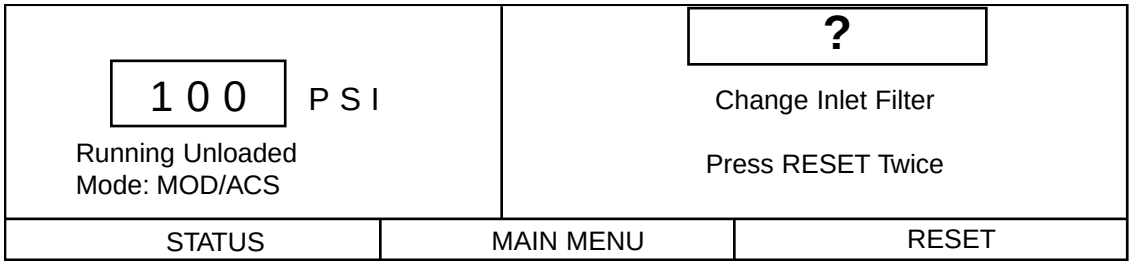
3.10.4 Load Delay Time- This is the number of seconds the lead compressor will wait for the package discharge pressure to start rising after issuing a load command to another compressor. If the package discharge pressure has not started rising at the end of this time period, the lead compressor will load the next compressor in the sequencer.

INTEGRAL SEQUENCING	RANGE	STEP	UNIT
Lead Compressor	On/Off/Always/Never	---	---
Total Compressors	2 to 4	1	---
Compressor Address	1 to Total Compressors	1	---
Load Delay Time	10 to 60	1	SEC
Lead Change - Hours	0 to 750	1	HRS
Lead Change - Day	Sun to Sat, Daily, Week Day, Week End	1	DAY
Lead Change - Time	00:00 to 23:59	1	TIME

3.10.5 Lead Change - Hours- This is the number of hours the compressor will operate as the lead unit. Once a compressor has operated as the lead for this number of hours, it will transfer the lead to the next compressor in the sequence. This setpoint does not apply to a unit where the lead compressor is set to always or never. If this setpoint is set to 0, the next 2 setpoints will determine when the lead is transferred.

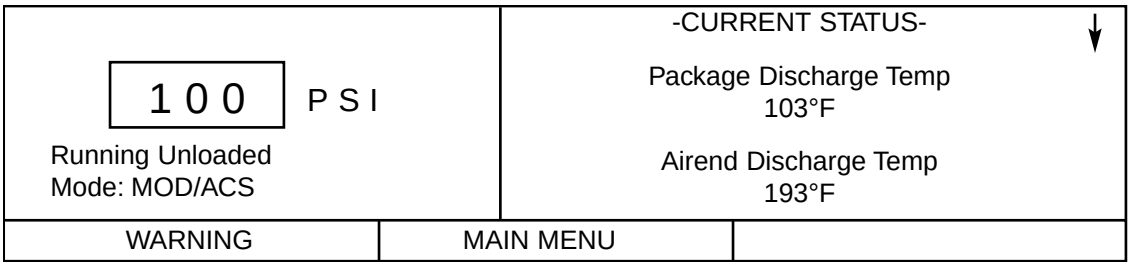
3.10.6 Lead Change - Day & Lead Change - Time- These two setpoints are used together. If the Lead Change - Hours setpoint is set to 0, these two setpoints will be used to determine when the compressor will transfer the lead to the next compressor in sequence. Lead Change - Day is the day of the week that the compressor will transfer the lead. Lead Change - Time is the time of the day that the compressor will transfer the lead.

3.11 WARNINGS



When a Warning occurs, a question mark will flash on the display screen and appear in large letters as shown above. The display message will indicate what caused the warning.

If multiple Warnings exist, the small up/down arrows will appear in the upper right corner of the display screen. The multiple Warnings can be seen by pressing the up and down arrow buttons. Pressing the STATUS button will display the CURRENT STATUS screen with the WARNING button indicating a Warning still exists.



Pressing the WARNING button will return the display to the WARNING screen and the RESET button.

A Warning needs to be reset by the operator by pressing the RESET button twice.

The possible Warning messages are as follows.

AIREND DISCHARGE TEMP- This will occur if the Airend Discharge (2ATT) exceeds 97% of the alarm limit, 228°F (109°C), and is not adjustable.

CHANGE COOLANT FILTER- This warning will occur if the high side pressure is 20 psig (1.4 bar) greater than the low side pressure of 1 DPS, and the Injected Coolant temperature (2CTT) is greater than 120°F (49°C).

CHANGE INLET FILTER- This will occur if the Inlet Vacuum (1AVPT) is greater than 0.7 psig (.05 bar) and the machine is fully loaded (inlet valve is completely open).

CHANGE SEPR ELEMENT- This warning will occur if the pressure on the Separator (3APT) is 12 psig (.8 bar) greater than the pressure at the Package Discharge (4APT), and the machine is fully loaded.

HIGH DISCHARGE PRESS- This can occur if the machine's loading function is being controlled by a host device, such as a sequencer or an lSC. This warning will occur when the package discharge pressure is above the maximum offline pressure (rated pressure plus 3 psig [.2 bar]) for more than 3 seconds. This warning will cause the compressor to unload. The host device will not be able to load the compressor until the package discharge pressure falls to the rated pressure of the machine.

SENSOR FAILURE 4ATT- This will occur if the Package Discharge Temperature Sensor (4ATT) is recognized as missing or broken.

AUXILIARY 1 (OR 2) - This warning will occur if either of the auxiliary contacts closes.

HIGH SUMP/LINE DIF - This warning will occur if the compressor is running loaded, the injected coolant temperature is greater than or equal to 120 deg. F, (49°C) the package discharge pressure is greater than 90 psig, (6.3 bar) the sump pressure is greater than the compressor's rated pressure, and the sump pressure is 25 psig (1.8 bar) or more above the package discharge pressure.

3.11 WARNINGS (CONTINUED)

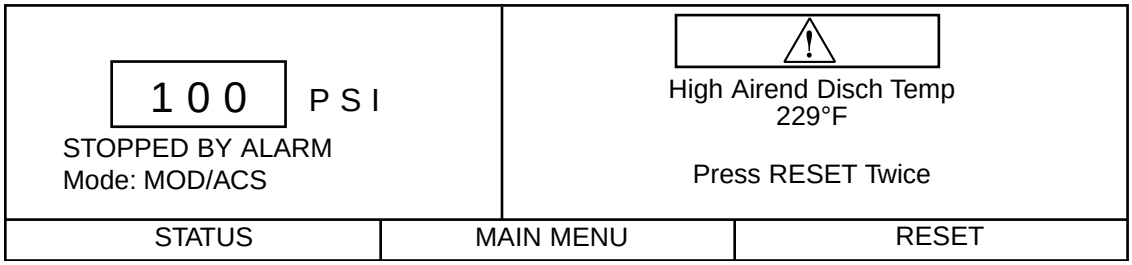
COMMUNICATION FAIL 1 (or 2 - 4) - This warning will occur if the compressor is the lead unit while using integral sequencing and is unable to communicate with another compressor.

SERVICED REQUIRED - The Intellisys has 2 levels of service. The service level can be set at the factory or by an Ingersoll-Rand service representative. Either service level will issue a “SERVICE REQUIRED” warning at 150 hours. This warning is a reminder for initial service and can be cleared by the operator.

Level 1 - If service level 1 (default) is selected, a “SERVICE REQUIRED” warning will be issued every 2000 operating hours. This warning is to serve as a reminder to have the unit serviced and can be cleared by the operator.
Level 2 - If service level 2 is selected, service warnings will be issued every 2000 operating hours (default) or in 3, 6, 9, or 12 month intervals, as selected at the factory or by an I-R service representative. Service warnings at level 2 are issued in 3 stages. First a “100 HOURS TO SERVICE” or 14 DAYS TO SERVICE” (depending on the service interval type) warning will be issued. This warning will let the operator know that the time for service is approaching and can be cleared by the operator. Following that, 100 hours or 14 days later a “SERVICE REQUIRED” warning will be issued. This warning can be temporarily cleared by the operator, however it will return 24 hours later if service has not been performed by an I-R service representative. A new service period will start when service is performed. If another 100 hours or 14 days elapses and service has not been performed, an “ALARM-SERVICE REQUIRED” warning will be issued. This warning can only be cleared by an I-R service representative.

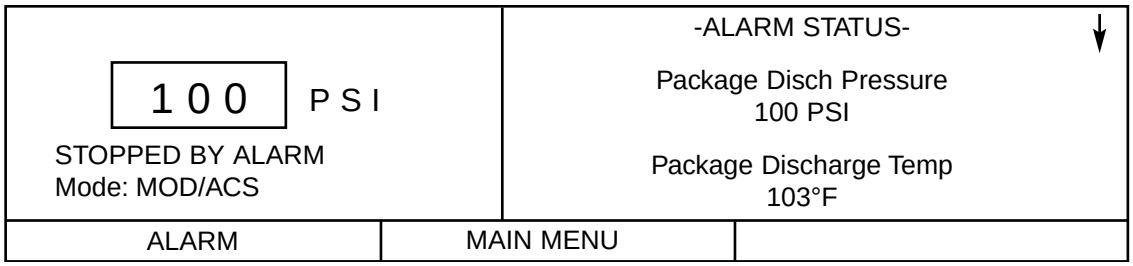
SENSOR FAILURE 6APT - This warning will occur if the separator delta-p sensor option is installed and sensor 6APT is recognized as missing or broken.

3.12 ALARMS



When an Alarm occurs, an exclamation mark will flash on the display screen as shown above. The display message will indicate what caused the Alarm.

Pressing the STATUS button will display the ALARM STATUS screen with the ALARM button indicating an Alarm still exists. Alarm Status is the list of machine operating conditions that existed at the time of the Alarm.



The name and value of each of the items listed can be seen by moving the list up and down using the arrow buttons. Pressing the ALARM button will return the display to the Alarm screen and the RESET button.

The Alarm needs to be reset by the operator by pressing the RESET button twice. Any exceptions to this are explained in the alarm descriptions.

The possible Alarm messages are as follows.

CHECK INLET CONTROL- This will occur if the machine is unloaded and the inlet vacuum is less than 3 psig (.2 bar).

CHECK INLET CTRL SYS 1 (2) - This will occur if the inlet butterfly valve fails to open or close properly. A 1 means the inlet valve failed to closer properly. A 2 means the inlet valve failed to open properly.

CHECK MOTOR ROTATION- This will occur if the machine is started and the compressor has incorrect rotation.

CONTROL POWER LOSS- This will occur if the controller detects a loss of the 110 VAC or 120 VAC control power.

EMERGENCY STOP- This will occur if the Emergency Stop button is engaged. The button must be disengaged before the alarm can be cleared.

FAN MOTOR OVERLOAD- This will occur if a fan motor overload is sensed.

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

LOW SUMP AIR PRESSURE- This will occur if the machine is running fully loaded and the sump pressure drops below 20 psig (1.4 bar).

LOW UNLOAD SUMP PRESS- This will occur if the machine is running unloaded and the sump pressure is less than 15 psig (1.0 bar) for 15 seconds.

MAIN MOTOR OVERLOAD- This will occur if a drive motor overload is sensed.

CHECK SET POINTS- This will occur if the controller has determined some of the data stored in memory contains unacceptable values. When this occurs, the sensors should be calibrated and all the set points checked. It is normal for this alarm to occur after changing controller software.

REMOTE START FAILURE- This will occur if the Remote Start button is pressed after the machine is running or if the Remote Start button remains closed.

REMOTE STOP FAILURE- This will occur if the Remote Stop button remains open and either Start button is pressed.

SENSOR FAILURE 1AVPT (or 3APT, 4APT, 5CPT,2CTT, 2ATT, 3CTT) - This will occur if a sensor is recognized as missing or broken. This does not apply to sensor 4ATT.

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

STEPPER LIMIT SWITCH- This will occur if both limit switches are activated at the same time.

INVALID CALIBRATION- This will occur during the calibration process if the sensor reads greater than 20% of scale.

LOW COOLANT PRESSURE- This will occur if the compressor is running and the following conditions are met. The coolant must be less than 1 psi and either the sump pressure is greater than 10 psi or the inlet vacuum is less than 12 psi.

4.0 SCHEDULED PREVENTATIVE MAINTENANCE

4.1 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
Inspect	Oil filter Delta P	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)
Analysis	Coolant	2000	See Section 4.15 x
Analysis	Vibration	2000	See Section 4.15 x
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 motor lubrication		See Section 4.10.

* 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.

4.2 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.

4.3 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 CHANGE SEPARATOR ELEMENT is displayed. See Section 3.9.

4.4 INLET AIR FILTER

To check condition of the inlet filter, run compressor in the LOADED mode and observe “Inlet Filter” on the CURRENT STATUS display screen. If the display says “Inlet Filter OK”, then no maintenance is required. If “ ? ” is flashing on the screen and the display says “CHANGE INLET FILTER”, then the inlet filter should be changed.

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.

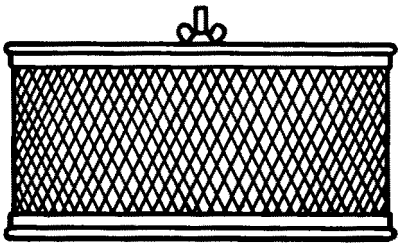
Install new element/s and inspect to ensure that they have seated properly.

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

125-150 HP/90-110KW REQUIRES (1) ELEMENT
200 HP/132-160 KW REQUIRES (2) ELEMENTS
100 HP/75 KW-2S REQUIRES (1) ELEMENT
125-200 HP/110-160 KW - 2S REQUIRES (2) ELEMENTS

4.5 COOLANT FILTER

To check the condition of the coolant filter, the compressor must be running. Observe “Injected Temperature” on the CURRENT STATUS display screen. If the temperature is less than 120°F (49°C), continue to run the machine. When the temperature is greater than 120°F (49°C), observe “Coolant Filter” on the screen. If the display says “Coolant Filter OK”, then the filter does not need service. If “ ? ” is flashing on the screen and the display says “CHANGE COOLANT FILTER”, then the filter should be replaced.

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.

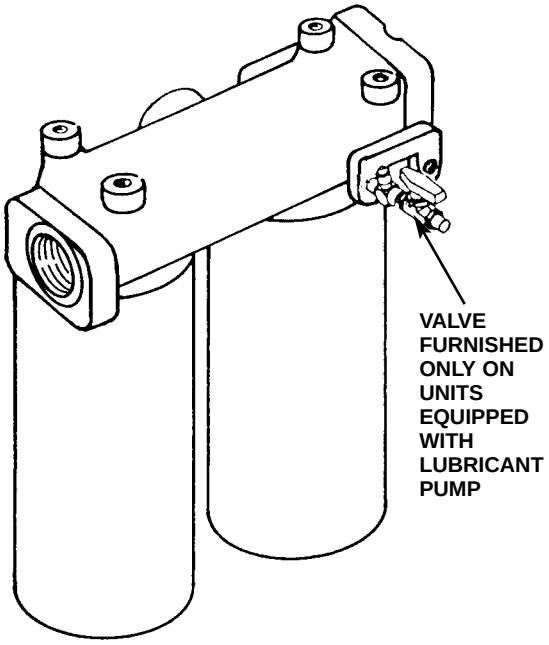
Screw element/s on until the seal makes contact with the head of the filter assembly. Tighten approximately one-half turn additional.

Start unit and check for leaks.

CAUTION

Improper maintenance of coolant filter can cause compressor damage.

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



COOLANT FILTER
100 HP/75 KW REQUIRES (1) ELEMENT
125-200 HP/90-160 KW REQUIRES (2) ELEMENTS

4.6 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.

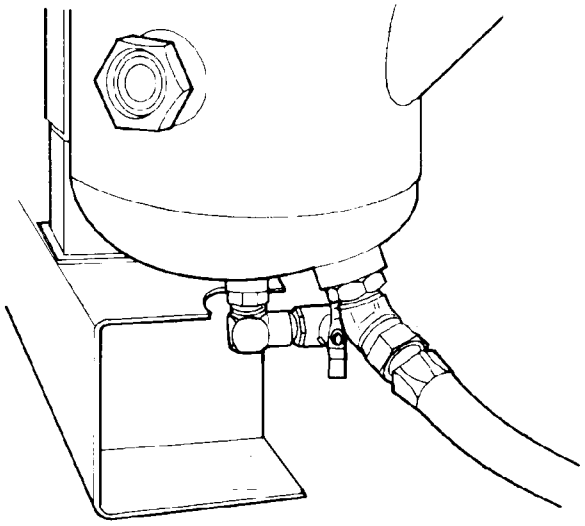
Hot coolant can cause severe injury. Use care when draining separator tank.

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

125-200 HP/90-160 KW - Single Stage.....23 gallons (87.4 liters)
100 HP/75 KW - 2 Stage .....22 gallons (83.3 liters)
125-200 HP/90-160 KW - 2 stage .....30 gallons (113.6 liters)



COOLANT DRAIN

⚠ WARNING

Hot coolant can cause severe injury.
Use care when near this area.

4.6 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.

4.7 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 4.7-1) and will require cleaning as outlined in the Maintenance Schedule, Section 4.1.

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.

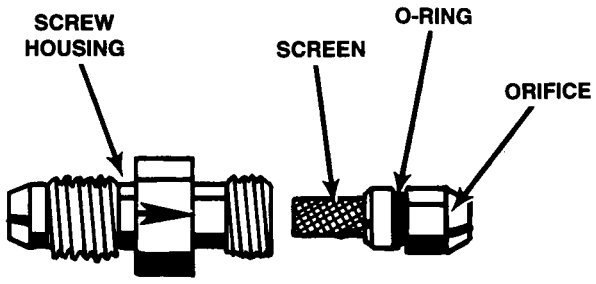


FIGURE 4.7-1 SEPARATOR TANK SCAVENGE SCREEN/ORIFICE

4.8 COOLANT SEPARATOR ELEMENT

To check condition of separator element, run compressor in full load mode and at rated pressure and observe “Separator Pressure Drop” on the CURRENT STATUS display screen. If the display says “xxPSI”, then no maintenance is required. If “ ? ” is flashing on the screen and the display says “CHANGE SEPR ELEMENT”, then the separator element should be replaced.

Disconnect the scavenge tube at the airend.

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

Disconnect the piping from the tank cover. Tag the lines if required.

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 to prevent over-tightening one side of the cover. An improperly tightened cover will likely result in a leak.

Tank cover bolt torque values

100-200 HP/75-160 KW	5/8-11 UNC 150 ft-lb. (203 N-M)

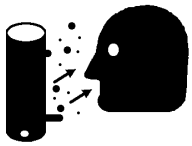
Inspect tank scavenge screen and orifice. Clean if necessary following instructions in Section 4.7.

Install scavenge tube down into the tank until the tube just touches the separator element and then raise it 1/8 inch (3.2 mm). Tighten fittings.

Install the regulation lines in their original position.

Start unit, check for leaks, place in service.

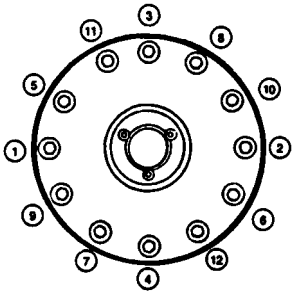
⚠ WARNING



This machine contains high air pressure which can cause severe injury or death from hot oil or flying parts.

Always relieve pressure before removing caps, plugs, covers or other parts. Blow down pressurized air system. Close isolation valve. See Operator’s Instruction Manual.

RECOMMENDED BOLT TIGHTENING CROSS PATTERN



125/200 HP

4.9 COOLER CORES: CLEANING

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

Ensure the main power disconnect switch is locked open and tagged. (See Figure 4.9-1).

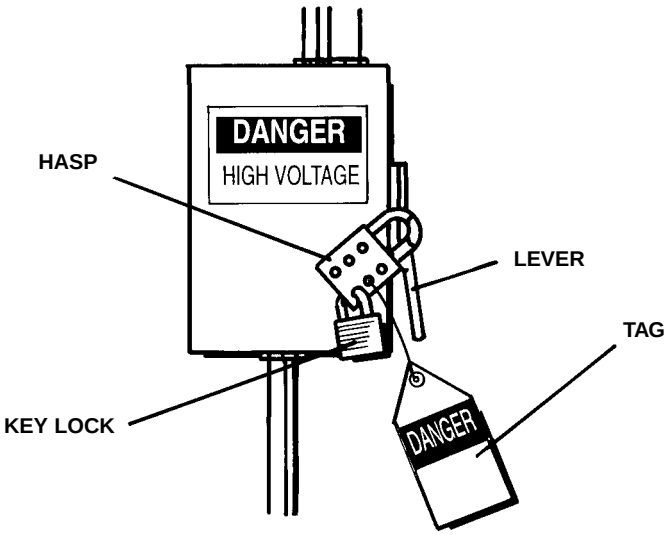


FIGURE 4.9-1 MAIN DISCONNECT LOCKED AND TAGGED

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.**

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 coolers.

Coolant Cooler
- Remove panels and top cover.
- Drain the coolant. See Section 4.6.
- Remove side panels from coolant cooler box.
- Disconnect piping from coolant cooler inlet and outlet ports.
- Plug cooler inlet and outlet ports to prevent possible contamination.
- Remove coolant cooler holding screws from sides of coolant cooler and remove cooler through side of cooler shroud.

Coolant Cooler Cleaning
- It is recommended the cooler be taken to a professional cooler service shop for flushing with an appropriate environmentally safe cleaning agent.
- Reassemble in reverse order.
- Make sure fan guards are replaced.
- Refill the compressor with coolant. If contamination is suspected, replace with new coolant.
- Replace fill plug.
- Run compressor for ten minutes. Check for possible leaks. Check coolant level.
- Replace enclosure panels.

⚠ CAUTION

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

Wear appropriate safety equipment.

AFTERCOOLER

Following are instructions for the removal and internal cleaning of aftercoolers.

Aftercooler

- Disconnect hose from aftercooler inlet flange.
- Disconnect tube from aftercooler outlet flange.
- Remove aftercooler holding screws from aftercooler support and remove cooler.

Aftercooler Cleaning

- It is recommended the cooler be taken to a professional cooler service shop for flushing with an appropriate environmentally safe cleaning agent.
- Reassemble in reverse order.
- Replace enclosure panels.

4.10 MOTOR LUBRICATION

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

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

Relubrication amount

Motor Frame Size	Lubricant Amount in³	cc	oz.	grams
182-215	.5	8	.4	11
254-286	1.0	16	.8	23
324-365	1.5	25	1.2	34
404-449	2.5	40	2.0	57
5000 Frame Series	1.0	16	.8	23

Relubrication Interval - 50 Hz
(or 9 months, whichever comes first)
2000 hours .....M90 - 160 KW TEFC drive motors
4000 hours.....M75 TEFC drive motors

Relubrication amount

Motor Frame Size	Lubricant Amount in³	cc	oz.	grams
M75-160	As indicated on motor nameplate			

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.

⚠ 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.

NOTICE

Motors must be greased periodically.
See Operator's Manual for procedure.

4.10 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>

60 Hz motors require:

Mobilith SHC 220 (39218193)

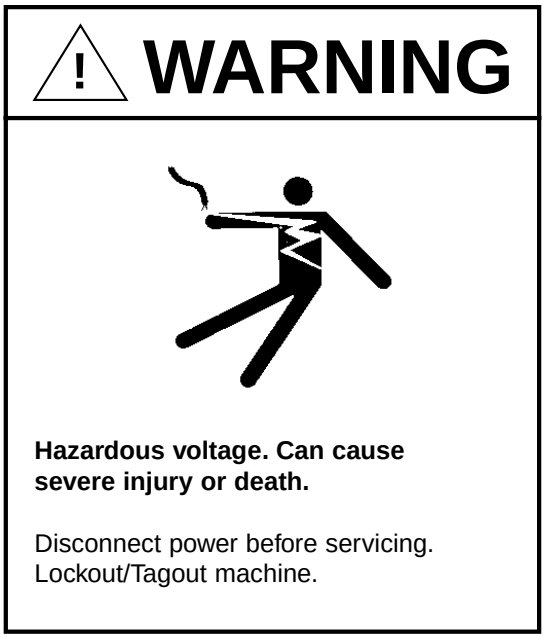
Use the grease as indicated on a special grease information nameplate on the motor. Use of alternative greases can result in shortened motor life due to incompatibility of greases. If there is not a grease nameplate on the motor use:

Chevron Black Pearl #2 (39204292)
(Preferred)

Chevron SRI 2 (39161641)

50 Hz motors require

Esso Unirex N3 (92844729)



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.

4.11 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.

4.12 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.

4.13 INTELLISYS REMOVAL

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

Ensure the main power disconnect switch is locked open and tagged (See Figure 4.13-1).

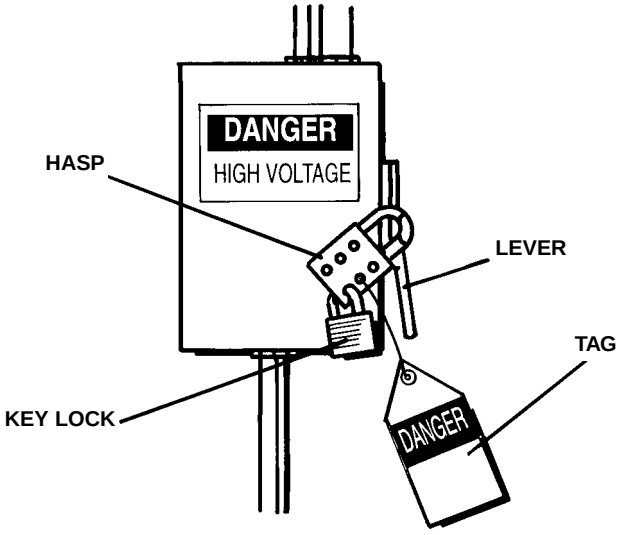


FIGURE 4.13-1 MAIN DISCONNECT LOCKED AND TAGGED

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.

This section gives guidelines for removing/replacing the Intellisys Controller assembly and the Intellisys Power Supply assembly. The controller is mounted in the starter box door, and the power supply is mounted on the upper right corner of the starter backpanel on the inside-rear of the starter box.

Controller Removal:

1) Open the starter box door.

2) Remove each plug-in connector, labeled P1-P10, from the sides of the controller. **If any of the cables are not labeled, label them with the appropriate plug designator, P1-P10. These must be plugged into the correct sockets in the replacement controller.**

3) Remove and save the Option Module if one is plugged into P9. This must be installed in the replacement controller. Note that it is keyed to plug into P9 only one way.

4) Remove the six holding screws from the controller on the inside of the starter box door.

5) Remove the controller through the front of the door, being careful to save the gasket that is between the controller and the door.

Power Supply Removal:

1) Open the starter box door.

2) Remove each plug-in connector, labeled J1 - J4, from the circuit board. **If any of the cables are not labeled, label them with the appropriate plug designator, J1-J4. These must be plugged into the correct sockets in the replacement power supply.**

3) Remove the four screws holding the power supply to the starter plate, save them for mounting the replacement board, and remove the power supply.

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

Ensure 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.

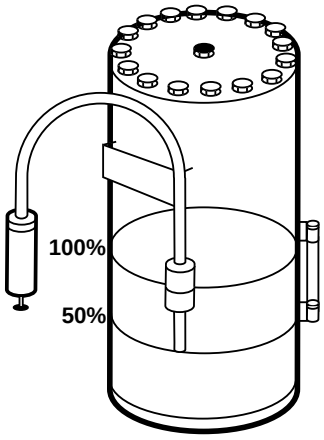
4.15 FLUID AND VIBRATION MONITORING

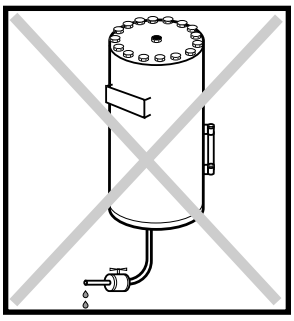
Ingersoll-Rand recommends incorporating predictive maintenance, specifically the use of coolant and vibration analysis, into all Preventative Maintenance programs. Predictive Maintenance is designed to increase system reliability and prevent costly downtime. Through the use of sophisticated diagnostic tools, including fluid, vibration, and optional air analysis, IRA Certified Service Technicians can identify and correct potential problems BEFORE they can cause expensive unscheduled downtime.

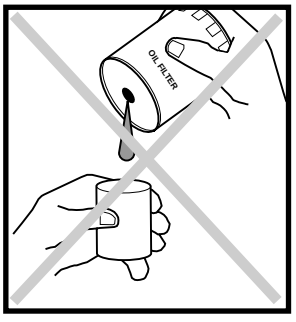
How does predictive analysis work? By establishing an initial baseline for normal operation, and then regularly monitoring fluid and vibration conditions, any sudden deviation or significant increase from this baseline can be identified and investigated to pinpoint the cause. More quickly diagnosing potential problems can directly save money by preventing costly failures and reducing or eliminating downtime. In addition, regular condition monitoring also helps to maximize the time between expensive preventative maintenance intervals, such as component rebuilds and coolant changes.

4.16 COOLANT SAMPLING PROCEDURE

Bring unit up to operating temperature. Draw sample, using pump kit, from separator tank port. DO NOT draw sample from drain port or oil filter. Use new hose on pump for each sample, failure to do this can give false readings.







5.0 SYSTEMS

5.1 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 with stepper motor inlet
- Motor starting control system
- Instrumentation
- Safety provisions
- Aftercooler
- Moisture separator and drain trap.

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

The motor, airend, separator tank, and piping are mounted on independent supports. The supports are isolated from the base by rubber isolation mounts. Flexible hoses are utilized on the separator tank coolant out and air discharge to isolate the motor/airend/tank.

5.2 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 the design levels described are encountered, we recommend you contact your nearest Ingersoll-Rand representative for additional information.

The standard maximum temperature 115°F (46°C) is applicable up to an elevation of 3300 ft (1000 m) 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, all mounted in the end section of the compressor enclosure. The cooling air flows in through the left end of the enclosure, through the vertically mounted cooler core, and discharges upward through the right end of the enclosure.

COOLING FAN MOTOR

In a standard compressor, the cooling fan motor is wired at the factory. It is a three-phase motor, protected by a suitable circuit breaker and overload relay. The fan motor is energized at the same time the compressor drive motor is energized. The fan motor 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 entrance 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.

5.3 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.

5.4 COMPRESSED AIR SYSTEM
The air system is composed of:

1) Inlet air filter
2) Inlet valve/stepper motor
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 butterfly 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 thru a discharge check valve into the separation system. This system, self-contained in the separator 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 butterfly inlet valve closes, via stepper motor, and the blowdown solenoid valve opens, expelling any compressed air back to the compressor inlet.

5.5 COOLANT/AIR SEPARATION SYSTEM
The coolant/air separation system is composed of a separator 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 through a tangential discharge outlet. This outlet directs the mixture along the inner circumference of the separator, allowing the coolant stream to collect and drop to the separator 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 separator-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 separator 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.

5.6 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) Intellisys controller
2) Compressor motor starter, with auxiliary contacts and overload relays
3) Cooling fan motor overload relays and circuit breaker or fuses
4) Intellisys Power Supply Board
5) Control transformer and fuses

Options, such as power outage restart can be enabled by installing plug-in (option) modules in the Intellisys controller.

5.6 ELECTRICAL SYSTEM (Continued)

STAR-DELTA TYPE STARTER
By use of the Star-Delta type starter, the compressor motor can be started and accelerated using a greatly reduced “inrush” electric current. The starter is completely automatic and controlled by the Intellisys controller. Refer to the Electrical Schematic 8.1 in Section 8.0.

5.7 STEPPER MOTOR INLET CONTROL
The inlet valve is opened and closed by a stepper motor mounted on the inlet valve. The Intellisys controller regulates the stepper motor to precisely position the inlet valve based upon the demand of the plant air system (See Section 5.8).

The stepper motor is maintenance free. Bearings are lubricated at the factory and sealed for life.

No adjustment of the stepper motor/inlet valve system is required.

5.8 CAPACITY CONTROL
The SSR compressor is supplied, as standard equipment, with three operator selectable capacity control systems, each designed for different plant air requirements:
— MOD/ACS (Modulation/Automatic Control Selector)
— On-Off Line
— Modulation Only

The desired control is selected at the Intellisys control panel (See Section 3.0).

AUTOMATIC UNLOADED START
The compressor will always start in the unload mode. When unloaded, the inlet valve is nearly closed, the blowdown solenoid valve is open (tank vented), and the compressor is operating at minimum power. The Intellisys will open the inlet valve slightly to maintain the proper sump pressure to ensure positive coolant flow and smooth, quiet operation. When the injected coolant temperature is less than 120°F (49°C), a separator (sump) pressure of 45-50 psig (3.1 - 3.4 bar) will be maintained. When the injected coolant temperature is above 120°F (49°C), a receiver pressure of 24-33 psig (1.7 - 2.3 bar) will be maintained. The minimum pressure check valve will prevent any backflow of air from the plant air system during unloaded operation.

ON-OFF LINE CONTROL
For those plants which have a widely varying air demand, on-off line control will deliver air at full capacity (compressor maximum efficiency condition) or will operate at zero capacity (compressor minimum power condition). The compressor is controlled by the Intellisys, responding to changes in plant air pressure. The Intellisys/stepper motor opens the inlet valve and closes the blowdown valve (3SV) whenever plant air pressure drops below the on-line pressure set point. The compressor will then operate to deliver full capacity air to the plant system. If the plant air system pressure rises to the off-line set point of the Intellisys, the inlet valve closes and the blowdown solenoid valve opens the separator vent line, allowing separator pressure to drop. The compressor will continue to run with minimum power draw.

MODULATION/ACS CONTROL
For those plants which have relatively high, constant air-demand relative to the compressor capacity, the recommended control mode is modulation.

The modulation control system retains the features of on-off line control, but provides for throttling of the inlet flow up to the modulation off line air pressure set point.

The throttling position of the inlet valve is controlled by the Intellisys, allowing the stepper motor to “trim” the inlet valve position as dictated by the line pressure.

The modulating pressure range is 10 psig (.7 bar). Modulation begins when the line pressure reaches the maximum modulation pressure setting minus 10 psig (.7 bar) and continues as/if the line pressure rises. Modulation becomes stable when the compressor output equals the plant air demand. When the modulation is at the maximum modulation pressure setting the maximum capacity reduction will be down to approximately 60 percent of the compressor rated capacity. If the air demand has decreased to a level below the 60 percent modulated output, the line pressure will increase slightly to actuate the Intellisys, unloading the compressor and venting the separator.

5.8 CAPACITY CONTROL (Continued)

MODULATION/ACS CONTROL (Continued)
The automatic control selector (ACS) is designed to continuously monitor the plant air demand and select either the on-off line, or the modulate control mode - whichever is most desirable at any time during an operating day.

It allows the compressor to operate in its most efficient mode without attendance, thereby reducing power costs to a minimum.

When the compressor operates in the on-off line control mode, the length of time the compressor remains in the “off line” condition is an indication of the plant air demand. Intellisys controller is sensing and awaiting a sufficient line pressure decrease before signaling a shift to the on line mode. If the “off line” time period is relatively short, thereby indicating a high demand for air, it is preferable to shift the control system to upper range modulation.

The Intellisys does this, and does it automatically if the compressor unloads 3 times within a 3 minute time period.

If later, the plant demand decreases, and even under modulate control the line pressure reaches the setting of the Intellisys controller and the control shifts to the “off line” mode, the time in this mode will still be monitored. A long “off line” time period indicates a low plant air demand, indicating the desirability of operating in the on-off line mode.

The Intellisys then does this, and does it automatically if the compressor operates unloaded for more than 3 minutes.

MODULATION ONLY
If MODULATION ONLY is turned on in the set point routine, the unit will shift to Modulation control mode immediately when the unit is running. The 3 cycles within 3 minutes time period required for ACS to change to Modulation mode is bypassed. The unit will stay in Modulation mode until the UNLOAD button is pressed or the Mode of Operation set point is changed.

5.9 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.

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 condition. 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.

Auto Restart Delay
This is the number of seconds the line pressure must remain below the online set point before the compressor will start if it was stopped due to an auto start/stop situation. This timer will not delay an auto restart if the time is set to 0.

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 4APT 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.

5.10 REMOTE START/STOP
The remote start/stop option allows the operator to control the compressor from a remote mounted start/stop station.

Two different switches can be wired to the controller for remote start/stop. (Refer to Electrical Schematic 8.1 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.

⚠ WARNING

This machine is remote start and stop equipped.

May start or stop at anytime.

Can cause severe injury or death.

Disconnect power before servicing.

Lock and tag out.

See Operators / Instruction Manual.

6.0 TROUBLESHOOTING CHART

TROUBLE	CAUSE &/OR DISPLAY	WHAT TO DO
Compressor fails to start.	110/120V control voltage not available, CONTROL POWER LOSS	■ Check fuses. Check transformer and wiring connections.
	STARTER FAULT	■ Inspect contactors.
	EMERGENCY STOP	■ Rotate emergency stop button to disengage, and press reset button twice.
	MAIN (OR FAN) MOTOR OVERLOAD	■ Manually reset main or fan motor overload relay, and press reset button twice.
	SENSOR FAILURE XXXX	■ Check for defective sensor, bad sensor connection, or broken sensor wires.
	CHECK INLET CTRL SYS.	■ Call factory representative.
	Intellisys 24 VAC control voltage not available	■ Check fuses.
	Display panel and power on light does not illuminate.	■ Check wiring. Verify 24 VAC is within voltage tolerance (± 15%).
Compressor shuts down. NOTE: If a shutdown occurs, press the Status button once to activate the display table. Using the adjacent up and down arrows, the values displayed will be those immediately preceding shutdown. Use these values when troubleshooting a problem.	HIGH AIREND DISCH TEMP.	■ Ensure that installation area has adequate ventilation. ■ Ensure that cooling fan is operating. If not, reset circuit breaker inside starter box. ■ Check coolant level. Add if required. ■ Cooler cores dirty. Clean coolers.
	LOW UNLOAD SUMP PRESS.	■ Check for air leak from tank or blowdown piping. ■ Check for slipping or broken stepper motor coupling.
	CHECK INLET CTRL SYS.	■ Call factory representative.
	SENSOR FAILURE XXXX	■ Check for defective sensor, bad sensor connection, or broken sensor wires.
	CHECK MOTOR ROTATION	■ Interchange any two line connections (L1, L2, L3) at the starter.
	MAIN MOTOR OVERLOAD	■ Check for loose wires. ■ Check supply voltage. ■ Check heater setting.
	FAN MOTOR OVERLOAD	■ Check for loose wires. ■ Check supply voltage. ■ Check heater setting. ■ Check for dirty cooler cores.
	STARTER FAULT	■ Inspect starter connectors. ■ Check for loose wires.
	CHECK SET POINTS	■ Reset to clear. ■ Calibrate sensors. ■ Check all set points.
	CONTROL POWER LOSS	■ Check fuses. Check transformer and wiring connections.
	STEPPER LIMIT SWITCH	■ Call factory representative.
	REMOTE STOP FAILURE	■ Check Remote Stop Switch and wiring.
	REMOTE START FAILURE	■ Check Remote Start Switch and wiring.
	EMERGENCY STOP	■ Disengage emergency stop button. ■ Press reset button twice.
	LOW SUMP AIR PRESS	■ See LOW UNLOAD SUMP PRESS
	CHECK INLET CONTROL	■ Check for air leaks at inlet valve. ■ Check for slipping or broken stepper motor coupling.

6.0 TROUBLESHOOTING CHART (Continued)

TROUBLE	CAUSE &/OR DISPLAY	WHAT TO DO
Low system air pressure	Compressor running in UNLOAD Mode.	■ Press LOAD button.
	Controller off-line set point too low.	■ Press 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.
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 screen/orifice.	■ Remove and inspect screen/orifice. Clean if required.
	Compressor operating at low pressure (75 psig [5.2 bar] 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.
	No aftercooler on unit.	■ Install aftercooler.
	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.
Excessive noise level	Compressor defective. (Bearing or gear failure or rotor contact.)	■ Contact authorized distributor immediately. Do not operate unit.
	Enclosure panels not in place.	■ Install enclosure panels.
	Loose component mounting.	■ Inspect and tighten.
Excessive vibration	Loose components.	■ Inspect and tighten.
	Motor or compressor bearing failure.	■ Contact authorized distributor 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 OTIONS

7.1 POWER OUTAGE RESTART OPTION

For customers that have interruptions in their incoming power supply to the compressor and must maintain an uninterrupted supply of compressed air, the Power Outage Restart Option allows an Intellisys compressor to restart automatically 10-120 seconds (adjustable) after incoming power is restored.

The Power Outage Restart Option is turned on by plugging in the required option module and enabling it thru the OPTION'S set point routine. The restart time delay, which is adjustable from 10-600 seconds, can also be adjusted while in the option's set 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 (10-600 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 factory installed or a field installation kit is available.

7.2 SEQUENCER

The sequencer option is turned on by enabling it through the OPTIONS set point routine. Enabling this option will allow the compressor to be controlled by an external device, such as an ISC or sequencer, using the communications port (P7) on the Intellisys.

7.3 LOW AMBIENT

The low ambient option is turned on by enabling it through the OPTIONS set point routine. Also temperature sensor, 3CTT, is added to the compressor and connected at P6-7 & 8 on the Intellisys. The options set point, minimum cooler out temperature, is set to the minimum temperature at which the unit can load. When this option is enabled, the compressor, after being started, will not load until the Intellisys reads a temperature from 3CTT at or higher than the value of the minimum cooler out temperature set point. **If this option is enabled without installing 3CTT, a SENSOR FAILURE 3CTT alarm will occur.**

7.4 SEPARATOR DELTA-P SOLENOID

The separator delta-p solenoid option is turned on by enabling it through the OPTIONS set point routine. When this option is enabled, the Intellisys will measure the pressure drop across the separator element by first reading the wet side sump pressure. Next the Intellisys will momentarily energize solenoid that will switch the dry side sump pressure to the sump pressure sensor (3APT). The Intellisys will then read the dry side sump pressure and subtract it from the wet side sump pressure to measure the pressure drop across the separator element. **Do not enable this option if the separator delta-p solenoid is not installed. This will result in an incorrect measurement of the pressure drop across the separator element.**

7.5 SEPARATOR DELTA-P SENSOR

The separator delta-p sensor option is turned on by enabling it through the OPTIONS set point routine. When this option is enabled, the Intellisys will measure the pressure drop across the separator element by subtracting the dry side sump pressure (6APT) from the wet side sump pressure (3APT). **Do not enable this option if the separator delta-p sensor is not installed. This will result in an incorrect measurement of the pressure drop across the separator element and a 6APT sensor failure warning.**

7.6 HIGH DUST FILTER

The high dust filter option is turned on by enabling it through the OPTIONS set point routine. If this option is enabled, the Intellisys; will change its measurement of the inlet filter. **Do not enable this option unless a high dust filter is installed.**

7.7 LEAD/LAG CYCLE LENGTH

The lead/lag cycle length option allows the Intellisys to automatically switch the online and offline pressure settings to the lead or lag values after a programmed number of hours. This option is enabled by selecting a number of hours greater than 0 in the OPTIONS set point routine.

7.8 SCHEDULEDSTART/STOP

The scheduled start/stop option allows the customer to automatically start and stop the compressor once each day, based on the real time clock. This is an installed option and is enabled by selecting a scheduled start and scheduled stop time. Setting the scheduled start and scheduled stop times to the same value will disable this option.

7.9 REMOTE LOAD/UNLOAD

The remote load/unload option gives the operator the ability to control the loading and unloading of the compressor. This option is enabled when two switches are wired to the Intellisys to perform this function. The firstswitch is the master/local input (P3, 25 & 26) and the second switch is the load/unload input (P3, 27 & 28). If the master/local switch is closed, the Intellisys will read the load/unload switch for loading and unloading the compressor. If the load/unload switch is closed, the Intellisys will load the compressor. If the load/unload switch is open, the Intellisys will unload the compressor. If the master/local switch is open, the Intellisys will ignore the load/unload switch and operate the compressor normally.

7.10 MODBUS

The Modbus option uses the Modbus protocol and modbus address set points in the OPTIONS menu. This is used by the Ingersoll-Rand service organization.

7.11 INTEGRAL SEQUENCING

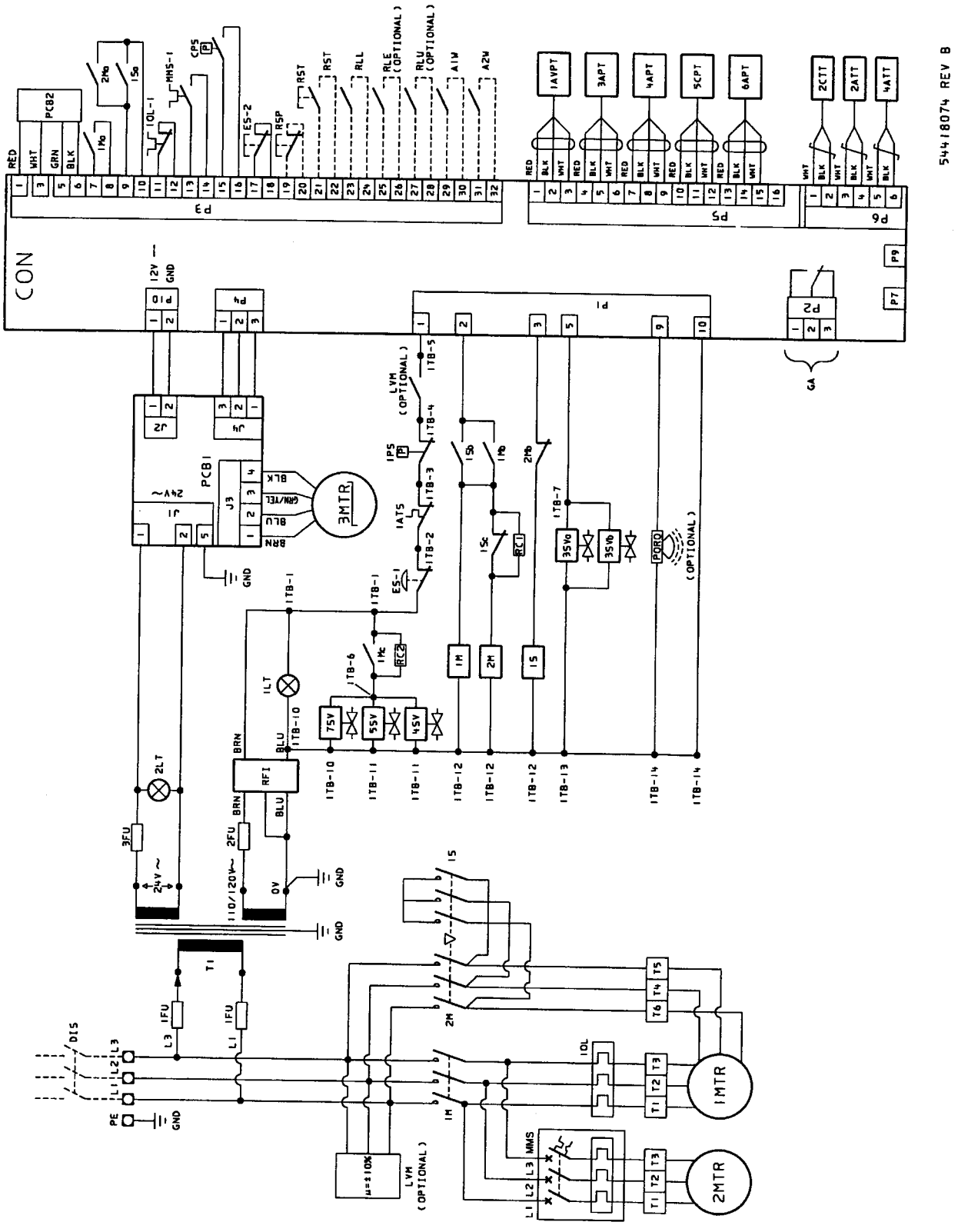
Integral sequencing allows one compressor, the lead, to sequence up to 3 other compressors. The compressors are daisy chained together using port P8 on the Intellisys. Each compressor has a unique address and the lead compressor will sequence the other units in numerical order based on that address.

The lead compressor will be the first to load and the last to unload. It is also the only compressor that can modulate. If the lead compressor's mode of operation is Mod/ACS or Modulation Only, it will modulate when it is loaded. Once loaded, if pressure falls to its online set point, the lead compressor will transmit a load command to the next compressor in sequence. The lead compressor will then wait for a period of time for the line pressure to rise. This time period is determined by the load delay time set point. At the end of this time period, if line pressure is not rising, the lead compressor will transmit a load command to the next compressor in sequence. This will be repeated until the line pressure starts to rise.

When line pressure rises to the lead compressor's offline set point, it will transmit an unload command to the last loaded compressor in the sequence. The lead compressor will do this every 10 seconds until the line pressure starts to fall.

After a certain amount of time or at a certain time, the lead compressor can change the sequence by transferring the lead to the next compressor in the sequence. If the set point, Lead Change - Hours, is set to a value greater than 0, the unit will operate as the lead compressor for that number of hours before transferring the lead. If Lead Change - Hours is set to 0, the set points Lead Change - Day and Lead Change - Time will be used to determine when the lead will be transferred. The Lead Change - Day set point will contain the day of the week the lead will be transferred. The time of the day will be contained in the Lead Change - Time set point. The lead will be transferred when the real time clock matches these 2 set points.

To connect the compressors for integral sequencing put the 4 position connector into port P8. One connector, I-R part number 39186101, will be needed for each compressor. The total length of cable for an integral sequencing system is not to exceed 1000 feet. For the cable, use I-R part number 39204508 or equivalent. This is a 4 wire, twisted pair cable. Use one pair for pins 1 and 2 and the other pair for pins 3 and 4. The connection on port P8 is a one to one connection. The wire on pin 1 on the first compressor will connect to pin 1 on the second compressor and so on. This is true for all 4 wires.



8.0 REFERENCE DRAWINGS

8.1 ELECTRICAL SCHEMATIC
STAR DELTA

54418074
REV B

LEGEND

ABBREV	DESCRIPTION
PE	EARTH LEAD, MAIN TERMINAL
GND	EARTH/GROUND
DIS	MAIN DISCONNECT (CUSTOMER SUPPLIED)
L1-L3	MAIN TERMINALS
1FU-3FU	CONTROL FUSE (3FU MUST BE A FAST ACTING TYPE BBS FUSE)
T1	TRANSFORMER, 110-1-50 OR 120-1-60, 24V

TRANSFORMER/FUSE SIZE:

T1(VA)	1FU(A)	2FU(A)	3FU(A)
280	1.8	2.0	5.0
380	2.5	3.2	5.0
580	3.5	5.0	5.0
625	3.5	5.0	6.0

1M	MAIN CONTACTOR
1Ma-c	MAIN CONTACTOR AUXILIARY CONTACTS
2M	DELTA CONTACTOR
2Ma-d	DELTA CONTACTOR AUXILIARY CONTACTS
1S	STAR CONTACTOR
1Sa-c	STAR CONTACTOR AUXILIARY CONTACTS
1MTR	MAIN DRIVE MOTOR
2MTR	FAN MOTOR
3MTR	STEPPER MOTOR
1OL	MAIN MOTOR OVERLOAD RELAY
MMS	FAN MANUAL MOTOR STARTER
RFI	RFI FILTER
1LT	LAMP, POWER ON - BACKPANEL
2LT	LAMP, POWER ON - INSTRUMENT PANEL
PCB1	PRINTED CIRCUIT BOARD, POWER SUPPLY
PCB2	PRINTED CIRCUIT BOARD, STEPPER, LIMIT
ES	EMERGENCY STOP
3SVa-b	SOLENOID VALVE, BLOWDOWN (3SVb REQUIRED ON 350-500HP UNIT ONLY)
4SV	SOLENOID VALVE, WATER SHUT OFF (WATER COOLED UNIT ONLY)
5SV	SOLENOID VALVE, COOLANT STOP (NOT REQUIRED ON UNITS WITH OIL PUMP)
7SV	SOLENOID VALVE, PRESSURE RELIEF (REMOTE COOLED UNIT ONLY)
1ATS	SWITCH, HIGH AIR TEMPERATURE
RC1-2	ARC SUPPRESSORS
CON	INTELLISYS CONTROLLER
GA	REMOTE ALARM CONTACTS
RSP	REMOTE STOP
RST	REMOTE START
1AVPT	TRANSDUCER, PRESSURE - INLET VACUUM
3APT	TRANSDUCER, PRESSURE - SEPARATOR TANK WET SIDE
4APT	TRANSDUCER, PRESSURE - PACKAGE DISCHARGE
6APT	TRANSDUCER, PRESSURE - SEPARATOR TANK DRY SIDE
5CPT	TRANSDUCER, PRESSURE - INJECTED COOLANT (TWO STAGE ONLY)

LEGEND

ABBREV	DESCRIPTION
2ATT	SENSOR, TEMPERATURE - AIREND DISCHARGE
2CTT	SENSOR, TEMPERATURE - INJECTED COOLANT
4ATT	SENSOR, TEMPERATURE - PACKAGE DISCHARGE
IPS	SWITCH, INTERSTAGE PRESSURE (TWO STAGE UNIT ONLY)
CPS	SWITCH, COOLANT DELTA PRESSURE
ITB	TERMINALS
P7	COMMUNICATIONS PORT
P9	OPTIONS MODULE
RLL	REMOTE LEAD/LAG SWITCH
RLE	REMOTE LOAD ENABLE SWITCH (OPTIONAL)
RLU	REMOTE LOAD/UNLOAD SWITCH (OPTIONAL)
A1W	AUXILIARY WARNING INPUT #1
A2W	AUXILIARY WARNING INPUT #2

LEGEND

ABBREV	DESCRIPTION
BLK	BLACK
BLU	BLUE
GRN	GREEN
RED	RED
WHT	WHITE
YEL	YELLOW
BRN	BROWN
GRN/YEL	GREEN/YELLOW

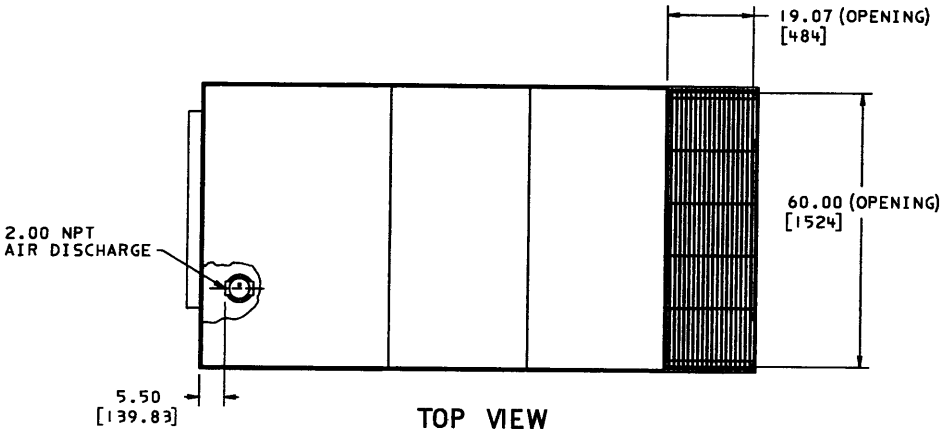
OPTIONS

LVM	LINE VOLTAGE MONITOR
PORO	HORN, POWER OUTAGE RESTART

NOTES:

1. MAIN DISCONNECT AND BRANCH CIRCUIT PROTECTION TO BE PROVIDED BY CUSTOMER.
2. DASHED LINES REPRESENT WIRING BY CUSTOMER.
3. SIZING OF ELECTRICAL COMPONENTS, NOT SUPPLIED BY INGERSOLL-RAND, IS THE RESPONSIBILITY OF THE CUSTOMER AND SHOULD BE DONE IN ACCORDANCE WITH THE INFORMATION ON THE COMPRESSOR DATA PLATE, NATIONAL AND LOCAL ELECTRICAL CODES.
4. IPS IS REPLACED WITH A JUMPER WIRE FROM 1TB-3 TO 1TB-4 ON UNITS NOT REQUIRING AN INTERSTAGE PRESSURE SWITCH.

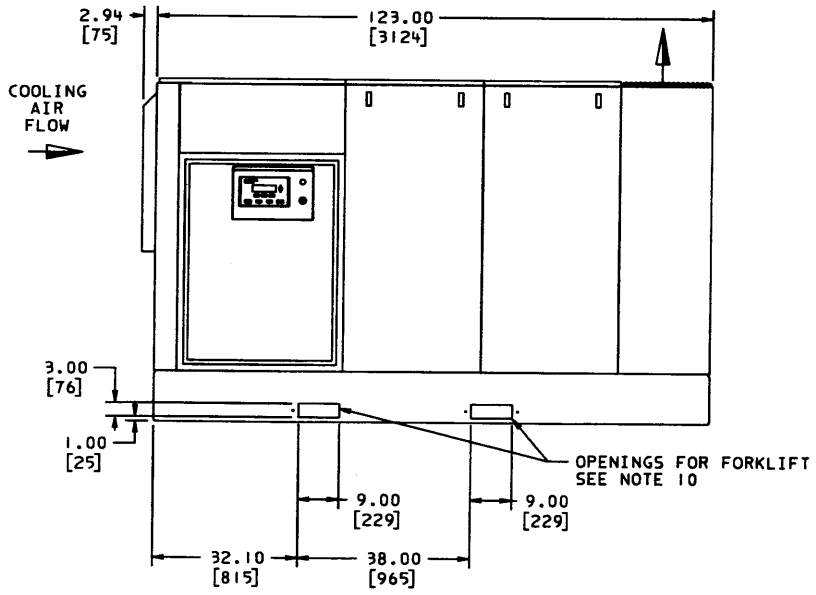
8.2 FOUNDATION PLAN
125-150 HP/90-110KW AIRCOOLED
SINGLE STAGE
(CONTINUED)



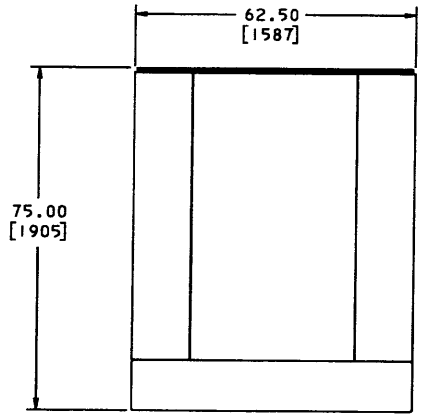
TOP VIEW

NOTES:

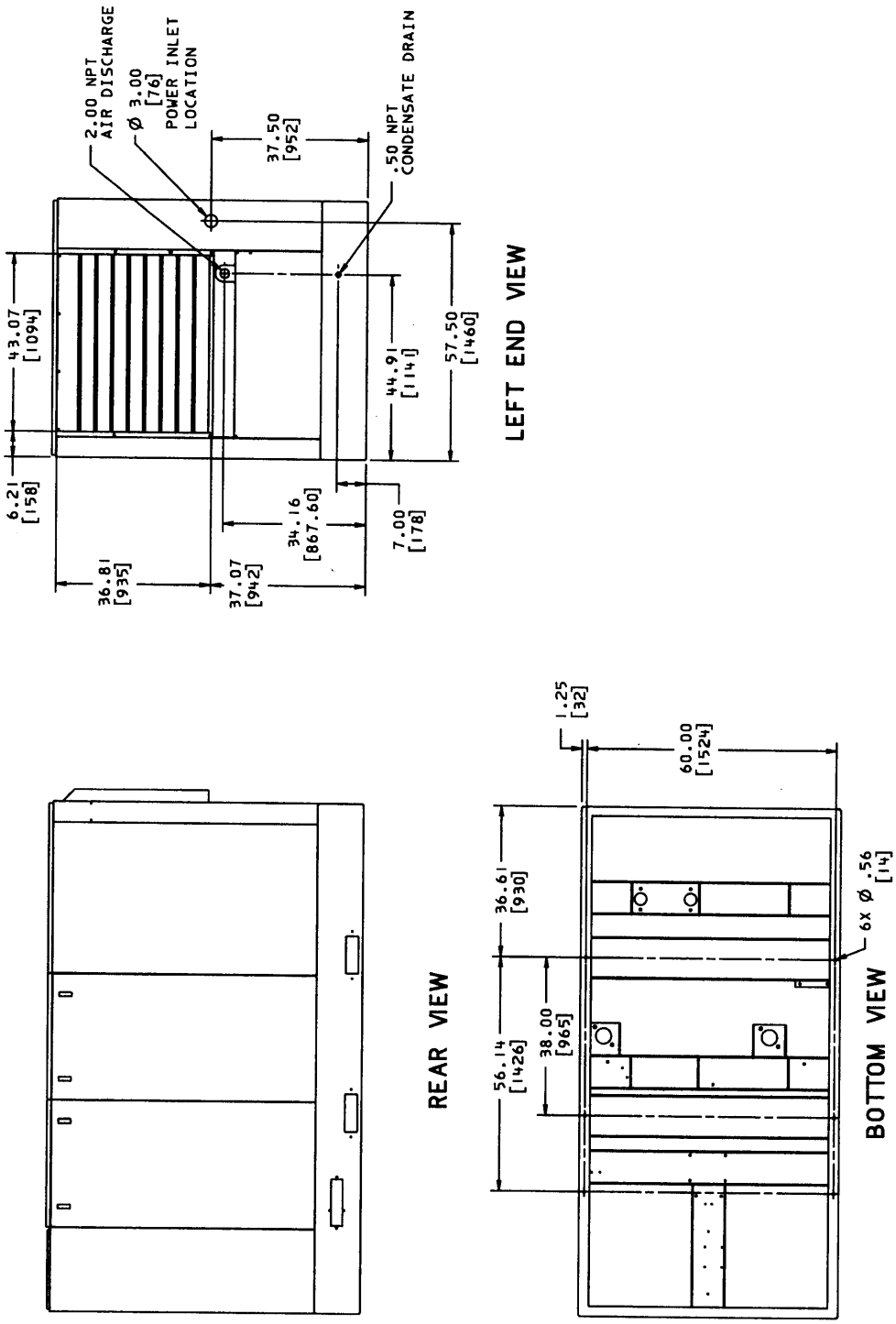
1. WEIGHT (APPROXIMATE)
   125 HP / 90 KW - 5770 LB (2617 KG)
   150 HP / 110 KW - 5820 LB (2640 KG)
2. COOLANT LUBRICANT FILL QTY (APPROXIMATE)
   DRY - 23 GAL (87 L)
   TANK ONLY - 16 GAL (61 L)
3. TOLERANCE ON ALL DIMENSIONS ±.12 (±3MM)
4. ALL DIMENSIONS IN INCHES (MM).
5. 36.00 (914) MINIMUM LENGTH OF WIRE FROM POWER INLET OPENING AT STARTER
6. AIR FLOW - 15,000 CFM (425 M3/MIN)
7. RECOMMENDED CLEARANCE ON THREE SIDES 36.00 (914); 42.00 (1067) IN FRONT OF CONTROL PANEL 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. SEPARATOR ELEMENT:
    MINIMUM CLEARANCE REQUIRED FOR REMOVAL ABOVE TOP OF UNIT IS 18.00 (457).
12. FIELD INSTALLED DUCTING TO AND FROM COMPRESSOR CAN NOT ADD MORE THAN 0.25 INCHES (6 MM) OF WATER AIR RESISTANCE.



FRONT VIEW



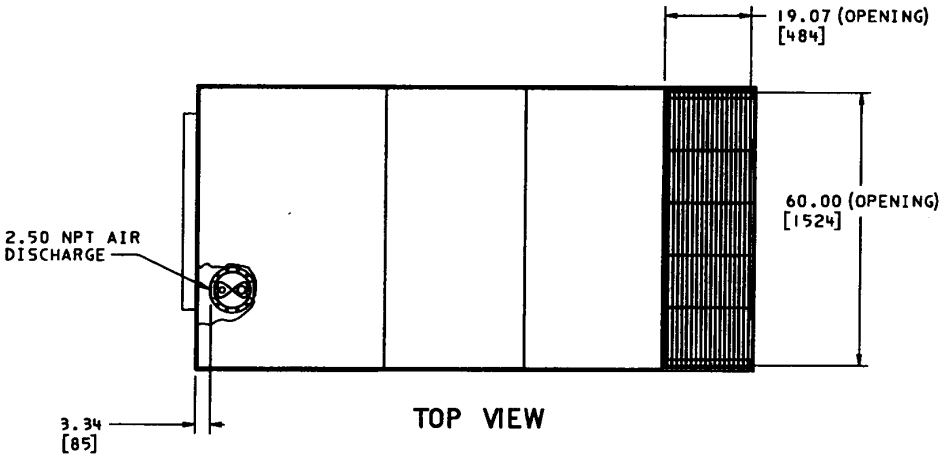
RIGHT END VIEW



8.2 FOUNDATION PLAN
125-150 HP/90-110 KW AIRCOOLED
SINGLE STAGE

54622865
REV B

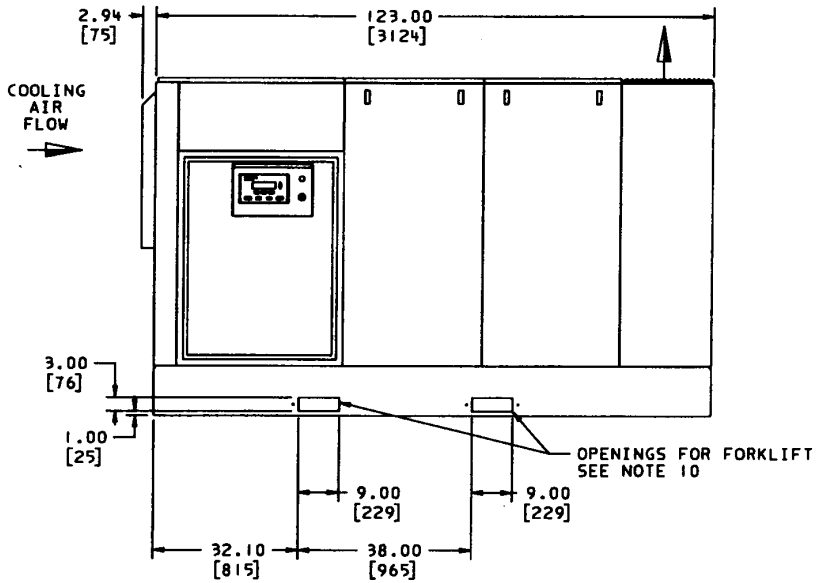
8.3 FOUNDATION PLAN
200 HP/132-160 KW AIRCOOLED SINGLE STAGE (CONTINUED)



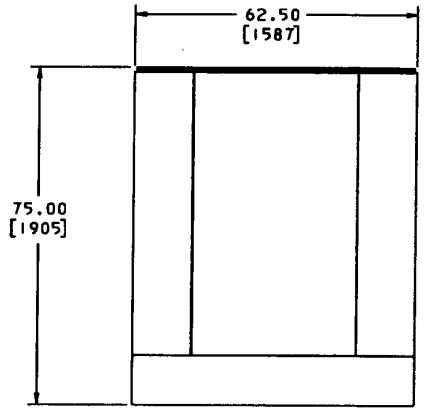
TOP VIEW

NOTES:

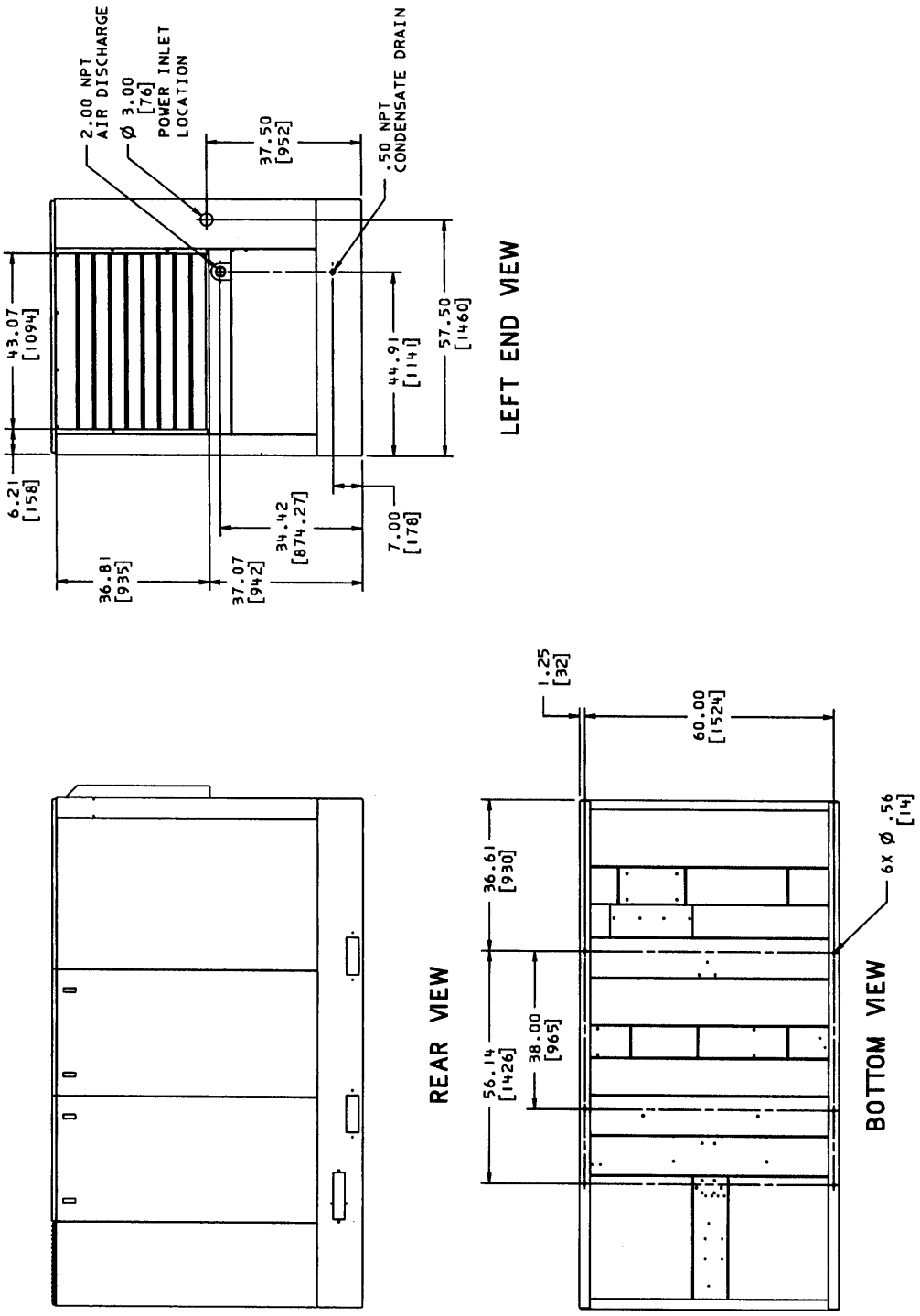
1. WEIGHT (APPROXIMATE)
   200 HP / 132-160 KW - 6020 LB (2731 KG)
2. COOLANT LUBRICANT FILL QTY (APPROXIMATE)
   DRY - 23 GAL (87 L)
   TANK ONLY - 16 GAL (61 L)
3. TOLERANCE ON ALL DIMENSIONS ±.12 (±3MM)
4. ALL DIMENSIONS IN INCHES (MM).
5. 36.00 (914) MINIMUM LENGTH OF WIRE FROM POWER INLET OPENING AT STARTER
6. AIR FLOW - 15,000 CFM (425 M3/MIN).
7. RECOMMENDED CLEARANCE ON THREE SIDES 36.00 (914); 42.00 (1067) IN FRONT OF CONTROL PANEL 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. SEPARATOR ELEMENT:
    MINIMUM CLEARANCE REQUIRED FOR REMOVAL ABOVE TOP OF UNIT IS 18.00 (457).
12. FIELD INSTALLED DUCTING TO AND FROM COMPRESSOR CAN NOT ADD MORE THAN 0.25 INCHES (6 MM) OF WATER AIR RESISTANCE.



FRONT VIEW



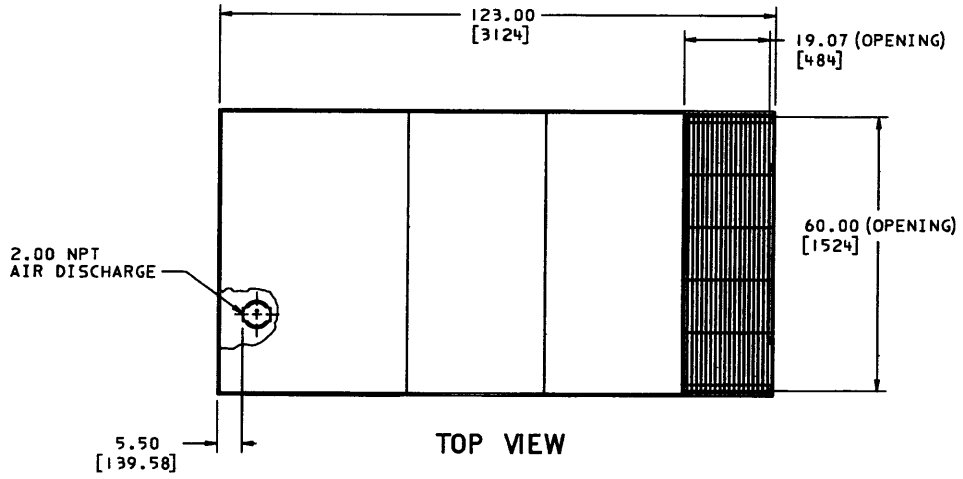
RIGHT END VIEW



8.3 FOUNDATION PLAN
200 HP/132-160 KW AIRCOOLED
SINGLE STAGE

54622931
REV B

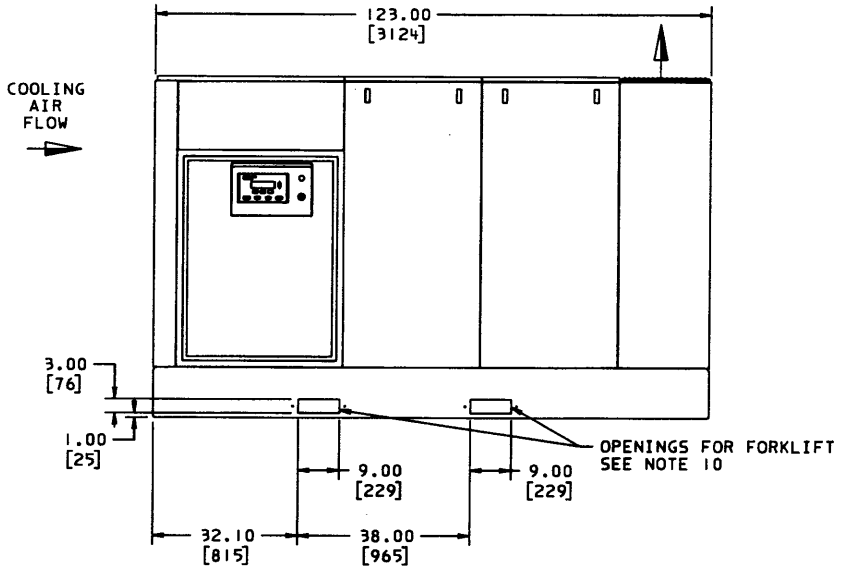
8.4 FOUNDATION PLAN
125-150 HP/90-110 KW WATERCOOLED
SINGLE STAGE
(CONTINUED)



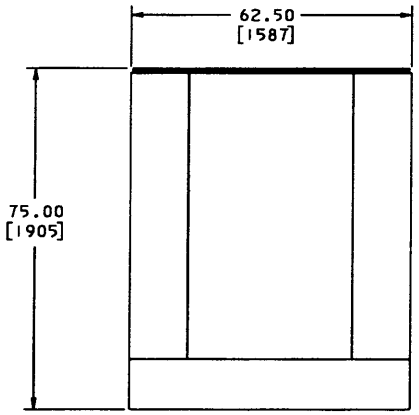
TOP VIEW

NOTES:

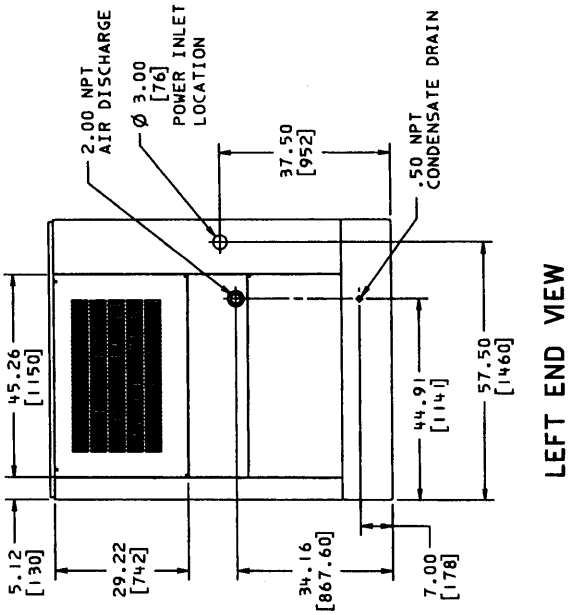
1. WEIGHT (APPROXIMATE)
   125 HP/90KW - 5770 LB (2617 KG)
   150 HP/110KW - 5820 LB (2640 KG)
2. COOLANT LUBRICANT FILL QTY (APPROXIMATE)
   DRY - 23 GAL (87 L)
   TANK ONLY - 16 GAL (61 L)
3. TOLERANCE ON ALL DIMENSIONS ±.12 (±3MM)
4. ALL DIMENSIONS IN INCHES (MM).
5. 36.00 (914) MINIMUM LENGTH OF WIRE FROM POWER INLET OPENING AT STARTER
6. AIR FLOW - 5000 CFM (2.36 M3/S)
7. RECOMMENDED CLEARANCE ON THREE SIDES 36.00 (914): 42.00 (1067) IN FRONT OF CONTROL PANEL 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. SEPARATOR ELEMENT: MINIMUM CLEARANCE REQUIRED FOR REMOVAL ABOVE TOP OF UNIT IS 18.00 (457).
12. FIELD INSTALLED DUCTING TO AND FROM COMPRESSOR CAN NOT ADD MORE THAN 0.25 INCHES (6 MM) OF WATER AIR RESISTANCE.

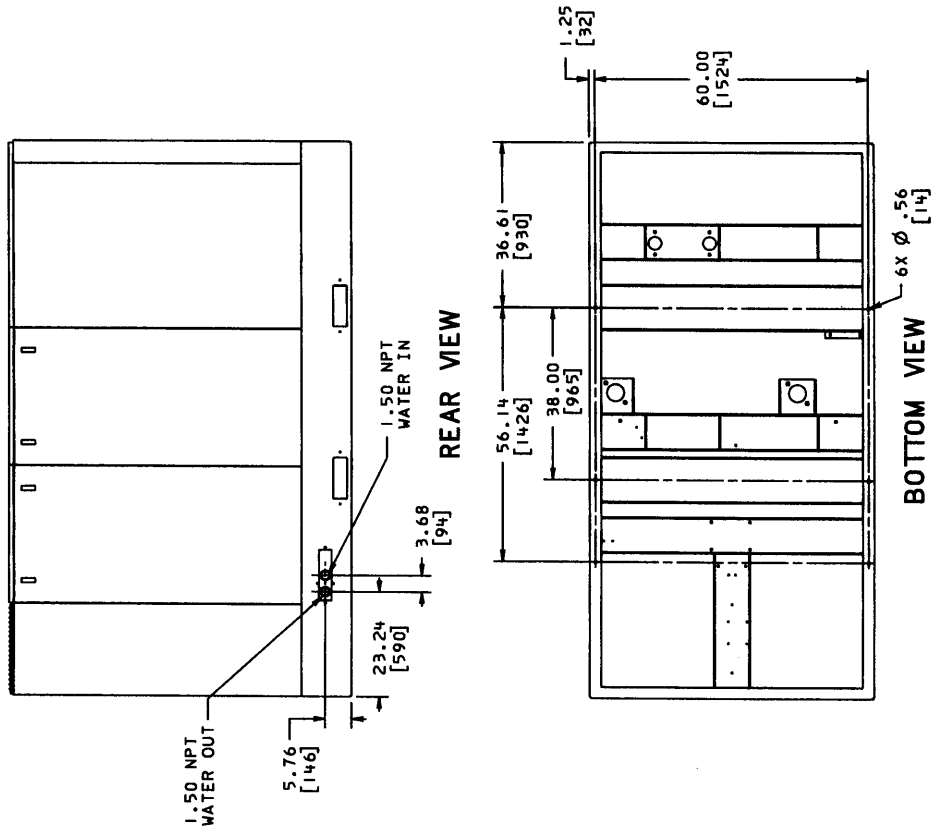


FRONT VIEW



RIGHT END VIEW

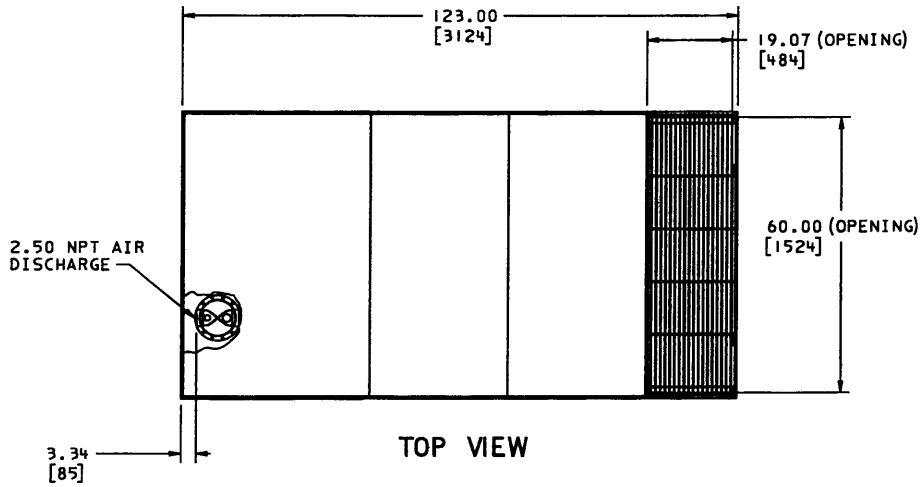




8.4 FOUNDATION PLAN
125-150 HP/90-110 KW WATERCOOLED
SINGLE STAGE

39925300
REV C

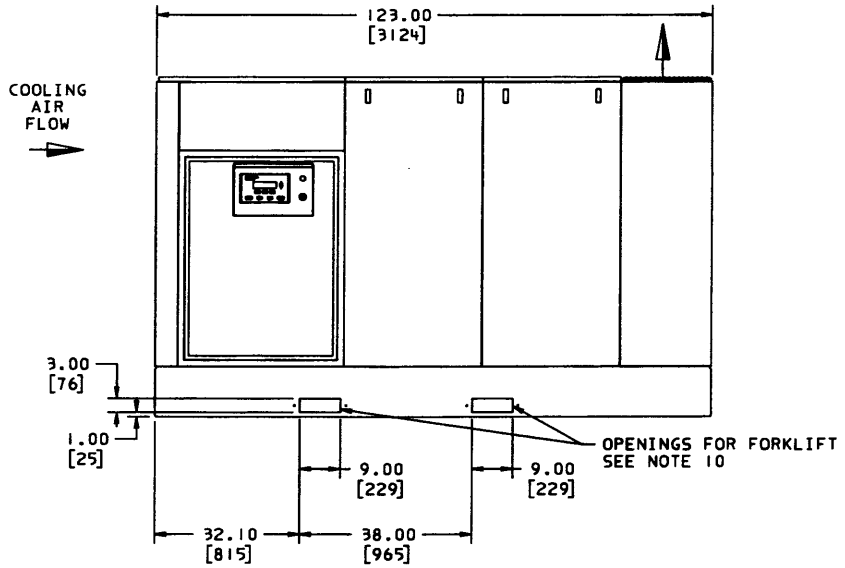
8.5 FOUNDATION PLAN
200 HP/132-160 KW WATERCOOLED SINGLE STAGE (CONTINUED)



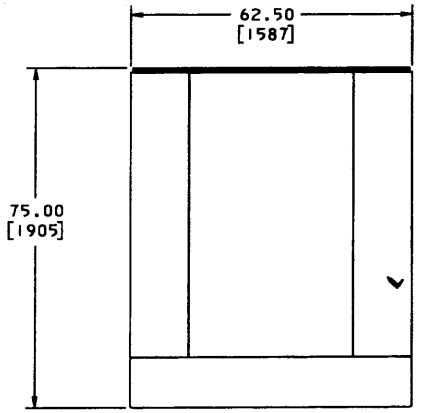
TOP VIEW

NOTES:

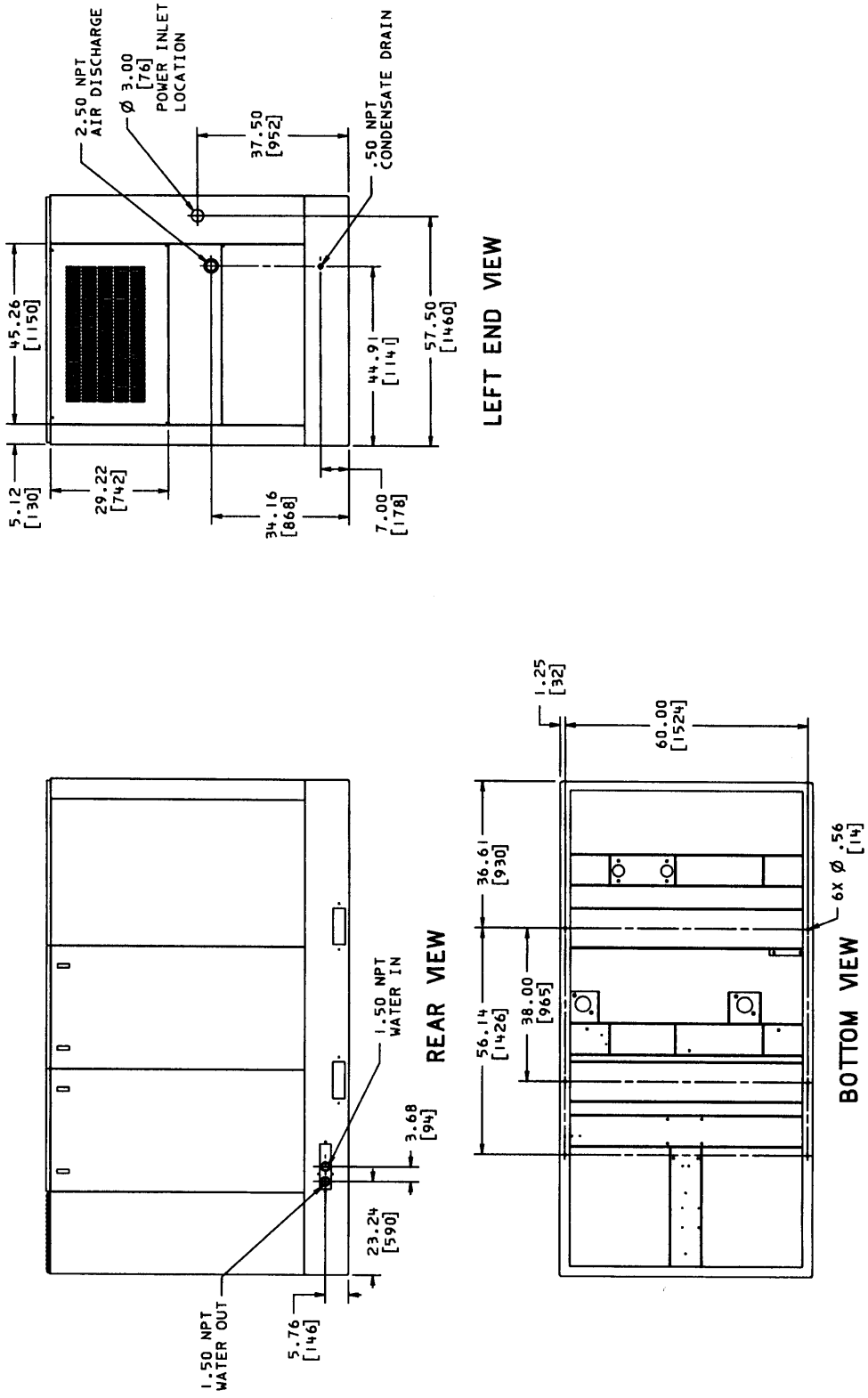
1. WEIGHT (APPROXIMATE)
   200 HP/132-160KW - 6020 LB (2731 KG)
2. COOLANT LUBRICANT FILL QTY (APPROXIMATE)
   DRY - 23 GAL (87 L)
   TANK ONLY - 16 GAL (61 L)
3. TOLERANCE ON ALL DIMENSIONS ±.12 (±3MM)
4. ALL DIMENSIONS IN INCHES (MM).
5. 36.00 (914) MINIMUM LENGTH OF WIRE FROM POWER INLET OPENING AT STARTER
6. AIR FLOW - 5000 CFM (2.36 M3/S)
7. RECOMMENDED CLEARANCE ON THREE SIDES 36.00 (914); 42.00 (1067) IN FRONT OF CONTROL PANEL 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. SEPARATOR ELEMENT:
    MINIMUM CLEARANCE REQUIRED FOR REMOVAL ABOVE TOP OF UNIT IS 18.00 (457).
12. FIELD INSTALLED DUCTING TO AND FROM COMPRESSOR CAN NOT ADD MORE THAN 0.25 INCHES (6 MM) OF WATER AIR RESISTANCE.



FRONT VIEW



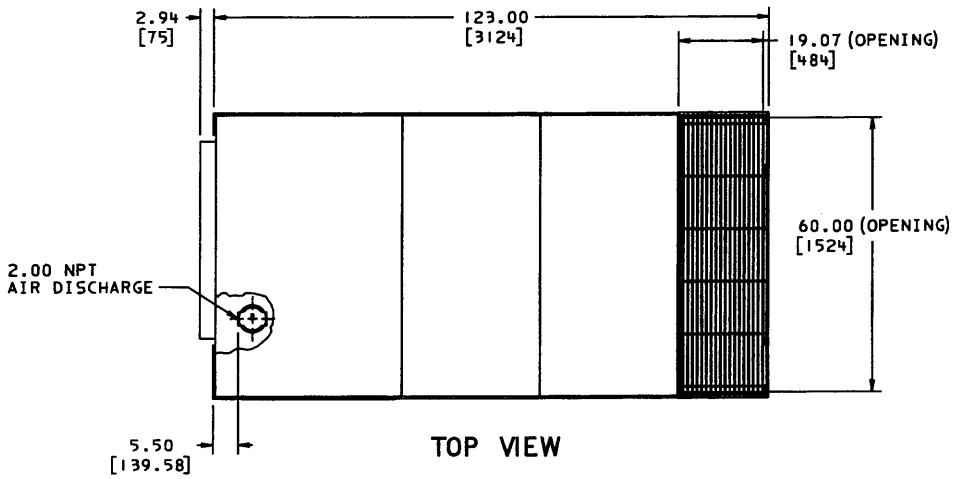
RIGHT END VIEW



8.5 FOUNDATION PLAN
200 HP/132-160 KW WATERCOOLED
SINGLE STAGE

39926191
REV C

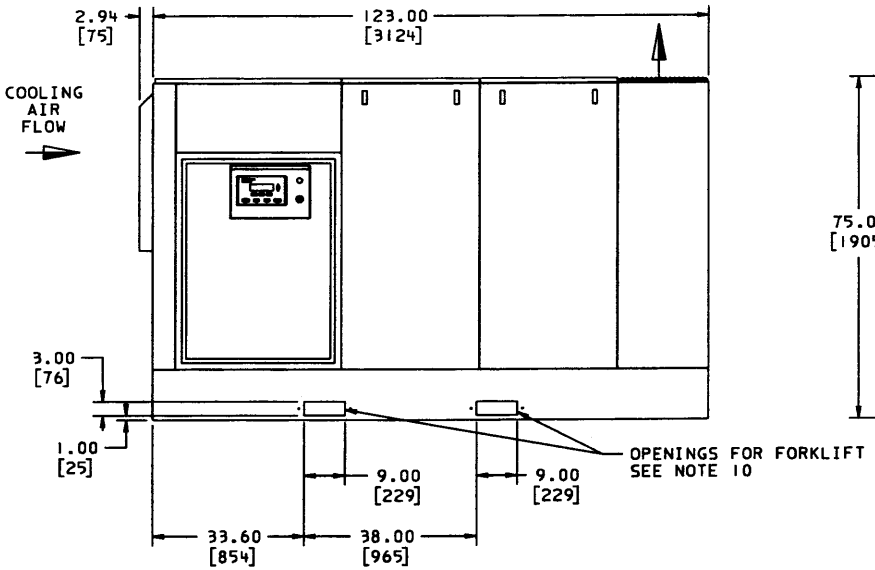
8.6 FOUNDATION PLAN - AIRCOOLED (CONTINUED)
100-150 HP/75-110 KW - TWO STAGE



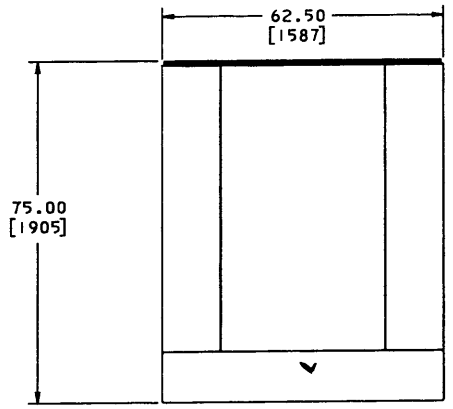
TOP VIEW

NOTES:

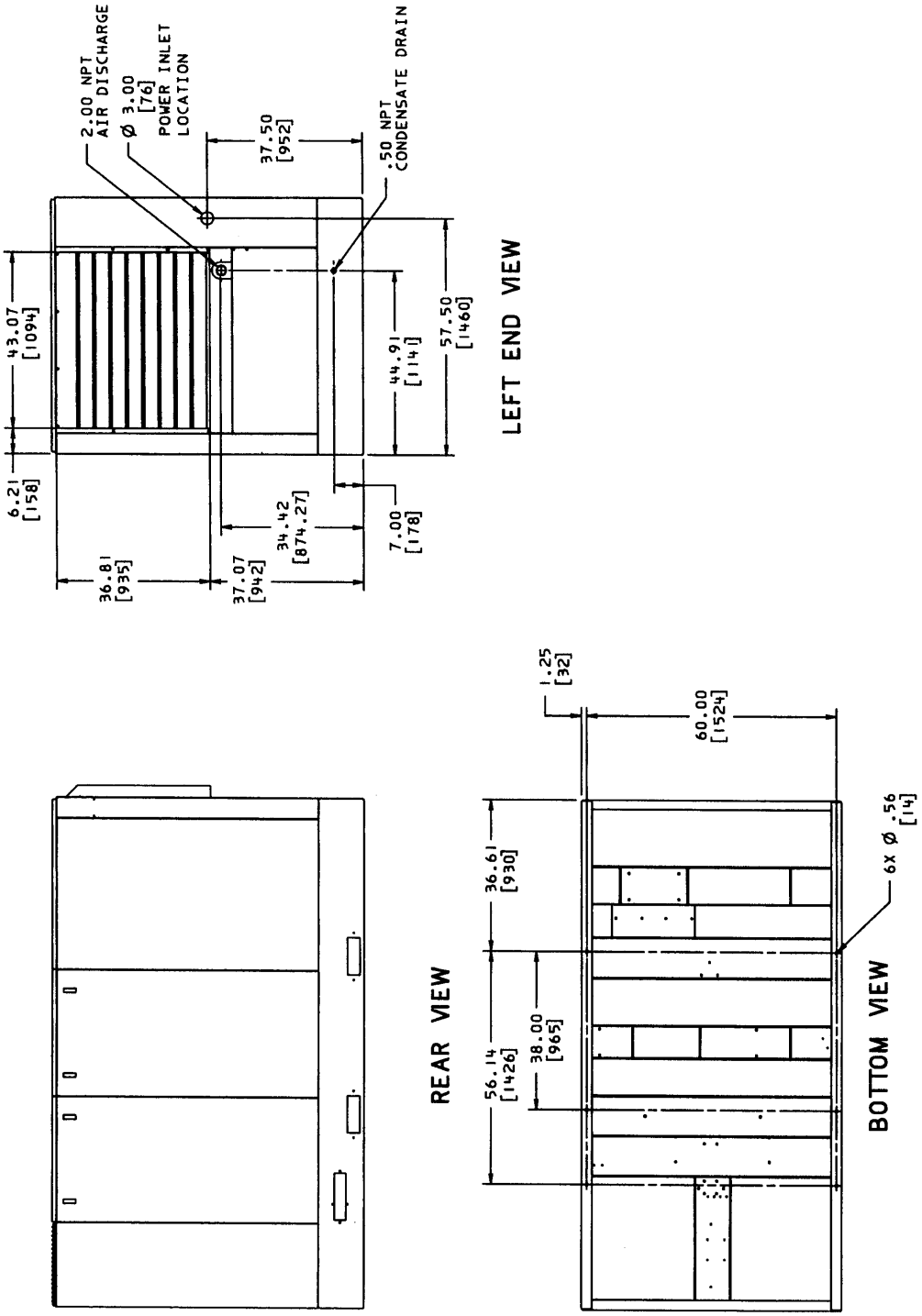
1. WEIGHT (APPROXIMATE)
   100 HP / 75 KW - 6050 LB (2744 KG)
   125 HP / 90 KW - 6770 LB (3071 KG)
   150 HP / 110 KW - 6820 LB (3094 KG)
2. COOLANT LUBRICANT FILL QTY (APPROXIMATE)
   DRY - 22 GAL (83 L) FOR 100HP/75KW
   30 GAL (114 L) FOR 125-150HP/90-110KW
   TANK ONLY - 16 GAL (61 L) FOR 100-150HP/75-110KW
3. TOLERANCE ON ALL DIMENSIONS ±.12 (±3MM)
4. ALL DIMENSIONS IN INCHES (MM).
5. 36.00 (914) MINIMUM LENGTH OF WIRE FROM POWER INLET OPENING AT STARTER
6. AIR FLOW - 100HP / 75KW - 10,400 CFM (295 M3/MIN)
   125-150HP / 90-110KW - 15,000 CFM (425 M3/MIN).
7. RECOMMENDED CLEARANCE ON THREE SIDES 36.00 (914): 42.00 (1067) IN FRONT OF CONTROL PANEL OR MINIMUM AS REQUIRED BY LATEST NATIONAL ELECTRICAL CODES OR APPLICABLE LOCAL CODES.
8. EXTERNAL PIPING SHALL NOT EXERT ANY UNRESOLVED MOMENTS OR FORCES ON UNIT.
9. THERE SHOULD BE NO PLASTIC PIPING
10. FORKLIFT HOLE COVERS MUST BE INSTALLED AFTER UNIT IS IN PLACE.
11. SEPARATOR ELEMENT: MINIMUM CLEARANCE REQUIRED FOR REMOVAL ABOVE TOP OF UNIT IS 18.00 (457).
12. FIELD INSTALLED DUCTING TO AND FROM COMPRESSOR CAN NOT ADD MORE THAN 0.25 INCHES (6MM) OF WATER AIR RESISTANCE.



FRONT VIEW



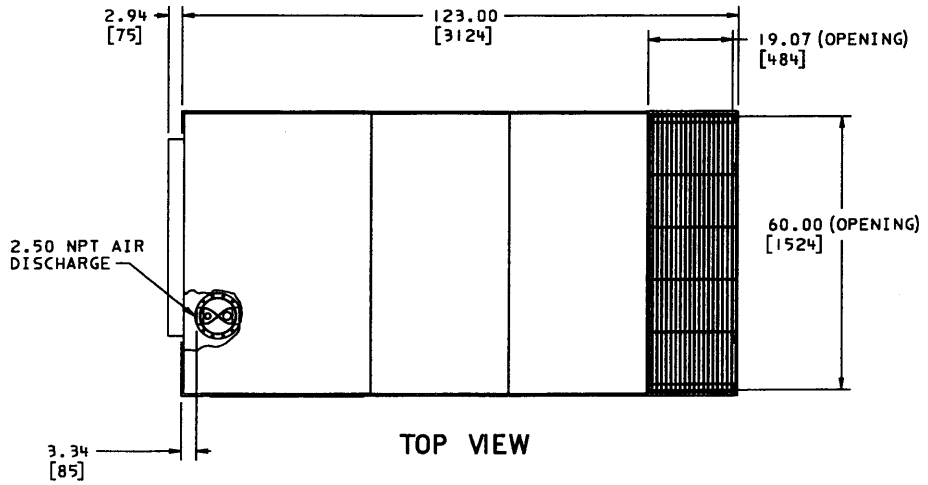
RIGHT END VIEW



54622980
REV B

8.6 FOUNDATION PLAN - AIRCOOLED
100-150 HP/75-110 KW - TWO STAGE

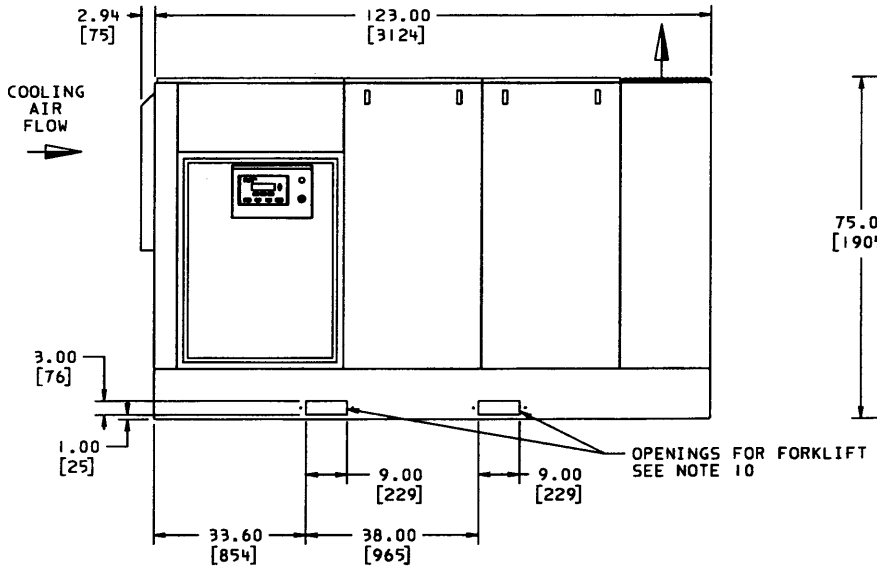
8.7 FOUNDATION PLAN - AIRCOOLED (CONTINUED)
200 HP/132-160 KW - TWO STAGE



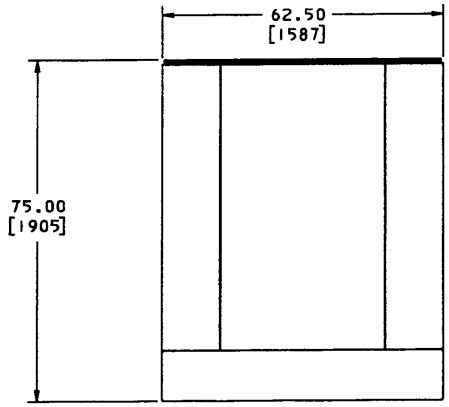
TOP VIEW

NOTES:

1. WEIGHT (APPROXIMATE)
   200 HP / 132-160 KW - 7020 LB (3184 KG)
2. COOLANT LUBRICANT FILL QTY (APPROXIMATE)
   DRY - 30 GAL (114 L)
   TANK ONLY - 16 GAL (61 L)
3. TOLERANCE ON ALL DIMENSIONS ±.12 (±3MM)
4. ALL DIMENSIONS IN INCHES (MM).
5. 36.00 (914) MINIMUM LENGTH OF WIRE FROM POWER INLET OPENING AT STARTER
6. AIR FLOW - 15,000 CFM (425 M3/MIN).
7. RECOMMENDED CLEARANCE ON THREE SIDES 36.00 (914); 42.00 (1067) IN FRONT OF CONTROL PANEL OR MINIMUM AS REQUIRED BY LATEST NATIONAL ELECTRICAL CODES 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
10. FORKLIFT HOLE COVERS MUST BE INSTALLED AFTER UNIT IS IN PLACE.
11. SEPARATOR ELEMENT:
    MINIMUM CLEARANCE REQUIRED FOR REMOVAL ABOVE TOP OF UNIT IS 18.00 (457).
12. FIELD INSTALLED DUCTING TO AND FROM COMPRESSOR CAN NOT ADD MORE THAN 0.25 INCHES (6MM) OF WATER AIR RESISTANCE.

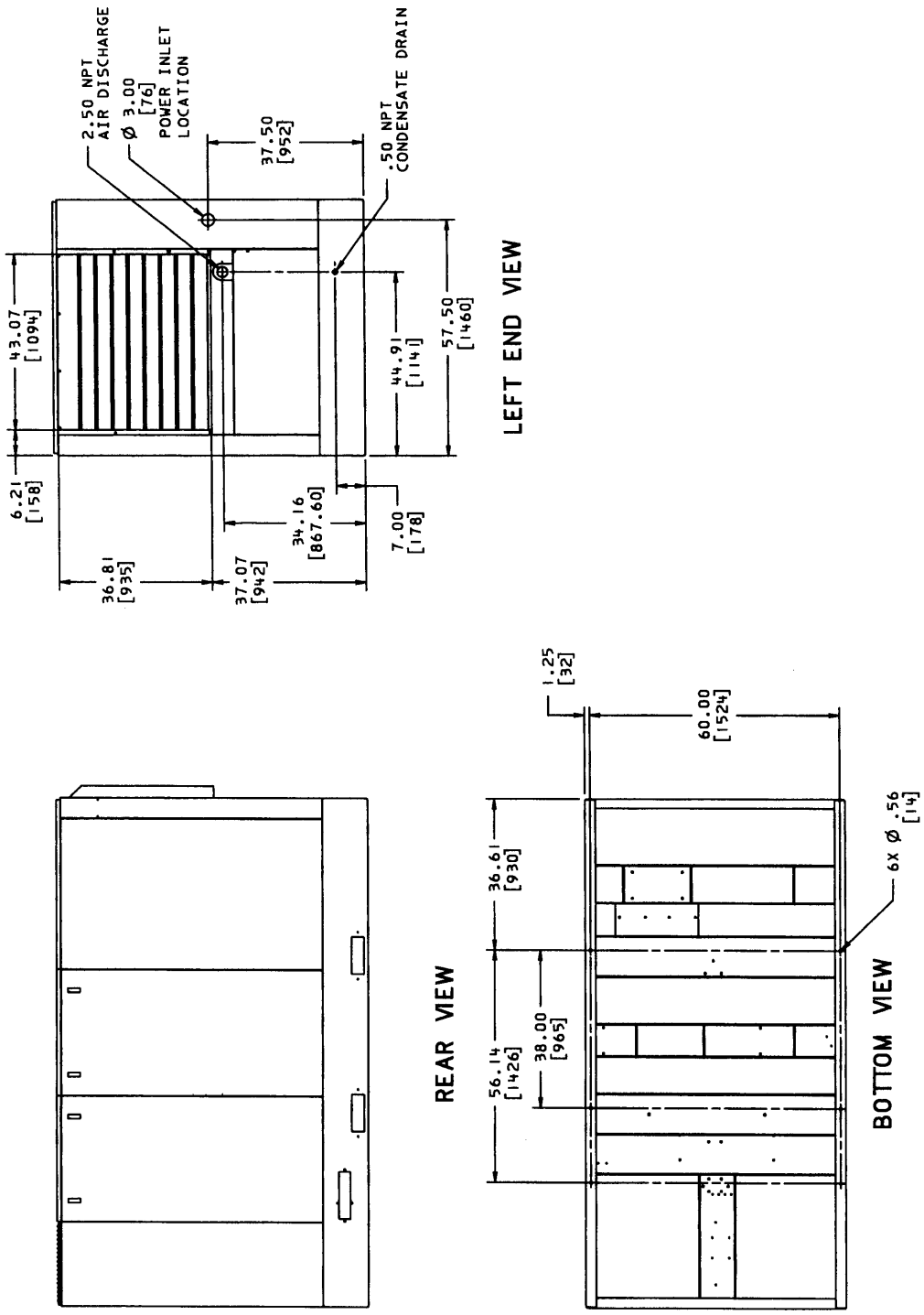


FRONT VIEW



RIGHT END VIEW

54623053
REV B



54623053
REV B

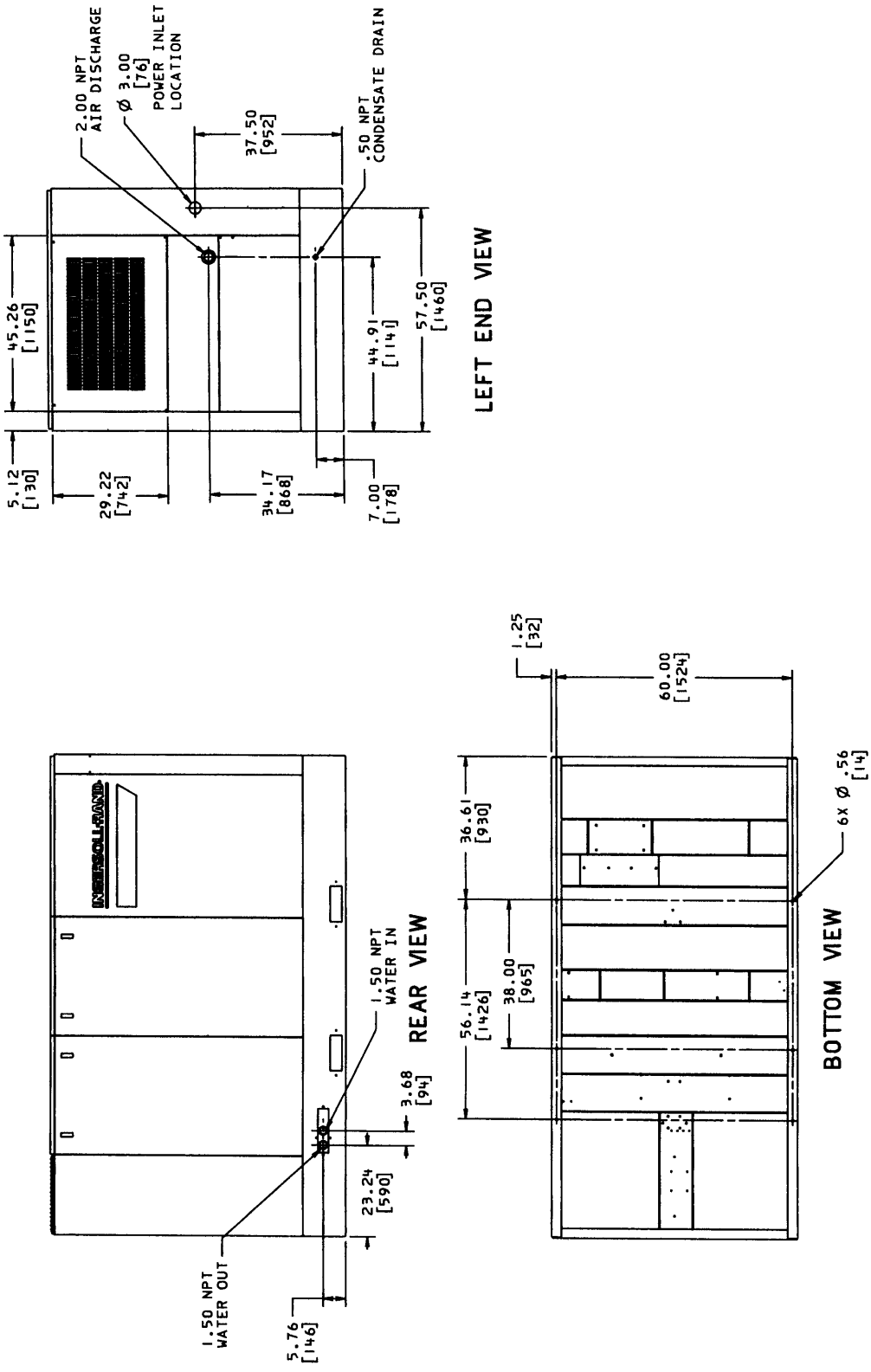
8.7 FOUNDATION PLAN - AIRCOOLED
200 HP/132-160 KW - TWO STAGE

NOTES:

1. WEIGHT (APPROXIMATE)
   100 HP / 75KW - 6050 LB (2746 KG)
   125 HP / 90KW - 6770 LB (3073 KG)
   150 HP / 110KW - 6820 LB (3096 KG)
2. COOLANT LUBRICANT FILL QTY (APPROXIMATE)
   DRY - 22 GAL (83 L) FOR 100HP
   30 GAL (114 L) FOR 125-150HP
   TANK ONLY - 16 GAL (61 L) FOR 100-150HP
3. TOLERANCE ON ALL DIMENSIONS ±.12 (±3MM)
4. ALL DIMENSIONS IN INCHES (MM).
5. 36.00 (914) MINIMUM LENGTH OF WIRE FROM POWER INLET OPENING AT STARTER
6. AIR FLOW - 5000 CFM (2.36 M3/S)
7. RECOMMENDED CLEARANCE ON THREE SIDES 36.00 (914); 42.00 (1067) IN FRONT OF CONTROL PANEL OR MINIMUM AS REQUIRED BY LATEST NATIONAL ELECTRICAL CODES 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. SEPARATOR ELEMENT: MINIMUM CLEARANCE REQUIRED FOR REMOVAL ABOVE TOP OF UNIT IS 18.00 (457).
12. FIELD INSTALLED DUCTING TO AND FROM COMPRESSOR CAN NOT ADD MORE THAN 0.25 INCHES (6MM) OF WATER AIR RESISTANCE.

8.8 FOUNDATION PLAN -WATERCOOLED (CONTINUED)
100-150 HP/75-110 KW - TWO STAGE

39925326
REV C



8.8 FOUNDATION PLAN -WATERCOOLED
100-150 HP/75-110 KW - TWO STAGE

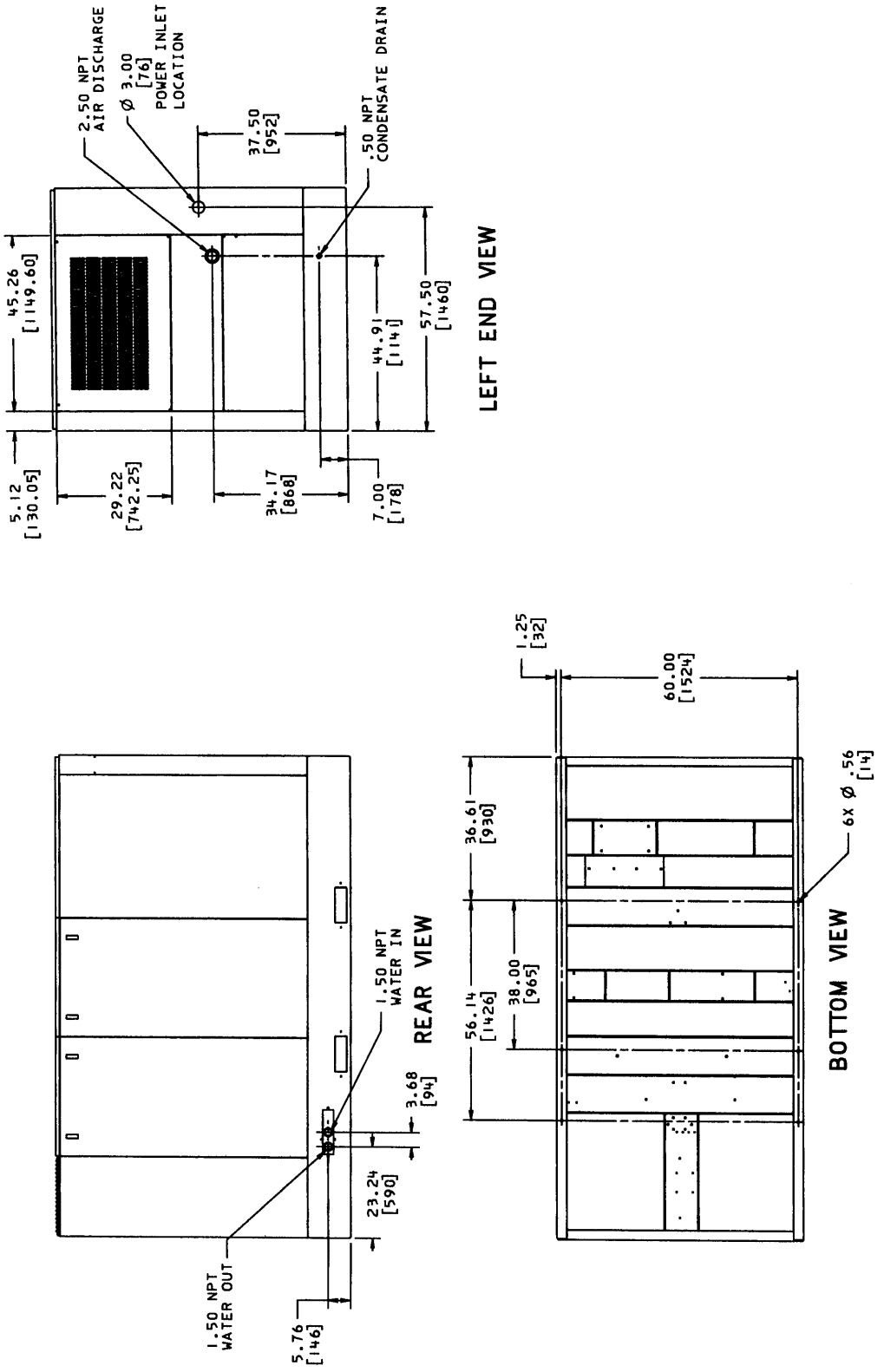
39925326
REV C

NOTES:

1. WEIGHT (APPROXIMATE)
   200 HP/132-160KW - 7020 LB (3187 KG)
2. COOLANT LUBRICANT FILL QTY (APPROXIMATE)
   DRY - 30 GAL (114 L)
   TANK ONLY - 16 GAL (61 L)
3. TOLERANCE ON ALL DIMENSIONS ±.12 (±3MM)
4. ALL DIMENSIONS IN INCHES (MM).
5. 36.00 (914) MINIMUM LENGTH OF WIRE FROM POWER INLET OPENING AT STARTER
6. AIR FLOW - 5000 CFM (2.36 M3/S)
7. RECOMMENDED CLEARANCE ON THREE SIDES 36.00 (914); 42.00 (1067) IN FRONT OF CONTROL PANEL OR MINIMUM AS REQUIRED BY LATEST NATIONAL ELECTRICAL CODES 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. SEPARATOR ELEMENT:
    MINIMUM CLEARANCE REQUIRED FOR REMOVAL ABOVE TOP OF UNIT IS 18.00 (457).
12. FIELD INSTALLED DUCTING TO AND FROM COMPRESSOR CAN NOT ADD MORE THAN 0.25 INCHES (6MM) OF WATER AIR RESISTANCE.

8.9 FOUNDATION PLAN -WATERCOOLED (CONTINUED)
200 HP/132-160 KW - TWO STAGE

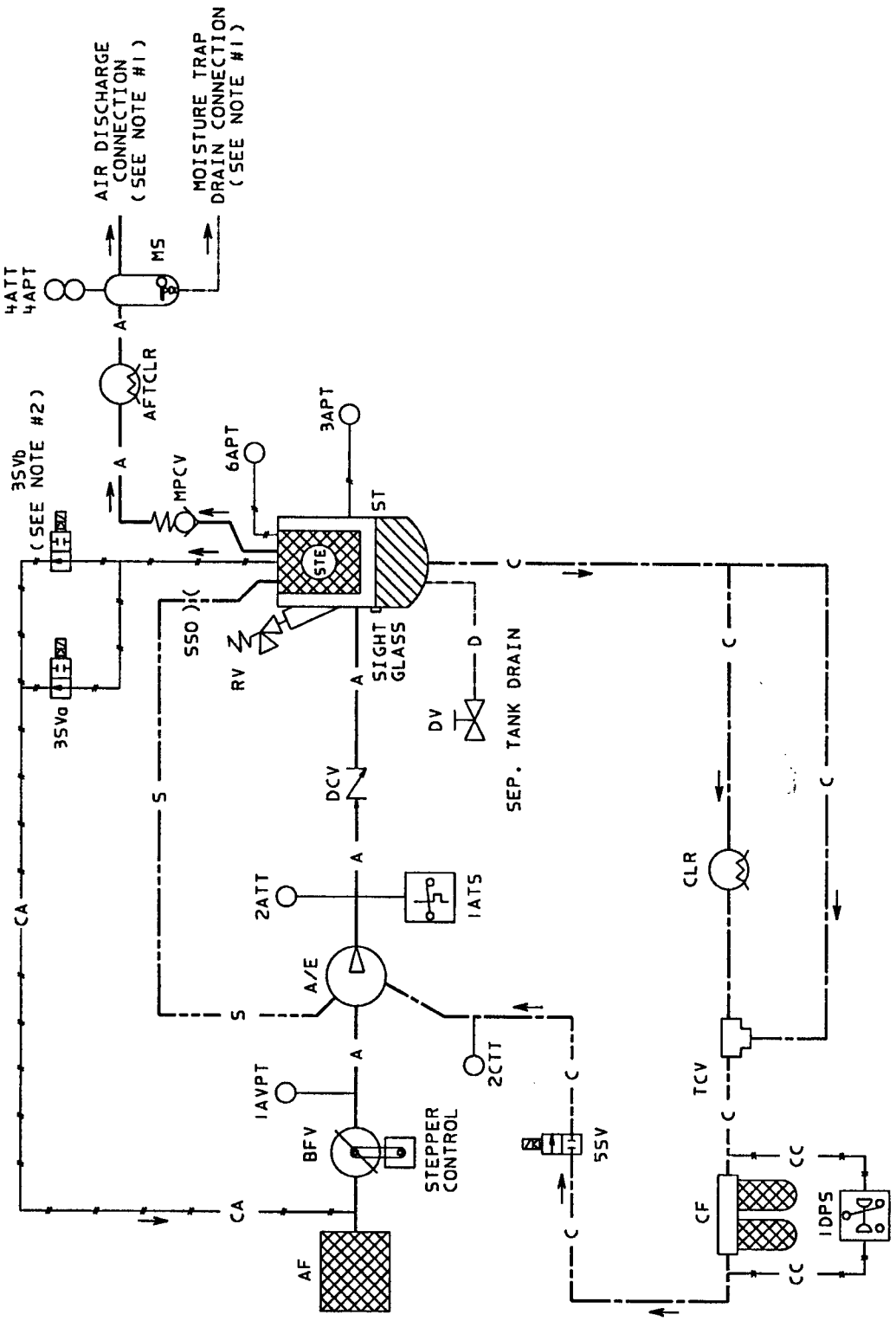
39926340
REV C



8.9 FOUNDATION PLAN -WATERCOOLED
200 HP/132-160 KW - TWO STAGE

39926340
REV C

54579081
REV A



8.10 FLOW SCHEMATIC
AIRCOOLED - SINGLE STAGE

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	PRESSURE RELIEF VALVE
CF	COOLANT FILTER
TCV	THERMOSTATIC CONTROL VALVE
DV	COOLANT DRAIN VALVE
3SVa,b	BLOWDOWN SOLENOID VALVE
5SV	COOLANT STOP SOLENOID VALVE
CLR	COOLANT COOLER
AFTCLR	AFTERCOOLER
MS	MOISTURE SEPARATOR
5SO	SEPARATOR SCAVENGE ORIFICE
1AVPT	INLET VACUUM PRESSURE TRANSDUCER
3APT	SEPARATOR TANK WET SIDE AIR PRESSURE TRANSDUCER
4APT	DISCHARGE AIR PRESSURE TRANSDUCER
6APT	SEPARATOR TANK DRY SIDE AIR PRESSURE TRANSDUCER
2CTT	COOLANT TEMPERATURE SENSOR
2ATT	AIREND DISCHARGE AIR TEMPERATURE SENSOR
4ATT	PACKAGE DISCHARGE AIR TEMPERATURE SENSOR
1ATS	HIGH AIR TEMPERATURE SWITCH
1DPS	COOLANT FILTER DIFFERENTIAL PRESSURE SWITCH

NOTES:

1. FOR CUSTOMER CONNECTIONS SEE FOUNDATION PLAN OF UNIT.
2. 3SVb REQUIRED ON 350-450HP ONLY.

PIPING LEGEND

A ———— AIR PIPING

C ———— COOLANT PIPING

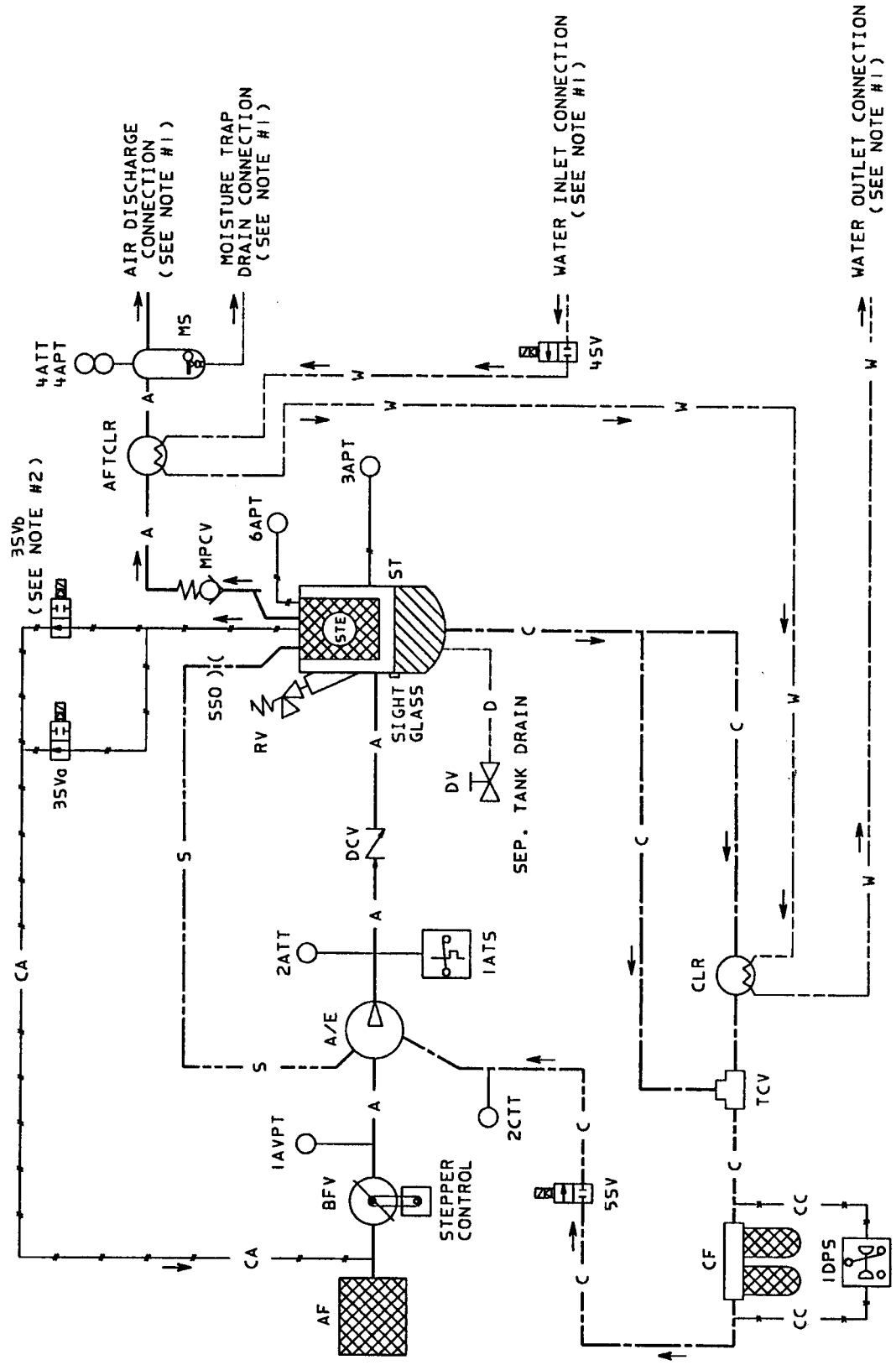
CA ———— CONTROL AIR PIPING

CC ———— CONTROL COOLANT PIPING

S ———— SCAVENGE PIPING

D ———— DRAIN PIPING

54579503
REV A



8.11 FLOW SCHEMATIC
WATERCOOLED - 90°F (32°C) - SINGLE STAGE

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	PRESSURE RELIEF VALVE
CF	COOLANT FILTER
TCV	THERMOSTATIC CONTROL VALVE
DV	COOLANT DRAIN VALVE
3SVa,b	BLOWDOWN SOLENOID VALVE
4SV	WATER SHUT-OFF SOLENOID VALVE
5SV	COOLANT STOP SOLENOID VALVE
CLR	COOLANT COOLER
AFTCLR	AFTERCOOLER
MS	MOISTURE SEPARATOR
SSO	SEPARATOR SCAVENGE ORIFICE
1AVPT	INLET VACUUM PRESSURE TRANSDUCER
3APT	SEPARATOR TANK WET SIDE AIR PRESSURE TRANSDUCER
4APT	DISCHARGE AIR PRESSURE TRANSDUCER
6APT	SEPARATOR TANK DRY SIDE AIR PRESSURE TRANSDUCER
2CTT	COOLANT TEMPERATURE SENSOR
2ATT	AIREND DISCHARGE AIR TEMPERATURE SENSOR
4ATT	PACKAGE DISCHARGE AIR TEMPERATURE SENSOR
1ATS	HIGH AIR TEMPERATURE SWITCH
1DPS	COOLANT FILTER DIFFERENTIAL PRESSURE SWITCH

NOTES:

1. FOR CUSTOMER CONNECTIONS SEE FOUNDATION PLAN OF UNIT.
2. 3SVb REQUIRED ON 350-450HP ONLY.

PIPING LEGEND

A ——————— AIR PIPING

C ——— - ——— COOLANT PIPING

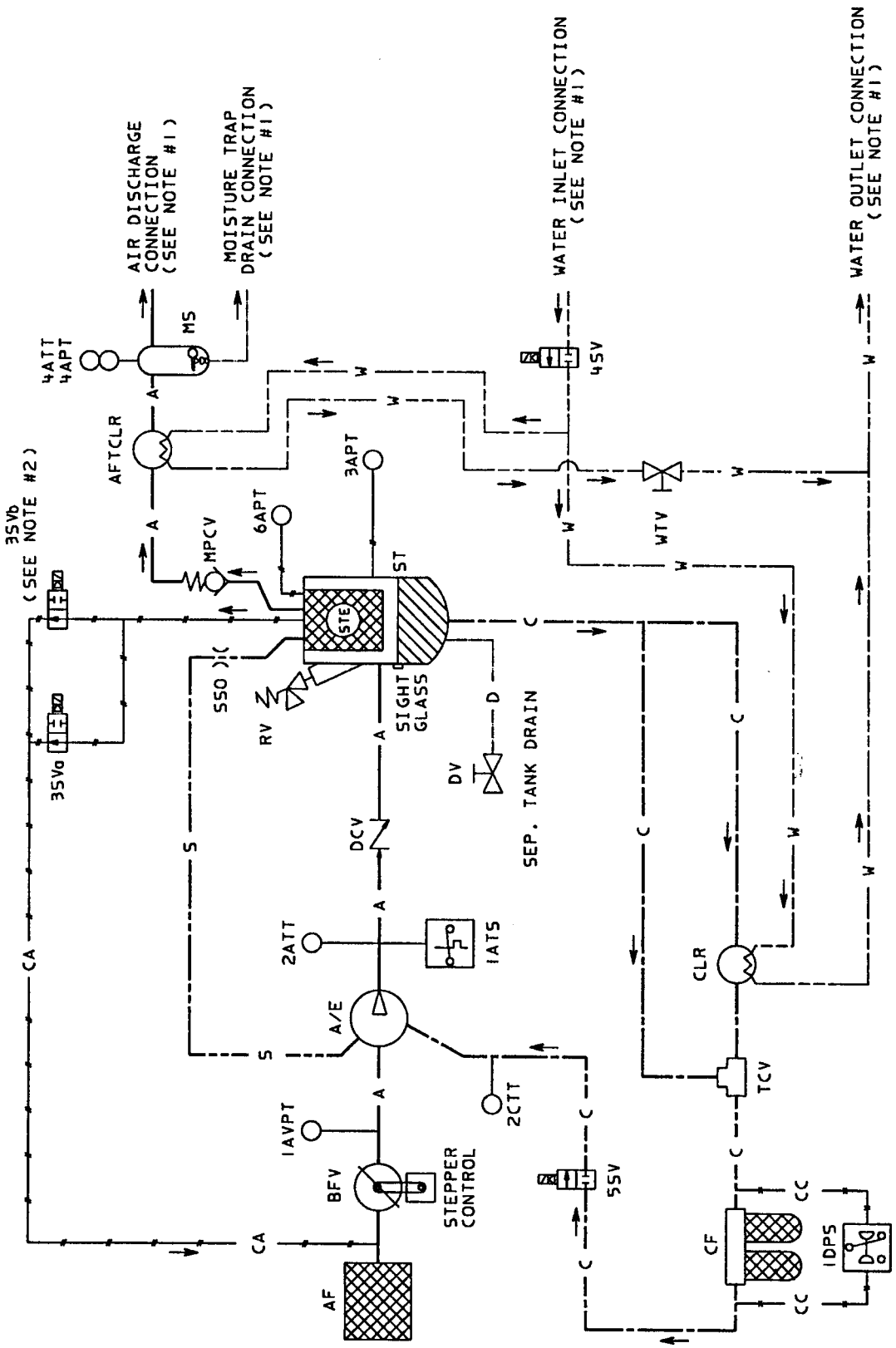
W ——— - - - ——— WATER PIPING

CA ——— • ——— • ——— CONTROL AIR PIPING

CC ——— • - - - • ——— CONTROL COOLANT PIPING

S ——— - - - ——— SCAVENGE PIPING

D ——————— DRAIN PIPING



8.12 FLOW SCHEMATIC
WATERCOOLED - 115°F (46°) - SINGLE STAGE

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	PRESSURE RELIEF VALVE
CF	COOLANT FILTER
TCV	THEMOSTATIC CONTROL VALVE
DV	COOLANT DRAIN VALVE
3SVa,b	BLOWDOWN SOLENOID VALVE
4SV	WATER SHUT-OFF SOLENOID VALVE
5SV	COOLANT STOP SOLENOID VALVE
CLR	COOLANT COOLER
AFTCLR	AFTERCOOLER
MS	MOISTURE SEPARATOR
SSO	SEPARATOR SCAVENGE ORIFICE
1AVPT	INLET VACUUM PRESSURE TRANSDUCER
3APT	SEPARATOR TANK WET SIDE AIR PRESSURE TRANSDUCER
4APT	DISCHARGE AIR PRESSURE TRANSDUCER
6APT	SEPARATOR TANK DRY SIDE AIR PRESSURE TRANSDUCER
2CTT	COOLANT TEMPERATURE SENSOR
2ATT	AIREND DISCHARGE AIR TEMPERATURE SENSOR
4ATT	PACKAGE DISCHARGE AIR TEMPERATURE SENSOR
1ATS	HIGH AIR TEMPERATURE SWITCH
1DPS	COOLANT FILTER DIFFERENTIAL PRESSURE SWITCH
WTV	WATER TRIM VALVE

NOTES:

1. FOR CUSTOMER CONNECTIONS SEE FOUNDATION PLAN OF UNIT.
2. 3SVb REQUIRED ON 350-450HP ONLY.

PIPING LEGEND

A ——————— AIR PIPING

C ——— - ——— COOLANT PIPING

W ——— - - ——— WATER PIPING

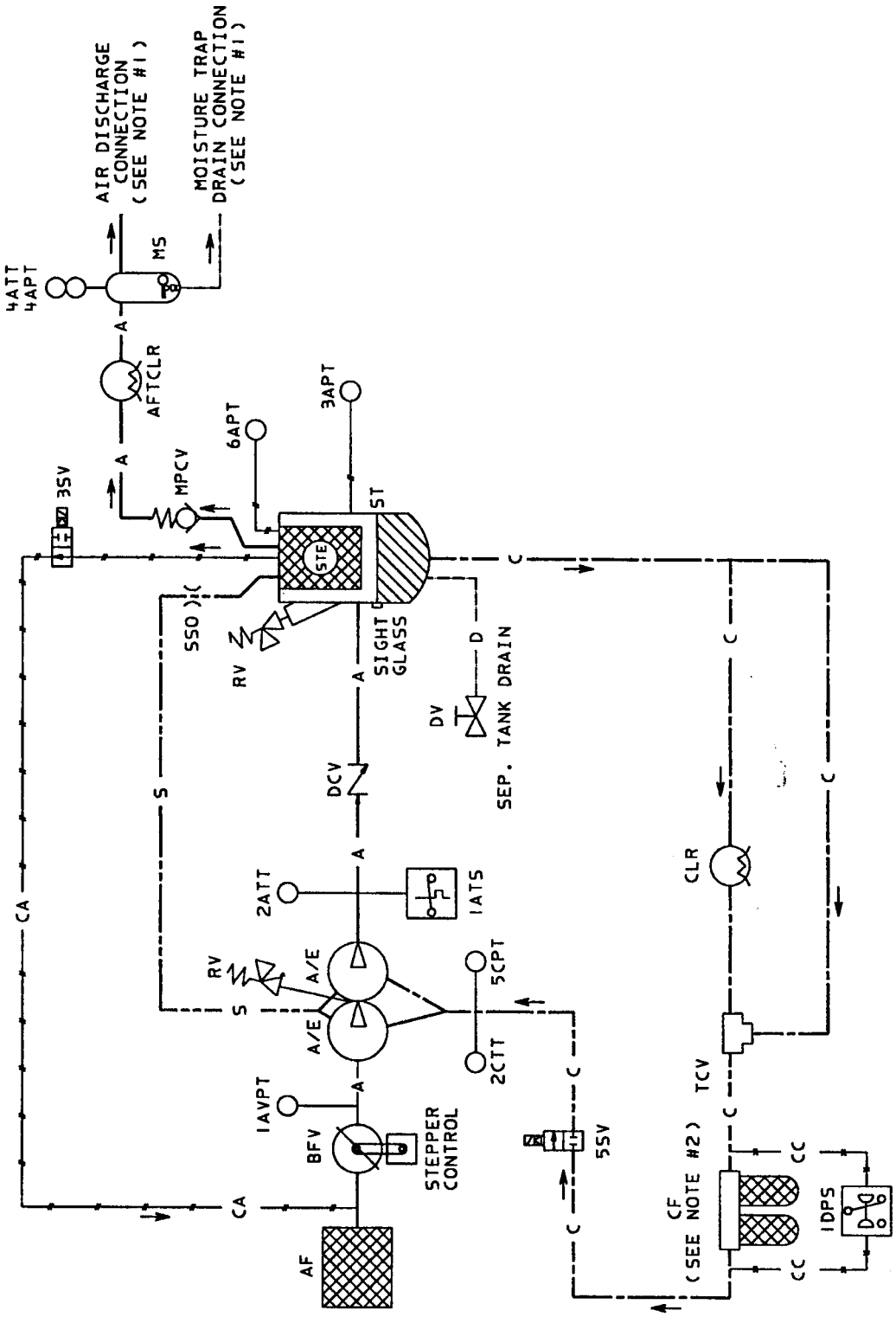
CA ——— • ——— • ——— CONTROL AIR PIPING

CC ——— • ——— • ——— CONTROL COOLANT PIPING

S ——— - - - ——— SCAVENGE PIPING

D ——————— DRAIN PIPING

54579644
REV A



8.13 FLOW SCHEMATIC
AIR-COOLED - TWO STAGE

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	PRESSURE RELIEF VALVE
CF	COOLANT FILTER
TCV	THERMOSTATIC CONTROL VALVE
DV	COOLANT DRAIN VALVE
3SV	BLOWDOWN SOLENOID VALVE
5SV	COOLANT STOP SOLENOID VALVE
CLR	COOLANT COOLER
AFTCLR	AFTERCOOLER
MS	MOISTURE SEPARATOR
SSO	SEPARATOR SCAVENGE ORIFICE
1AVPT	INLET VACUUM PRESSURE TRANSDUCER
3APT	SEPARATOR TANK WET SIDE AIR PRESSURE TRANSDUCER
4APT	DISCHARGE AIR PRESSURE TRANSDUCER
6APT	SEPARATOR TANK DRY SIDE AIR PRESSURE TRANSDUCER
2CTT	COOLANT TEMPERATURE SENSOR
5CPT	INJECTED COOLANT PRESSURE TRANSDUCER
2ATT	AIREND DISCHARGE AIR TEMPERATURE SENSOR
4ATT	PACKAGE DISCHARGE AIR TEMPERATURE SENSOR
1ATS	HIGH AIR TEMPERATURE SWITCH
1DPS	COOLANT FILTER DIFFERENTIAL PRESSURE SWITCH

NOTES:

1. FOR CUSTOMER CONNECTIONS SEE FOUNDATION PLAN OF UNIT.
2. 100HP UNITS HAVE ONLY ONE COOLANT FILTER ELEMENT.

PIPING LEGEND

A ——————— AIR PIPING

C ——— — ——— COOLANT PIPING

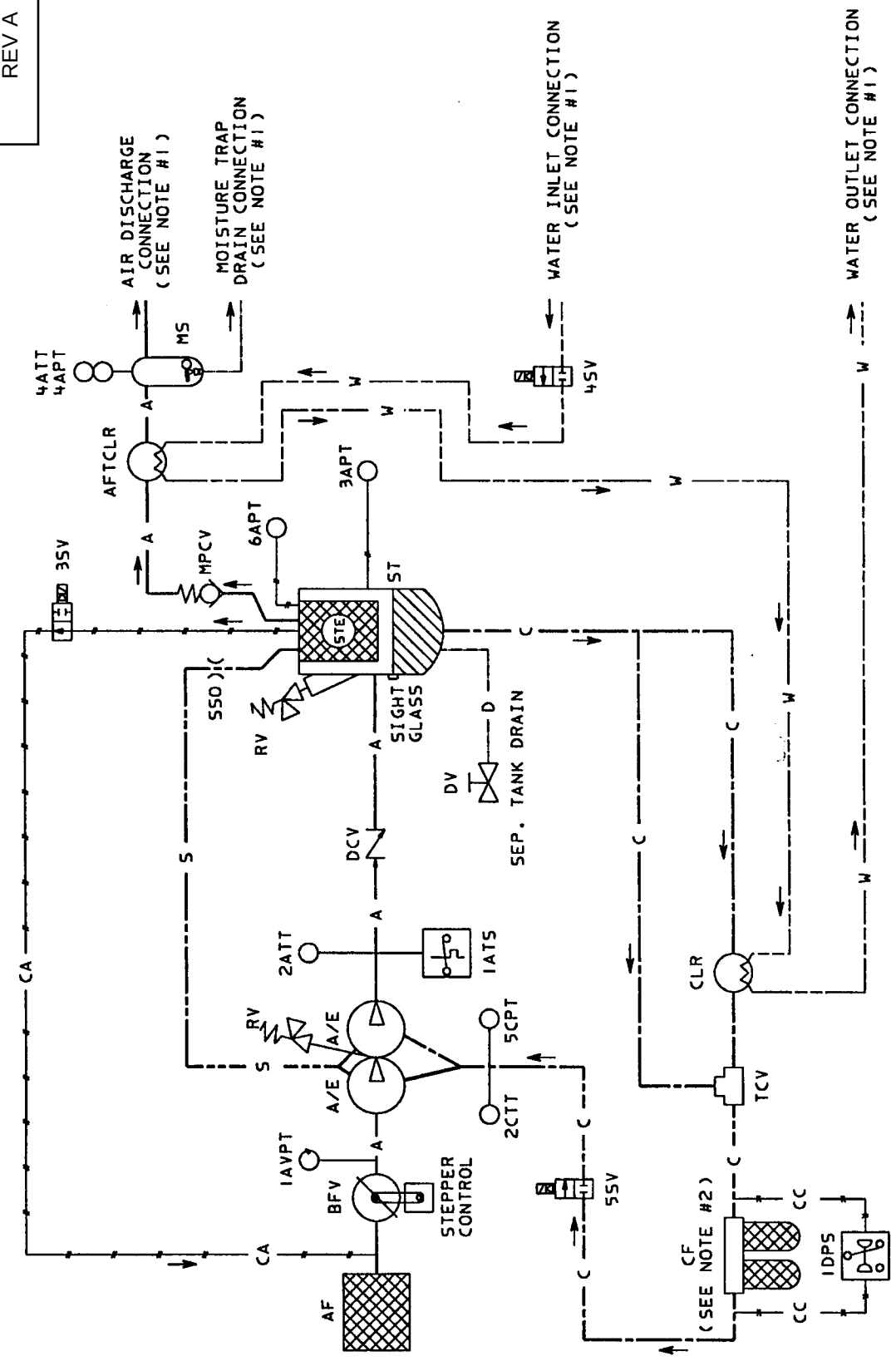
CA —— * ——— * —— CONTROL AIR PIPING

CC —— * ——— * —— CONTROL COOLANT PIPING

S ——— — — ——— SCAVENGE PIPING

D ——————— DRAIN PIPING

54579693
REV A



8.14 FLOW SCHEMATIC
WATERCOOLED 90°F (32°C)
TWO STAGE

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	PRESSURE RELIEF VALVE
CF	COOLANT FILTER
TCV	THERMOSTATIC CONTROL VALVE
DV	COOLANT DRAIN VALVE
3SV	BLOWDOWN SOLENOID VALVE
4SV	WATER SHUT-OFF SOLENOID VALVE
5SV	COOLANT STOP SOLENOID VALVE
CLR	COOLANT COOLER
AFTCLR	AFTERCOOLER
MS	MOISTURE SEPARATOR
SSO	SEPARATOR SCAVENGE ORIFICE
1AVPT	INLET VACUUM PRESSURE TRANSDUCER
3APT	SEPARATOR TANK WET SIDE AIR PRESSURE TRANSDUCER
4APT	DISCHARGE AIR PRESSURE TRANSDUCER
6APT	SEPARATOR TANK DRY SIDE AIR PRESSURE TRANSDUCER
2CTT	COOLANT TEMPERATURE SENSOR
5CPT	INJECTECD COOLANT PRESSURE TRANSDUCER
2ATT	AIREND DISCHARGE AIR TEMPERATURE SENSOR
4ATT	PACKAGE DISCHARGE AIR TEMPERATURE SENSOR
1ATS	HIGH AIR TEMPERATURE SWITCH
1DPS	COOLANT FILTER DIFFERENTIAL PRESSURE SWITCH

NOTES:

1. FOR CUSTOMER CONNECTIONS SEE FOUNDATION PLAN OF UNIT.
2. 100HP UNITS HAVE ONLY ONE COOLANT FILTER ELEMENT.

PIPING LEGEND

A ———— AIR PIPING

C ——-—- COOLANT PIPING

W ——-——- WATER PIPING

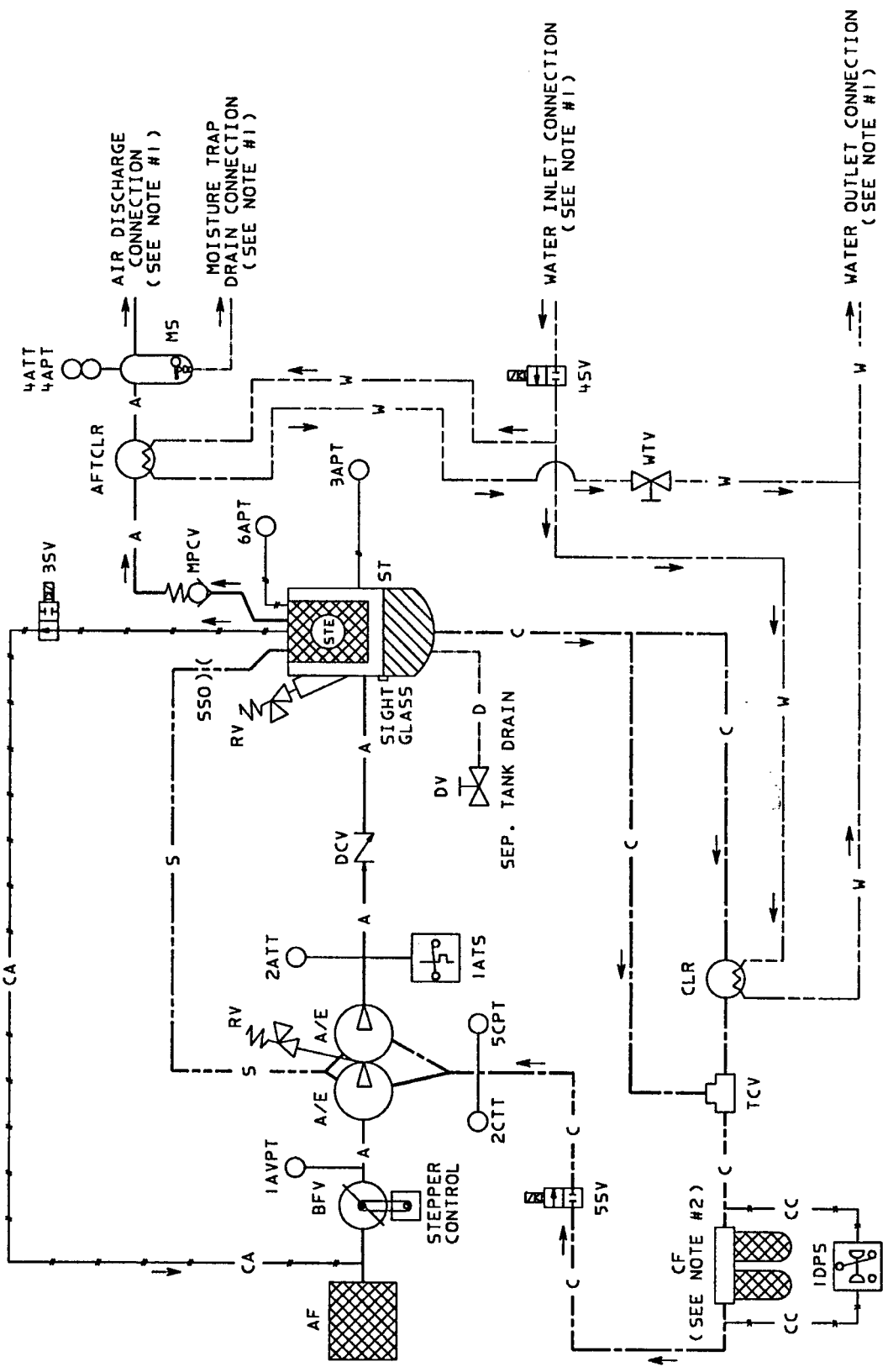
CA —-—-— CONTROL AIR PIPING

CC —-—-— CONTROL COOLANT PIPING

S ——-——- SCAVENGE PIPING

D ———— DRAIN PIPING

54579727
REV A



8.15 FLOW SCHEMATIC
WATERCOOLED 115°F (46°C)
TWO STAGE

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	PRESSURE RELIEF VALVE
CF	COOLANT FILTER
TCV	THERMOSTATIC CONTROL VALVE
DV	COOLANT DRAIN VALVE
3SV	BLOWDOWN SOLENOID VALVE
4SV	WATER SHUT-OFF SOLENOID VALVE
5SV	COOLANT STOP SOLENOID VALVE
CLR	COOLANT COOLER
AFTCLR	AFTERCOOLER
MS	MOISTURE SEPARATOR
SSO	SEPARATOR SCAVENGE ORIFICE
1AVPT	INLET VACUUM PRESSURE TRANSDUCER
3APT	SEPARATOR TANK WET SIDE AIR PRESSURE TRANSDUCER
4APT	DISCHARGE AIR PRESSURE TRANSDUCER
6APT	SEPARATOR TANK DRY SIDE AIR PRESSURE TRANSDUCER
2CTT	COOLANT TEMPERATURE SENSOR
5CPT	INJECTED COOLANT PRESSURE TRANSDUCER
2ATT	AIREND DISCHARGE AIR TEMPERATURE SENSOR
4ATT	PACKAGE DISCHARGE AIR TEMPERATURE SENSOR
1ATS	HIGH AIR TEMPERATURE SWITCH
1DPS	COOLANT FILTER DIFFERENTIAL PRESSURE SWITCH
WTV	WATER TRIM VALVE

NOTES:

1. FOR CUSTOMER CONNECTIONS SEE FOUNDATION PLAN OF UNIT.
2. 100HP UNITS HAVE ONLY ONE COOLANT FILTER ELEMENT.

PIPING LEGEND

A ———— AIR PIPING

C ——— - ——— COOLANT PIPING

W ——— — ——— WATER PIPING

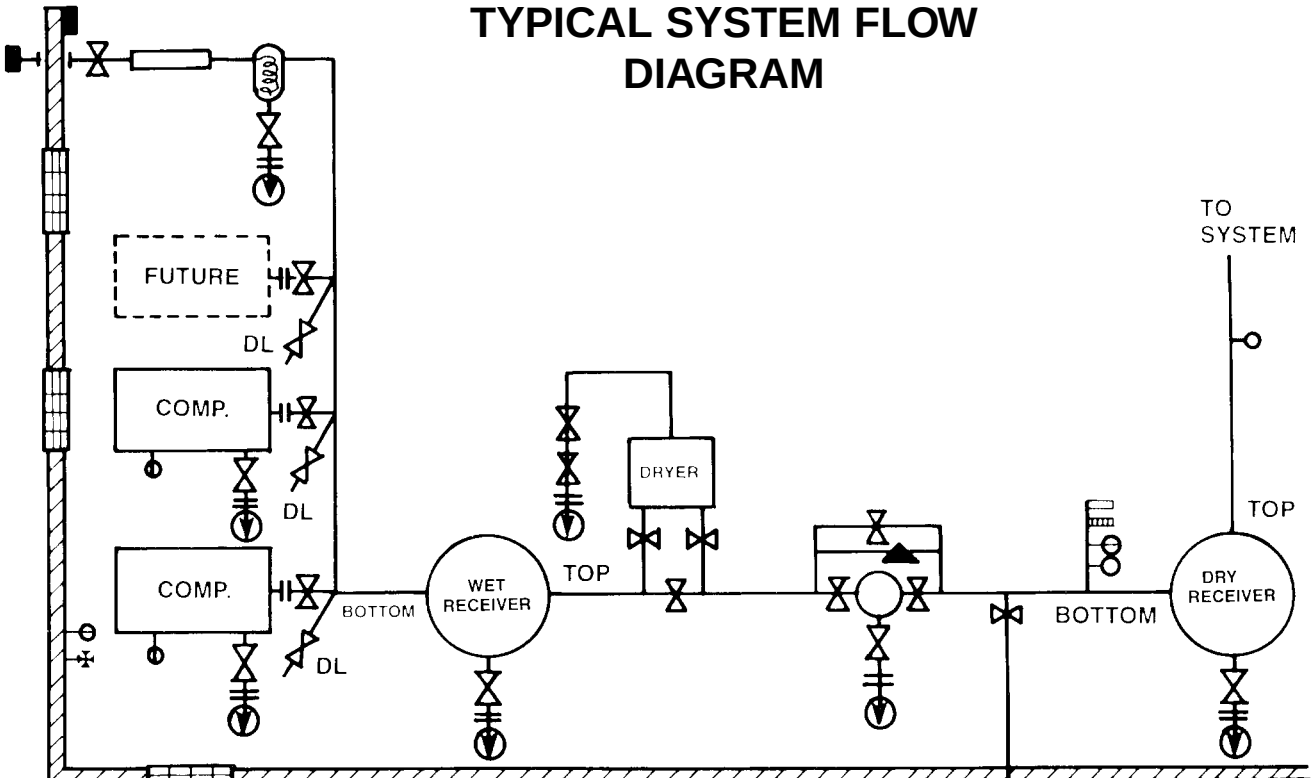
CA ——•———▸—— CONTROL AIR PIPING

CC ——•———•—— CONTROL COOLANT PIPING

S ——— - ——— SCAVENGE PIPING

D ———— DRAIN PIPING

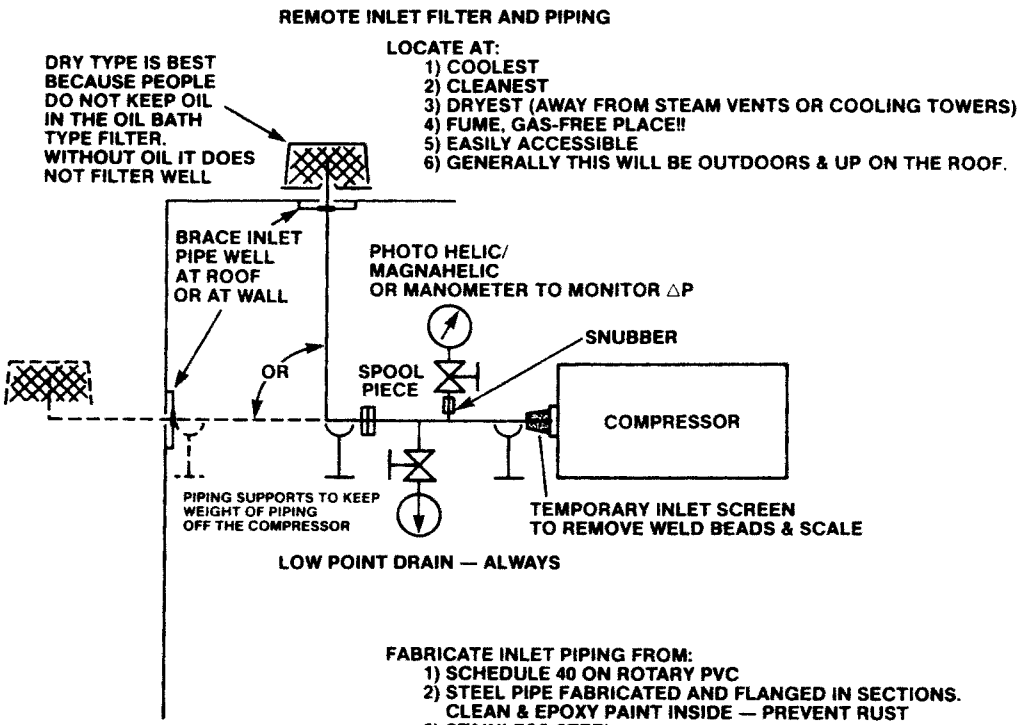
TYPICAL SYSTEM FLOW DIAGRAM

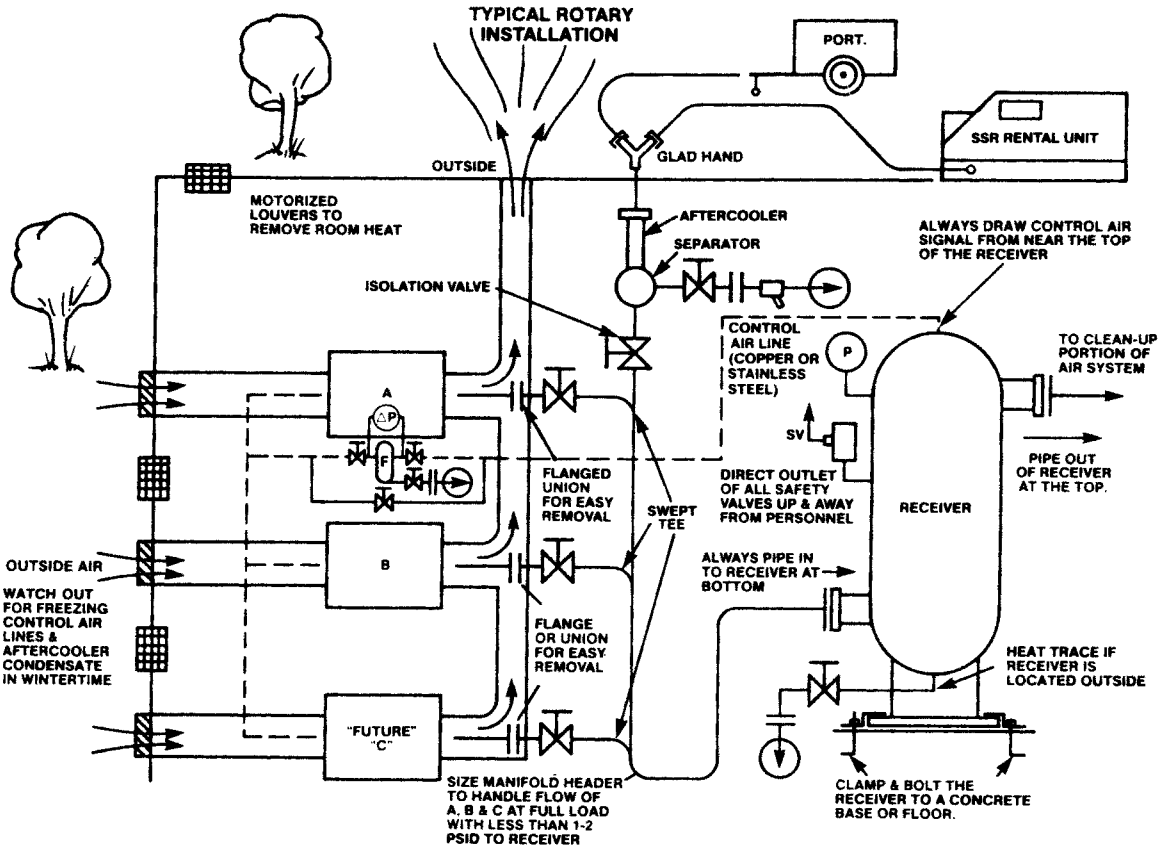


SYMBOLS

	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	

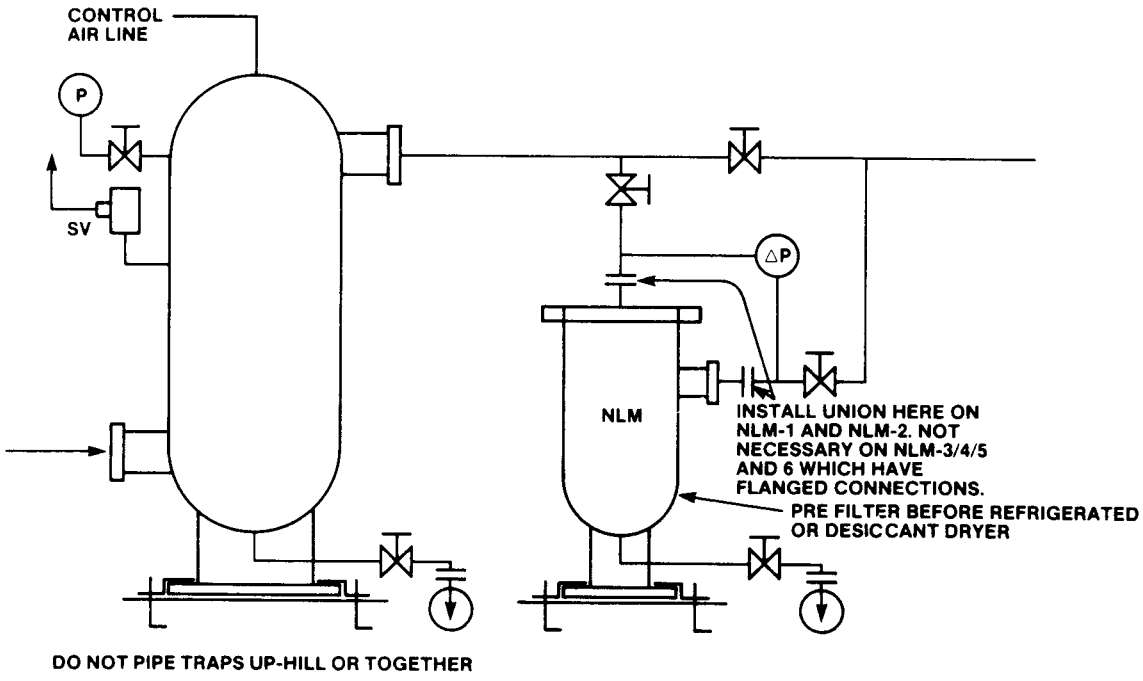
8.16 TYPICAL SYSTEM FLOW DIAGRAMS



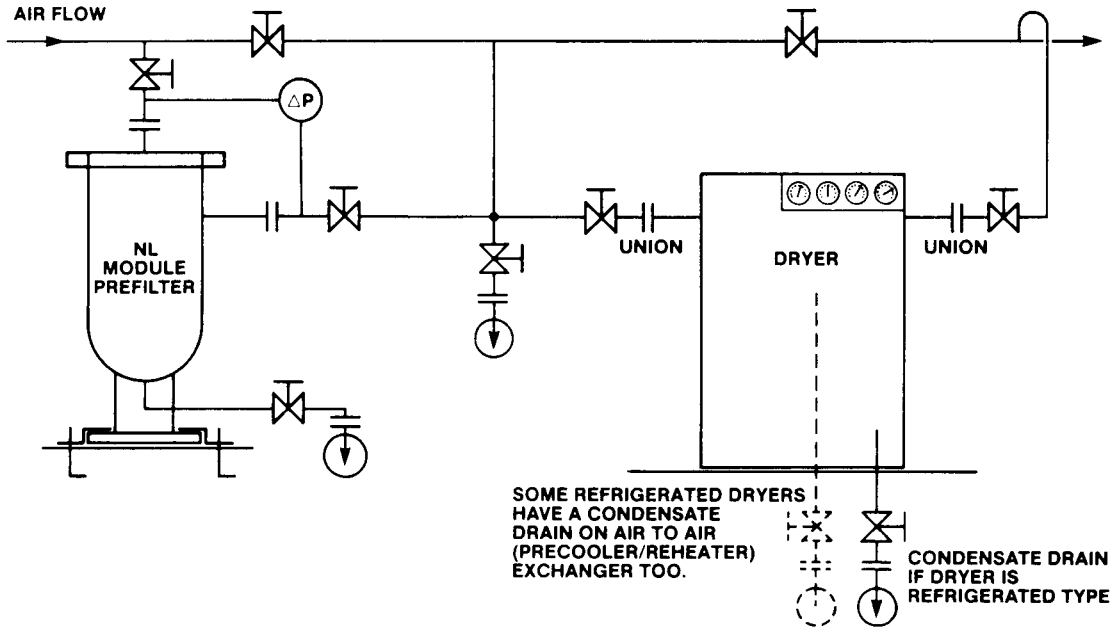


8.16 TYPICAL SYSTEM FLOW DIAGRAMS

RECEIVER AND NLM CLEANUP PIPING

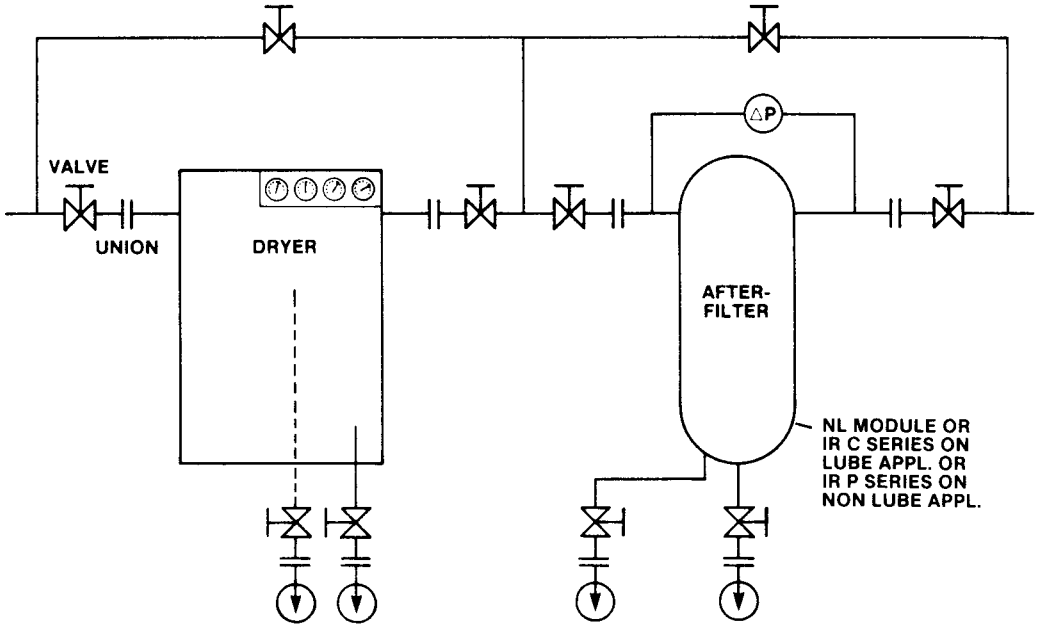


PRE-FILTER & DRYER WITH BLOCK & BYPASS

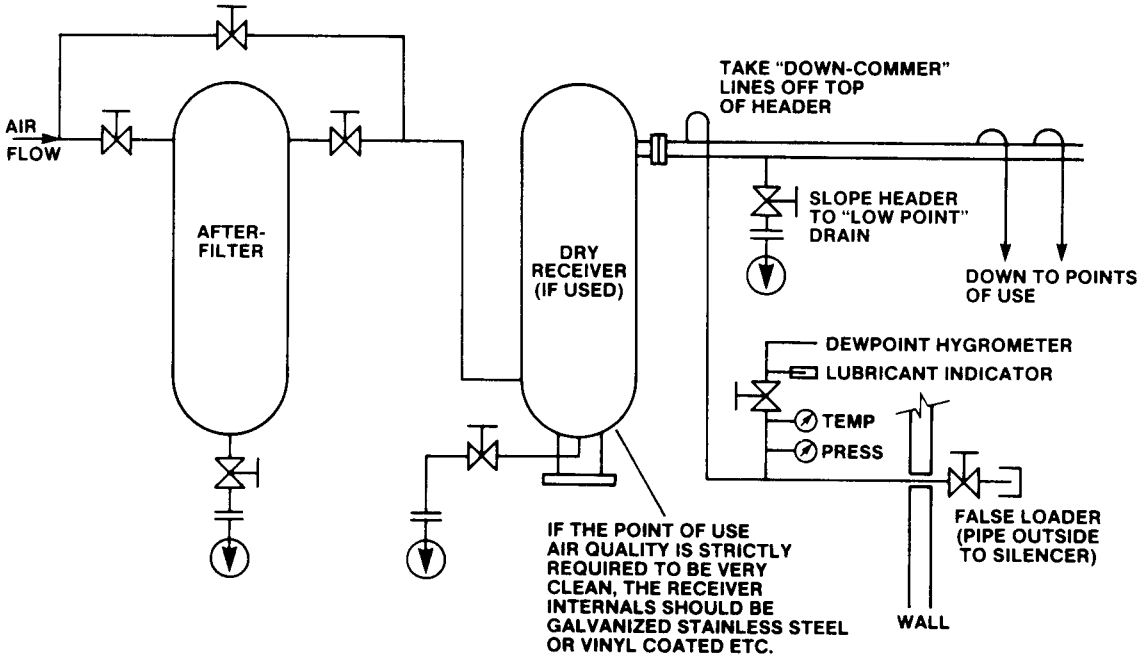


8.16 TYPICAL SYSTEM FLOW DIAGRAMS

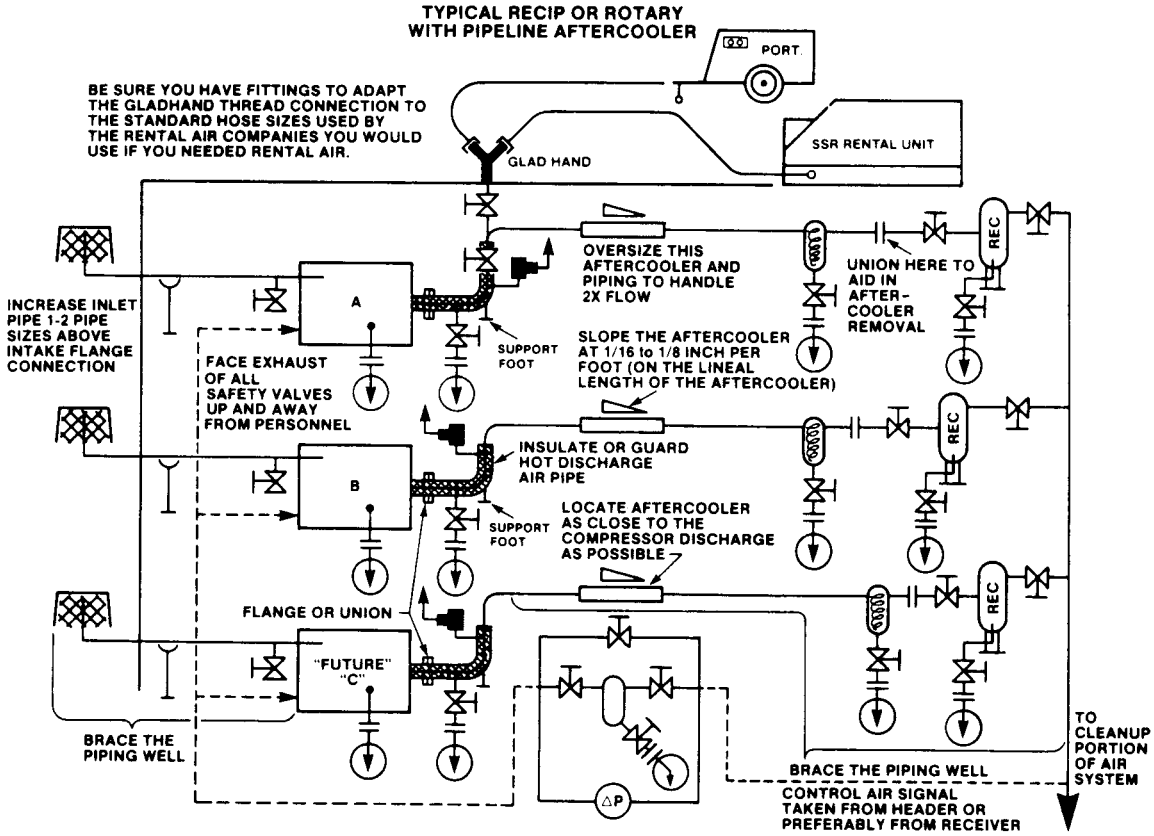
DRYER WITH POLISHING (NLM OR IR C SERIES) OR PARTICULATE IR P SERIES (FOR DESICCANT DRYERS)



DRY RECEIVER AND MONITORING DEVICES ON AIR QUALITY



8.16 TYPICAL SYSTEM FLOW DIAGRAMS



8.16 TYPICAL SYSTEM FLOW DIAGRAMS

9.0 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

10.0 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