



Fermilab

Particle Physics Division
Mechanical Department Engineering Note

Number: MD-ENG-060

Date: 10/28/04

Project Internal Reference: NMI-015

Project: NMI

Title: MS65 AIR COMPRESSOR

Author(s): ED CAVALLI PPD

Reviewer(s): Amy Lee 10/20/04

Key Words:

Abstract Summary:

Applicable Codes:

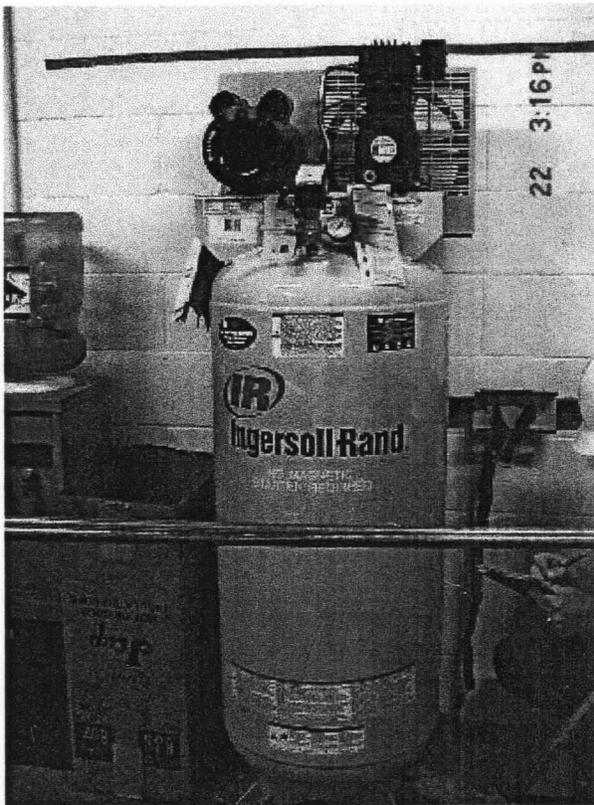
Engineering Note

Air Compressor @ MI-65

Grainger Item: 4YW09

Manufacturer: INGERSOLL-RAND

Ingersoll Model#: SS3L3



Description:

Compressor, Air, 3.0 HP

High Performance Cast Iron Air Compressor, Motor Running Power 3.0 HP, Free Air Flow @ Maximum Pressure 10.3 CFM, Free Air Flow @ 90 psi 11.3 CFM, Maximum Pressure-135 PSI, Phase Single, Voltage Rating 230 Volts, Current Rating 14.7 Amps, Tank Capacity 60 Gallons, Tank Type Vertical, Height 66 Inches, Length 20 Inches, Width 23 Inches, NPT Outlet (F) 3/8 Inches, 60 Hz

Amendment No.:

Reviewed by:

Date:

Lab Property Number(s): **None**
 Lab Location Code: **MI-65 Mechanical Room** (obtain from safety officer)
 Purpose of Vessel(s): **Operate Pneumatics in Mechanical Room**

Vessel Capacity/Size: **60 Gal.** Length: **20"** Width: **23"** Height: **66"**
 Normal Operating Pressure (OP): **90 PSI to 135 PSI**
 MAWP-OP = **150 PSI-135 PSI**

List the numbers of all pertinent drawings and the location of the originals.

Drawing #

Location of Original

None (Purchased Compressor)

_____	_____
_____	_____
_____	_____
_____	_____

2. Design Verification

Is this vessel designed and built to meet the Code or "In-House Built" requirements?
 Yes No _____.

If "No" state the standard that was used _____.
 Demonstrate that design calculations of that standard have been made and that other requirements of that standard have been satisfied.
 Skip to part 3 "system venting verification."

Does the vessel(s) have a U stamp? Yes No _____. If "Yes", complete section 2A; if "No", complete section 2B.

A. Staple photo of U stamp plate below.
 Copy "U" label details below.



Copy data here:

340608

Certified By

U-STAMP Manchester Tank - IL

W MWAP 150PSI @650 F

RT-4 MDMT 20F @ 150 PSI

CAT # 301230 YR 2004

CRN E7403.2C

SH .094 GAL 60

HD .094 2:1 SE

56269582

Provide ASME design calculations in an appendix. On the sketch below, circle all applicable sections of the ASME code per Section VIII, Division I. (Only for non-coded vessels)

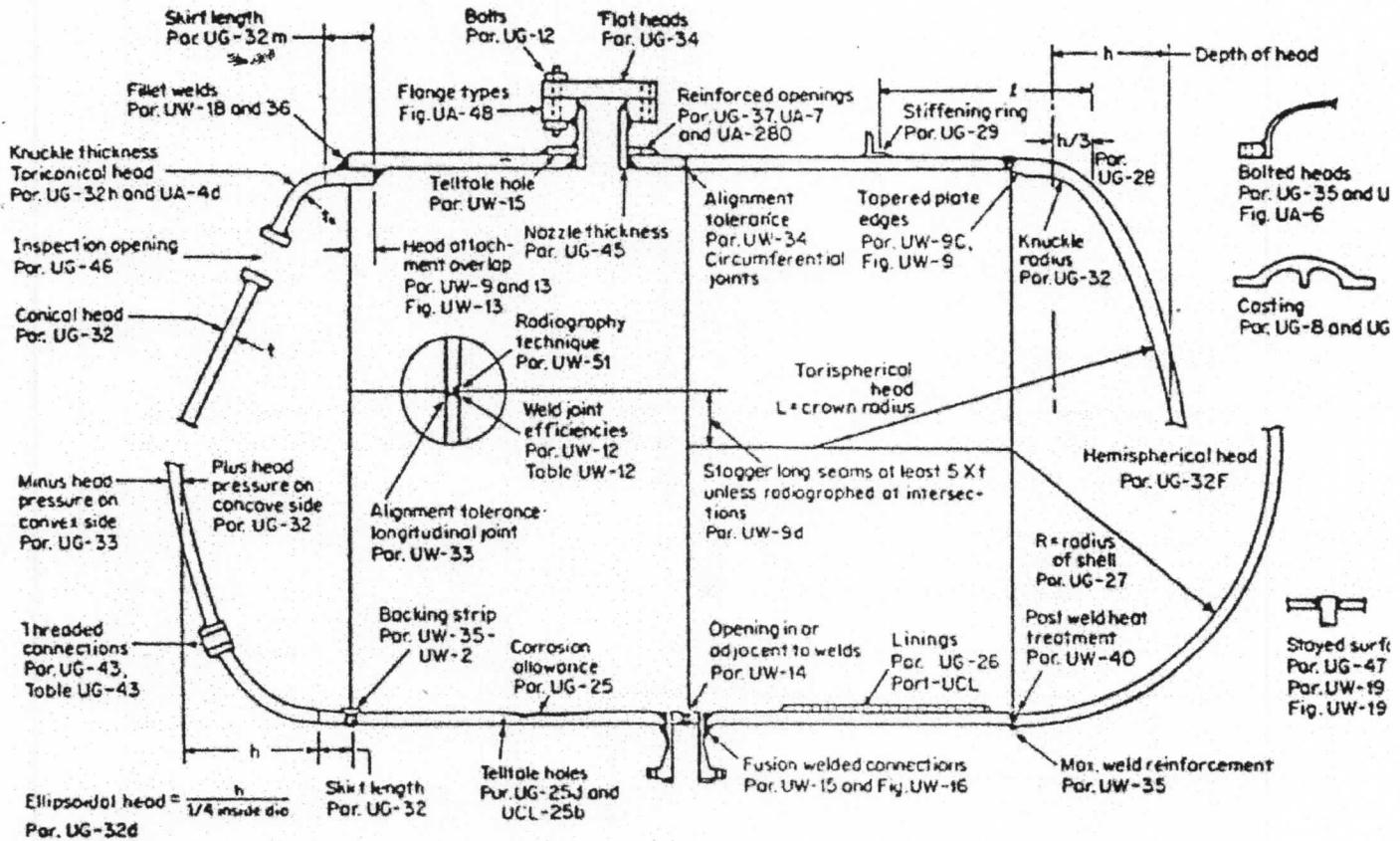


Figure 1. ASME Code: Applicable Sections

2B.

Summary of ASME Code

or stress thickness Item level)	Code Section	Reference ASME level vs. actual calculated stress	CALCULATION RESULT (Required thickness)	
			vs	

3. System Venting Verification Provide the vent system schematic.

Does the venting system follow the Code UG-125 through UG-137?
Yes: No

Does the venting system also follow the Compressed Gas Association Standards S-1.1 and S-1.3?
Yes No

A "no" response to both of the two proceeding questions requires a justification and statement regarding what standards were applied to verify system venting is adequate.

List of reliefs and settings:

<u>Manufacturer</u>	<u>Model #</u> <u>Size</u>	<u>Set Pressure</u>	<u>Flow Rate</u>	
CDI (Code Stamped) CRN OG8703.5	SA-12	150 PSI	129 SCFM 1/8 NPT	
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____

4. Operating Procedure

Is an operating procedure necessary for the safe operation of this vessel?

Yes: (Owners Manual Attach./Operating Procedure on Tank)
No (If "Yes", it must be appended)

5. Welding Information

Has the vessel been fabricated in a non-code shop? Yes No:
If "Yes", append a copy of the welding shop statement of welder qualification (Procedure Qualification Record, PQR) which references the Welding Procedure Specification (WPS) used to weld this vessel.

6. Existing, Used and Unmanned Area Vessels

Is this vessel or any part thereof in the above categories?
Yes No:

If "Yes", follow the requirements for an Extended Engineering Note for Existing, Used and Unmanned Area Vessels.

7. Exceptional Vessels

Is this vessel or any part thereof in the above category?
Yes No:

If "Yes", follow the requirements for an Extended Engineering Note for Exceptional Vessels.

THIS VESSEL CONFORMS TO FERMILAB ES&H MANUAL CHAPTER 5031

Vessel Title: **Ingersoll-Rand 3 HP Air Compressor**

Vessel Number _____

Vessel Drawing Number: **None (Purchased Compressor)**

Maximum Allowable Working Pressures (MAWP):

Internal Pressure: **150 PSI**

External Pressure: **One Atmosphere**

Working Temperature Range: **20° F (-6.6°C) Min. 125°F (51°C) Max.**

Contents: **Compressed Air**

Designer: **None (Purchased Compressor)**

Test Pressure (if tested at Fermi) _____ DATE / /

_____ PSIG, Hydraulic _____ Pneumatic _____

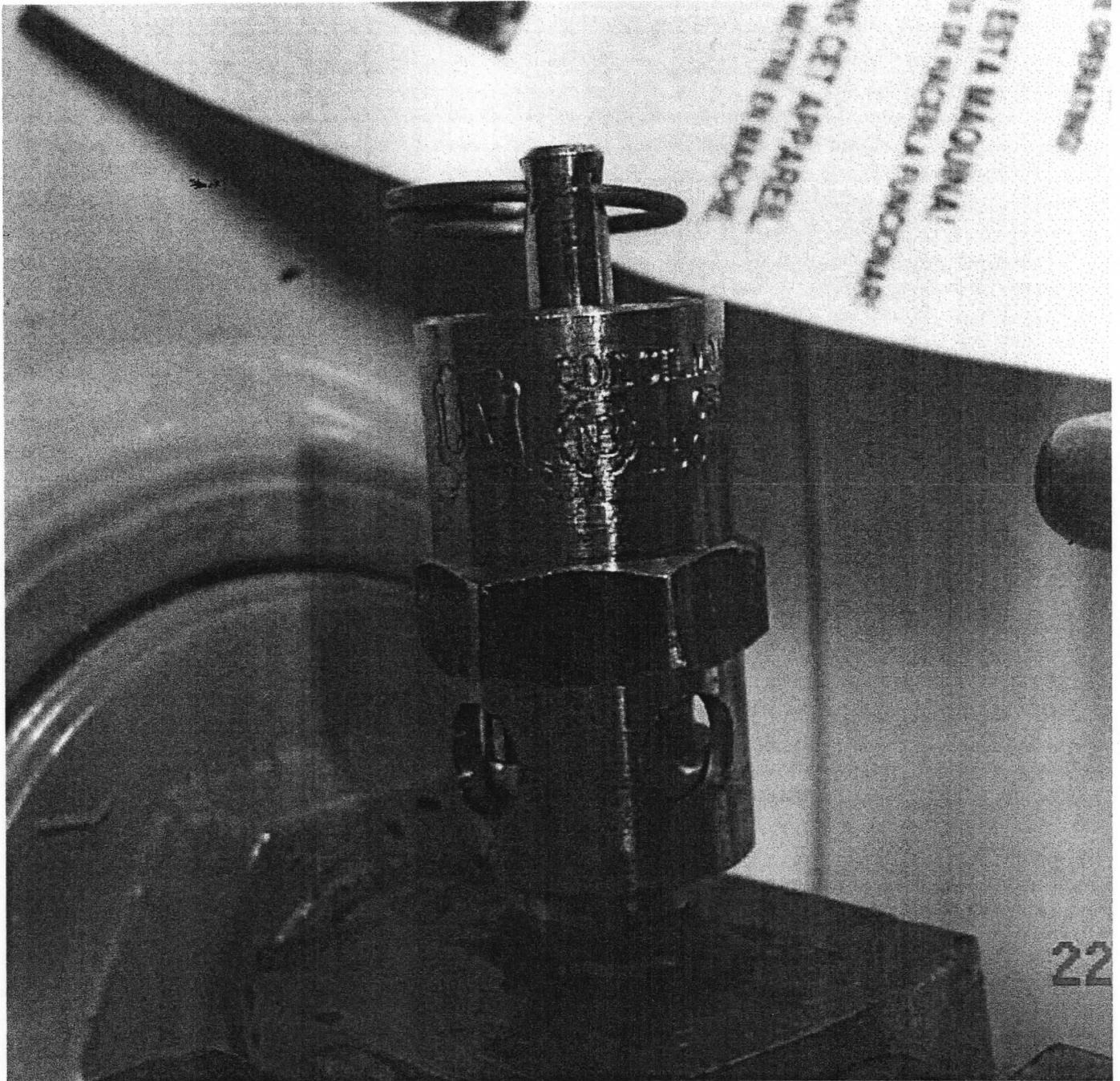
Accepted as conforming to standard by _____

Of Division/Section _____

NOTE: Any subsequent changes in content, pressures, temperatures, valves, etc., which affect the safety of this vessel shall require another review and test.

Figure 2: Sample of sticker to be completed and be placed on vessel.

Photo Pressure Relief Valve with UV Code Stamp





Owner's Manual

Installation, Operation and Maintenance Instructions for Models SS3 and SS5 Stationary Air Compressors

IMPORTANT INFORMATION! READ AND FOLLOW THESE INSTRUCTIONS. RETAIN FOR REFERENCE.

SAFETY

DEFINITIONS

- △ **DANGER** WILL cause DEATH, SEVERE INJURY or substantial property damage.
- △ **WARNING** CAN cause DEATH, SEVERE INJURY or substantial property damage.
- △ **CAUTION** WILL or CAN cause MINOR INJURY or property damage.

GENERAL SAFETY PRECAUTIONS

- △ **DANGER** **INTAKE AIR.** Can contain carbon monoxide or other contaminants. Will cause serious injury or death. Ingersoll-Rand air compressors are not designed, intended or approved for breathing air. Compressed air should not be used for breathing air applications unless treated in accordance with all applicable codes and regulations.
- △ **WARNING** **HAZARDOUS VOLTAGE.** Can cause serious injury or death. Disconnect power and bleed pressure from tank before servicing. Lockout/Tagout machine. Compressor must be connected to properly grounded circuit. See grounding instructions in manual. Do not operate compressor in wet conditions. Store indoors.
MOVING PARTS. Can cause serious injury. Do not operate with guards removed. Machine may start automatically. Disconnect power before servicing. Lockout/Tagout machine.
HOT SURFACES. Can cause serious injury. Do not touch. Allow to cool before servicing. Do not touch hot compressor or tubing.
HIGH PRESSURE AIR. Bypassing, modifying or removing safety/relief valves can cause serious injury or death. Do not bypass, modify or remove safety/relief valves. Do not direct air stream at body. Rusted tanks can cause explosion and severe injury or death. Drain tank daily or after each use. Drain valve located at bottom of tank.
- △ **CAUTION** **RISK OF BURSTING.** Use only suitable air handling parts acceptable for pressure of not less than the maximum allowable working pressure of the machine.

GENERAL INFORMATION

Your air compressor unit is suitable for operating air tools, caulking guns, grease guns, sandblasters, etc. Depending on your application, the following accessories may be required:

- An air pressure regulator to adjust the air pressure entering the tool or accessory.
- An air line filter for removal of moisture and oil vapor in compressed air.
- An in-line lubricator to prolong the life of air tools.
- Separate air transformers which combine the functions of air regulation and/or moisture and dirt removal.

Contact your nearest authorized dealer or call 1-800-AIR-SERV for more information on air tools and accessories for your application.

RECEIPT & INSPECTION

Ensure adequate lifting equipment is available for unloading and moving your unit to the installation site.

NOTE: Lifting equipment must be properly rated for the weight of the unit.

Lift the unit by the shipping skid only. Use straps to prevent tipping.

△ **CAUTION** Do not work on or walk under the compressor while it is suspended.

Before signing the delivery receipt, inspect for damage and missing parts. If damage or missing parts are apparent, make the appropriate notation on the delivery receipt, then sign the receipt. Immediately contact the carrier for an inspection. All material must be held in the receiving location for the carrier's inspection. Delivery receipts that have been signed without a notation of damage or missing parts are considered to be delivered "clear." Subsequent claims are then considered to be concealed damage claims. Settle damage claims directly with the transportation company.

If you discover damage after receiving the unit (concealed damage), the carrier must be notified within 15 days of receipt and an inspection must be requested by telephone with confirmation in writing. On concealed damage claims, the burden of establishing that the unit was damaged in transit reverts back to the claimant.

Read the unit specification label to verify it is the model ordered, and read the motor nameplate to verify it is compatible with your electrical conditions. Make sure electrical enclosures and components are appropriate for your application.

FRANÇAIS

ESPAÑOL

ENGLISH

INSTALLATION

SELECTING A LOCATION

GENERAL. Select a clean, dry, well-lighted indoor area with plenty of space for proper cooling air flow and accessibility. Locate the unit at least 12 inches (30 cm) from walls, and make sure the main power supply is clearly identified and accessible.

TEMPERATURE. Ideal operating temperatures are between 32°F and 100°F (0°C and 37.8°C). If temperatures consistently drop below 32°F (0°C), locate the unit inside a heated building. If this is not possible, you must protect safety/relief valves and drain valves from freezing.

CAUTION Never operate in temperatures below 20°F (-6.6°C) or above 125°F (51.0°C).

HUMID AREAS. In frequently humid areas, moisture may form in the bare pump and produce sludge in the lubricant, causing running parts to wear out prematurely. Excessive moisture is especially likely to occur if the unit is located in an unheated area that is subject to large temperature changes. Two signs of excessive humidity are external condensation on the bare pump when it cools down and a "milky" appearance in petroleum compressor lubricant. You may be able to prevent moisture from forming in the bare pump by increasing ventilation, operating for longer intervals or installing a crankcase heater kit.

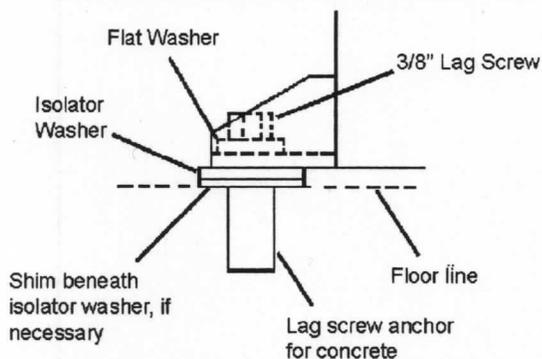
NOISE CONSIDERATIONS. Consult local officials for information regarding acceptable noise levels in your area. To reduce excessive noise, use vibration isolator pads or intake silencers, relocate the unit or construct total enclosures or baffle walls.

PERMANENT MOUNTING

WARNING Remove the unit from the skid before mounting.

The unit must be permanently mounted. When mounting the unit, bolt the feet to a firm, level foundation (such as a concrete floor). Do not bolt uneven feet tightly to the foundation, as this will cause excessive stress on the receiver tank. Use metal shims under the "short" feet if necessary.

Typical Permanent Mounting (Customer-Supplied Hardware)



INSTALLING THE AIR INLET FILTER

CAUTION Do not operate the unit without the air inlet filter(s).

If the air around the unit is relatively free of dirt, install the air inlet filter(s) at the inlet connection(s) at the bare pump. If remote air inlet piping or heavy duty filtration is required, contact your dealer for information.

INSTALLING DISCHARGE PIPING

If it is necessary to install air discharge and condensate discharge piping, adhere to the following general guidelines. Contact your dealer for more information.

WARNING Do not use plastic pipe, rubber hose, or lead-tin soldered joints anywhere in the compressed air system.

WARNING If an aftercooler, check valve, block valve, or any other restriction is added to the compressor discharge, install a properly-sized ASME approved safety/relief valve between the compressor discharge and the restriction.

CAUTION If you will be using Ingersoll-Rand synthetic compressor lubricant, all downstream piping material and system components must be compatible. Refer to the following material compatibility list. If there are incompatible materials present in your system, or if there are materials not included in the list, contact your dealer or call 1-800-AIR-SERV.

Suitable:

Viton®, Teflon®, Epoxy (Glass Filled), Oil Resistant Alkyd, Fluorosilicone, Fluorocarbon, Polysulfide, 2-Component Urethane, Nylon, Delrin®, Celcon®, High Nitrile Rubber (Buna N. NBR more than 36% Acrylonitrile), Polyurethane, Polyethylene, Epichlorohydrin, Polyacrylate, Melamine, Polypropylene, Baked Phenolics, Epoxy, Modified Alkyds
(® indicates trademark of DuPont Corporation)

Not Recommended:

Neoprene, Natural Rubber, SBR Rubber, Acrylic Paint, Lacquer, Varnish, Polystyrene, PVC, ABS, Polycarbonate, Cellulose Acetate, Low Nitrile Rubber (Buna N. NBR less than 36% Acrylonitrile), EPDM, Ethylene Vinyl Acetate, Latex, EPR, Acrylics, Phenoxy, Polysulfones, Styrene Acrylonitrile (San), Butyl

GENERAL REQUIREMENTS. The piping, fittings, receiver tank, etc. must be certified safe for at least the maximum working pressure of the unit. Use hard-welded or threaded steel or copper pipes and cast iron fittings that are certified safe for the unit's discharge pressure and temperature. **DO NOT USE PVC PLASTIC.** Use pipe thread sealant on all threads, and make up joints tightly to prevent air leaks.

CONDENSATE DISCHARGE PIPING. If installing a condensate discharge line, the piping must be at least one size larger than the connection, as short and direct as possible, secured tightly and routed to a suitable drain point. Condensate must be disposed of in accordance with local, state, and federal laws and regulations.

NOTE All compressed air systems generate condensate which accumulates in any drain point (e.g. tanks, filters, drip legs, aftercoolers, dryers). This condensate contains lubricating oil and/or substances which may be regulated and must be disposed of in accordance with local, state, and federal laws and regulations.

ELECTRICAL WIRING

WARNING Electrical installation and service should be performed by a qualified electrician who is familiar with all applicable local, state and federal laws and regulations.

NOTE This product should be connected to a grounded, metallic, permanent wiring system, or an equipment-grounding terminal or lead on the product.

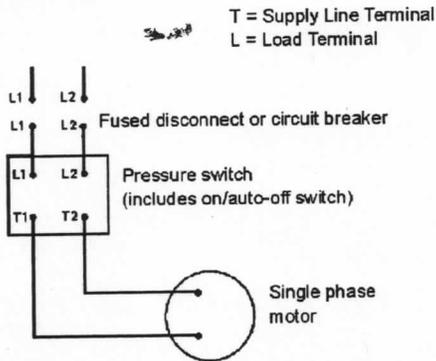
GENERAL. The motor rating, as shown on the motor nameplate, and the power supply must have compatible voltage, phase and hertz characteristics.

WIRE SIZE. The electrical wiring between the power supply and electric motor varies according to motor horsepower. Power leads must be adequately sized to protect against excessive voltage drop during start-up. Information for selecting the proper wire size and securing connections should be provided with the motor. If not, refer to the National Electric Code (NEC) or applicable local, state and federal laws and regulations. If other electrical equipment is

connected to the same circuit, the total electrical load must be considered in selecting the proper wire size. **DO NOT USE UNDERSIZE WIRE.**

FUSES. Refer to the National Electric Code to determine the proper fuse or circuit breaker rating required. When selecting fuses, remember the momentary starting current of an electric motor is greater than its full load current. Time-delay or "slow-blow" fuses are recommended.

Single-Phase Wiring



COMPRESSOR LUBRICATION

CAUTION Do not operate without lubricant or with inadequate lubricant. Ingersoll-Rand is not responsible for compressor failure caused by inadequate lubrication.

SYNTHETIC LUBRICANT. We recommend Ingersoll-Rand synthetic compressor lubricant from start-up. See the WARRANTY section for extended warranty information.

ALTERNATE LUBRICANTS. You may use a petroleum-based lubricant that is premium quality, does not contain detergents, contains only anti-rust, anti-oxidation, and anti-foam agents as additives, has a flashpoint of 440°F (227°C) or higher, and has an auto-ignition point of 650°F (343°C) or higher.

See the petroleum lubricant viscosity table below. The table is intended as a general guide only. Heavy duty operating conditions require heavier viscosities. Refer specific operating conditions to your dealer for recommendations.

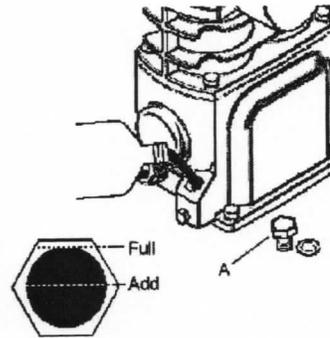
Temperature Around Unit		Viscosity @ 100°F (37.8°C)		Viscosity Grade	
°F	°C	SUS	Centistokes	ISO	SAE
40 & below	4.4 & below	150	32	32	10
40 - 80	4.4 - 26.7	500	110	100	30
80 - 125	26.7 - 51.0	750	165	150	40

If you use a petroleum-based compressor lubricant at start-up and decide to convert to Ingersoll-Rand synthetic compressor lubricant later on, the compressor valves must be thoroughly decarbonized and the crankcase must be flushed before conversion.

FILLING PROCEDURES:

1. Unscrew and remove the oil fill plug (A).
2. Slowly fill the crankcase with lubricant until the lubricant reaches the top thread of the oil fill opening and the top of the sight glass. Crankcase capacity for the SS3 is one-half (0.5) liter. Crankcase capacity for the SS5 is one (1) liter.
3. Replace the oil fill plug **HAND TIGHT ONLY.**

Filling Procedures

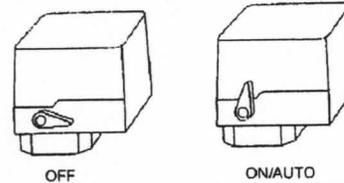


INITIAL START-UP

Follow this procedure before putting the unit into service for the first time:

1. Set the pressure switch lever to "OFF".

Pressure Switch Lever



2. Open the service valve fully to prevent air pressure from building in the tank. (A=Open, B=Closed).

Service Valve

3. Move the pressure switch lever to "ON/AUTO". The unit will start.
4. Run the unit for 30 minutes. Ensure the service valve is fully open and there is no tank pressure build up.

CAUTION Unusual noise or vibration indicates a problem. Do not continue to operate until you identify and correct the source of the problem. **IF EMERGENCY CONDITIONS ARE ENCOUNTERED, SHUT OFF THE MAIN POWER IMMEDIATELY.**

5. After 30 minutes, close the service valve fully. The air receiver will fill to cut-out pressure and the motor will stop. The unit is now ready for use.

OPERATION

GENERAL

Your air compressor was designed for 100% continuous duty operation with the use of Ingersoll-Rand synthetic compressor lubricant and 60% continuous duty operation with the use of petroleum lubricant. In other words, synthetic lubricant allows the compressor to pump continuously without cycling. Petroleum lubricant limits the compressor to a maximum of 36 minutes of pumping time per hour. The compressor should not cycle more than 10 times per hour.

NORMAL START-UP

1. Set the pressure switch lever to "OFF".
2. Close the service valve.
3. Attach hose and accessory.
4. Move the pressure switch lever to "ON/AUTO". The unit will start.
5. Allow tank pressure to build. The motor will stop when tank pressure reaches cut-out pressure.
6. Open the service valve. The unit is now ready for use.

NOTE When the receiver tank pressure drops below the factory pre-set minimum, the pressure switch resets and restarts the unit.

WHEN YOU ARE FINISHED:

1. Set the pressure switch lever to "OFF".
2. Close the service valve fully.
3. Remove the air tool or accessory.
4. Slowly open the service valve to bleed air pressure down to 20 psig.
5. Slowly open the manual drain valve at the bottom of the tank to drain all condensate (water).
6. Close the drain valve and the service valve for the next use.

MAINTENANCE

△ WARNING Disconnect, lock and tag the main power supply and release air pressure from the system before performing maintenance.

NOTE All compressed air systems contain maintenance parts (e.g. lubricating oil, filters, separators) which are periodically replaced. These used parts may be, or may contain, substances that are regulated and must be disposed of in accordance with local, state, and federal laws and regulations.

NOTE Take note of the positions and locations of parts during disassembly to make reassembly easier. The assembly sequences and parts illustrated may differ for your particular unit.

NOTE Any service operations not included in this section should be performed by an authorized service representative.

ROUTINE MAINTENANCE SCHEDULE

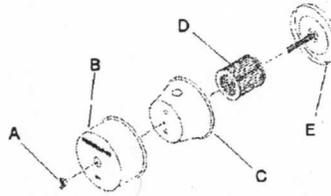
Daily or Before Each Operation	<ul style="list-style-type: none"> ● Check lubricant level. Fill as needed. ● Drain receiver tank condensate. Open the manual drain valve and collect and dispose of condensate accordingly. ● Check for unusual noise and vibration. ● Ensure beltguards and covers are securely in place. ● Ensure area around compressor is free from rags, tools, debris, and flammable or explosive materials.
Weekly	<ul style="list-style-type: none"> ● Inspect air filter element. Clean or replace if necessary.
Monthly	<ul style="list-style-type: none"> ● Inspect for air leaks. Squirt soapy water around joints during compressor operation and watch for bubbles. ● Check tightness of screws and bolts. Tighten as needed. ● Clean exterior.
3/500 *	<ul style="list-style-type: none"> ● Change petroleum lubricant while crankcase is warm.
12/2000 *	<ul style="list-style-type: none"> ● Change synthetic lubricant while crankcase is warm. ● Replace filter element.

* Indicates months/operating hours, whichever occurs first.

FILTER REPLACEMENT (SS3)

1. Unscrew and remove the wing nut (A).
2. Remove the filter cover (B), baffle (C) and element (D) from the base (E).
3. Install a new element and reassemble the filter assembly.

NOTE The air intake holes in the baffle and cover must be staggered 180°. When reinstalling the assembly at the inlet connection, ensure the intake hole in the cover is on the bottom to minimize the entry of foreign matter from the air.

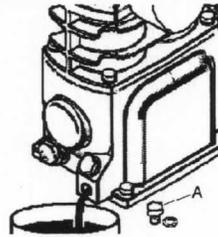


FILTER REPLACEMENT (SS5)

1. Unscrew and remove the wing nut (A) securing the filter housing (B) to its base (C).
2. Remove the filter housing and withdraw the old filter element (D). Clean the element with a jet of air or vacuum.
3. Replace the filter element and housing, securing it in place with the wing nut previously removed.

OIL CHANGE

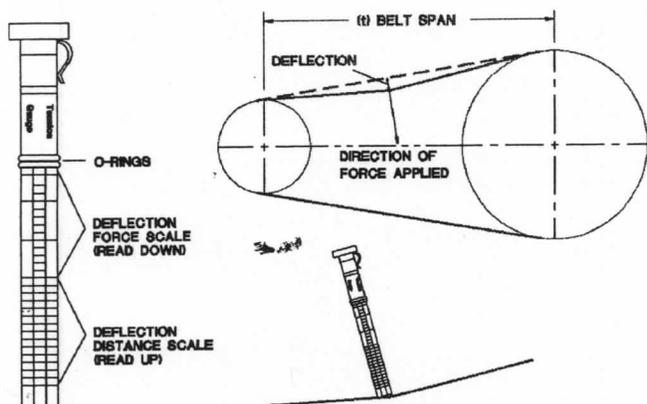
1. Remove the oil drain plug (A) and allow the lubricant to drain into a suitable container.
2. Replace the oil drain plug.
3. Follow the filling procedures in OPERATION section.



BELT ADJUSTMENT

CHECKING BELT TENSION Check belt tension occasionally, especially if looseness is suspected. A quick check to determine if adjustment is proper may be made by observing the slack side of the belt for a slight bow when the unit is in operation. If a slight bow is evident, the belt is usually adjusted satisfactorily.

TENSIONING BELTS Belt tensioning can be achieved by loosening the motor anchor screws, pushing the motor away from the pump, and retightening the motor anchor screws. The motor can be easily moved by placing a prying tool beneath it. A commercially available spreader or other belt tensioning device can also be helpful should tensioning be necessary.



Follow the procedures outlined below to correctly set and measure belt tension.

1. Lay a straight edge across the top outer surface of the belt drive from pulley to sheave.
2. At the center of the span, perpendicular to the belt, apply pressure to the outer surface of the belt with a tension gauge. Force the belt to the deflection indicated in the table at right. Compare the reading on the tension gauge to the following table.

Deflection in Inches	Min. Tension (Lbs.)	Max. Tension (Lbs.)
0.17	3.0	6.0

Ensure the pulley and sheave are properly aligned and the motor anchor screws are adequately retightened prior to restarting the compressor.

△ CAUTION Improper pulley/sheave alignment and belt tension can result in motor overload, excessive vibration, and premature belt and/or bearing failure.

To prevent these problems from occurring, ensure the pulley and sheave are aligned and belt tension is satisfactory after installing new belts or tensioning existing belts.

TANK INSPECTION

The life of an air receiver tank is dependent upon several factors including, but not limited to, operating conditions, ambient environments, and the level of maintenance. The exact effect of these factors on tank life is difficult to predict; therefore, Ingersoll-Rand recommends that you schedule a certified tank inspection within the first five years of compressor service. To arrange a tank inspection, contact the nearest I-R Air Center or distributor, or call 1-800-AIR SERV.

If the tank has not been inspected within the first 10 years of compressor service, the tank must be taken out of service until it has passed inspection. Tanks that fail to meet requirements must be replaced.

△ WARNING Failure to replace a rusted air receiver tank could result in air receiver tank rupture or explosion, which could cause substantial property damage, severe personal injury, or death. Never modify or repair tank. Obtain replacement from service center.

TROUBLESHOOTING

PROBLEM	POSSIBLE CAUSE	POSSIBLE SOLUTION
Abnormal piston, ring or cylinder wear	<ol style="list-style-type: none"> 1. Lubricant viscosity too low. 2. Lubricant level too low. 3. Detergent type lubricant being used. 4. Cylinder(s) or piston(s) scratched, worn or scored. 5. Extremely dusty atmosphere. 6. Worn cylinder finish. 	<ol style="list-style-type: none"> 1. Drain existing lubricant and refill with proper lubricant. 2. Add lubricant to crankcase to proper level. 3. Drain existing lubricant and refill with proper lubricant. 4. Repair or replace as required. 5. Install remote air inlet piping and route to source of cleaner air. Install more effective filtration. 6. Deglaze cylinder with 180 grit flex-hone.
Air delivery drops off	<ol style="list-style-type: none"> 1. Clogged or dirty inlet and/or discharge line filter. 2. Air leaks in air discharge piping. 3. Lubricant viscosity too high. 4. Compressor valves leaky, broken, carbonized or loose. 5. Piston rings damaged or worn (broken, rough or scratched). Excessive end gap or side clearance. 6. Piston rings not seated, are stuck in grooves or end gaps not staggered. 7. Cylinder(s) or piston(s) scratched, worn or scored. 8. Defective safety/relief valve. 	<ol style="list-style-type: none"> 1. Clean or replace. 2. Check tubing and connections. 3. Drain existing lubricant and refill with proper lubricant. 4. Inspect valves. Clean or replace as required. Install valve kit. 5. Install ring kit. 6. Adjust piston rings. 7. Repair or replace as required. 8. Replace.
Unit does not come up to speed	<ol style="list-style-type: none"> 1. Loose beltwheel or motor pulley, excessive end play in motor shaft or loose drive belts. 2. Lubricant viscosity too high. 3. Improper line voltage. 4. Compressor valves leaky, broken, carbonized or loose. 5. Defective ball bearings on crankshaft or motor shaft. 	<ol style="list-style-type: none"> 1. Check beltwheel, motor pulley, crankshaft, drive belt tension and alignment. Repair or replace as required. 2. Drain existing lubricant and refill with proper lubricant. 3. Check line voltage and upgrade lines as required. Contact electrician. 4. Inspect valves. Clean or replace as required. Install valve kit. 5. Inspect bearings and replace crankshaft assembly if required.
Unit is slow to come up to speed	<ol style="list-style-type: none"> 1. Lubricant viscosity too high. 2. Leaking check valve or check valve seat blown out. 3. Ambient temperature too low. 4. Bad motor. 	<ol style="list-style-type: none"> 1. Drain existing lubricant and refill with proper lubricant. 2. Replace check valve. 3. Relocate unit to warmer environment. Install crankcase heater kit. 4. Replace.
Unit runs excessively hot	<ol style="list-style-type: none"> 1. Inadequate ventilation around beltwheel. 2. Drive belts too tight or misaligned. 3. Compressor valves leaky, broken, carbonized or loose. 4. Wrong beltwheel direction of rotation. 	<ol style="list-style-type: none"> 1. Relocate unit for better air flow. 2. Adjust belts to proper tension and alignment. 3. Inspect valves. Clean or replace as required. Install valve kit. 4. Check motor wiring for proper connections. Reverse two leads on three-phase motors.
Excessive noise during operation	<ol style="list-style-type: none"> 1. Loose beltwheel or motor pulley, excessive end play in motor shaft or loose drive belts. 2. Lubricant viscosity too high. 3. Lubricant level too low. 4. Compressor valves leaky, broken, carbonized or loose. 5. Carbon build-up on top of piston(s). 6. Defective ball bearings on crankshaft or motor shaft. 7. Leaking check valve or check valve seat blown out. 	<ol style="list-style-type: none"> 1. Check beltwheel, motor pulley, crankshaft, drive belt tension and alignment. Repair or replace as required. 2. Drain existing lubricant and refill with proper lubricant. 3. Add lubricant to crankcase to proper level. 4. Inspect valves. Clean or replace as required. Install valve kit. 5. Clean piston(s). Repair or replace as required. 6. Inspect bearings and replace crankshaft assembly if required. 7. Replace check valve.
Excessive starting and stopping	<ol style="list-style-type: none"> 1. Air leaks in air discharge piping. 2. Pressure switch differential too narrow. 3. Leaking check valve or check valve seat blown out. 4. Excessive condensate in receiver tank. 	<ol style="list-style-type: none"> 1. Check tubing and connections. 2. Adjust pressure switch to increase differential, if differential adjustment is provided. Install pressure switch with differential adjustment feature if differential adjustment is desired. 3. Replace check valve. 4. Drain receiver tank with manual drain valve.
High oil consumption	<ol style="list-style-type: none"> 1. Clogged or dirty inlet and/or discharge line filter. 2. Lubricant viscosity too low. 3. Detergent type lubricant being used. 4. Piston rings damaged or worn (broken, rough or scratched). Excessive end gap or side clearance. 5. Piston rings not seated, are stuck in grooves or end gaps not staggered. 6. Cylinder(s) or piston(s) scratched, worn or scored. 7. Connecting rod, piston pin or crankpin bearings worn or scored. 8. Crankshaft seal worn or crankshaft scored. 9. Worn cylinder finish. 	<ol style="list-style-type: none"> 1. Clean or replace. 2. Drain existing lubricant and refill with proper lubricant. 3. Drain existing lubricant and refill with proper lubricant. 4. Install ring kit. 5. Adjust piston rings. 6. Repair or replace as required. 7. Inspect all. Repair or replace as required. 8. Replace seal or crankshaft assembly. 9. Deglaze cylinder with 180 grit flex-hone.

PROBLEM	POSSIBLE CAUSE	POSSIBLE SOLUTION
Knocking or rattling	<ol style="list-style-type: none"> 1. Loose beltwheel or motor pulley, excessive end play in motor shaft or loose drive belts. 2. Compressor valves leaky, broken, carbonized or loose. 3. Carbon build-up on top of piston(s). 4. Cylinder(s) or piston(s) scratched, worn or scored. 5. Connecting rod, piston pin or crankpin bearings worn or scored. 6. Defective ball bearings on crankshaft or motor shaft. 	<ol style="list-style-type: none"> 1. Check beltwheel, motor pulley, crankshaft, drive belt tension and alignment. Repair or replace as required. 2. Inspect valves. Clean or replace as required. Install valve kit. 3. Clean piston(s). Repair or replace as required. 4. Repair or replace as required. 5. Inspect all. Repair or replace as required. 6. Inspect bearings and replace crankshaft assembly if required.
Lights flicker or dim when running	<ol style="list-style-type: none"> 1. Improper line voltage. 2. Wiring or electric service panel too small. 3. Poor contact on motor terminals or starter connections. 4. Improper starter overload heaters. 5. Poor power regulation (unbalanced line). 	<ol style="list-style-type: none"> 1. Check line voltage and upgrade lines as required. Contact electrician. 2. Install properly sized wire or service box. Contact electrician. 3. Ensure good contact on motor terminals or starter connections. 4. Install proper starter overload heaters. Contact electrician. 5. Contact power company.
Moisture in crankcase or "milky" appearance in petroleum lubricant or rusting in cylinders	<ol style="list-style-type: none"> 1. Detergent type lubricant being used. 2. Extremely light duty cycles. 3. Unit located in damp or humid location. 	<ol style="list-style-type: none"> 1. Drain existing lubricant and refill with proper lubricant. 2. Run unit for longer duty cycles. 3. Relocate unit.
Motor overload trips or draws excessive current	<ol style="list-style-type: none"> 1. Lubricant viscosity too high. 2. Improper line voltage. 3. Wiring or electric service panel too small. 4. Poor contact on motor terminals or starter connections. 5. Improper starter overload heaters. 6. Poor power regulation (unbalanced line). 7. Drive belts too tight or misaligned. 8. Compressor valves leaky, broken, carbonized or loose. 9. Cylinder(s) or piston(s) scratched, worn or scored. 10. Connecting rod, piston pin or crankpin bearings worn or scored. 11. Defective ball bearings on crankshaft or motor shaft. 12. Leaking check valve or check valve seat blown out. 13. Ambient temperature too low. 14. Bad motor. 	<ol style="list-style-type: none"> 1. Drain existing lubricant and refill with proper lubricant. 2. Check line voltage and upgrade lines as required. Contact electrician. 3. Install properly sized wire or service box. Contact electrician. 4. Ensure good contact on motor terminals or starter connections. 5. Install proper starter overload heaters. Contact electrician. 6. Contact power company. 7. Adjust belts to proper tension and alignment. 8. Inspect valves. Clean or replace as required. Install valve kit. 9. Repair or replace as required. 10. Inspect all. Repair or replace as required. 11. Inspect bearings and replace crankshaft assembly if required. 12. Replace check valve. 13. Relocate unit to warmer environment. Install crankcase heater kit. Convert to synthetic lubricant. 14. Replace
Motor will not start	<ol style="list-style-type: none"> 1. Improper line voltage. 2. Wiring or electric service panel too small. 3. Poor contact on motor terminals or starter connections. 4. Improper starter overload heaters. 5. Bad motor. 	<ol style="list-style-type: none"> 1. Check line voltage and upgrade lines as required. Contact electrician. 2. Install properly sized wire or service box. Contact electrician. 3. Ensure good contact on motor terminals or starter connections. 4. Install proper starter overload heaters. Contact electrician. 5. Replace
Oil in discharge air (oil pumping)	<ol style="list-style-type: none"> 1. Lubricant viscosity too low. 2. Detergent type lubricant being used. 3. Piston rings damaged or worn (broken, rough or scratched). Excessive end gap or side clearance. 4. Piston rings not seated, are stuck in grooves or end gaps not staggered. 5. Cylinder(s) or piston(s) scratched, worn or scored. 6. Worn cylinder finish. 7. Excessive condensate in receiver tank. 	<ol style="list-style-type: none"> 1. Drain existing lubricant and refill with proper lubricant. 2. Drain existing lubricant and refill with proper lubricant. 3. Install ring kit. 4. Adjust piston rings. 5. Repair or replace as required. 6. Deglaze cylinder with 180 grit flex-hone. 7. Drain receiver tank with manual drain valve.
Oil leaking from shaft seal	<ol style="list-style-type: none"> 1. Crankshaft seal worn or crankshaft scored. 	<ol style="list-style-type: none"> 1. Replace seal or crankshaft assembly.
Safety/relief valve "pops"	<ol style="list-style-type: none"> 1. Clogged or dirty inlet and/or discharge line filter. 2. Compressor valves leaky, broken, carbonized or loose. 3. Defective safety/relief valve. 	<ol style="list-style-type: none"> 1. Clean or replace. 2. Inspect valves. Clean or replace as required. Install valve kit. 3. Replace